

CHAPTER

6.3

INNOVATION OUTPUT AND KNOWLEDGE VALORISATION¹

KEY FIGURES

48 %

of EU companies were
considered innovative

1 in 5

worldwide PCT
patent applications
come from the EU

9x better

performance
on average for the top 10
EU economies in PCT
patent applications

101.2

EU Innovation Output
Indicator, below Japan
and the United States

¹ Valorisation in the context of the EU Framework Programmes is referred to as exploitation.



What can we learn?

- ▶ The **EU is falling short in the Innovation Output Indicator compared to Japan and the United States. The economic impacts** seen as an outcome of innovation are not only related to innovation capacity but also **to the structure of the economy**, which explains the differences between countries.
- ▶ **Japan and China have increased** their share in PCT patent applications while **EU and US shares have dropped significantly** since 2000. In relative terms, the **EU lags behind South Korea, Japan and the United States.**
- ▶ **In PCT patent applications, there is still an innovation divide in the EU**, with north-western Europe performing well and south-eastern Europe performing poorly.
- ▶ The **EU is leading technological progress in the fields of energy, climate and environment and food and bioeconomy.**
- ▶ Nearly **half of the enterprises in the EU were considered innovative**, with higher shares for **product and/or process innovation.**



What does it mean for policy?

- ▶ The EU needs to **support European IP policy and culture, foster science-industry interaction and engage citizens, local communities and policymakers** in a **knowledge-valorisation policy** for societal, environmental and economic impact. In addition to improving innovation systems, the EU must **encourage structural reforms** that **upgrade Member States' technology profiles.**
- ▶ To tackle the current innovation divide, the EU needs to **support poorly performing countries** to improve their innovation systems, **facilitate knowledge circulation** among EU countries and **incentivise the creation** of innovation-intensive sectors in the economy.

1. Innovation output in Europe is lagging

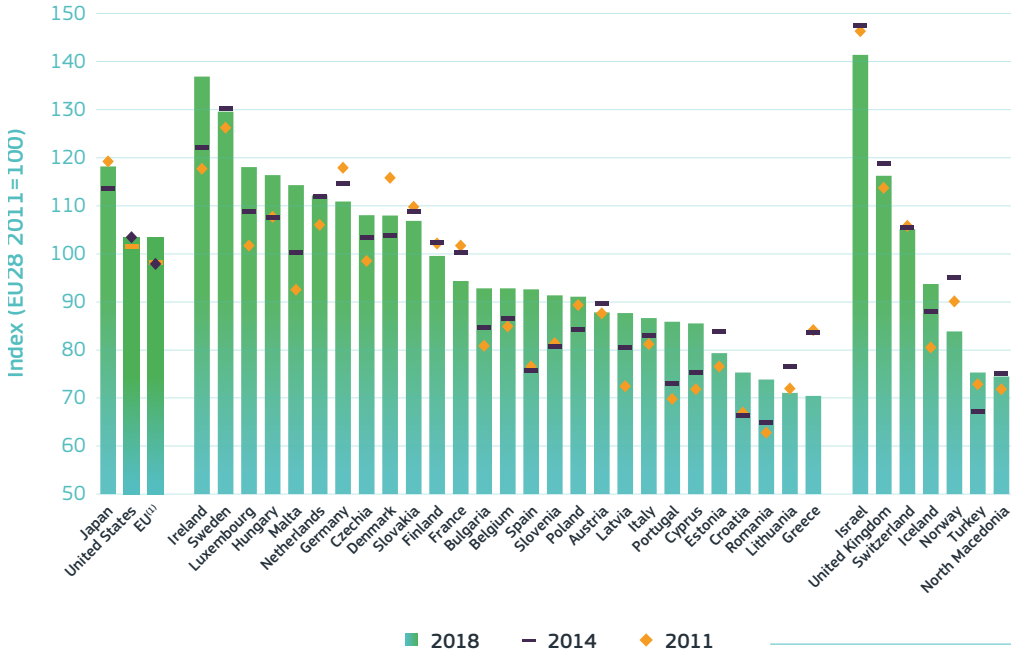
According to the European Commission's Innovation Output Indicator (IOI), the EU lags behind Japan and the United States in terms of innovation output, mainly due to its poor performance in PCT patent applications, with very slow progress in recent years². The composite indicator aggregates four components to measure innovation output (patents, employment in knowledge-intensive activities, trade in knowledge-based goods and services, and innovativeness of high-growth enterprises). These figures differ from the latest results from the European Innovation Scoreboard (EIS) in which the EU surpasses the United States for the first time. However, in addition to these four components, the EIS includes several other dimensions such as investments and framework conditions. Even though the EU is not performing well as a whole, some EU Member States, such as Sweden, the Netherlands and Denmark, show identical or better performances than international competitors in several innovation indexes. For instance, the top 10 in the latest Global Innovation Index³ includes 5 EU Member States, with Sweden as the best EU performer. In the latest EIS, Sweden, followed by Finland, Denmark and the Netherlands, are the innovation leaders.

Within the EU, Ireland is the best performer, followed by Sweden, Luxembourg and Hungary. Conversely, with its performance worsening, Greece is at the bottom end of the Index, followed by Lithuania and Romania. To some extent, the Innovation Output Indicator confirms the innovation divide between north-western and south-eastern Europe (Figure 6.3-1). However, countries such as Hungary, Malta and Czechia, which show high shares of both medium and high-tech products in total exports and employment in fast-growing enterprises in innovative sectors, are remarkable exceptions. In terms of progress, innovation output has improved in most EU countries. Countries such as Malta and Portugal have improved considerably over time as a result of significant increases in patent applications and innovative high-growth enterprises, while innovation output has declined substantially in Greece due to deterioration in knowledge-intensive services exports and the innovativeness of high-growth enterprises. The mixed progress across the EU indicates that the innovation divide is not diminishing, even though the performance of some innovation leaders, such as Finland, Germany and Denmark, has also dropped.

2 For the last release of the Innovation Output Indicator see Vertesy and Damioli (2020).

3 Cornell University, INSEAD, and WIPO (2019); The Global Innovation Index 2019.

Figure 6.3-1 Innovation output indicator (EU28, 2011 = 100), 2011, 2014 and 2018



Science, research and innovation performance of the EU 2020

Source: European Commission, DG Joint Research Centre (Vértesy and Damioli, 2020)

Note: ⁽¹⁾EU: Two sets of values are available: values for worldwide comparison and values for European comparison. The values for worldwide comparison are shown on the graph. The value for European comparison for 2018 is 101.7.

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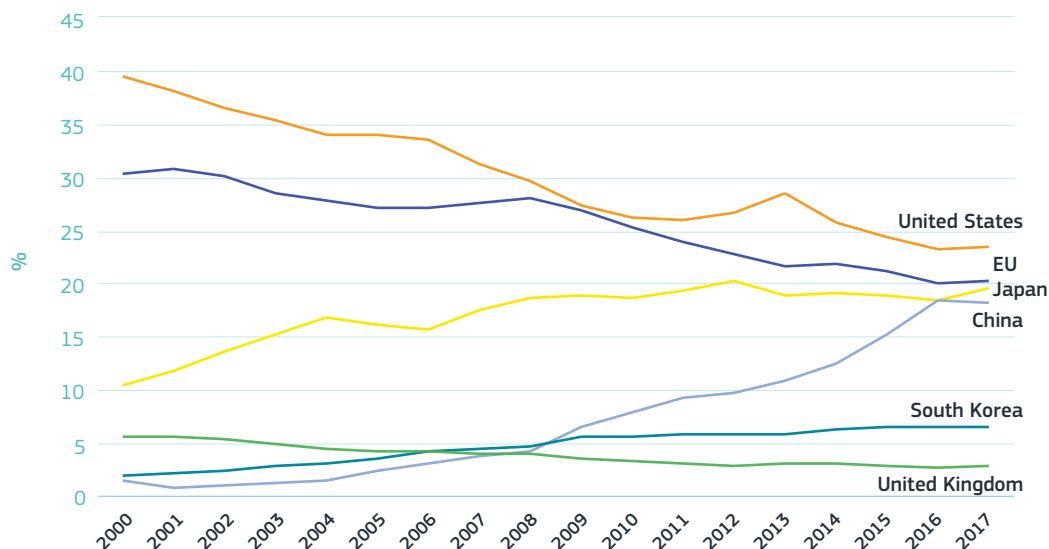
2. Intellectual property in Europe: a mixed picture

To a certain extent, technological innovation resulting from investment in R&I is reflected in the patenting activities of R&I actors. In 2017, the EU accounted for 20% of worldwide PCT⁴ patent applications, a decline from its 30% share in 2000 (Figure 6.3-2). While the share of PCT patent applications has been growing quickly in East Asian countries, mainly in Japan and China, in Western countries, such as the United States, the EU and the United Kingdom, the share has been declining. In 2016, China, in particular,

became a powerhouse in international patent applications, having caught up quickly by growing at an annual rate of roughly 22% between 2000 and 2017. Even though the United States remains the world leader in PCT patent applications, its share declined significantly from 40% in 2000 to 23.5% in 2017. When comparing these figures with research production in terms of scientific publications, it can be concluded that the EU is not capable of capturing the full value of its excellent science.

4 Patent Cooperation Treaty.

Figure 6.3-2 World shares (%) of PCT patent applications⁽¹⁾, 2000-2017



Science, research and innovation performance of the EU 2020

Source: OECD (Patents by technology)

Note: ⁽¹⁾Patent applications filed under the PCT, at international phase, designating the European Patent Office (EPO). Patent counts are based on the priority date, the inventor's country of residence and fractional counts.

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In per capita terms, however, China's performance is well below that of the United States, the EU and advanced Asian economies. When normalised by population, PCT patent applications in Japan and South Korea improved remarkably over time (Figure 6.3-3). In 2000, while South Korea was behind the United States, Europe and Canada, in 2017 it was well ahead of those countries. In recent years, the EU's performance has been quite stable, with an increasing gap with Japan, South Korea and the United States, but remaining ahead of Canada.

Within the EU, performances vary considerably across Member States, reinforcing the persistent innovation divide. While north and western Europe mainly perform well, eastern and southern Europe's performance is poor. Nonetheless, it is

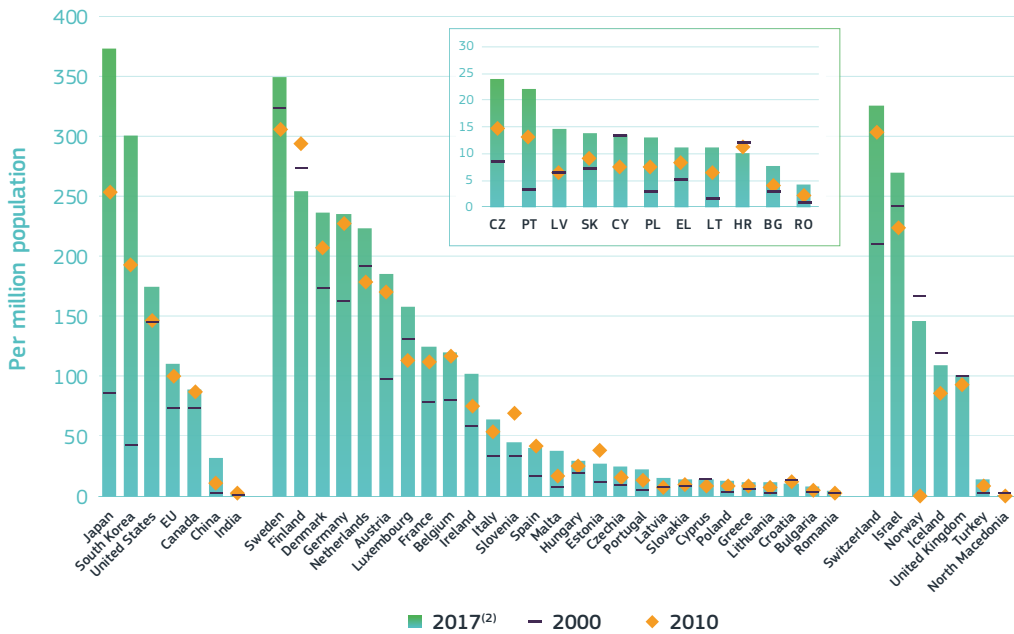
important to highlight that several factors explain the differences in performance, i.e. patenting is linked, among other factors, to the share of manufacturing in value added (as manufacturing companies tend to patent more than service-sector companies⁵), to the high-tech orientation of the manufacturing sector, to the share of ICT and research-related services as against other types of services, to the enterprises' size distribution in a country (as larger enterprises tend to have higher patent propensity), and to the location of company's headquarters, as patenting tends to be carried out in countries with legislation which favours patent activity. Between 2000 and 2017, with the exception of Croatia and Finland, all the other EU countries have seen their performance improving. On the negative side, Finland stands out as its performance

5 EPO and EIPO (2019), IPR-intensive industries and economic performance in the European Union.

has worsened substantially. This might be associated with the weak performance of Nokia which is the most important patent applicant⁶ in the country. On the other hand, countries like Portugal, Lithuania and Malta have seen two-digit compound growth rates over the same period. As possible explanations, in the case of Portugal, incentives for patent applications,

such as the creation of a patent box in 2014, seemed to have boosted patent applications, mainly from the higher education sector^{7,8}. Similarly, in the case of Lithuania, several measures to promote the protection of IP rights seemed to have boosted patent applications⁹. Other countries, such as Ireland and Austria, also show significant improvements.

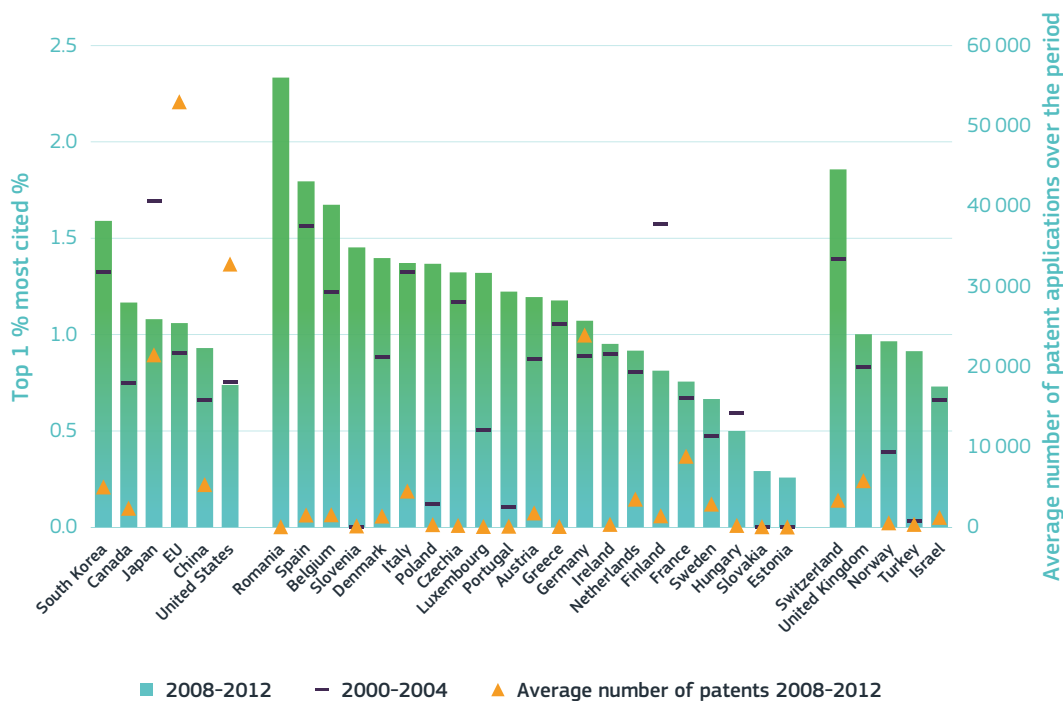
Figure 6.3-3 PCT patent applications⁽¹⁾ per million population, 2000, 2010 and 2017



Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on OECD (Patents by technology), Eurostat and World Bank data
 Notes: ⁽¹⁾Patent applications filed under the PCT, at the international phase, designating the European Patent Office (EPO). Patent counts are based on the priority date, the inventor's country of residence and fractional counts. ⁽²⁾MK: 2016.
 Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-3.xlsx>

6 ETLA - Research Institute of the Finnish Economy (2010), Nokia and Finland in a Sea of Change.
 7 European Commission (2015), RIO country report 2015: Portugal.
 8 European Commission (2014), a Study on R&D Tax Incentives.
 9 European Commission (2015), RIO country report 2015: Lithuania.

Figure 6.3-4 Top 1% most-cited patent applications filed with the EPO, average over 2000-2004 and 2008-2012, and average number of patent applications over 2008-2012



Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit
 Notes: Data produced by Science-Matrix using data from EPO Patstat Spring 2019 database. A minimum of 30 patent applications for a given country and period are required to calculate a score. Fractional counting method was used. Five-year window used in the calculation. Data is calculated with five-year average to reduce volatility.
 Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-4.xlsx>

As a measure of patent quality, the top 1% most-cited patent applications filed with the EPO shows South Korea, followed by Canada and Japan, ahead of the EU. On the other hand, the EU is ahead of China and the United States. Japan, which was the best performer at the beginning of the century, has declined significantly (Figure 6.3-4). Within the EU, Romania tops the ranking, followed by Spain and Belgium. At the bottom, Estonia, Slovakia and Hungary are the worst performers. Over time, only Finland has shown a decline, which is probably due to over reliance on Nokia, as mentioned

above. Romania, Slovenia, Poland and Portugal have made the most improvements since the period 2000-2004. The results show a lack of innovation divide, with modest innovators such as Romania or Poland performing well, and lead innovators such as Sweden and Finland performing poorly. However, the absolute number of patents can have an impact on the results, with smaller amounts inflating the indicator and contributing to more volatility. For instance, during the period 2000-2004, Romania had fewer than 30 patents, which is the minimum necessary to calculate the score.

422

Figure 6.3-5 Patent applications⁽¹⁾ per billion GDP (PPSE), 2017⁽²⁾ and business R&D intensity, 2016⁽³⁾

Country	Business R&D intensity, 2016 (X)	Patents per billion GDP (PPSE), 2017 (Y)
LV	0.15	7.2
TR	0.55	13.0
JP	2.4	12.5
CA	0.7	7.5
SK	0.4	6.0
EL	0.45	5.5
CY	0.2	5.5
LT	0.3	5.0
HR	0.4	5.0
RO	0.3	2.2
MK	0.1	0.5
SE	2.2	9.5
IL	3.6	9.5
FI	1.5	7.8
DE	2.0	6.5
CH	2.4	7.0
NL	1.1	5.8
DK	2.0	6.2
AT	2.2	4.8
FR	1.5	4.0
US	2.0	4.2
EU	1.5	3.8
BE	1.8	3.5
UK	1.4	3.2
IS	1.4	2.8
CN	1.7	2.8
NO	1.1	3.5
IT	0.9	2.2
IE	0.8	2.0
LU	0.8	2.0
ES	0.6	1.8
EE	0.6	1.5
HU	0.8	1.5
PT	0.6	1.2
PL	0.6	1.0
BG	0.6	0.8
CZ	1.0	1.5
SI	1.5	1.8
MT	0.4	1.0

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on OECD (Patents by technology), Eurostat and Unesco data

Notes: ⁽¹⁾Patent applications filed under the PCT, at the international phase, designating the European Patent Office (EPO). Patent counts are based on the priority date, the inventor’s country of residence and fractional counts. ⁽²⁾IL, MK: 2016. ⁽³⁾CH: 2015.

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Japan and Canada are the most efficient in translating their business R&D investments into technological progress.

They have high patent intensities when compared to their levels of business expenditure in R&D intensities, and are outperforming the EU, the United States and China. By assuming business investment in R&D as knowledge input and patents as knowledge output, patents

can be considered as a return on investing in R&D¹⁰. In fact, as shown in Figure 6.3-5, there is a positive correlation between business R&D intensity and patent intensity. Compared to the United States, for a similar level of patent intensity, the EU uses less business investment in R&D. However, according to the latest Industrial R&D Investment Scoreboard¹¹, the top US R&D performers are companies in

10 Maastricht University and UNU-MERIT (2019), R&D, innovation and productivity.

11 European Commission (2018), The 2019 EU Industrial R&D Investment Scoreboard.

the ICT sector, while in the EU, the top R&D performers are companies in the automotive and pharmaceutical sectors, which are more patent intensive. This might explain the differences between the United States and EU. Within the EU, according to the European Innovation Scoreboard, the most innovative economies, such as Sweden, Finland and the Netherlands, are also the countries with very high levels of patent intensity in relation to their levels of BERD intensity. On the other hand, Slovenia, Austria and Czechia, despite their relatively high levels of business expenditure in R&D, do not translate this into patent applications.

In order to assess how innovation is contributing to addressing sustainability and the challenges our society is currently facing, one can look at the evolution of patent activity in areas such as the bioeconomy and food security, climate and environment, energy, security, transport and health.

As regarding PCT patent applications by societal challenges¹², as defined under the Horizon 2020 Framework Programme, the total number of patent applications increased over time in all fields. However, not all of them follow the same path. After a significant increase up to 2012, the energy sector has shown a decline in recent years, albeit caused by a methodological issue¹³. Transport, which was the third most-patented field until 2010, overtook the food and bioeconomy sector with more than 22 000 patent applications in 2016, reducing the gap with health. Health remains the most-

patented field over the period. Both sectors have a high patent propensity¹⁴, reflecting their high number of patents compared to other fields. Even though the field of climate has a persistently low number of patents, this has more than doubled and, in 2016, accounted for almost 2 000 patents. Positive variations in the transport (+233%), energy (+239%), security (+209%) and climate (+133%) sectors show how fields like climate change, environment and resilience have moved significantly higher in the global political agenda (Figure 6.3-6)¹⁵.

When considering the geographical differences, both the EU and the United States have been losing ground in patent applications in the societal challenges field, while Japan, South Korea and China, in particular, have become more important. In fact, only in bioeconomy and health do the EU and United States combined still represent more than 50% of patent applications. The United States is the leader in the health, bioeconomy and security sectors, while the EU leads in the fields of energy, climate and transport. Besides its growing importance in all fields, China has becoming particularly strong in energy and security, while Japan has remained strong in the bioeconomy and transport.

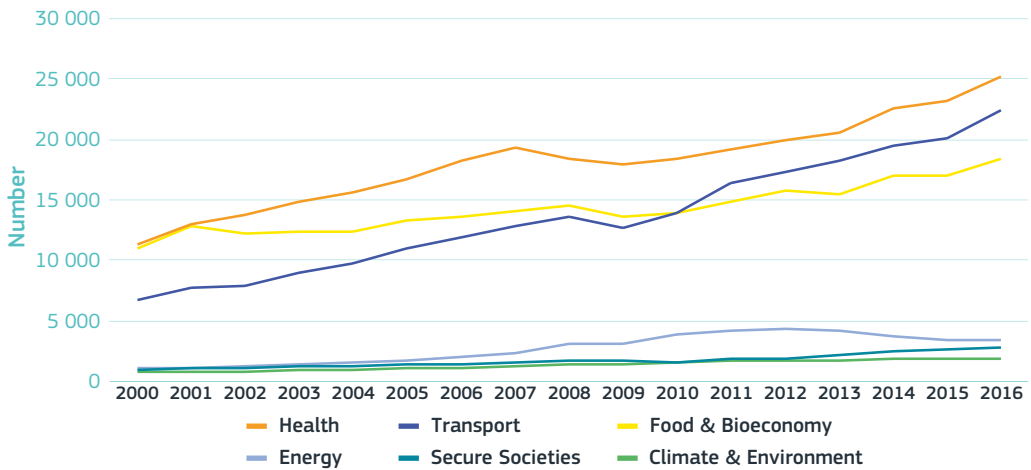
12 <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges>

13 The decline is only due to the classification of the energy SGC, namely the Y-classification. A disadvantage of the Y-classification is that the CPC (Cooperative Patent Classification), on which it is based, is not provided for patents until the patents pending via the PCT process are transferred to the national phase. This is only the case 30 months after registration. The current margin in the figures is therefore even further back than in purely IPC-based patent searches. European Commission (2017), Final report on the collection of patents and business indicators by economic sector: Societal Grand Challenges and Key Enabling Technologies.

14 EPO and EIPO (2019), IPR-intensive industries and economic performance in the European Union.

15 European Commission (2019), Reflection Paper - Towards a Sustainable Europe by 2030.

Figure 6.3-6 Total number of PCT patent applications by Societal Challenge, 2000-2016



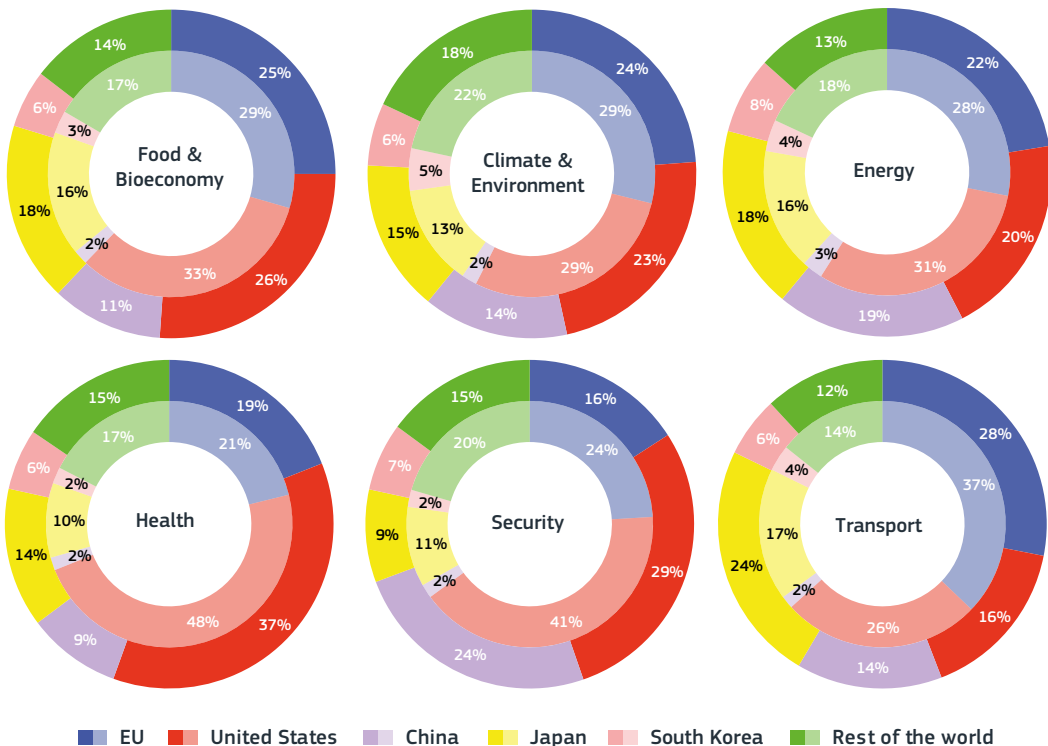
Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit

Note: Data produced by Science-Metrix using data from the European Patent Office Patstat Spring 2019 database.

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Figure 6.3-7 Share of PCT patent applications by Societal Challenges, 2016 (exterior) versus 2006 (interior)



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit

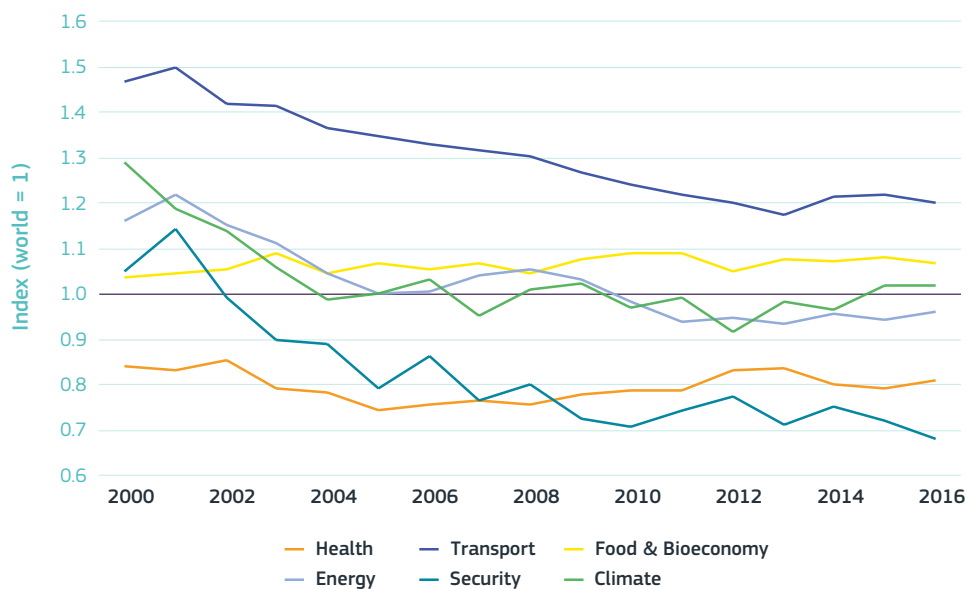
Note: Data produced by Science-Metrix using data from the European Patent Office Patstat Spring 2019 database.

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Compared to the rest of the world, the EU is more specialised in patenting in the fields of transport and food and bioeconomy, and less specialised in the health and security sectors. However, this can also be explained by the strong and patent-intensive automotive sector in some European countries. Over time, the EU has undergone significant changes (Figure 6.3-8). While in 2000, the EU was more specialised than the rest of the world in all fields except

health, in 2016, only transport, food and the bioeconomy and climate, which have recovered slightly in recent years, were above the world average. In addition, the greatest negative variation was in the fields of security and climate. When comparing the performance with scientific publications, the EU is clearly stronger in the food and bioeconomy sector, with specialisation indexes above its main competitors in both scientific publications and patent applications.

Figure 6.3-8 EU Specialisation Index⁽¹⁾ by Societal Grand Challenge (vs. rest of the world), 2000-2016



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit

Notes: Data produced Science-Matrix using data from the European Patent Office Patstat Spring 2019 database.

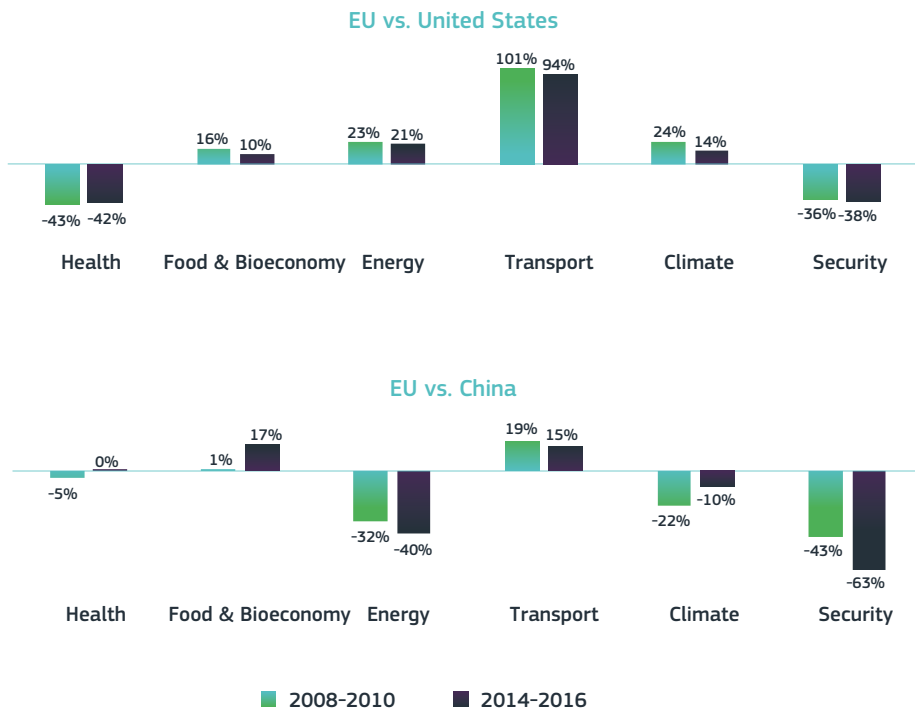
⁽¹⁾Specialisation refers to the Intensity in the EU for a given societal challenge relative to the intensity in the world for the same research area. Fractional counts and date of application used. ⁽²⁾World average = 1.0.

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The EU is stronger in both transport and food and bioeconomy than the United States and China but weaker in security. Compared to the United States, the EU also patents more in the climate and energy fields (Figure 6.3-9). These results are also in line with the specialisation indexes in scientific publications in the same fields. In the health sector, however, the United States is significantly more specialised than the EU in

both patenting and publishing. Compared to China, the EU has a very small advantage in the field of health, in addition to a very strong performance in terms of scientific publications. As regards the security and energy sectors, the EU not only shows lower specialisation than China, but its position has also deteriorated over time. In the field of climate, the EU has recovered in comparison with China, but worsened when compared to the United States.

Figure 6.3-9 EU Specialisation Index⁽¹⁾ by societal grand challenge (vs. United States and China), three-year average period



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit

Note: Data produced by Science-Metrix using data from the European Patent Office Patstat Spring 2019 database.

⁽¹⁾Specialisation refers to the Intensity in EU for a given societal challenge, relative to the intensity of the United States and China for the same research area. Fractional counts and date of application used.

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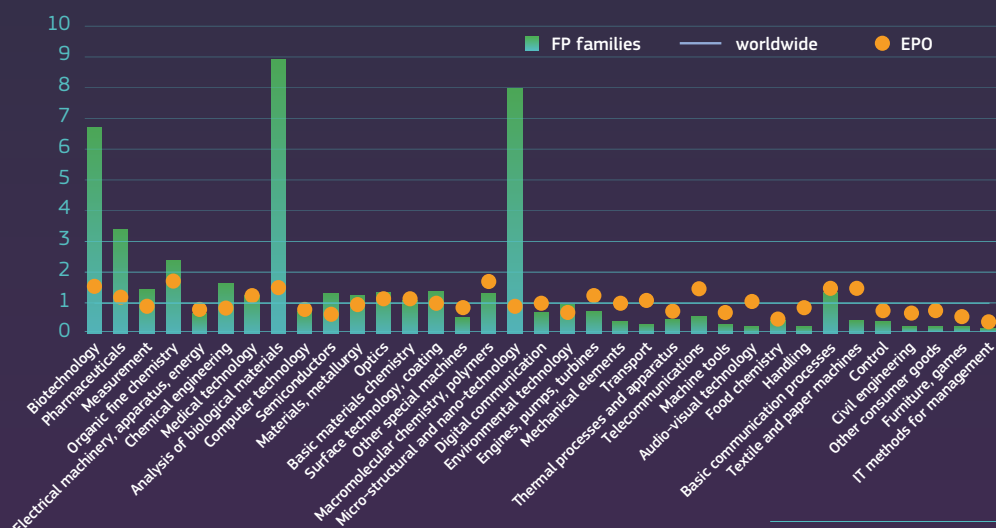
BOX 6.3-1 What type of inventions are self-reportedly patented as a result of the Framework Programme?

The majority of the FP self-reported inventions (patent families) are patented in health-related areas such as biotechnology, pharmaceuticals, organic chemistry or medical technology. Only a limited number of inventions relate to environmental technology.

The highest share of FP self-reported inventions (patent families) is related to biotechnology¹⁶ (14% of all self-reported inventions). This is almost 6 times higher than the worldwide average (2.1% of world patents are in biotechnology). Pharmaceutical inventions follow with around 9% of FP inventions, almost 4 times more than the global average (2.7% of world patents are in this class) and 3 times more than inventions registered

at the EPO in this class (3.4% of all EPO patents). Organic fine chemistry FP inventions are also visibly better represented than the overall world picture (a more than twofold increase from 6.1% of FP inventions to 2.6% in world patents) and in line with the percentage of EPO patents in the same class. Inventions in the analysis of biological materials class, as well as nanotechnology FP inventions seem to be over-represented in the FP compared to the percentage of patents in these classes worldwide. At the same time, the Framework Programmes produce proportionately fewer patents than what is observed worldwide in the electrical machinery and energy class, as well as in computer technology, digital communication, telecommunication, transport and environmental technology classes, among others.

Figure 6.3-10 Technological specialisation index of FP main patents, EPO published in 2009–2018 (worldwide=1)



Source: Upcoming Monitoring Flash #4 Patents in FP, DG R&I based on ORBIS Intellectual Property (IP), CORDA and own calculations. The analysis covers self-reported patents from more than 50,000 FP7 and Horizon 2020 projects funded until 2019.

Note: Values are normalised so that worldwide percentage of patents in each WIPO technology class equals 1. A value of 2 indicates a percentage (of FP or EPO patents) twice as high as the worldwide percentage of patents in that class.

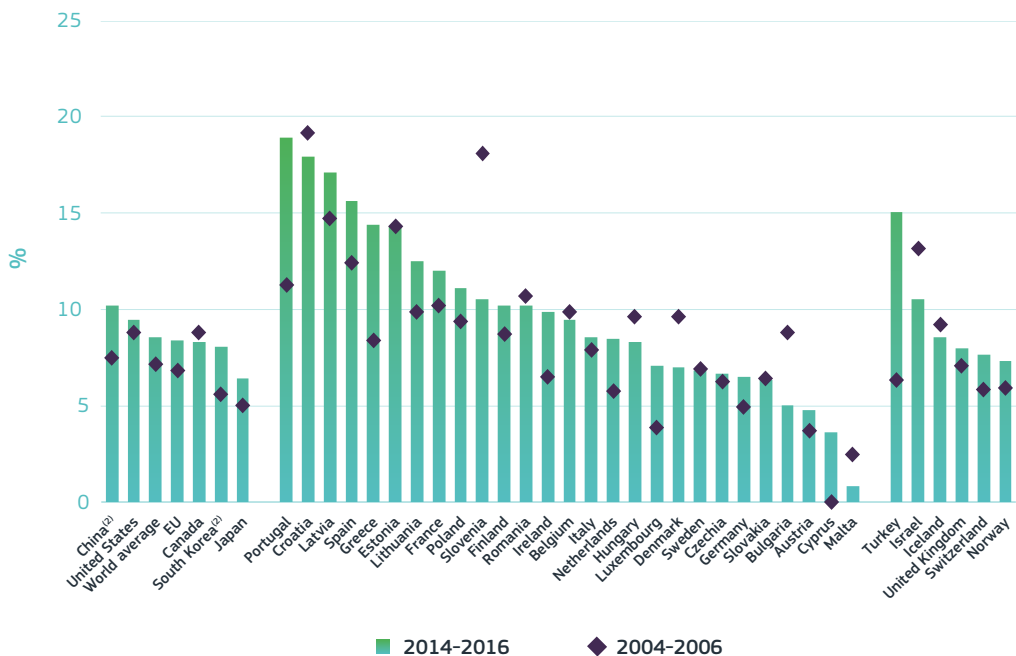
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¹⁶ Note that WIPO technology classes are counted only for the main patent of each FP foreground patent family, due to data constraints. Worldwide figures are, nevertheless, at patent-level, rather than patent family (invention) level. Given that the patents covering an invention are very similar, one can assume that they are registered in the same WIPO class.

China, followed by the United States, shows a slightly higher share of female applicants on patent applications than the EU. However, the EU performed marginally better than Canada, South Korea and Japan, and just below the world average with a share of 8.4% during the period 2014–2016. Together with climate, environment and inequality, gender equality has become more relevant in the political agenda in recent years¹⁷. Therefore, it is important to analyse the contribution women have made to technological progress as patent applicants. Even though the share of

female applicants in patent applications to the European Patent Office is small, performances vary significantly across Europe. Portugal then Croatia, Latvia and Spain display the highest shares, at over 15%, while Malta then Cyprus and Austria display the lowest shares, at below 5% for the period 2014–2016. Between the two periods presented, most countries have shown an improvement in the share of female applicants, with a particular emphasis on Portugal, Greece and Turkey. Conversely, Slovenia, Israel and Denmark saw a decline.

Figure 6.3-11 Share of female applicants on patent applications filed with the EPO by country (%), 2004–2006 and 2014–2016⁽¹⁾



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit

Note: Data produced by Science-Metrix using data from the European Patent Office Patstat Spring 2019 database. Gender was assigned to applicant names using the NamSor API. ⁽¹⁾Due to high volatility over time, an average of three-year period was used. The fractional counting method was used. ⁽²⁾Data for China and South Korea has a high margin of error, thus results should be interpreted with caution.

Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-11.xlsx>

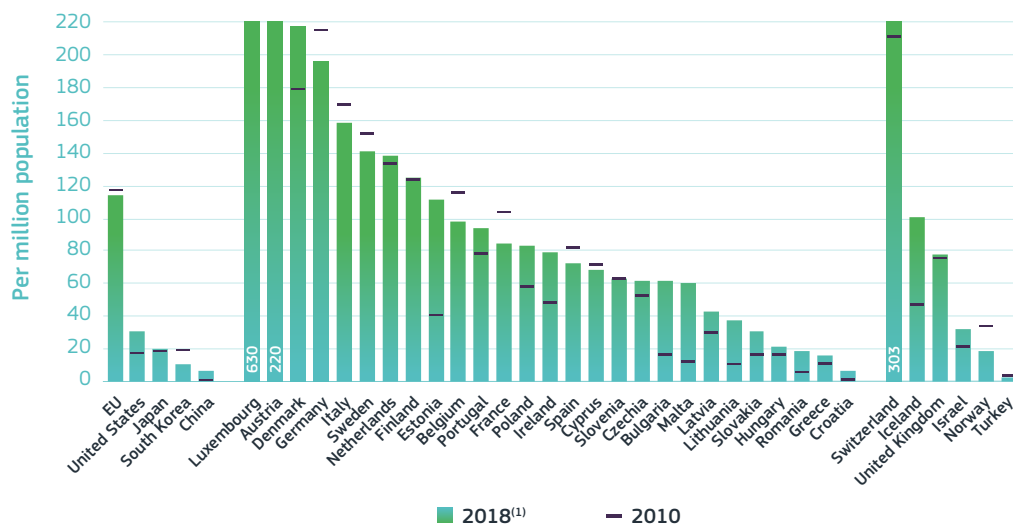
17 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Union of Equality: Gender Equality Strategy 2020–2025.

Over time, the EU has shown significant improvements in the case of trademarks, while achieving a stable performance in community designs. By looking at per capita community designs and trademarks¹⁸ as a proxy for assessing patterns of innovation outside of the traditional exploitation of R&I results (Figures 6.3-12 and 6.3-13), the EU extensively outperforms the United States, Japan, South Korea and China.

Within Europe, the innovation divide is less striking in trademarks and community design applications than in patent applications. Countries like Cyprus and Estonia, which perform poorly in patent applications, rank particularly high in these types of IP applications. In addition, countries

such as Lithuania and Bulgaria have shown significant improvements in recent years. These patterns might be the result of initial reforms in incentive systems and framework conditions. However, good performances in small countries like Luxembourg and Malta might be the result of legislation, easy procedures and attractive taxation systems rather than investment in innovation or more innovative companies. Despite the good performance of some less-innovative economies, countries performing traditionally well in innovation, like Denmark or Sweden, not only lead patent applications but also other types of IP applications. On the other hand, countries like Romania or Greece with less-attractive innovation systems perform poorly in both types of intellectual property rights.

Figure 6.3-12 Community design applications to the EU Intellectual Property Office (EUIPO) per million population, 2010 and 2018



Science, research and innovation performance of the EU 2020

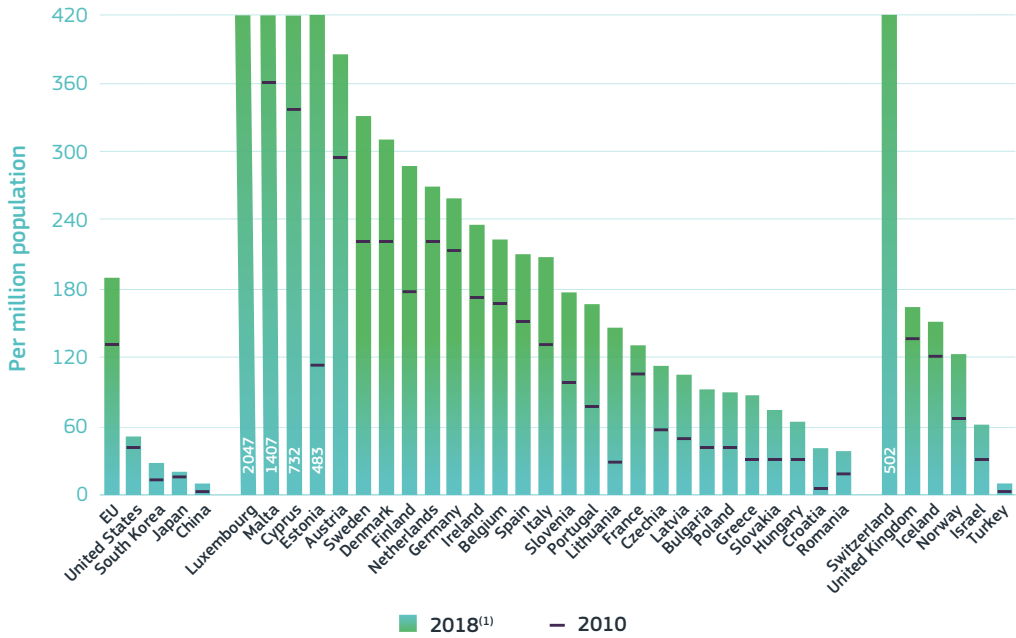
Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on data produced by Science-Metrix using data from the EUIPO database, Eurostat and World Bank data

Note: ⁽¹⁾US, KR, JP, CN: 2017.

Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-12.xlsx>

18 Design covers the visual appearance of a product, part of a product and/or its ornamentation, i.e. A design covers the appearance of a product but cannot protect its functions, which fall under the regime of patent protection. A trademark is a distinctive sign that identifies certain goods or services such as those provided by a specific person or organisation and distinguishes them from those of other organisations. Trademarks can be words, pictures, stylised words, logos, a colour or colour combination, a shape, a sound or a combination of those signs.

Figure 6.3-13 Trademark applications to the EU Intellectual Property Office (EUIPO) per million population, 2010 and 2018



Source: DG Research and Innovation, Chief Economist – R&I Strategy & Foresight Unit based on data produced by Science-Metrix using data from the EUIPO database, Eurostat and World Bank data
 Note: ⁽¹⁾US, KR, JP, CN: 2017.
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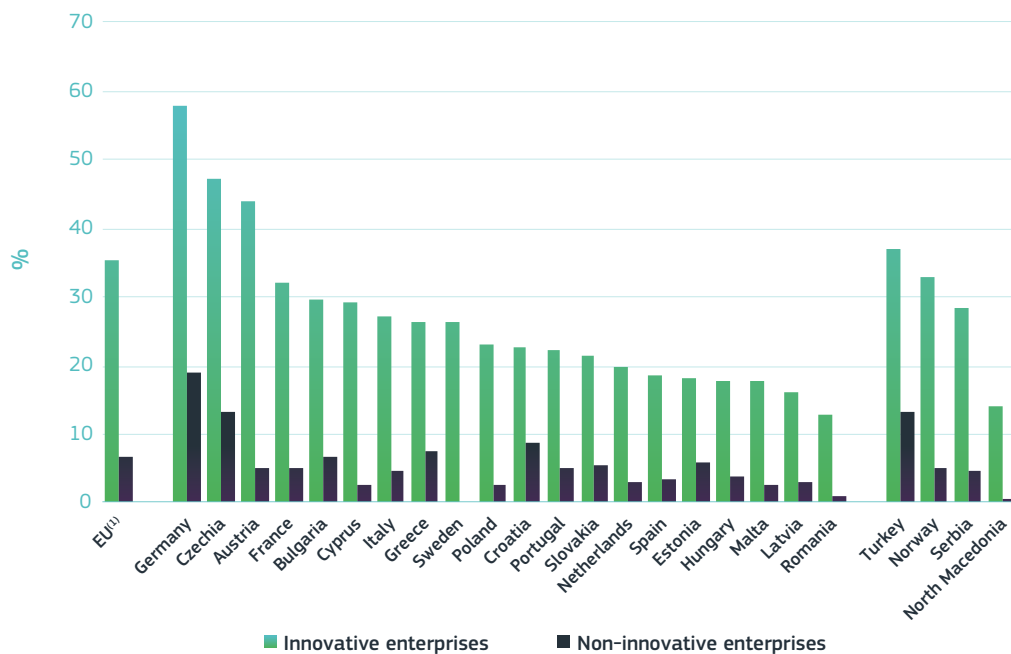
Innovative companies use significantly more IPRs than non-innovative companies.

Intellectual property rights are one of the main tools used by companies to extract a benefit from investment in R&I and to protect their innovations¹⁹. The extent to which IPRs are used among innovative companies diverges among EU countries. As shown in Figure 6.3-14, in Germany, almost 60% of innovative companies use IPRs, whereas in Romania, the share is just above 10%. Moreover, there are certain differences between innovation leaders and modest innovators; for example, a substantial share of innovative enterprises in Bulgaria and Czechia use IPRs, while the shares of innovative enterprises using IPRs are lower

in the Netherlands and Estonia. Differences in the dominant economic sector can explain the results. In countries with higher shares, IPR-intensive sectors, such as automotive, software and equipment manufacturing, dominate the share of innovative enterprises, while in countries with lower shares, the dominant sectors are primarily services such as wholesale and retail trade, which are not IPR-intensive sectors. In addition, country-specific policies on IPRs, such as incentives and enforcement of IPR, can contribute to higher shares. For instance, in 2014, Czechia introduced a programme that supported expenses on IPR protection in businesses²⁰.

19 European Union Intellectual Property Office (2017), Protecting innovation through trade secrets and patents: determinants for European Union firms.
 20 EC-OECD STIP COMPASS, <https://stip.oecd.org/stip.html>

Figure 6.3-14 Share of innovative and non-innovative enterprises (%) that used intellectual property rights (IPRs), 2016



Science, research and innovation performance of the EU 2020

Source: Eurostat - Community Innovation Survey 2016 (online data code: inn_cis10_ipr)

Note: ⁽¹⁾EU value estimated with the available 20 EU countries.

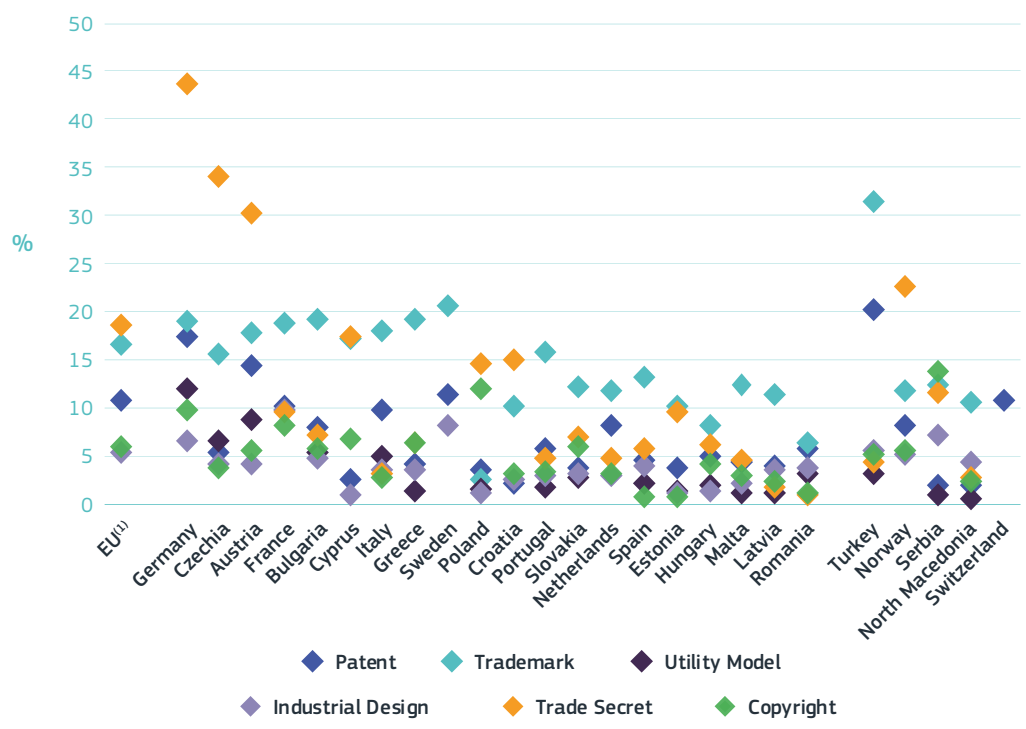
Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-14.xlsx>

The most commonly used IPR by innovative companies in the EU are trade secrets and trademarks and, to a lesser extent, patents, as shown in Figure 6.3-15. These figures are in line with the very high numbers shown in Figure 6.3-12 and 13 in which trademarks are used much more than patents and community designs. In fact, while patents are used mainly for products and to protect innovations that are new to the market, trade secrets and trademarks can be applied in both products/services and processes and also in innovations new to a firm²¹, thereby increasing the scope of these types of IP for innovation protection. By type of IPR, Germany, followed by Austria and Czechia, show the highest shares

for trade secrets in the EU; Sweden, followed by Bulgaria and Germany, show the highest shares for trademarks; and Germany, followed by Austria and Sweden, show the highest shares for patents. As for utility models, industrial design and copyright, the top countries are Germany, France and Poland, respectively. Once again, differences in the dominant economic sector to which innovative companies belong and variations in IPR legislation can explain the results. Nonetheless, the highest shares are concentrated in the more innovative countries such as Sweden, Germany and Austria.

21. European Union Intellectual Property office (2017), Protecting innovation through trade secrets and patents: determinants for European Union firms.

Figure 6.3-15 Share of innovative enterprises (%) by intellectual property rights (IPRs) and licensing in the enterprise, 2016



Science, research and innovation performance of the EU 2020

Source: Eurostat - Community Innovation Survey 2016 (online data code: inn_cis10_ipr)

Note: ⁽¹⁾EU value estimated with the available 20 EU countries.

Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-15.xlsx>

3. An unequal landscape of innovative enterprises

The share of innovative enterprises in an economy also illustrates its innovativeness. By definition, and according to the Community Innovation Survey of 2016, enterprises are considered innovative if they carried out innovation activities during the period 2014-2016, including ongoing and abandoned activities, i.e. regardless of whether the innovation activity resulted in implementation of an innovation²².

In 2016, 48% of EU enterprises reported innovation activities in the period 2014-2016, a decline of 5.7 percentage points since 2010. Even though innovation performance has improved over time, according to the latest European Innovation Scoreboard²³, half of the EU countries have also shown a decline in the share of innovative enterprises. On the negative side, countries such as Germany, Romania and Poland stand out with a significant decline in the share of innovative enterprises (Figure 6.3-16). Conversely, Lithuania shows a significant improvement when compared to 2010. Belgium is the EU country with the highest share of innovative companies (almost 70%), followed by Portugal and Finland. Among all countries, Switzerland and Norway are the best performers with shares above 70%. On the downside, Romania, Poland, Bulgaria and Hungary have the lowest shares of innovative companies (less than 30%). Looking at the figures, the share of innovative enterprises demonstrates the innovation divide between north-western and south-eastern Europe, with some exceptions such as Portugal, Greece and Italy. Portugal, for instance, reports a relatively

high share of innovative enterprises, mainly driven by a very high share of innovative SMEs in combination with a relatively high share of public support to business R&D investment and a good performance of SME investment in R&D. In addition, the share of innovative companies is connected with countries' economic structures. The higher share of SMEs in medium-high, high-tech manufacturing and knowledge-intensive services (such as ICT and finance) is likely to translate into a higher share of innovative enterprises which, for instance, might explain the results from Belgium and Luxembourg.

In terms of company size, with more resources to invest in R&D, large companies are naturally more innovative than SMEs. However, the gap in both shares varies across countries (Figure 6.3-17). More-innovative countries, such as Luxembourg, the Netherlands, Finland, Belgium and Denmark show not only a lower gap but also high shares of innovative SMEs and innovative big companies which, as mentioned previously, is partly explained by the economic structure. Portugal comes out on top with a high share of innovative SMEs and the lowest gap. On the contrary, eastern European and less-innovative countries like Romania, Bulgaria²⁴, Slovenia, Poland and Slovakia, where business structures are dominated by few large multinational companies that control most of the business investment in R&D, have the lowest shares of innovative SMEs as well as the largest gaps between large enterprises and SMEs.

22 The concepts are in line with those recommended by the Oslo Manual (2005, 3rd edition) which is the internationally recognised standard methodology for collecting innovation statistics.

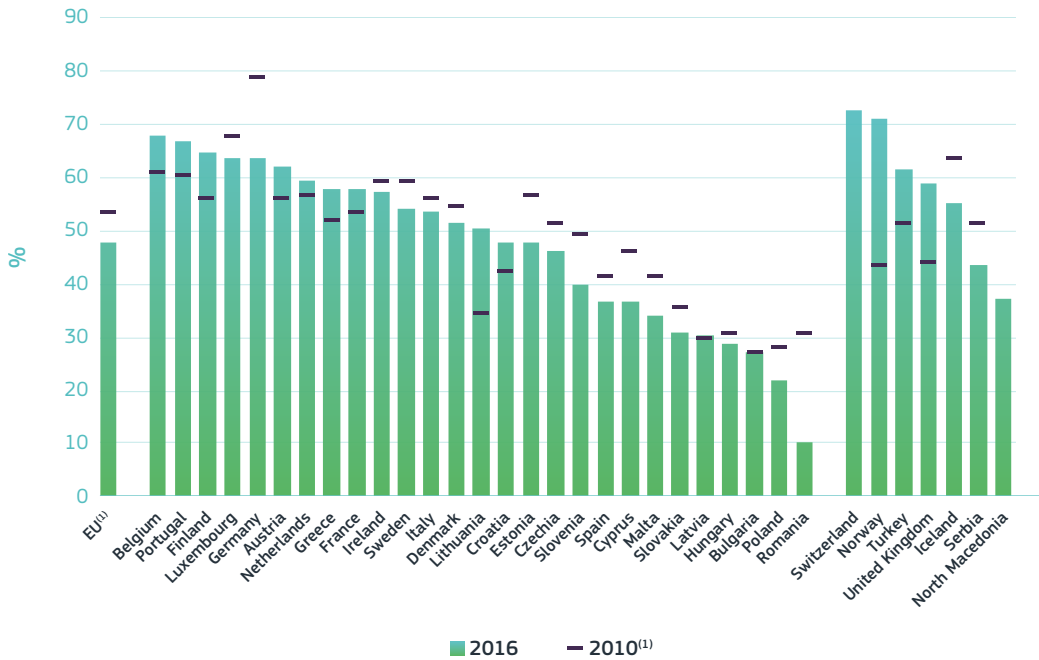
23 European Commission (2019), European Innovation Scoreboard 2019.

24 European Commission (2019). European Semester – Country Report.

As regards the different types of innovation activities, the share of innovative enterprises in product and process innovation is generally higher than in organisational and marketing

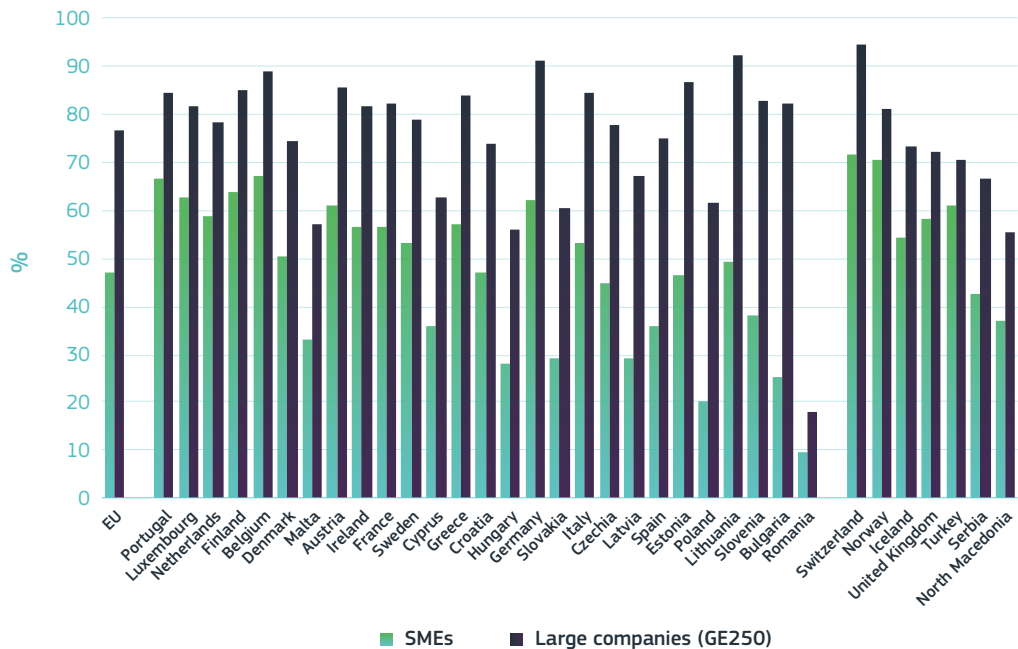
innovation. This is an important result because it means that companies are investing more in new or significantly improved products and/or services rather than promoting existing ones.

Figure 6.3-16 Innovative enterprises as % of total number of enterprises, 2010 and 2016



Science, research and innovation performance of the EU 2020
 Source: Eurostat - Community Innovation Survey 2016 and 2010 (online data code: inn_cis10_type and inn_cis7_type)
 Note: ⁽¹⁾EU estimated and not including EL. EL: 2012.
 Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-16.xlsx>

Figure 6.3-17 Share of innovative enterprises by size, 2016



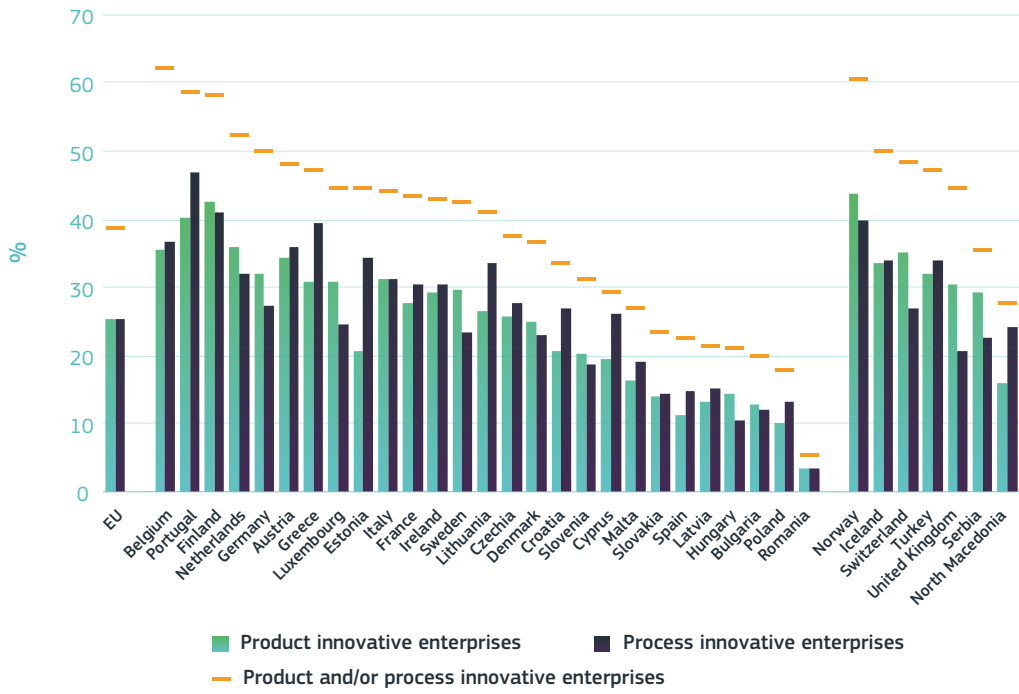
Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat - Community Innovation Survey 2016 (online data code: inn_cis10_type)
 Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-17.xlsx>

Science, research and innovation performance of the EU 2020

In geographical terms, there is generally a divide between leading innovative countries performing better in both types of innovation and less-innovative countries performing poorly equally in both types of innovation. However, some exceptions, such as Portugal and Greece, stand out with high shares and both types (Figures 6.3-18 and 6.3-19). In addition, countries such as the Netherlands, Estonia, Belgium and Finland perform much better in product

and process innovation than in organisational and marketing innovation. In more detail, the majority of countries perform better in organisational than marketing innovation and tend to do better in process rather than product innovation. However, because product innovation requires more and better resources, leading innovative countries such as Finland, the Netherlands, Denmark and Sweden show higher shares in product innovation as against process innovation.

Figure 6.3-18 Innovative enterprises by type of innovation activity as % of total enterprises, 2016

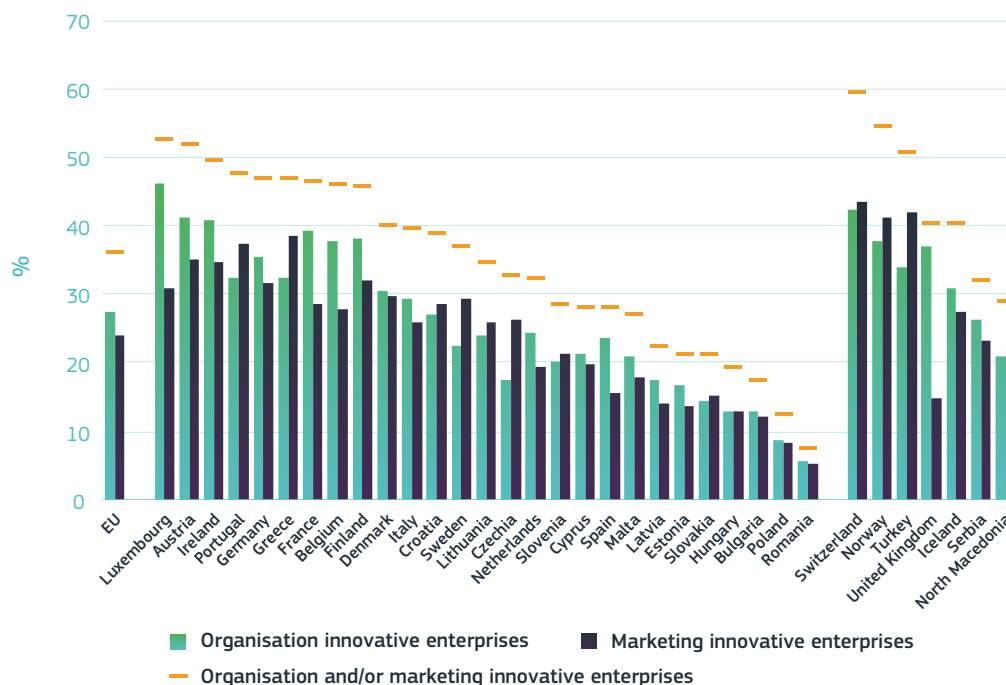


Science, research and innovation performance of the EU 2020

Source: Eurostat - Community Innovation Survey 2016 (online data code: inn_cis10_type)

Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-18.xlsx>

Figure 6.3-19 Innovative enterprises by type of innovation activity as % of total enterprises, 2016



Science, research and innovation performance of the EU 2020

Source: Eurostat - Community Innovation Survey 2016 (online data code: inn_cis10_type)

Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-19.xlsx>

At the EU level, approximately 30% of product- and/or process-innovative enterprises received public funding for their innovation activities during the period 2014-2016. Public funding is an important tool to support business innovation activities, either through tax incentives or direct public support²⁵. Figure 6.3-20 shows there is no clear innovation divide between the most- and least-innovative countries. For instance, France reports the highest share of product and process innovation enterprises that have received public funding, followed by the Netherlands and Romania. However, the source of funding diverges. While enterprises in

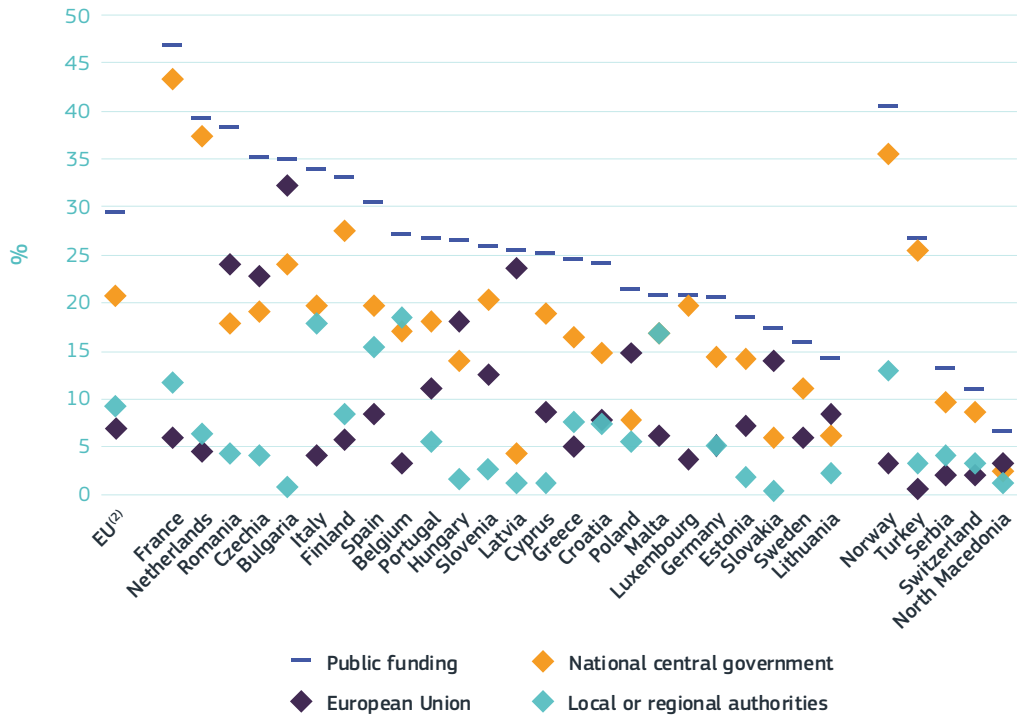
countries with better innovation capacities and more public support for business investment in R&D, such as France, the Netherlands, Finland and Luxembourg, show relatively higher shares of funding from national sources, in less-developed public innovation systems, like Bulgaria, Czechia, Romania, Latvia and Slovakia, companies tend to use relatively more funding from the EU. Furthermore, these figures show that companies might look for public support to fund their innovation activities either as the result of a well-developed public investment system, when the highest share comes from national sources, or because of poor framework conditions that are

²⁵ European Commission (2017), The economic rationale for public R&I funding and its impact.

unable to secure business investment in R&D, when the highest share comes from external sources. As a consequence of deprived national investment systems, the results confirm the

importance of European funding in helping innovative companies to fund their activities, especially in the countries that are more distant from the technological frontier.

Figure 6.3-20 Share of product and/or process-innovative enterprises⁽¹⁾ (%) that received public funding for innovation activities by source of funding, 2016



Science, research and innovation performance of the EU 2020

Source: Eurostat - Community Innovation Survey 2016 (online data code: inn_cis10_pub)

Notes: ⁽¹⁾Public funding includes financial support via tax credits or deductions, grants, subsidised loans, and loan guarantees.

⁽²⁾EU value estimated with the available 24 EU countries.

Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-20.xlsx>

4. The economic impact of innovation illustrates diverse national economic structures

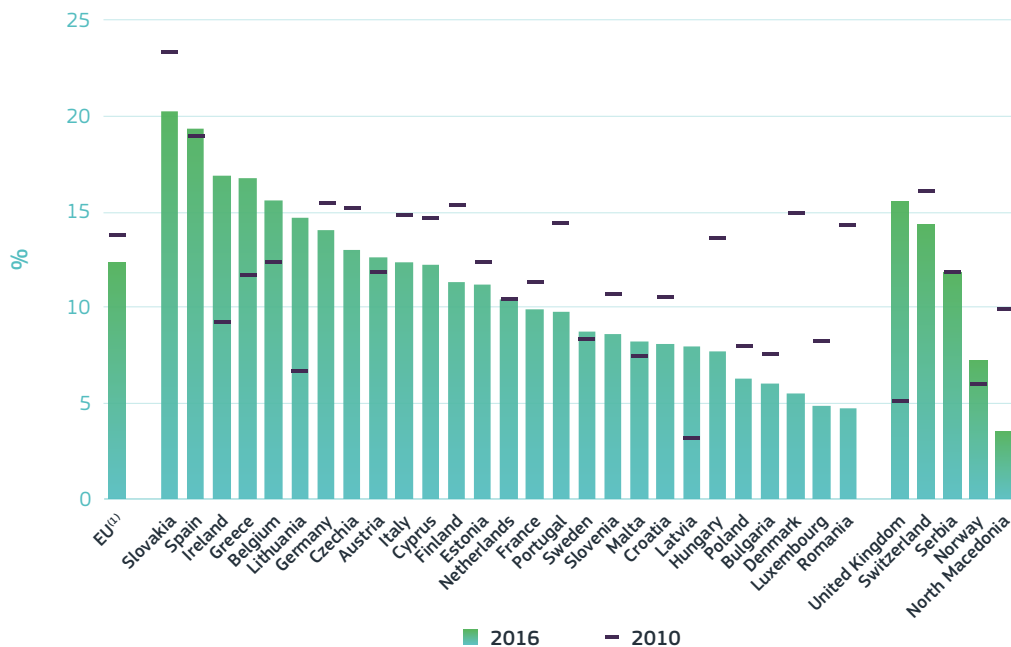
In 2016, innovation turnover in the EU, measured as sales of new-to-market and new-to-firm innovations, was 12.4% of total turnover. Even though in absolute terms,

innovation turnover increased by 7%, the share is slightly lower than in 2010. In addition, the share of innovation turnover fell in 17 of the 27 EU countries. The decrease is particularly

significant in Denmark, Romania and Hungary (Figure 6.3-21). On the other hand, a few countries have shown big improvements, such as Ireland, Latvia and Lithuania. Slovakia, followed by Spain and Ireland, show the highest shares of innovation turnover while Romania, Luxembourg and Denmark display the lowest shares. In Denmark, the result seems to be linked to a high concentration of a few very large R&D-intensive industries, especially in the pharmaceutical sector. Similarly, a concentration of a few very large R&D-intensive industries in Luxembourg's services sector might explain

its low share. Therefore, these figures indicate that innovation turnover does not seem to be aligned to the share of innovative enterprises or the country's innovation capacity. However, it is important to note that, while data on company shares includes several types of innovation and are dominated by the high number of SMEs, as regards turnover, larger companies play a bigger role, especially multinational companies that import innovations from the headquarter country. Countries with a relatively large high-tech and medium-high-tech manufacturing sector also tend to show higher innovation turnover.

Figure 6.3-21 Sales of new-to-market and new-to-firm innovations as % of total turnover, 2010 and 2016



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat - Community Innovation Survey 2016 and 2010 (online data code: inn_cis10_prod and inn_cis7_prod) and European Innovation Scoreboard 2019

Note: ⁽¹⁾EU value was estimated.

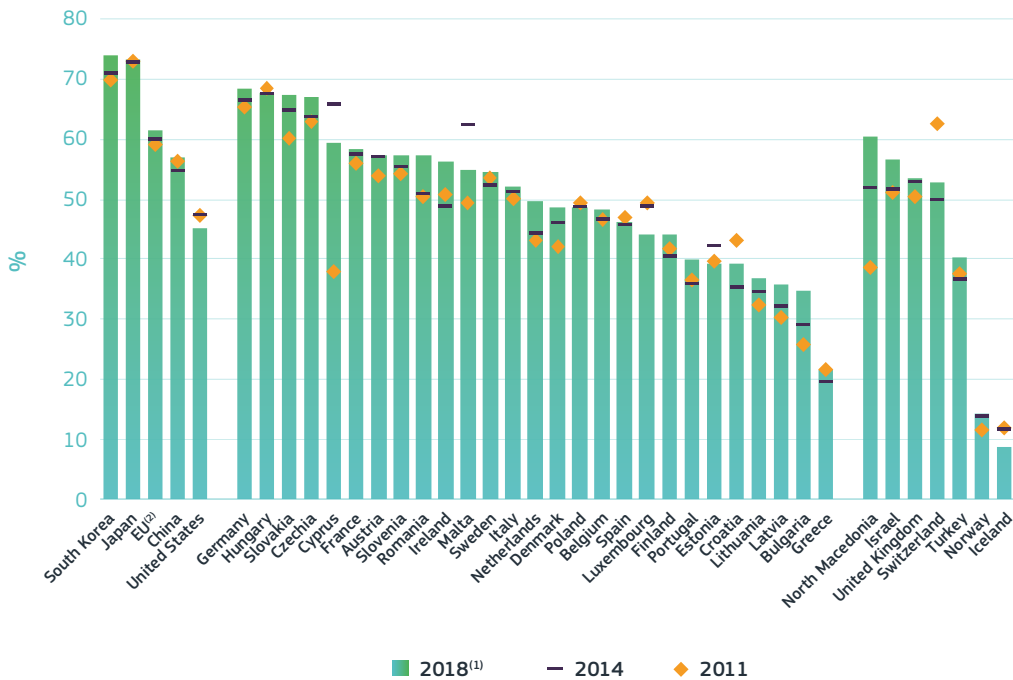
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As regards the export share of medium- and high-tech products, South Korea and Japan, with strong ICT hardware and automotive industries, show the best performance. While the EU lags behind those two countries, it performs better than China and the United States. As key drivers of economic growth and productivity, medium- and high-technology products might reflect a country's ability to commercialise the results of R&D in international markets.

Within Europe, Germany, with its strong R&D-intensive automotive and equipment industries, shows the best performance.

Central and eastern Europe, in particular Hungary, Slovakia and Czechia, also report very good performances as a result of their foreign affiliate companies' strong automotive, machinery and pharmaceutical exporting sectors. Over time, most countries have improved their shares of medium- and high-tech exports, particularly Bulgaria and Cyprus (Figure 6.3-22). Certain leading innovation countries, such as Finland which has a very strong R&D-intensive industry in the ICT hardware sector, is not able to translate the investment into exports of internationally competitive high-tech products. However, as with the innovation turnover indicator, the

Figure 6.3-22 Exports of medium- and high-technology products as % of total product exports, 2011, 2014 and 2018



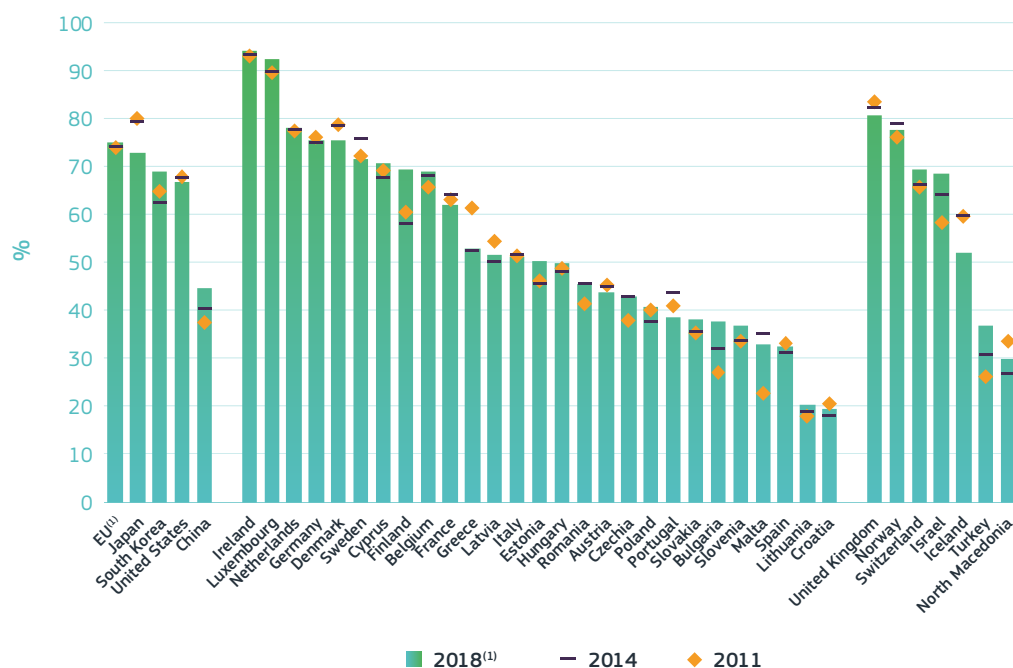
Source: European Commission, DG Joint Research Centre based on Eurostat, Comext 'DS-018995' and UN Comtrade (Vértesy and Damioli, 2020, Figure 4)
 Note: ⁽¹⁾CN, KR, NO: 2017. ⁽²⁾Two sets of values are available: values for worldwide comparison that exclude foreign trade between EU countries and values for European comparison that include it. The values for worldwide comparison are shown on the graph. The value for EU comparison for 2018 is 56.6.
 Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-22.xlsx>

results seem to be linked more closely to the country's economic structure (i.e. the weight that certain sectors have in the economy), rather than its innovation capacity.

The EU shows the highest share of knowledge-intensive service exports, ahead of Japan, South Korea, the United States and China. Within the EU, countries with a high share of R&D-intensive financial and ICT services in their economies, like Ireland and Luxembourg, are leading the EU (Figure 6.3-23). On the other hand, those with a high share of tourism-related services, such as Spain, Croatia and Malta, tend to perform poorly in this indicator, notwithstanding

their R&D investment in professional, scientific and technical services. Contrary to the previous indicators, the share of KIS exports seems to be in line not only with the country's economic structure but also with its innovation capacity. Leading innovative countries, such as the Netherlands, Sweden, Denmark and Finland, perform very well while less-innovative countries, such as Lithuania, Slovakia and Bulgaria, perform poorly. This might be an indication that digitalisation and new technologies are changing the way innovation is happening, with investments in R&D and innovation more easily translated into competitive innovative services than innovative goods.

Figure 6.3-23 Exports of knowledge-intensive services as % of total services exports, 2011, 2014 and 2018



Source: European Commission, DG Joint Research Centre based on Eurostat (bop_its6_det), OECD (TISP_EBOPS2010) and ITC (Vértesy and Damioli, 2020, Figure 5)

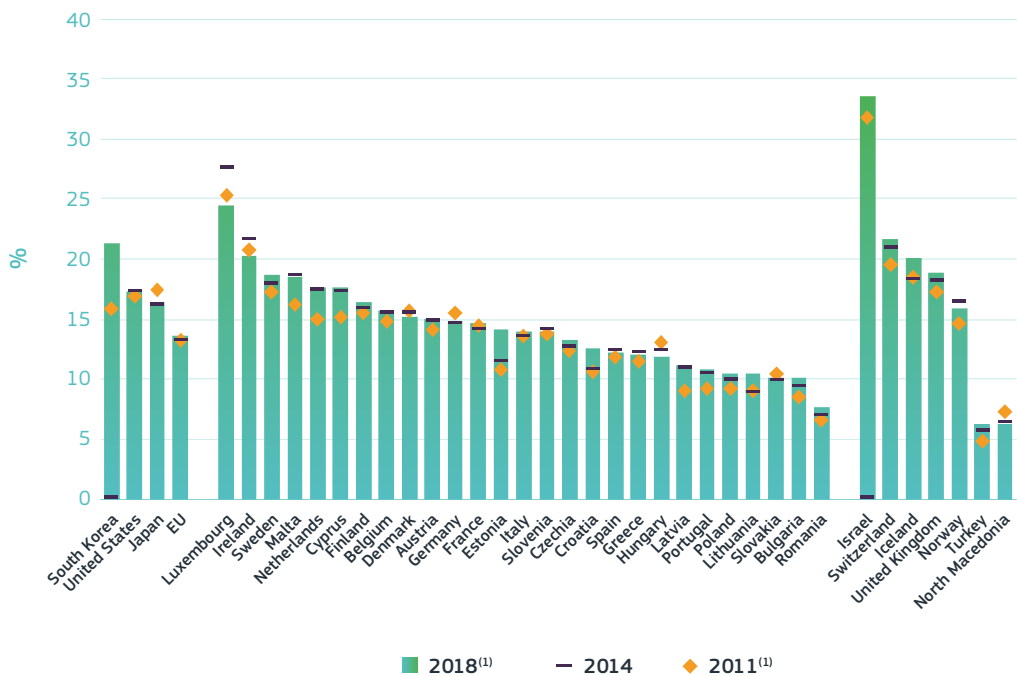
Note: ⁽¹⁾Two sets of values are available: values for worldwide comparison that exclude foreign trade between EU countries and values for European comparison that include it. The values for worldwide comparison are shown on the graph. The value for EU comparison for 2018 is 68.4.

Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-23.xlsx>

In terms of employment in knowledge-intensive activities²⁶, which measures the economic impact of R&I activities towards the creation of new high-skilled jobs, the United States, Japan and South Korea outperform the EU. Within the EU, this performance indicator reflects the innovation divide between north-western Europe and south-eastern Europe, with some exceptions such as

Malta, Cyprus and Estonia which have seen their shares increase over time due to their growing R&D investments in ICT and professional and scientific services (Figure 6.3-24). Once again, economic structure plays an important role: Luxembourg and Ireland, which have a high share of financial services and ICT services, respectively, top the ranking in the EU.

Figure 6.3-24 Employment in knowledge-intensive activities in business industries as % of total employment, 2011, 2014 and 2018



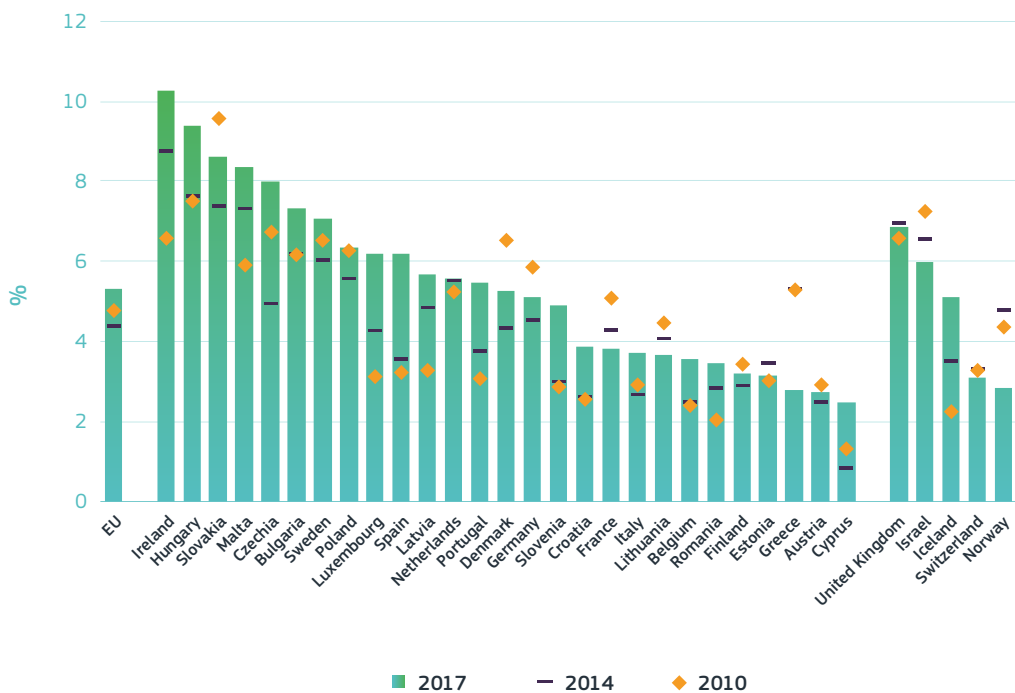
Source: European Commission, DG Joint Research Centre based on Eurostat (htec_kia_emp2) Japan Statistical Office, US BLS CBP and OECD (Vértesy and Damioli, 2020, Figure 3)
 Note: ⁽¹⁾KR, IL: 2015. KR: 2009.
 Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-24.xlsx>

26 By definition, an activity is classified as knowledge-intensive if the tertiary educated people employed represent more than 33% of total employment in that activity.

The last component of the Innovation Output Indicator builds on the dynamism of fast-growing enterprises in the most-innovative sectors and tries to capture countries' capacity to respond to new needs and emerging demands. At the EU level, there is no clear innovation divide, with good performances among both the most-innovative and least-innovative countries. Ireland, followed by Hungary and Slovakia, show the highest shares (Figure 6.3-25). However, while the shares in Ireland

reflect its strength in the knowledge-intensive services sector, in Hungary and Slovakia they are reflected in the medium-high-technology manufacturing sector. In addition, these countries have shown high rates of economic growth in recent years, which subsequently has contributed to strong employment growth. On the downside, Cyprus, Austria and Greece show the lowest shares. Over time, Slovenia, Luxembourg and Spain have seen the biggest improvements.

Figure 6.3-25 Employment in fast-growing enterprises in the top 50% most innovative sectors as a percentage of total employment, 2010, 2014 and 2017



Source: European Commission, DG Joint Research Centre based on Eurostat (online data code: bd_9prm_r2) (Vértesy and Damioli, 2020, Figure 6)

Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-25.xlsx>

BOX 6.3-2 Innovation beyond its economic impacts and the importance of social innovation

Beyond the impacts of innovation in job creation, new products and markets, and sustainable economic growth, impacts can also be seen in a more social context, such as through engagement with citizens and local communities, reflecting the importance of social innovation.

In 2018, Athens was awarded with the European Capital of Innovation prize for the way in which the capital's authorities responded to the deepening economic and refugee crisis. Athens used innovation to engage citizens, revive the local community, boost creativity and dynamism, and open the city to the world.

After major cuts in resources and greater pressure on public services, Athens revamped its policymaking processes to innovate quickly so that, along with its citizens, it could revive the local economy, build up infrastructure and rebuild the residents' confidence in their city. Inclusion and cooperation with citizens and civil society is, more than anything else, what has made this approach work. The innovation-support processes were accountable and transparent, while citizens were consulted on decisions throughout. This helped to regenerate neighbourhoods, integrate refugees, and improve education and digital access. Athens now brings groups together to improve the city rather than directing change from the top, showing that innovation enables cities to do more with less. In the end, the city has new businesses, a more attractive urban environment a revived cultural scene and better services.

As the previous Commissioner, Carlos Moedas stated: 'Athens stands out as an example that a city facing many challenges can achieve great things. Through innovation, Athens has found new purpose to turn around the economic and social crisis.'

Examples of initiatives include:

- ▶ The **POLIS²⁷** project aimed to revitalise abandoned buildings by providing small grants to residents, small enterprises, creative communities and other civil society groups and to bring life to all corners of Athens.
- ▶ The **Curing the Limbo²⁸** initiative gives refugees and migrants the possibility to connect with other residents in order to learn the language, develop new skills, find employment opportunities, and engage in active citizenship.
- ▶ The **Digital Council²⁹** brought together companies and educational institutions in the city to provide training on digital literacy and civic technology as well as to promote sustainable innovations like smart recycling bins

In 2019, Athens passed its title to the city of Nantes, awarded for its open and inclusive governance approach, involving citizens in 'grand debates' and discussions on major societal challenges, leading to concrete initiatives. In addition, the city has built a dynamic and thriving digital and start-up community, driving the city's innovative ecosystem and providing cutting-edge solutions to local challenges.

27 <http://www.polis2.thisisathens.org/en/>

28 <https://www.uia-initiative.eu/en/uia-cities/athens>

29 <http://athenspartnership.org/news/>

Nantes' flagship policies and projects include:

- ▶ [15 places to be reinvented](#)³⁰: a competitive selection of ideas submitted by citizens that resulted, for instance, in turning an unused chapel into an urban mushroom farm or creating a zero-waste awareness hub in a former art school.
- ▶ [Nantes CityLab](#)³¹ helps innovators test new solutions in real life by providing physical and digital infrastructure, such as a 3D-printed social house constructed in 3 days or an autonomous shuttle powered exclusively by a solar road.
- ▶ [Creative factory](#)³², a support system for creative and cultural industries, and the [Eco-innovation factory](#)³³, a programme that selects projects such as one which uses bicycle trailers to collect biowaste from restaurants and offices for local composting.
- ▶ **The Nantes French Tech Capital**³⁴ programme fosters start-ups, scale-ups, attracting talents and breakthrough technologies, and enables the coordination and promotion of the regional innovation ecosystem.
- ▶ **Ecosolies**³⁵ is a network that gathers private and public members to develop initiatives in the field of social and solidarity economy and promote them by awarding the best social innovation solutions, such as the [Hacoopa](#)³⁶ project for housing the elderly or the **Bout' à Bout' association**³⁷ which is reducing the impact of the used glass bottles.
- ▶ [MySMARTLife](#)³⁸ is an innovative European project focusing on smart solutions for urban transition.

30 <https://www.nantes.fr/15lieux>

31 <https://twitter.com/NantesCitylab>

32 <https://www.creativefactory.info/>

33 <http://www.nantes.fr/home/actualites/ville-de-nantes/economie/2017/ecoinnovation.html>

34 <https://lacite-nantes.fr/nantes-labellisee-capitale-french-tech-465488.html>

35 <https://ecosolies.fr/>

36 <https://www.hacoopa.coop/decembre-2018-laureat-du-prix-de-linnovation-sociale/>

37 <http://www.boutabout.org/>

38 <https://www.mysmartlife.eu/cities/nantes/>

5. The need for a stronger knowledge valorisation policy in Europe

Innovation encompasses several dimensions. As shown previously, innovation output – as defined by the composite indicator produced by the Joint Research Centre – includes four indicators: patents, employment in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and a measure of employment in fast-growing firms in innovative sectors (Vértesy and Damioli, 2020). The patents component includes inventions that use the knowledge generated by investing in R&D and innovation, and which can be transformed into successful technologies. Similarly, indicators for the intensity of skilled labour employment, in knowledge-intensive activities and in fast-growing firms provide an indication of an economy's orientation towards the production of goods and services with innovation added value. Finally, the trade flows associated with these commodities measure their capacity to reach global markets³⁹.

It is necessary to go beyond the approach of innovation output only, towards a more holistic approach in order to understand how knowledge is valorised, i.e. the process of creating value from knowledge and turning the results into sustainable solutions with economic value and societal benefits. This holistic approach should also include investments, knowledge flows, scientific performance and citizens' engagement. R&I can only play a decisive role in shaping the climate-ecological, social and economic transitions if excellent results are made available quickly and put to practical use on a large scale. This is fully in line with the Council Resolution of 29 May 2018 on 'Accelerating knowledge circulation in the EU'⁴⁰.

There is a need to reinforce knowledge valorisation in Europe. When looking at Figure 6.3-26, even though the EU outperforms the United States in terms of scientific output and number of researchers, it is surpassed in scientific quality, technological progress and the share of high-tech sectors in the economy. More worryingly, the EU lags significantly behind in terms of business-academia linkages. If Europe wants to catch up and become more competitive internationally, it needs to address its deficiencies by promoting a culture of knowledge valorisation in European R&I system, ensuring that the knowledge-based institutions know how to manage their intellectual capital and improving the links between academia, industry, citizens and policymakers.

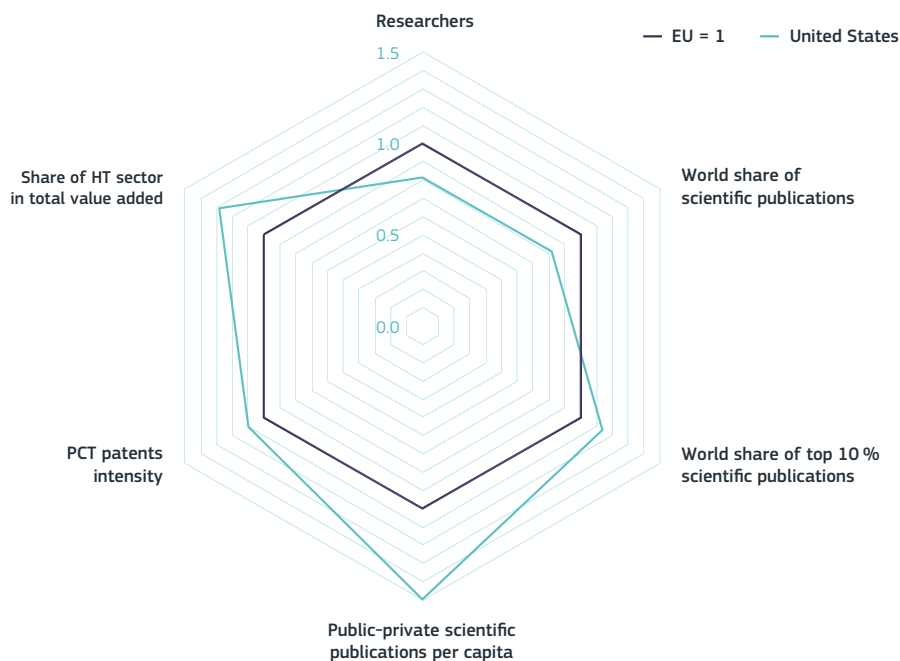
A strong valorisation policy relies on a toolbox of instruments that acknowledges different knowledge valorisation channels. Many strategies, instruments and measures have been developed at the European, national and regional level, by private and public players, to enhance knowledge transfer and valorisation. For instance:

- ▶ **Academia-industry connections** as well as the interaction of innovative companies in different sectors provide key channels for knowledge diffusion and valorisation. The EU Framework Programmes and Member States support these collaborations through, for example, collaborative research, public-private partnerships, innovation brokers and other intermediaries, mobility programmes, knowledge clusters, startup finance schemes, etc. Digital solutions such as platforms

39 COM(2013), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

40 <https://data.consilium.europa.eu/doc/document/ST-9507-2018-INIT/en/pdf>

Figure 6.3-26 Knowledge-valorisation approach, latest available year



Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat, data produced by Science-Matrix using data from the Scopus database and OECD data
 Stat. link: <https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter63/figure-63-26.xlsx>

provide new opportunities for industry cross-fertilisation and for better linking the various actors in the innovation system, for instance, to connect the demand side, including end-user expectations, with the supply of innovations.

- ▶ Without **citizen engagement** even the best-designed strategies and activities for valorisation would not achieve the highest impact or sufficiently support the economic, social and ecological transition in an inclusive way – so that no community or region across Europe is left behind. A European knowledge valorisation policy also needs to ensure that it benefits all citizens, including by enabling research results and innovations to feed solutions in cities and regions across Europe that respond to their needs.

- ▶ **Intellectual property** fosters innovation, creativity and knowledge sharing, as the basis for progress, growth and employment. IP protection is a tool to balance the interests of both society and innovators. **Standardisation** facilitates the access to and spreading of new products in the market.

Examining and sharing experiences and best practices of knowledge valorisation can be a powerful way to improve national and European strategies and policies and to enhance the societal and economic uptake of research-based solutions across the Union.

6. Conclusions

This chapter shows that innovation output in the EU continues to lag behind Japan and the United States. Compared to the United States, the **EU is stronger in exporting high-tech manufacturing products and knowledge-intensive services**, but weaker in terms of qualified employment and patent applications. On the other hand, **Japan and South Korea are leading in patent applications and exports of high-tech products.** In terms of PCT patent applications, the EU and the United States have been losing their share to countries like Japan and China, while in the case of China, its growth has been particularly impressive, putting additional competitive pressure on the EU. The findings show that **if the EU wants to remain competitive and catch up with its main competitors it needs to make extra efforts, especially in supporting European IP policy, in fostering science-industry interaction and in improving its knowledge valorisation policy.**

The innovation divide within the EU remains stable. While north-western Europe performs relatively well in most of the indicators, south-eastern Europe performs relatively poorly. Despite the fact that the countries' economic structure also plays an important role in explaining the differences in innovation performance, the EU can still do more to reduce the innovation divide among its Member States by supporting the improvement of national innovation systems and facilitating knowledge circulation. Ultimately, tackling the innovation divide will help the EU as a whole to become more competitive and innovative worldwide.

The chapter also shows that **the share of innovation companies and innovation turnover fell in the EU between 2010 and 2016.** Nearly half of the companies in the EU are innovative, with higher shares for product and/or process innovation. In addition, around half of European SMEs are innovative. **Encouraging the creation of innovation-intensive sectors and upgrading the technology profiles of Member States** would definitely help the EU to have more innovative enterprises that can boost jobs and economic growth.

Last but not least, the figures show that the **EU is leading technological progress in the fields of transport, climate and energy**, where it shows the highest shares in terms of patent applications, while the United States leads in the health, bioeconomy and food and security sectors. In all fields, China has reported extraordinary increases in its share. Given the importance of innovation and technological progress in addressing the SDGs, the EU should **not only continue to invest in scientific leadership in these areas but should also promote a culture of knowledge valorisation able to benefit fully from its research results.**

7. References

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