

# Innovation Performance in Romania and EU's Member States - A Comparative Approach

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## Abstract

Romania's innovation performance did not improve in the last years. Consequently, the country remained in the Modest/Emerging innovators category in the European Innovation Scoreboard. Considering the importance of innovation for the economic development and recovery after Covid-19 pandemic, the present research aims to compare the development of the RD&I systems in five Member States- Romania and other four states with better performance in EIS. The main objective of the study is to investigate Romania's situation regarding the RD&I system development compared with EU's average and other Member States in order to identify the existing problems and the causes that led to its low performance in the EIS. The research methodology consists of an exploratory study conducted using secondary data analysis collected from the European Innovation Scoreboard database. The results of the analysis revealed that Romania registered upward trends only regarding four indicators: exports of knowledge- intensive services, high-tech exports, presence of venture capital funds and broadband penetration. The analysis of innovation activities revealed a constant underfunding of the research and innovation field, which also has repercussions on the quality of scientific activity, the attractiveness of the academic environment and on the number of applications for patents, brands and design.

**Keywords:** European Innovation Scoreboard, Romanian RD&I system

**JEL classification:** I20, I23, I29

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## 1. Introduction

For all economies and especially for the advanced ones, such as in Europe, science, innovation and education are strong determinants in increasing productivity and competitiveness. Over the last twenty years, two thirds of the economic growth of the industrialized countries is attributed to the development of science and

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innovation. The economic impact of EU-funded research under the Framework Programmes, in particular the Seventh Framework Programme (FP7), has revealed important economic inputs to support growth and job creation. Moreover, FP7 was estimated to contribute to an increase of EUR 500 billion in GDP in 25 years, the creation of 130,000 research jobs in a period of 10 years and 160,000 additional jobs in 25 years (European Commission, 2017b).

The Covid-19 pandemic had negative impact on the economic development of all Member States inclusively on their research and innovation systems, forcing them to develop and strengthen their resilience as to continue to manage the crises triggered by the coronavirus. In this respect, the Recovery and Resilience Plan was adopted (European Commission, 2021a, b). The financial allocation of €723.8 billion is expected to help to rebuild a greener, more digital and more resilient Europe in the post-COVID-19 period. Over 50% of the total amount of the Community budget (for the 2021-2027 period) and of the Next Generation EU programme will be allocated for the modernization of the European Union through research and innovation, fair climate and digital transitions, preparation, recovery and resilience. 30% of the EU's budget will be allocated to combating climate change effects, to the protection of biodiversity and gender issues and 20% of the Next Generation EU allocation will be invested in digital transformation. As it can be observed, the development of research and innovation remains a key factor for the economic recovery of the European Member States (European Commission, 2021a, b).

Considering the importance of innovation for the economic development and recovery after Covid-19 pandemic, the present research aims to analyze the development of the RD&I systems in five Member States including Romania, in a comparative manner. As building resilient economies implies the development of the research and innovation systems, the following analysis is based on data collected from the European Innovation Scoreboard (EIS) and reveals Romania's position among Member States helping to identify which is the country's performance in the EIS and what needs to be improved in order to develop the RD&I system as to have positive impact on the economic development and resilience.

## **2. The impact of innovation on economic development**

Previous studies showed that a 10% increase of the R&D investments is associated with productivity growth between 1.1 and 1.4 % (Donselaar & Koopmans, 2016). It should be mentioned that, in absolute terms, an increase of 1.1 -1.4 % in labor productivity is higher than a 10% increase of the R&D investments. For example, in the European case, if the number of working hours remains the same, an increase of 1.1% in labor productivity would represent a 1.1% GDP increase. In other terms, an increase in R&D investments of 0.2% of GDP would lead to an increase of 1.1% of GDP, namely five times higher in absolute terms (European Commission, 2017a). Some studies computed the economic return of public R&D at around 20%, meaning that for every EUR 100 invested through

public funds in R&D, the economy is expanding by EUR 120, giving a benefit of EUR 20 per year (Georghiou, 2015).

Other studies (OECD, 2011; 2017; Mazzoleni & Nelson, 2007; Mulyanto, 2014; Intarakumnerd & Goto, 2016) analyzed the similarities and differences between the national research policies, as well as how these policies have evolved in the past decades. These studies showed that the financial support for research institutes and universities, key actors in knowledge development, represent an important characteristic of the national research and innovation policies (OECD, 2011; 2017; Mazzoleni & Nelson, 2007; Mulyanto, 2014; Intarakumnerd & Goto, 2016).

More than that, the studies on national innovation systems focused on knowledge flows and on improving performance in ‘knowledge-based economies’ (OECD, 1996). Knowledge, owned by human capital and technology, has always been in the center of the economic development. However, it was only in the 1990s that its relative importance was recognized. Economic activities have become increasingly intensive in knowledge, illustrated by the growth of high-tech industries and the growing demand for highly skilled personnel. Investments in knowledge, such as in research and development, education and training as well as in innovative working approaches, are considered key factors for economic growth. Investing in research and development also allows an organization or company to absorb existing knowledge that has been generated elsewhere, which then, can be transformed into innovation more quickly and efficiently (OECD, 1997).

Publicly funded R&D activities through accredited institutions aim to deliver excellent services, notable results and meet the stakeholders needs (industry, community and government) by managing effective programmes that improve people’s life quality.

As regards the impact of R&D on market labor, empirical evidence is still inconclusive. New technologies such as information technology and communications, robotization or artificial intelligence are expected to automate a large part of the existing jobs and to profoundly transform others, potentially leading to job losses (Frey and Osborne, 2017).

### **3. Romania’s innovation performance**

Romania is among the worst innovation performers in EU, with a GDP allocation of only 0.51 %, compared to the 2% set target, ranking last in the EU. All countries with similar characteristics invest more in R&D than Romania does. This low level of investments has led to poor scientific performance and quality. Cooperation between academia and business environment takes place mainly on an ad hoc basis and the development of this cooperation is influenced by regulatory obstacles. In the absence of significant regulatory and budgetary changes, the current measures are not sufficient to address underfunding and structural problems affecting the research and innovation sector (European Commission, 2020).

Government's expenditure on R&D (GERD) has continuously decreased since 2011, from 0.32 % of GDP to 0.20 % in 2018. Private R&D expenditure was only 0.30 % of GDP, below EU's average of 1.41%. On the other hand, business R&D expenditure (BERD) increased from 0.12% of GDP in 2013 to 0.30% in 2018 (European Commission, 2020).

Also, it should be mentioned that Government's allocation for fundamental research in all scientific fields, including medicine, biology, ecology, mathematics, physics, chemistry, engineering sciences and humanities, maintains at a very low level. In 2020, the budget allocation was only 6.2 million Euro, an amount considered insufficient to support the centers of excellence whose results are expected to help Romania to improve its performance significantly. Moreover, the last exploratory research project competition (PCE) was launched in 2016 and had a total budget of 170 million lei, financing 199 projects out of 936 submitted, having a success rate of 21.26%. Although the PNCDI III, implemented by Government's Decision No. 583/2015, provides for the annual allocation of at least 15 % of the annual budget of PNCDI III to Programme 4, for 4 years, no PCE competition has been launched. Thus, the top research groups in Romania continue to be chronically underfunded (European Commission, 2020).

#### **4. Research methodology**

The purpose of the study is to analyse the performance of some European Member States in the European Innovation Scoreboard (one state for each category of innovators) as to observe Romania's position compared with the other states with more developed RD&I systems and to find solutions for improving the country's performance.

The main objective of the study is to investigate Romania's situation regarding the RD&I system development compared with EU's average and other Member States in order to identify the existing problems and the causes that led to its low performance in the EIS.

The research methodology consists of an exploratory study conducted using secondary data analysis. The analyzed data was collected from the European Innovation Scoreboard database and the results are presented in a comparative manner, by activities and indicators as to reveal the differences in innovation performance between Romania and the analyzed countries, as well as their position compared to the EU's average.

The Innovation Scoreboard (EIS) is the main tool for analyzing innovation performance in the 27 EU Member States and other 11 neighbor countries. The purpose of this review published every summer by the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs is to assess Europe's progress vis-à-vis global competitors and to help EU countries to reduce the gaps between them regarding their RD&I systems (European Commission, 2021).

Until this year, the EIS has classified EU countries into four categories using computed scores: innovation leaders, strong innovators, moderate and modest/emerging innovators. The last EIS was released in 2021.

I. **Innovation leaders** are all countries with a relative performance in 2020 above 125% of the EU's average in 2020.

II. **Strong innovators** are all countries with relative performance in 2020 between 95% and 125% of the EU's average in 2020.

III. **Moderate innovators** are all countries with a relative performance in 2020 between 50% and 95% of the EU's average in 2020.

IV. **Modest/Emerging innovators** are all countries with relative performance in 2020 below 50% of the EU's average. The EIS 2020 measured the average performance of countries' innovation systems for 2019.

The scores are based on four types of activities involving ten innovative dimensions. The dimensions are classified in 27 indicators. The four types of activities are:

1. **Framework conditions** that include human resources, attractive research systems and innovation-friendly environment,
2. **Investments comprising:** financing, support and investments by firms,
3. **Innovation activities** consisting of innovators, linkages and intellectual assets,
4. **Impact on employment and sales.**

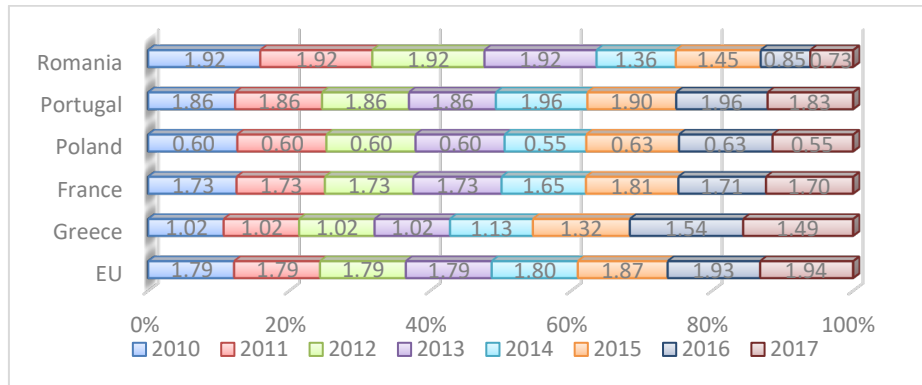
The collected data represent the latest available data in the EIS and show the evolution of the indicators over a period of seven years, starting from 2010/2011/2012, depending on availability until 2017/2018/2019. Each chosen country represents a category from the European Innovation Scoreboard. France is an innovation leader and an example to follow, Portugal is one of the countries that has increased its performance, despite the circumstances created by the Covid-19 pandemic, moving from the Moderate Innovators to the Strong Innovators group. Greece is a Moderate innovator. Romania remains a representative of the Modest/Emerging Innovators, one of the countries where innovation performance has decreased the most. Beside these four countries, Poland was chosen because even if the country is a Modest/Emerging innovator, it is a successful model regarding RD&I development from each Romania should inspire.

## **5. The results of the comparative study regarding research and innovation performance in EU's member states**

This chapter presents the results of the comparative study between Romania and four other countries – France, Portugal, Greece and Poland. The comparison between the five countries situated in the different categories of EIS is important because it helps to reveal Romania's weaknesses, the areas where the country should focus its policies and actions to improve its innovative performance.

The data is presented grouped in the four types of activities from the EIS: *framework conditions, investments, innovation activities and impact* and by the indicators measuring them.

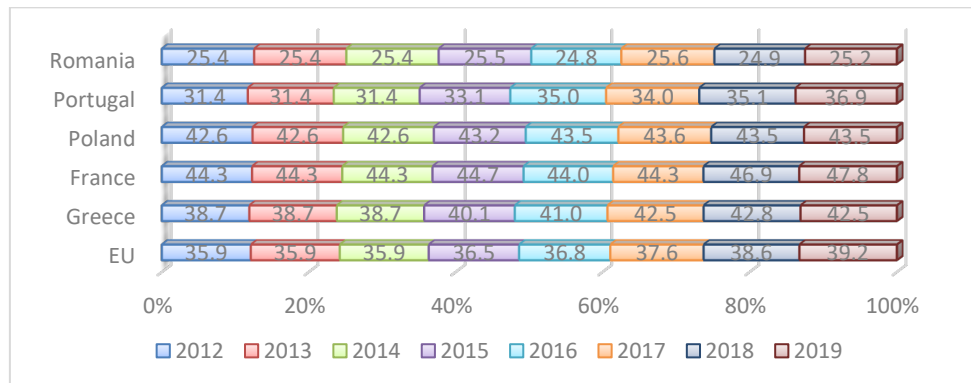
## 5.1 Framework conditions



**Figure 1. New PhDs per 1000 inhabitants aged 25-34**

Source: Authors, own processing after the European Innovation Scoreboard, 2021

It can be observed that among the five countries under review, Portugal has exceeded the European average almost every year, followed by France. Romania's situation is paradoxical because for the 2010-2013 period, the country sits above the European average. Then, the number of new PhD's registered a decrease of almost 40% between 2013 and 2014, reaching a record low level in 2016-2017 – about half of the 2010-2013 value. The situation can be explained by the increased standards and requirements (publications, participations to conferences). Poland maintains on a constant level throughout the period under review, with a number of new doctorates almost 4 times lower than the European average.

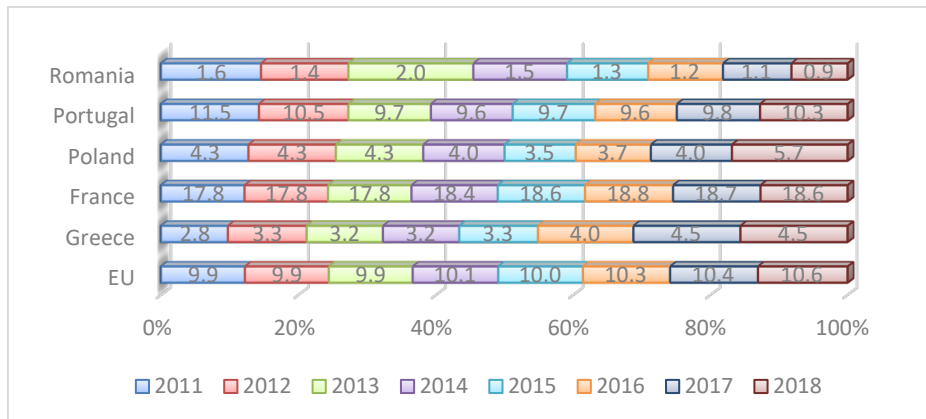


**Figure 2. Population aged 25-34 that completed tertiary education (post-secondary and bachelor) (%)**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

As regards the situation of the population with tertiary educational attainment aged 25-34, France's position is consistently above the European average, followed by Poland and Greece, indicating the existence of a skilled workforce.

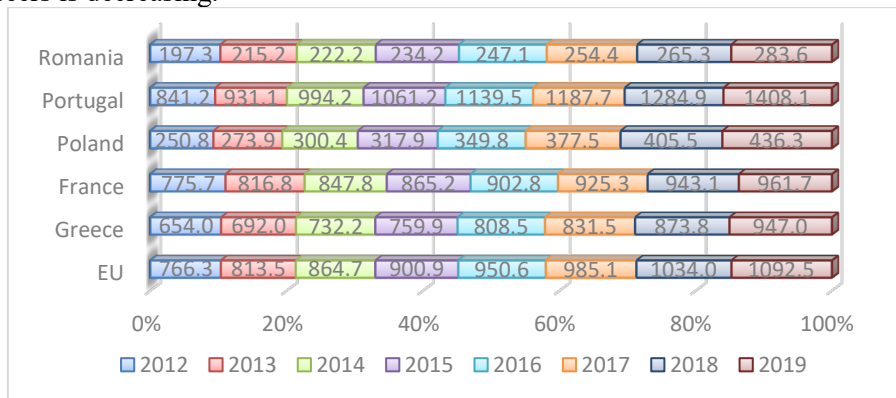
Romania's situation remains constant, with almost 36% less population aged 25-34 that completed tertiary education than the European average. It can be observed that the proportion of graduates in Romania's case remained constant throughout the period under review.



**Figure 3. Lifelong learning (%)**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

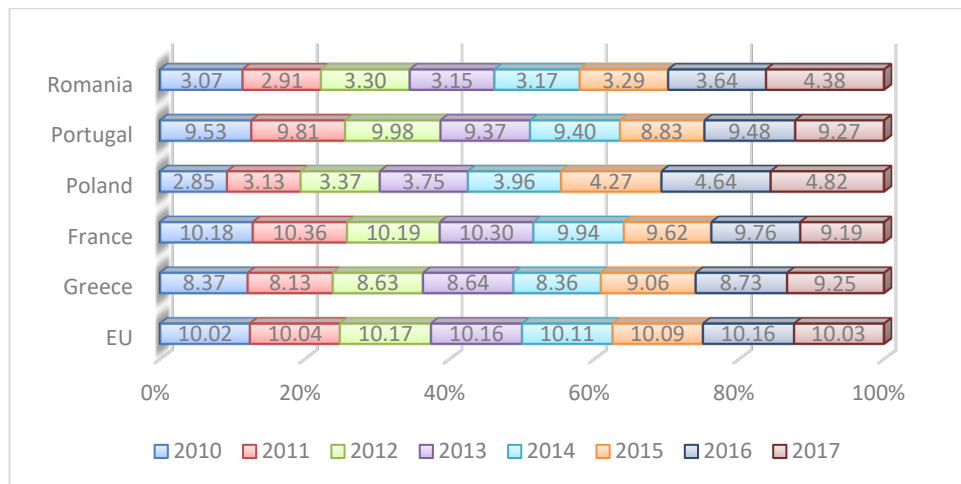
As regards the active population carrying out lifelong learning activities during their professional career (%), France's superior position can be observed, where the percentage of the active population is almost double compared with the European average for all the years under review. The lowest percentage is registered in Romania, 10 times lower than the European average and more than 18 times lower than the proportion in France. The situation in Portugal is similar to EU's average while Poland and Greece are registering lower proportions. However, in these countries' cases, although the proportion of the population involved in lifelong learning is low, it has increased over the period under review, compared to Romania, where the number of people who choose to improve their knowledge during their careers is decreasing.



**Figure 4. International scientific co-publications per million inhabitants**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

Regarding the number of international scientific co-publications per million inhabitants, the performance of Portugal, which goes beyond the European average, as well as the increase in international co-publications in the case of Greece, can be observed. Also, a remarkable increase can be observed in Poland's performance. In Romania's case, although an increasing trend throughout the period under review is observed, the number of co-publications is almost 4 times lower compared with the European average.

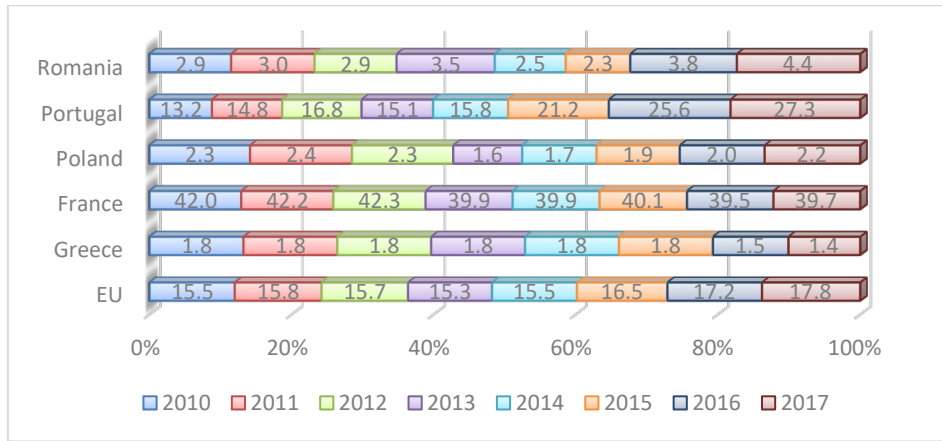


**Figure 5. Scientific publications among the top 10% most quoted in the world as % of all scientific publications in the country**

*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

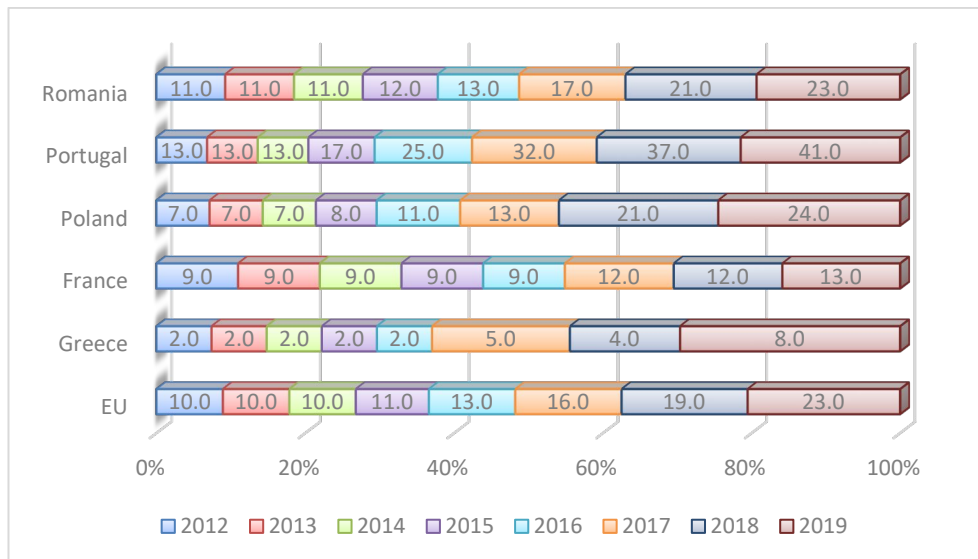
In the case of scientific publications among the top 10% of the world's most cited as % of all scientific publications in the country, there are relatively similar values recorded in France, Greece and Portugal, which are, moreover, very close to the EU's average and almost double reported to the number of publications registered in Poland and Romania. However, the number of scientific publications among the top 10% most quoted in the world as a percentage of all publications in Romania, has been on an upward trend over the last 7 years (for which data processing is done).





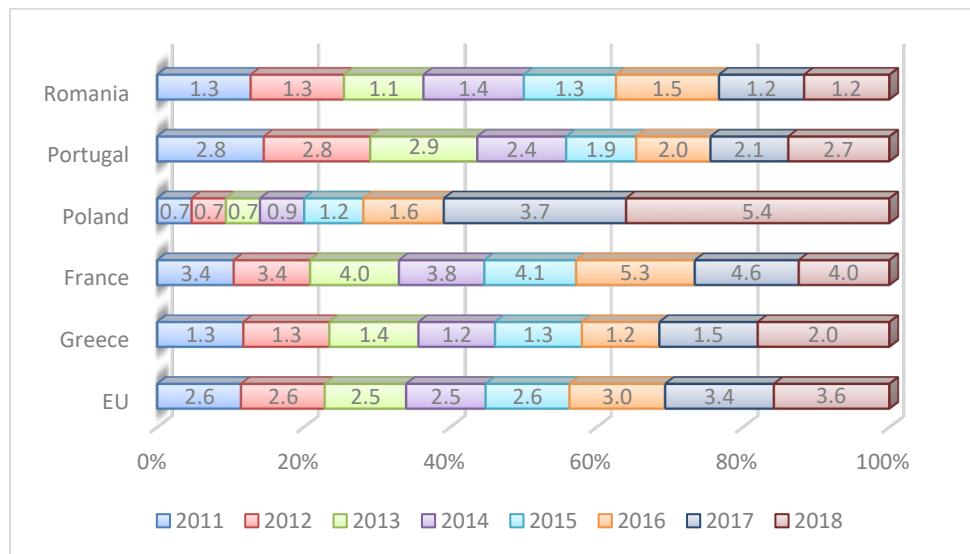
**Figure 6. Foreign PhD students as % of the total number of PhD students**  
*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

Regarding the proportion of foreign doctoral students in the total number of PhD students, the data show the constant increase of Portugal's attractiveness, in which case can be observed that the proportion of foreign doctoral students in 2017 was double compared to the first year of the analysis – 2010. France maintains its leading position on this indicator, the proportion of foreign PhD students being more than double than the European average, which is the result of a prestigious academic environment. Romania situates on the third place among the analyzed states, being one of the few indicators where its performance was on an upward trend. Similar proportions are observed in Greece and Poland, well below the European average.



**Figure 7. Broadband penetration (subscriptions per 100 inhabitants)**  
*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

Although in 2012, Romania and Portugal were above the European average, in 2019, Portugal reaches almost twice the European average. Poland leads slightly over Romania. Surprisingly, on this indicator France is well below the European average, while Greece is making an improvement only in the last analyzed year (from 2% to 8% compared to 2012-2016).



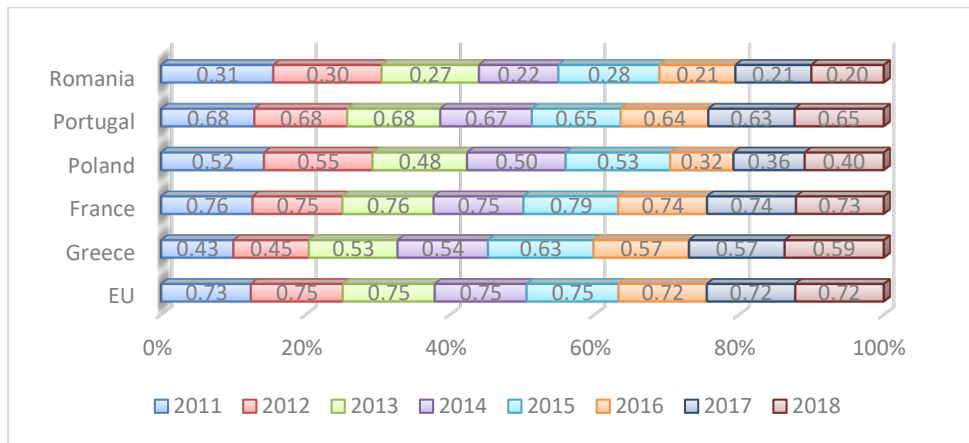
**Figure 8. Opportunity-led entrepreneurship (motivational index)**

*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

The motivational index measures the relationship between opportunity and the need to develop entrepreneurial activities. It is an important indicator that measures entrepreneurial capacity, indirectly indicating optimism and long-term expectations of entrepreneurs. It is noted that Poland and France are placed in the top of the motivational index. Portugal declines its position between 2014 and 2015 and then recovers in 2018. If in 2011-2012, Romania and Greece were at the same level, Greece manages to increase its initial score, while Romania is stagnating. Romania continues to situate on the last position, scoring three times lower than France, in opposition with the spectacular increase in Portugal.

## 5.2 Investments

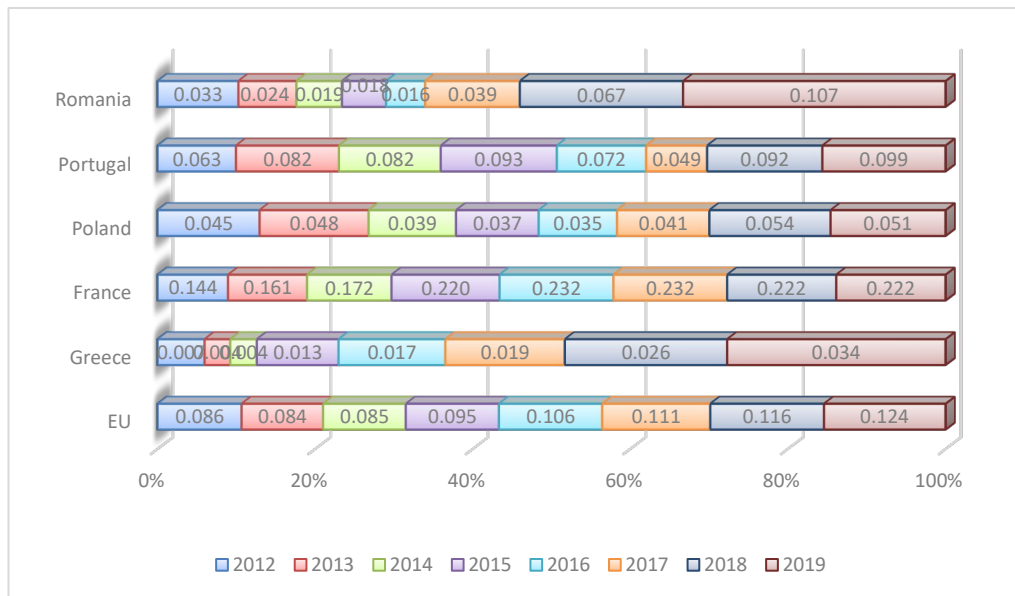
An extremely important category in creating an innovation-friendly ecosystem is the level of investments. Four indicators are considered, aiming to reflect as accurately as possible the total public and private investments in activities that can generate innovation.



**Figure 9. Public sector R&D expenditure (% GDP)**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

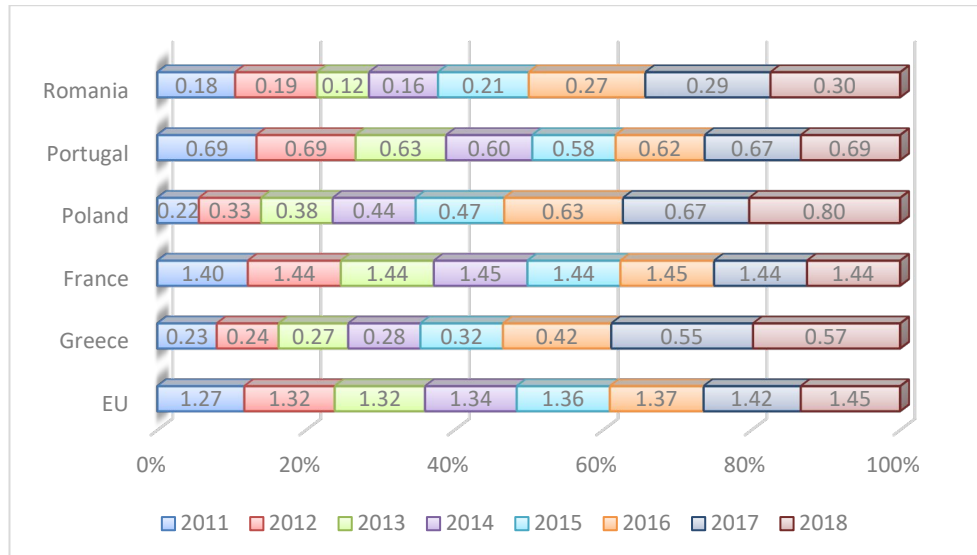
As regards public sector RD&I expenditure as % of GDP, the only country situating above the European average is France. Portugal is slightly below the European level, followed by Greece and Poland. The level of budget allocation in Romania is very low, widening the gap between the other categories of innovators. This low allocation has consequences on the number of research and innovation projects, research infrastructure and internationalization.



**Figure 10. Venture capital (% GDP)**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

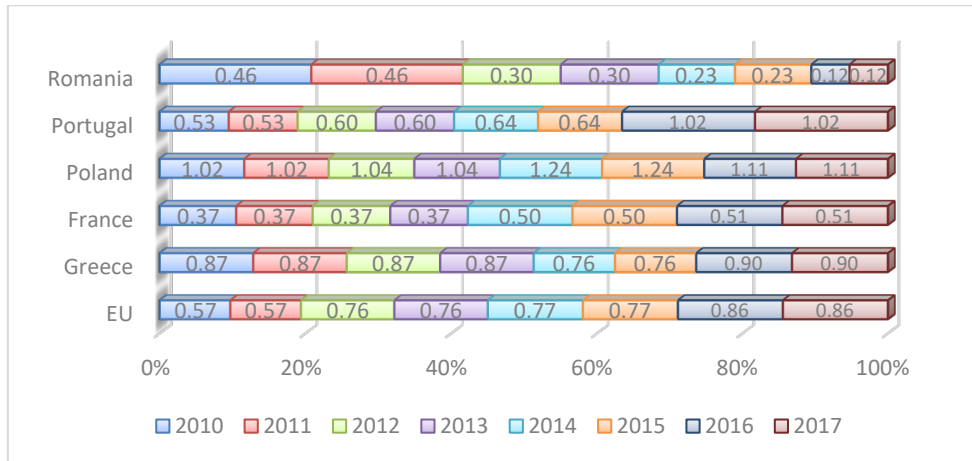
An extremely important presence in the financial landscape ensuring investments in innovative ideas are venture capital funds. It is well known that Europe suffers from the absence of a culture of risk-taking, and in this context, France offers double opportunities than the European average. Romania enjoys notable presences in this respect, GapMinder, Early Game, Gecad (with investments between 200,000 and 5 million euros). Portugal follows Romania quite close, Poland and Greece registering the lowest scores.



**Figure 11. Business sector expenditure on R&D (% GDP)**

*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

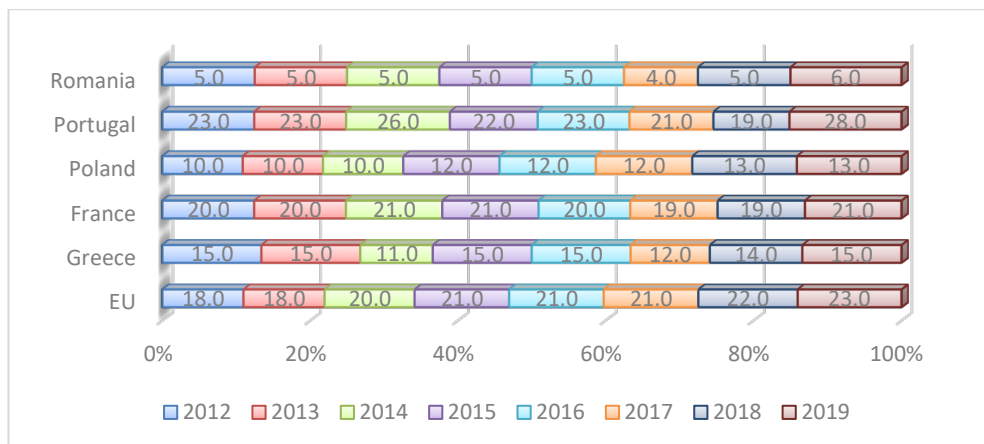
The percentage of GDP allocated to R&D expenditure in the business sector is steadily increasing since 2011 for all analyzed countries. France situates again above the European average. Poland increased the allocation four times compared to 2011. Greece doubles the amount of support provided to the private sector for R&D activities, while Portugal remains at a constant level, halfway through the European average. Romania's level of funding for private firms is low being close to the budget allocation for state-owned institutions.



**Figure 12. Non-R&D innovation expenditures (% of turnover)**

*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

As regards the amounts invested by private companies in innovation activities other than research and innovation, it is worth noting Poland's constant position above the European average over the last seven years under review. Portugal has doubled its percentage since 2010, situating also above the European average. Greece also surpassed the European average almost every year, excepting 2014-2015 period. Unexpectedly, France situates below the European average, with a relatively modest and almost unchanged level since 2014. A regressive trend is also recorded by Romania, which decreased these expenditures by one third since 2010.



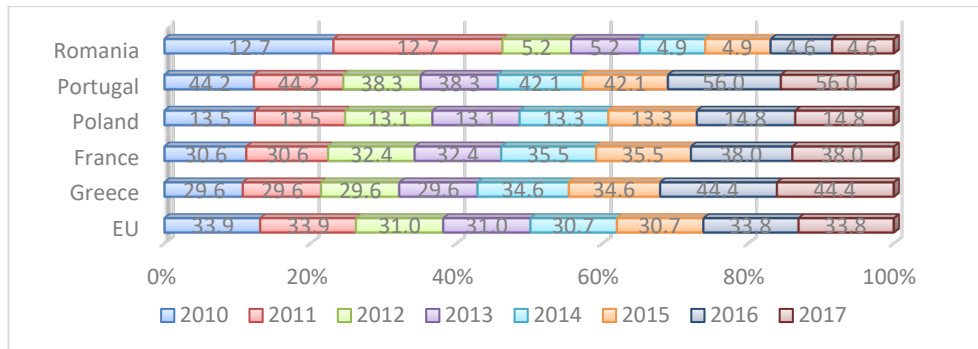
**Figure 13. Enterprises providing training to develop or upgrade ICT skills of their personnel**

*Source:* Author, own processing, after European Innovation Scoreboard, 2021

In the field of companies providing ICT skills training services, with the exception of Portugal, all other countries are below the European average. There are also no significant variations in the time scale.

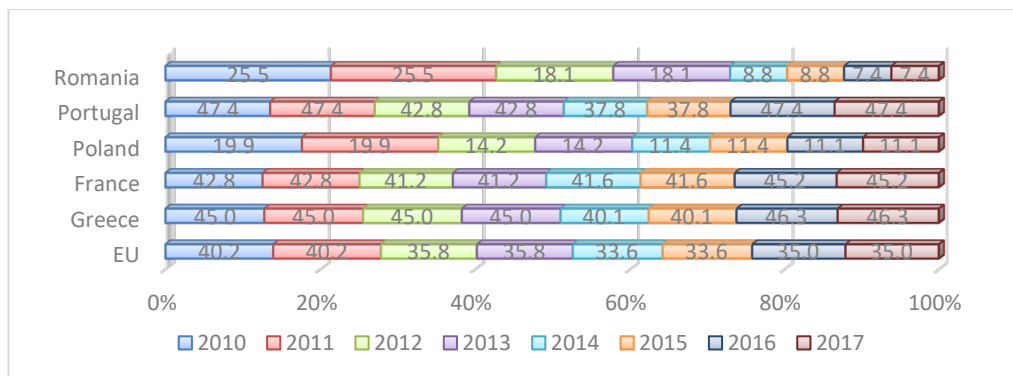
### 5.3 The analysis of the innovation activities

Innovation activities are an important stimulus for technological progress and increased economic efficiency. The role played by small and medium-sized enterprises in adopting new processes or promoting innovative products or services on the market is well known. The flexibility offered by small organizations makes it easier to adapt to changes.



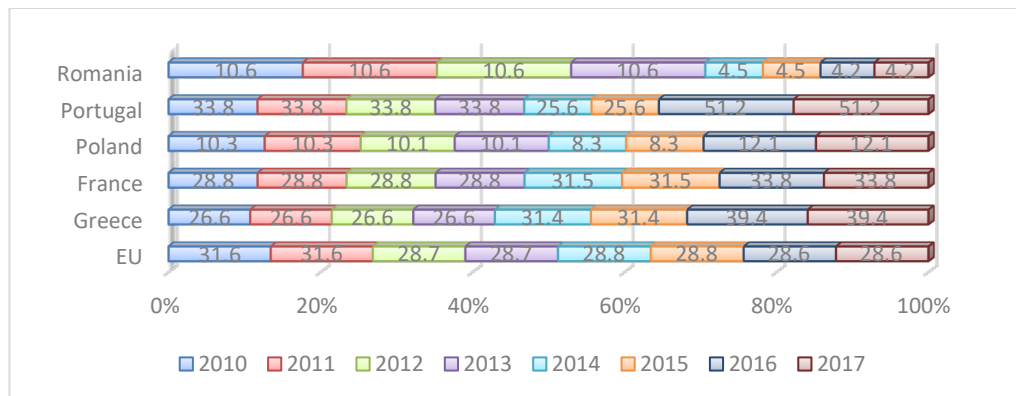
**Figure 14. SMEs introducing product or process innovations as % of SMEs**  
*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

Three out of the five analyzed countries (Portugal, France and Greece) are above the European average regarding SMEs producing or developing innovative processes as % of the total number of SMEs. Poland remains at a steady level compared to 2010, while Romania situates on the last place.



**Figure 15. SMEs introducing marketing or organizational innovations (% total SMEs)**  
*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

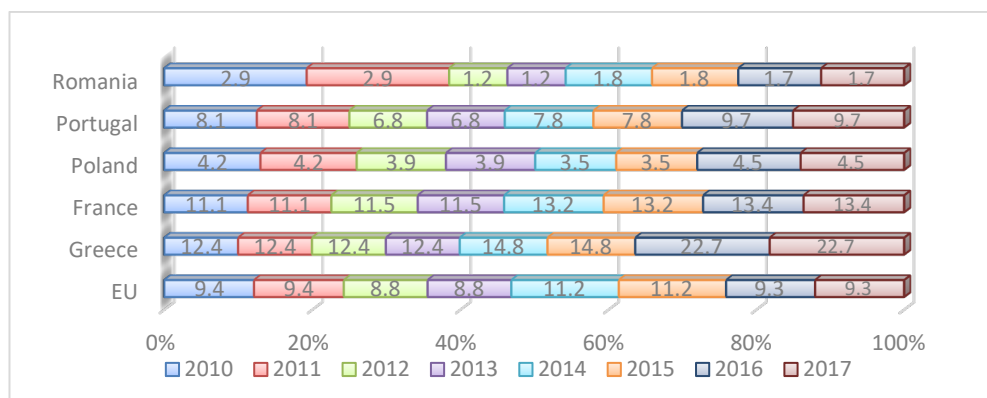
The same positive trend can be observed in the area of SMEs introducing innovative marketing processes at organizational level. However, Poland and Romania are declining, reaching 3 and over 4.5 times lower levels than the European average.



**Figure 16. SMEs innovating in-house as % of SMEs**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

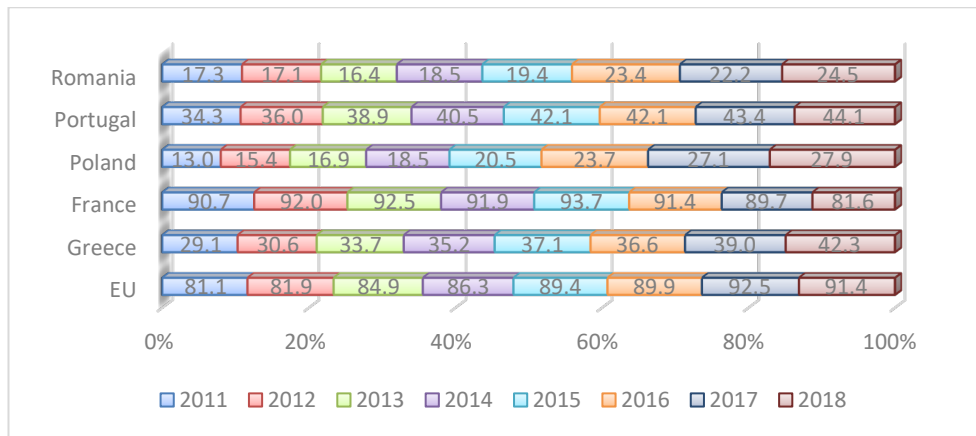
It can be observed that regarding SMEs innovating in-house as % of SMEs, Portugal, Greece and France maintain above the European average. Poland is slightly increasing its %, while in Romania's case the % registered in the last analyzed year is 50% lower than in 2010.



**Figure 17. Innovative SMEs collaborating with others (% of SMEs)**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

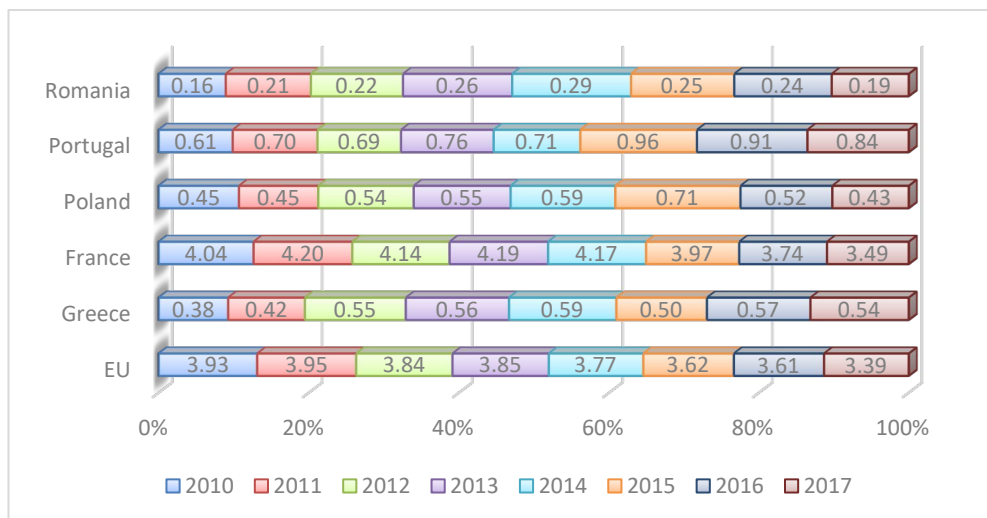
As regards the links that innovative SMEs have with other SMEs, Greece's leader position is observed. France and Portugal are still above the European average, while Poland and Romania are experiencing substantial gaps. Again, Romania position is declining compared with 2010



**Figure 18. Public-private publications per million population**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

In the production of public-private scientific publication indicator, all countries situate below the European average, France being the closest to the scores registered at EU's level. Portugal and Greece are halfway across the European average, while Poland and Romania are increasing the number of scientific publications since 2011, but still situating well below EU's average.



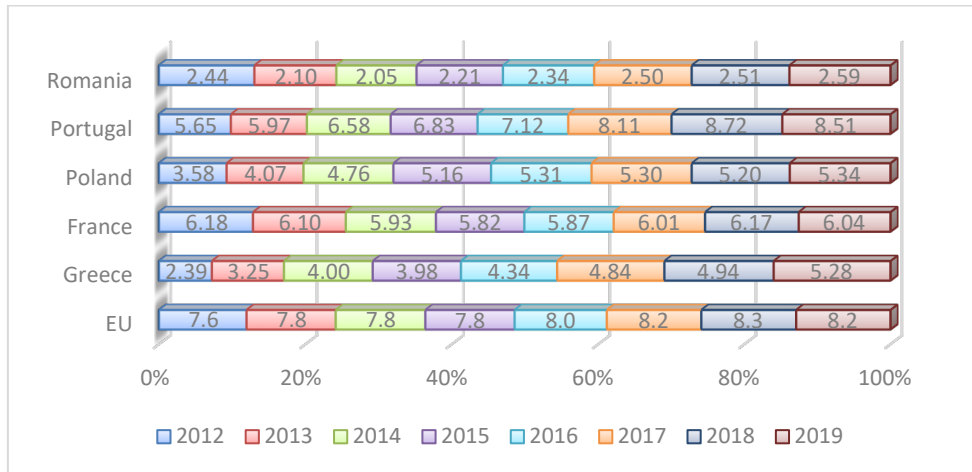
**Figure 19. Patent applications per billion GDP (in PPS)**

Source: Authors, own processing, after European Innovation Scoreboard, 2021

In the above analysis, the basic figures are expressed in the Standard Power Standards (PPS), a common currency that eliminates differences in price levels between countries, as well as currency exchange differences allowing for significant comparisons of GDP volumes between countries. France is the only country above the European average, followed at a long distance by Portugal. Greece and Poland



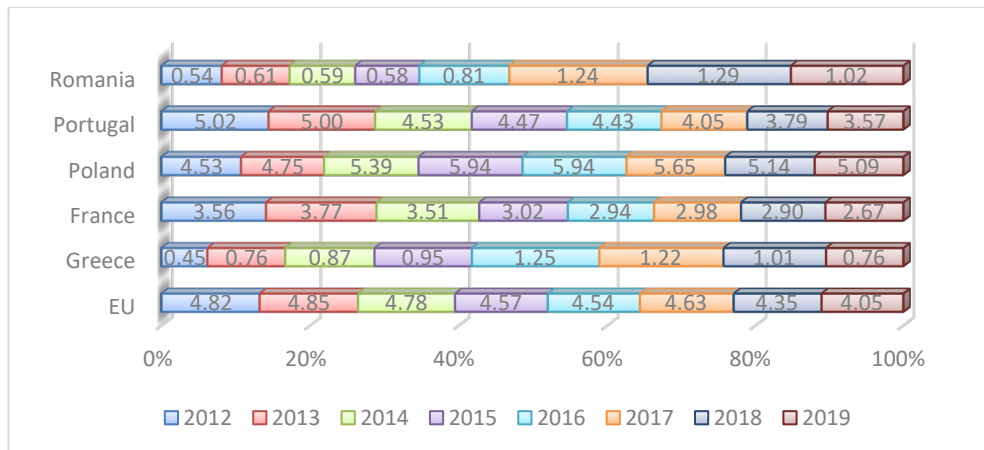
register six times lower numbers of applications while Romania sits on the last place with continuous decreases since 2014.



**Figure 20. Trademark applications per billion GDP (in PPS)**

*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

Regarding trade mark registration applications, the leading position is ensured by Portugal, the only one situating above the European average. France values are fluctuating, registering a lower level in 2019 compared to 2012. Greece and Poland are in similar situations, registering 35% lower values as the European average.



**Figure 21. Design applications per billion GDP (in PPS)**

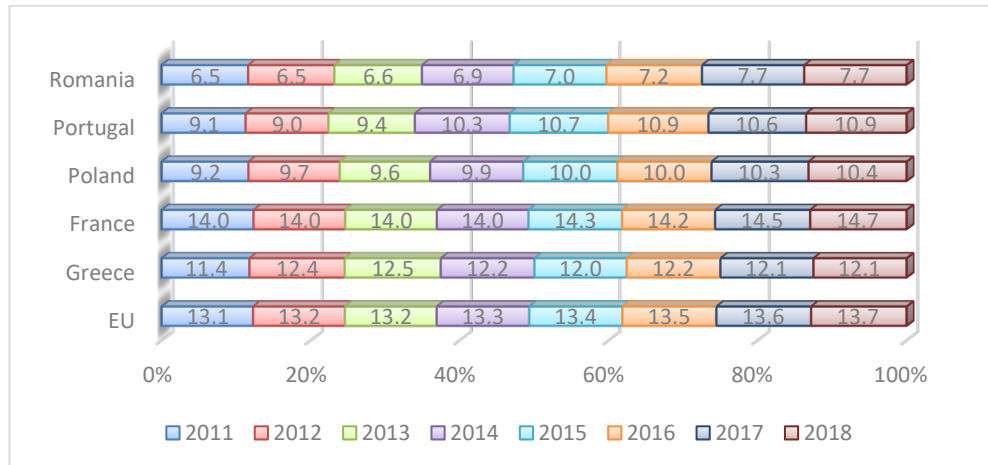
*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

For design applications per billion GDP (in PPS) Poland is the only country that sits above the European average. Portugal and France follow a downward

trend compared to 2012, while Romania doubles its performance compared to the same year. Greece ranks last, with more than five times lower number of design applications than the European average.

#### 5.4 Economic and social impact

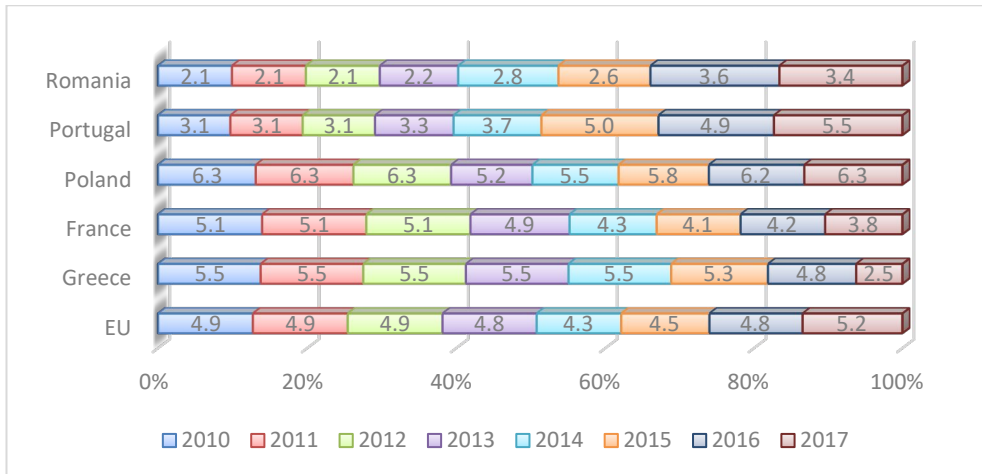
The following five analyzed indicators measure the impact of innovative activities in terms of employment as well as the profit of companies selling innovative products or services.



**Figure 22. Employment in knowledge-intensive activities (% of total employment)**

*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

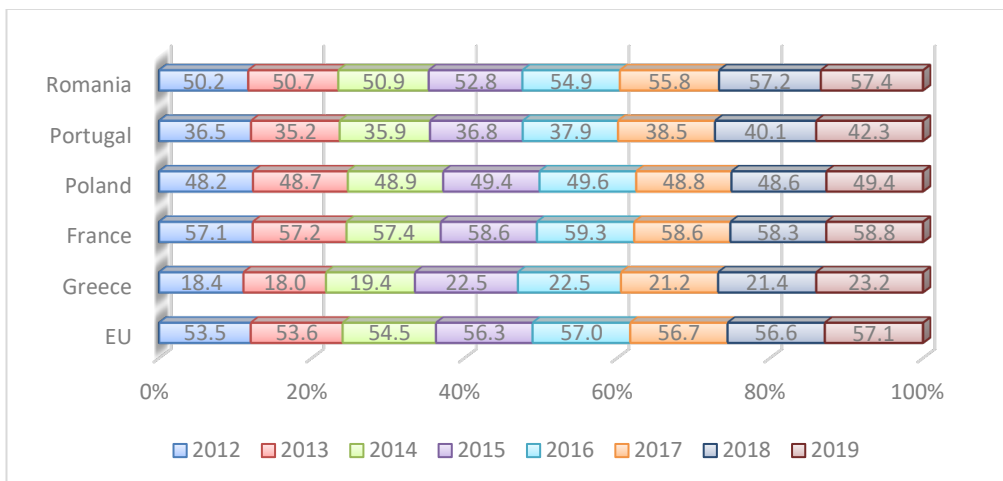
In terms of employment in intensive knowledge, the European average stands at 13.7% of all employment. France is again the only country that exceeds the average, followed by Greece, but below the European level. Portugal, Poland and Romania register an increasing trend, but Romania remains at almost half of France's average.



**Figure 23. % employment in fast-growing enterprises**

*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

Regarding the percentage of employment in fast-growing firms, Poland holds the first position. Portugal is also above the European average, which has grown steadily since 2010. France has been on track since 2010 and Romania is recovering closer to its level. Greece is experiencing a 50% decrease in its performance.

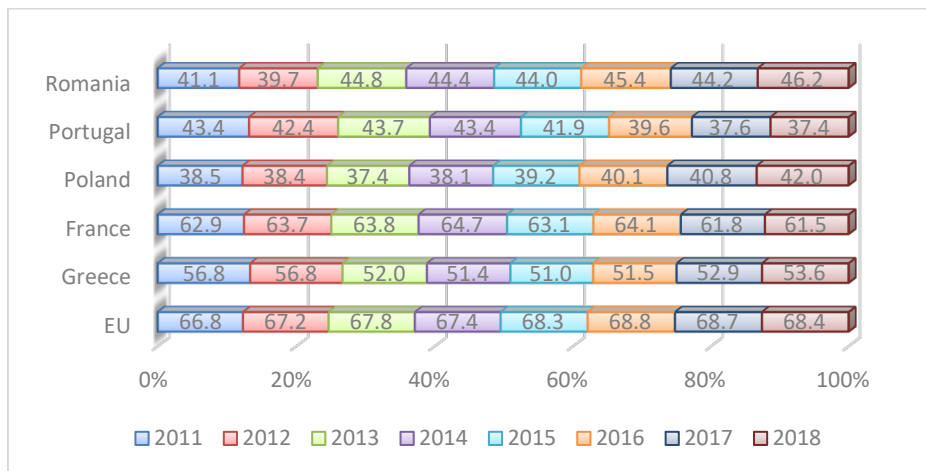


**Figure 24. High-tech exports from total exports**

*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

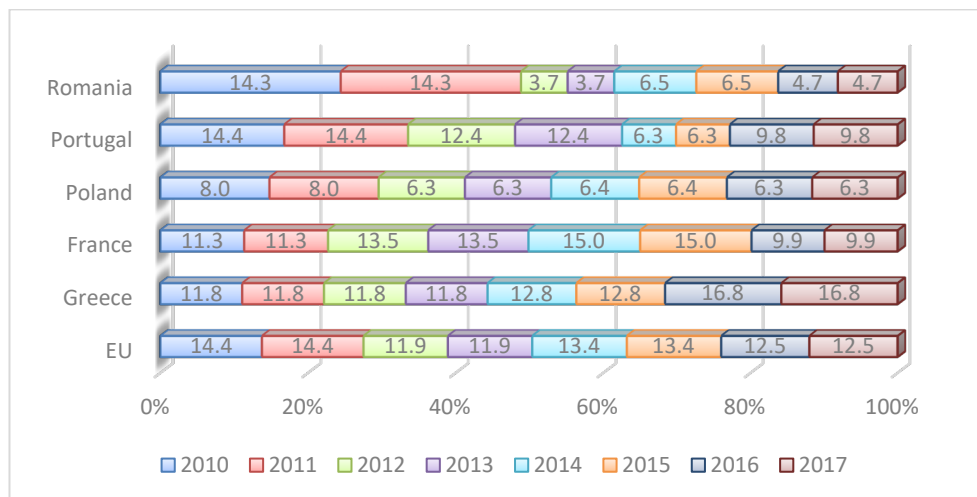
For the last three categories of indicators, variations are observed in the scores of each analyzed country. Thus, for exports of high-tech products, France and Romania situate above the European average. Poland keeps a relatively steady path,

20% below the European average. However, Greece is showing limited progress, situating below the European average.



**Figure 25. Exports of intensive knowledge services (% of total exports of services)**  
*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

In the case of exports of intensive knowledge services, France maintains its leading position, followed by Greece, but below the European average. Romania ranks third, with moderate growth in the last eight years. Portugal's position is declining since 2011, with a slight increase in 2013.



**Figure 26. Sales of new-to-market and new-to-firm innovations as % of turnover**  
*Source:* Authors, own processing, after European Innovation Scoreboard, 2021

The last analyzed indicator is the percentage of sales of new innovations on the market to firms. Greece is improving its situation being above the European

average. France and Portugal are very close to each other, both below the European average. The worst performers are Poland and Romania.

### Conclusions

The study revealed that out of the 27 analyzed indicators, Romania registered upward trends only for: exports of intensive knowledge services, high-tech exports, presence of venture capital funds and broadband penetration. The analysis of innovation activities reveals the constant underfunding of the research and innovation field, which also has repercussions on the quality of scientific activity, the attractiveness of the academic environment and on the number of applications for patents, brands and designs. Romania should put on the list of priorities the reform of the research field, strengthen the relationship between academia and business environment, provide a wide range of services to support the activities of companies aiming to develop businesses capable of leading to the economic growth of the areas where they operate.

It has been observed that countries in the categories of innovation leaders and strong innovators support the scientific results (number of patents, brands and design), the creation of intensive knowledge products that subsequently generate economic activities capable of driving prosperity. Romania needs to exploit the advantages of human capital in the ICT field, as well as the existence of a venture capital financial environment that supports creativity.

Romania needs to step up its efforts in higher education, research and innovation and adopt a strong, open and true entrepreneurial culture, which is essential for fueling and sustaining the value of research and innovation, setting up new businesses and achieving the implementation of market innovations in high-growth sectors. The country should follow the European example and encourage the role of higher education institutions as drivers of innovation, as talented people need to be equipped with the right skills, knowledge and attitudes to create added value.

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