Net Zero 2050 As An Eu Prioty – Modeling a System for Efficient Investment in Eco Innovation for Climate Change Mitigation

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Abstract

Background: Study background is based on the fact that the EU recovery plan envisages investing 30% of the huge budget in climate change, with the goal of zero gas emission by 2050. This ambitious plan will require (for now indefinitely) investment in research and innovation. The main objective of the study is to check and analyze the existing and propose a new model of effective investment in eco-innovation, on the basis of which a contribution to effective long-term investment policy, climate change impact and mitigation of consequences will be given.

Methods: The basic methodological tools for solution of the problems discussed in this study were correlation analysis, regression analysis and paired sample t-test. All calculations were performed in the statistical software SPSS 20. Time series data of the selected indicators were obtained from the European Innovation Scoreboard 2020. Database used to collect the data for EU member countries and selected third countries for the conducted analysis is the European Innovation Scoreboard 2020. To avoid sample selection bias, we considered all of the available data for all member countries and selected third countries in European Innovation Scoreboard 2020 for period 2012 to 2019.

Results: Results of the study are showing the path which developing countries should direct their inevitable and increasing eco-innovation investments, taking into account the arguments of structural differences in financing R&D. According to European Eco-innovation Scoreboard the best eco-innovation performers are Luxembourg, Denmark, Finland, Sweden and Austria. While countries catching up with eco-innovations are Lithuania, Greece, Estonia, Malta, Croatia, Slovakia, Poland, Romania, Cyprus, Hungary, Bulgaria.

Conclusions: Study conclusions are summarized as proposal of appropriate approach of R&D financing model to developing countries with a greater share of eco-innovation and self-sustainable R&D financing for climate preserving products. This study is important as it provides the new evidence on financing R&D investments in leading and developing countries according to Innovation Scoreboards.

Background

The EU recovery plan envisages investing 30% of the huge budget in climate change, with the goal of zero gas emission by 2050. This ambitious plan will require (for now indefinitely) investment in research and innovation. The aim of the paper is to check and analyze the existing and propose a new model of effective investment in eco-innovation, on the basis of which a contribution to effective long-term investment policy, climate change impact and mitigation of consequences will be given.

The Innovation Index is an established mechanism and tool for measuring global, national and regional innovation systems. As an indicator of measuring the increasing impact on environmental and social spheres, systematic financing the R&D as important part of EU Innovation Agenda and Recovery Plan for EU, as well as way to pull developing countries to structure their funds for financing R&D, following the best and most successful examples for financing structures and models. The eco-innovation scoreboard and the eco-innovation index complements other measurement approaches of innovativeness of EU countries and aims to promote a holistic view on economic, environmental and social performance.

The Eco-Innovation Scoreboard (Eco-IS) and the Eco-Innovation Index illustrate eco-innovation performance across the EU Member States. They aim at capturing the different aspects of eco-innovation by applying 16 indicators grouped into five dimensions: eco-innovation outputs, eco-innovation activities, eco-innovation outputs, resource efficiency and socio-economic outcomes. The Eco-Innovation Index shows how well individual Member States perform in different dimensions of eco-innovation compared to the EU average and presents their strengths and weaknesses. The Eco-IS and the Eco-Innovation Index complements other measurement approaches of innovativeness of EU countries and aims to promote a holistic view on economic, environmental and social performance.

Very important process for developing countries is identification of structural differences in financing the R&D between countries Innovation leaders, Strong Innovators, Moderate and Modest Innovators. Indicators which significantly directly or indirectly affect the level of innovation achieved of individual countries are precisely determined by Global Innovation Index, European Innovation Scoreboard, Eco-Innovation Scoreboard etc. This selection of indicators was undertaken pursuant to a particular economic theory and logical interpretation of the influence of financing from different institutions on the Country Performance according to European Innovation Scoreboard. The complementary objective of this work is to compare these dependencies between selected indicators and suggested contextual indicators value within Member states and selected third countries. Based on fact-based Reports which also explores the extent to which differences in the scores of a country in the European Innovation Scoreboard (EIS) can be explained by various socio-economic, demographic, cultural, etc. factors, this analysis find that Innovation leaders use more financing of R&D from business sector. Interesting results emerged when the sample was divided into two groups: group which is mostly financed from public sector and group which is mostly financed from business sector. The results show that structural differences in R&D financing influence on Countries Performance presented in European Innovation Scoreboard. Innovation Leaders have predominantly characteristics of R&D financed from business sector while Moderate and Modest Innovators are significantly lower in business and public funds for financing R&D investments.

Global innovation trends and the innovation performance of 131 economies are presented for more than a decade in Global innovation index 2020. In addition to significant data and fostering innovation debates and policies - a clear question of this year's edition of Global innovation index 2020 is - Who Will Finance Innovation? This endeavour and striving to make the best ratio of investment and results in research and development are more than necessary, especially in terms of searching for sustainable products and services that will be less harmful to the natural environment.

The transition to a climate-neutral, climate-resilient and environmentally sustainable economy will require significant investment. Achieving existing climate and energy targets for 2030 requires additional investments of € 260 billion per year. This figure mainly includes investments related to energy, buildings and part of the transport sector (vehicles). Average investment needs by sector are greatest in the area of building renovation. It is necessary to maintain the
continuity of these investment flows. Significant resources will also be needed in other sectors, notably agriculture, to address wider environmental challenges, including biodiversity loss and pollution, protection of natural capital and support for the circular and blue economy, and for human capital and transition-related social investment.

Digitization is a key driving force of the green plan. Significant investments in Europe's strategic digital capacities and in the development and extensive introduction of state-of-the-art digital technologies will create the preconditions for smart, innovative and tailor-made solutions to address climate issues.

Due to the planned increase in the EU's target for reducing greenhouse gas emissions by 2030, as announced in the European Green Plan, investment needs will increase further. A detailed analysis supporting the Commission's long-term strategic vision for the EU's climate-neutral economy has already suggested that the transformation to a low-carbon economy would require additional investment of up to 2% of GDP by 2040. This deadline may need to be shortened in order to a higher level of ambition was achieved by 2030. Under the Investment Plan for a Sustainable Europe, the investment components of the European Green Plan, sustainable investments of at least EUR 1 trillion will be mobilized in the next decade. This amount of funding for the green transition will come from allocations from the EU's long-term budget, a quarter of which for climate change and an estimated € 39 billion in environmental expenditure. In addition, the Plan will add additional private investment thanks to the effect of the EU budget guarantee under the InvestEU program.

In addition to EU expenditure related to climate action and environmental policy, the Investment Plan for a Sustainable Europe also includes amounts for the Fair Transition Mechanism, which help transition regions most affected. The European Investment Bank will become the Climate Union Bank. She announced that she would gradually increase her share of funding for climate action and environmental sustainability to 50% of total operations in 2025. Cooperation with other financial institutions will also be crucial. While this contribution demonstrates the EU's commitment to funding the European Green Agenda, it alone will not be enough to mobilize the necessary investment. Significant contributions will be needed from both national budgets and the private sector.

According to Gsdam et al. [1], key resources comprise renewable energy plants, which are usually smaller than conventional power plants, but are quite similar to conventional power plants regarding value creation. The revenue model reflects costs that arise from financing, construction, operation and maintenance, and revenues that arise from paying the customer for the amount of electricity delivered. A new tariff for green electricity can increase the revenues.

In different periods, growth, stagnation or decline of economic development, even before, during or after the crisis, a range of new factors, such as venture capitalists, investment funds, biomedical research organizations, sovereign wealth funds, and not-for-profit organizations, are interested in supporting innovation. Innovative process is complex and uncertain even for the experienced and accomplished financial institutions and mechanisms, whether it is private or public funds. World Intellectual Property Organization (WIPO) asserts that even after the crisis mechanisms of innovation such as corporate venturing, intellectually property (IP) marketplaces, crowdfunding, and fintech solutions will not vanish. At the same time, public support schemes remain essential vehicles of innovation financing. Another important source of information related to innovation index at national and regional levels is European innovation scoreboard, which provides a comparative analysis of innovation performance in EU countries, other European countries, and regional neighbors. It assesses relative strengths and weaknesses of national innovation systems and helps countries identify areas they need to address. The latest European innovation scoreboard 2020 was released on 23 June 2020. Based on the previous period 2012–2019 and collected relevant data, main question in this analysis is the extent to which is financing of R&D from business sector has influenced the success of national Innovation index according to European Innovation Scoreboard (EIS). Also, what is the role of public investment in R&D in developed countries and developing countries. Competitiveness indices have been monitored for about 40 years and show the rankings of economies according to current factors that define competitiveness. A review of the relevant literature established the existence of a separate group of indices that measure the competitiveness of economic innovation [2].

According Conway [3], Demirel and Kesidou's study [4] found that whilst regulation is effective in stimulating end-of-pipe solutions to eco-innovations (so-called 'quick-fixes') to environmental emissions, for example) and environmental R&D, internal drivers, such as efficiency, were more responsible for increased investment in cleaner production technologies through equipment upgrades. This is clearly a longer term view but one which requires more financial and organisational investment.

Innovation has received more and more attention in the European Union since adoption of the Lisbon Strategy in 2000. In 2010 the European Commission 2010; European Council adopted a new strategy, Europe 2020, which stressed again the importance of innovations. Therefore, it is important to evaluate the current level of the European Union Member States' technological and economic development as well as its innovations impact on it. As author Okanovic [5] has also comprehensively described in her previous research, "These indices bring innovative changes to the environment and include factors such as: human resources, intellectual property, research systems, networking, sources of funding for innovation, etc. This group includes: The Global Innovation Index, published by the Confederation of Indian Industry along with INSEAD, since 2008; European Innovation Scoreboard, a study published by the European Commission since 2010; Comparison of EU and US Innovation and competitiveness, a study published by The Information Technology and Innovation Foundation since 2006; The Global Cleantech Innovation Index, published by the Cleantech Group and WWF, since 2012; The Global Innovation Policy Index, published by the Information Technology and Innovation Foundation and the Kauffman Foundation, since 2012; The Regional Innovation Scoreboard, a study published by the European Commission since 2010; The Global Innovation Cities Global Index, published by the Global Innovation Agency Thinknow since 2007". Furthermore, eco-innovations are at the heart of European policies. Every effort must be made to ensure that developing countries catch up and raise awareness of the necessity of investing and supporting eco-innovation programmes.

Innovation impact on economic development was analyzed by correlating various composite indices with GDP per capita indicator [6]. European Union Strategies remains strongly focused on fostering innovation. Open innovation, open science and open to the world are the 3 main policy goals for EU research and innovation. Strategy on research and innovation in EU is still very strong and it is based on many actual policy initiatives and practices in European research and innovation. To contribute to research and innovation strategy, European Commission set a new goal, through the Green deal, to become the world's first climate-neutral continent by 2050 is a once in a lifetime opportunity to modernise the EU's economy and society and re-orient them towards a just
and sustainable future. The EU's next research and innovation programme starting in 2021, as a powerful instruments and innovative governance will drive the necessary systemic changes to reach climate neutrality and ensure an inclusive ecological and economic transition. Horizon Europe, in synergy with other EU programmes, will be key to leveraging national public and private investment. Through Green partnerships. There will be a new wave of research and innovation partnerships under Horizon Europe. Partnerships will help drive the huge transformations in environment, society and the economy that the European Green Deal calls for. The EU will work closely with industry and countries to support partnerships in critical areas such as transport - including batteries - clean hydrogen, low-carbon steel, circular biobased sectors, the built environment and biodiversity.

Analyzing the current impact of research and development funding from private and public funds, comparing with the results the goals and trends of developed countries, we could suggest how to construct future R&D investment in developing countries. Differences in economic structures are important. In particular, differences in the share of manufacturing industry in GDP, and in the so-called high-tech activities in manufacturing and services, are important factors that explain why countries can perform better or worse on indicators like business R&D expenditures, PCT patents, and innovative enterprises. Medium-high and high-tech industries have higher technological intensities than other industries. These industries, on average, will have higher R&D expenditures, more patent applications, and higher shares of innovating enterprises. Countries with above average shares of these industries are expected to perform better on several EIS indicators. For example, for the EU27 on average, 85% of R&D expenditures in manufacturing are accounted for by medium-high and high-technology manufacturing industries. Also, the share of enterprises that introduced a product and/or process innovation is higher in medium-high and high-technology manufacturing industries compared to all core industries covered in the Community Innovation Survey [7, p. 10].

The term 'structural indicators' is used (e.g. by Eurostat) to refer to statistical indicators used for a quantitative comparison of performances of territories in selected fields. Furceri and Mourougane [8] point out that such indicators can be both 'perception-based' and 'fact-based'. Both types of indicators have specific advantages and disadvantages. For the purposes of this report, we define structural indicators as independent variables that may influence or determine the behaviour (current values or trends) of innovation indicators used in the EIS (or RIS). These indicators can be thought of as parameters that may influence the medium-to-long run performance of all or parts of a national or regional innovation system. The annual European Innovation Scoreboard (EIS) provides a comparative assessment of the research and innovation performance of EU Member States and selected third countries, and the relative strengths and weaknesses of their research and innovation systems. It helps countries assess areas in which they need to concentrate their efforts in order to boost their innovation performance [7, p.8]. A great number of indicators for monitoring the model of competitiveness, i.e. competitiveness indices, have appeared to monitor the degree of achievement the objectives of these strategies, the level of market development, and the level of competitiveness of national and regional economies at the end of the 20th Century. However, while strategies define clear objectives, the basic problem is the selection of appropriate indicators, which should show the degree of achievement of the set strategies, as well as monitoring and controlling the set objectives [9].

In the previous studies [10] many highlighted problems related to regional disparities and existing research were pointed out, although the European Union has set ambitious goals regarding innovation policies and R&D, there are still problems in achieving the set goal of R&D representing 3% of GDP. Regional disparities have increased over time as well. An objective analysis of achievements and shortfalls is needed so that the required policy changes within a country can be made on time and to the best quality. The existing research has some shortfalls, including static analysis being used in the majority of cases, peculiar results being found in some of the research (namely, findings in which some of the worst-ranked countries in many international rankings have been found to be among the best-performers), and usage of aggregated R&D data without the separation of the sources of (in)efficiencies for individual countries.

In the last century, most of the economic growth theories have been based on innovation-generating processes focusing on the role of productivity, technology change and knowledge, as well as on the role of the actors contributing to them. In the Neoclassical Growth Theory, as developed by Solow [11] and his followers, economic growth in the long-run is the result, within the industrial sphere, of the combination of capital, labour and technological progress (accounted as an exogenous element). Years later, the so-called New or Endogenous Growth Theory proposed by Romer [12] and Lucas [13] introduced the "shift from a resource-based economy to a knowledge-based economy. It underscores the point that the economic processes which create and diffuse new knowledge are critical to shaping the growth of nations, communities and individual firms" [14]. According to Romer [12], "under the new system, firms will increasingly take advantage of each person's innate curiosity and willingness to experiment...every worker in an organization, from top to bottom, can become a 'knowledge' worker if given the opportunity to do so".

Cavallini et al. [15] emphasize that both the Triple Helix (TH) concept and the Quadruple Helix (QH) approach are grounded on the idea that innovation is the outcome of an interactive process involving different spheres of actors, each contributing according to its 'institutional' function in society. Traditional protagonists of the TH are University (UNI), Industry (IND), and Government (GOV). Civil society (CIV) is the additional sphere included in the QH. Contribution to innovation is envisaged in terms of sharing of knowledge and transfer of know-how, with the helices models assigning and formalising a precise role to each sphere in supporting economic growth through innovation.

Author Iliina [16] asked if we could expect more of qualitative factors in fostering innovation competitiveness of Moderate and Modest Countries. The problem of competitive sustainability ensuring in case of R&D sector is multidimensional. On the one hand there is the lack of public funding and support of R&D, on the other hand, there is the lack of effective communication between science and the real sector of economy, ensuring the effectiveness in usage of R&D in practice.

The state's role is complementary to the private sector, but yet fundamental due to its capacity to mobilise national resources and its capability to stimulate innovations or whole new sectors when market fails to do so [17]. Lundvall et al. [18, p.227] underline the need to coordinate various policy areas to support development strategies at the national level. As is the case with some post-socialist economies, governance capacities may not be supportive enough of smart specialisation strategies to really stimulate growth through innovations [19, p.169].

With this research, we want to examine the impact of business and public funding on Innovation index positioning in EU and selected third countries, how much available resources are well distributed, which countries had a better investment and result ratio. Also, we are discussing and concluding with the results
which impact has led to better results of certain countries.

**Methods**

Research sample includes EU Member States, which fall into four performance groups: 1. Innovation Leaders includes 5 Member States where performance is above 125% of the EU average. The Innovation Leaders are Denmark, Finland, Luxembourg, Netherlands and Sweden. 2. Strong Innovators includes 7 Member States with a performance between 95% and 125% of the EU average. Austria, Belgium, Estonia, France, Germany, Ireland, and Portugal are Strong Innovators. 3. Moderate Innovators includes 13 Member States where performance is between 50% and 95% of the EU average. Croatia, Cyprus, Czechia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, and Spain belong to this group. 4. Modest Innovators includes two Member States that show a performance level below 50% of the EU average. This group includes Bulgaria and Romania. The basic methodological tools for solution of the problems discussed in this study were correlation analysis, regression analysis and pared sample t-test. All calculations were performed in the statistical software SPSS 20. Time series data of the selected indicators were obtained from the European Innovation Scoreboard 2020. A correlation analysis was used to examine the association between the three parameters between the overall innovation index with R&D expenditures in the public sector, business sector and public-private co-publications for the period from 2012 to 2019. A pared sample t-test was used to examine the differences in relation to the dominant sector of investment in innovation. Regression analysis was applied to predict the Innovation index based on independent variables (investment in the public and business sectors).

The observed indicators were selected with the aim to point out how much impact on performance and the result of the innovation index ranking, have investments in R&D, from the private and public sector in developed and developing countries. For developed countries we used the first ten countries with the highest Innovation index. The countries with the highest innovation index are: Switzerland, Sweden, Finland, Denmark, the Netherlands, Luxembourg, Belgium, Great Britain, Norway and Germany. For the developing countries we used countries with the lowest innovation index: Ukraine, Romania, Montenegro, Macedonia, Bulgaria, Croatia, Poland, Serbia, Turkey, Latvia, Slovakia and Hungary.

Database used to collect the data for EU member countries and selected third countries for the conducted analysis is the European Innovation Scoreboard 2020. To avoid sample selection bias, we considered all of the available data for all member countries and selected third countries in European Innovation Scoreboard 2020 for period 2012 to 2019. Descriptive statistics were already used in the evaluation and processing - they are used to describe the sample and in our case is used to describe the difference between each individual parameter for each country, which is already presented in European Innovation Scoreboard 2020.

**Results**

Correlation analysis were used to examine whether there is a significant relationship between the overall innovation index with R&D expenditures in the public sector, business sector and public-private co-publications for the period from 2012 to 2019.

**Tab. 1: Correlation coefficients between the summary innovation index and R&D financing by public and business sector.**

| Variable                  | Summary Innovation Index |
|---------------------------|--------------------------|
| R&D expenditure in the public sector | 0.759**                  |
| R&D expenditure in the business sector | 0.756**                |
| Public-private co-publications | 0.857**              |

The Pearson's correlation coefficient for 37 countries was calculated for time period of eight year. The asterisks represents significant differences ($p < 0.01**$).

Source: own research, based on European Innovation Scoreboard, Eurostat

Based on correlation coefficient it could be concluded that there was medium positive significant correlation between the overall innovation index with R&D expenditures in the public sector and the business sector as well as a high positive significant correlation between the overall innovation index and public-private co-publications. Based on the positive correlation coefficient, it could be concluded that with higher expenditures in the public and business sectors, there is an increase in the innovation index for the observed countries in Europe.

An additional observation was made, whether there were statistically significant differences in public and business sector expenditures for the ten countries in Europe with the highest Innovation index. Paired sample t-test was used to examine the differences in relation to the dominant sector of investment in innovation. Results of this observation pointed out differences in investment from the public and business sectors for the total period from 2012 to 2019, and then for each year individually (Table 2).

**Tab. 2: Differences in investment from the public and business sectors for the countries with the highest innovation index for the period from 2012 to 2019.**
R&D expenditure in the public sector | R&D expenditure in the business sector | p value
--- | --- | ---
Total period from 2012 to 2019 | 0.849 ± 0.236 | 1.534 ± 0.604 | < 0.005**
For 2012. | 0.829 ± 0.185 | 1.593 ± 0.637 | 0.001**
For 2013. | 0.84 ± 0.172 | 1.586 ± 0.62 | 0.001**
For 2014. | 0.838 ± 0.178 | 1.575 ± 0.577 | 0.001**
For 2015. | 0.851 ± 0.176 | 1.61 ± 0.589 | 0.001**
For 2016. | 0.849 ± 0.179 | 1.622 ± 0.575 | 0.001**
For 2017. | 0.853 ± 0.189 | 1.655 ± 0.592 | 0.001**
For 2018. | 0.842 ± 0.201 | 1.694 ± 0.571 | < 0.005**
For 2019. | 0.895 ± 0.501 | 0.939 ± 0.517 | 0.709

The asterisks represents significant differences (p < 0.01**).

Source: own research, based on European Innovation Scoreboard, Eurostat

The significance of paired sample t-test is lower than the threshold level of significance (p =0.05) for all years except for 2019, based on which it could be concluded that there are statistically significant differences in investment from public and business sector for countries with higher innovation index. In the countries with the highest innovation index, more is invested from the business sector compared to the public sector (Figure 1).

We observed whether there were statistically significant differences in public and business sector expenditures for the ten countries in Europe with the lowest innovation index. Paired sample t-test was used to examine differences in relation to the dominant sector of innovation investment for developing countries. We observed differences in investment from the public and business sectors for the total period from 2012 to 2019, and then for each year individually (Table 3).

Tab. 3: Differences in investment from the public and business sectors for developing countries with the lowest Innovation index for the period from 2012 to 2019.

| R&D expenditure in the public sector | R&D expenditure in the business sector | p value |
--- | --- | ---
Total period from 2012 to 2019 | 0.362 ± 0.138 | 0.364 ± 0.246 | 0.954
For 2012. | 0.398 ± 0.109 | 0.337 ± 0.204 | 0.177
For 2013. | 0.379 ± 0.099 | 0.337 ± 0.236 | 0.559
For 2014. | 0.308 ± 0.112 | 0.353 ± 0.238 | 0.717
For 2015. | 0.414 ± 0.171 | 0.379 ± 0.261 | 0.720
For 2016. | 0.325 ± 0.107 | 0.377 ± 0.243 | 0.511
For 2017. | 0.335 ± 0.111 | 0.398 ± 0.261 | 0.424
For 2018. | 0.354 ± 0.123 | 0.435 ± 0.31 | 0.389
For 2019. | 0.31 ± 0.226 | 0.324 ± 0.251 | 0.881

The asterisks represents significant differences (p < 0.01**).

Source: own research, based on European Innovation Scoreboard, Eurostat

The significance of the paired sample t-test is higher than the significance level (p <0.05) for all years, based on which it could be conclude that there are no statistically significant differences in investment from the public and business sectors for countries with the lowest innovation index. In the countries with the lowest innovation index, the amount of invested funds from the public and business sector varies from year to year, but this difference in investment is not significant.

When we look at the ranking on the list, there are significant differences in the performances of these two groups. For example, in developed countries, investment from the business sector is far greater than in the public sector (Figure 3). The only year that stands out is 2019. For developing countries, there is no statistical significance in the differences between the public and business sectors. Values vary from year to year, but investments in R&D from both the public and business sectors are drastically less than in developed countries.

Factors why developed countries invest more in R&D than developing countries probably the reasons are most likely to be found in analyses of contextual indicators value within Member states and selected third countries. Based on fact-based
Reports which also explores the extent to which differences in the scores of a country in the European Innovation Scoreboard (EIS) can be explained by various socio-economic, demographic, cultural, etc. factors, this analysis find that innovation leaders use more financing of R&D from business sector. The right answer is how to increase investment in developing countries when the most of elderly population remains, the impoverished state policies are missing. What will be the right model which would improve investment in developing countries, both from the public and from the business sector.

The regression analysis is applied to predict innovation index based on investments in the public sector and for the business sector. Models obtained with regression analysis were presented in Figure 4 and in the Figure 5. Investments in the public sector could be used for prediction on innovation index based on obtained statistically significant model (p < 0.0005). The coefficient of determination is 0.649, and model explains 64.9% of total variance. Investments in the business sector also could be used for prediction on innovation index based on obtained statistically significant model (p < 0.0005). The coefficient of determination is 0.625, and model explains 62.5% of total variance.

The regression models in Figure 4 and in the Figure 5. showing the results of analysis whether the innovation index can be predicted individually based on investments in the public sector are shown (Figure 4) and for the business sector also (Figure 5). Based on investments in the public sector, a statistically significant model is obtained (p < 0.0005) on the basis of which we can conclude that the innovation index can be predicted based on investments in the public sector. The coefficient of determination is 0.649 and based on the obtained model, 64.9% of the total sample was explained. Based on investments in the business sector, we obtained a statistically significant model (p < 0.0005) on the basis of which we can conclude that the innovation index can be predicted based on investments in the business sector. The coefficient of determination is 0.625 and based on the obtained model, 62.5% of the total sample was explained.

In Figure 6, by multiple regression analysis we assay to predict Innovation index based on investment in the public and business sectors. The obtained model is statistically significant (p < 0.0005) and could be used for prediction of the innovation index on the basis of investments in the public and private sector. The coefficient of determination is 0.748, and model explains 74.8% of total variance. The obtained model is more precise than the models of predicting the innovation index based on individual investments in the public and business sector.

Fundamentally, the pandemic has not changed the fact that the potential for breakthrough technologies and innovation continues to abound. Clearly, the top companies and R&D spenders would be ill-advised to drop R&D, IP, and innovation in their quest to secure competitiveness in the future. Many top R&D firms in the information technology sector, for example, hold vast cash reserves, and the push to digitalization will fortify innovation [20, p.18]. As EU tends to foster green research and innovation investments, other key possible opportunity sectors, such as sustainable transport, will have to adapt faster as the quest for "clean energy" is receiving renewed interest. The pharmaceuticals and biotechnology sector, another top R&D spender, is likely to experience R&D growth boosted by the renewed and consequential focus on health R&D. But whatever potentially growing sector we talk about, we will have the imperative of sustainability and green innovation.

If we look at the individual efforts of firms to invest in research and development to increase their performance and market success, there is no conclusive evidence that more innovative firms grow more [21]. Some studies for both the developed countries' context and the emerging market context find positive evidence for this link, though. For the UK, Mason, Bishop and Robinson [22, p.5] find that high-growth firms innovate more, and firms that are more innovative achieve higher growth. A study on Brazilian firms finds that product innovations, especially when combined with process innovations, drive their sales growth [23, p.19]. A large study found that innovative firms create more jobs than non-innovative ones, and that they also exhibit faster productivity growth throughout the business cycle [24, p.160]. On the other hand, Freel and Robson [25], for Scotland and Northern England, do not find evidence for the link between innovation and different measures of firm growth that is equally straightforward. We can find different narratives about who creates value and where that value is created, how efficient is investment in research and development - is investing from public sector less efficient than business sector... Our findings support the thesis that investment in R&D is low in developing countries, while in developed EU countries there is more investment in R&D from the business sector, for the period 2012-2019.

**Discussion**

As Homski [26] points out that the empirical results occurred to be consistent with the research hypotheses – the public sector's share in the R&D financing structure affects the efficiency of the R&D sector positively, while the private sector's share affects it negatively. Such a view goes in line with assurances and evidence which expresses by Mazzucato that an entrepreneurial society needs an entrepreneurial state, one that through visionary and strategic public investments, distributed across the innovation chain, can create animal spirits in private businesses. Entrepreneurs then see growth opportunities, and business investment follows. Mazzucato [27] asserts that we need to 'replace our current parasitic system with a more sustainable, symbiotic type of capitalism', at a time when the public sector is much maligned, that government has played a powerful innovative role in the modern economy, creating much of the technology behind the world's most successful companies.

Creative industries represent activities based on individual creativity, skills and talents that have the potential to accumulate revenue and opening up new jobs through the creation and exploitation of various forms of intellectual property. Specific dimensions of innovation, viewed in a wider context, relate to the support of the development of eco-innovation and green economics, or the transformation of environmental challenges into a business opportunity. Improving energy efficiency and resource efficiency, as an integral part of environmental care, has become an important requirement of modern business. In the following period, it is very important to build and strengthen the capacities of the national innovation system as a whole, which will effectively enable the linking of science, government and business entities and support the highly innovative SMEs, enable greater use of foreign funds available for these purposes, and encourage companies to innovatively think. It is also necessary to provide support for eco-innovation, improvement of energy efficiency and efficiency of resource use in SMEs and development of innovative entrepreneurial ventures in the field of creative industries.
The main role and key importance of the Quadruple helix model is also confirmed in the strengthening of human resources for innovation and cooperation (recruiting staff from the economy and the public sector by universities and hiring staff and students from universities in the economy and the public sector), thus creating even more room for innovation processes. First of all, by creating regional innovation strategies, we assist all actors in the innovation process in order to build comparative advantages, based on technological improvement - strengthening relatively weak sectors, but not neglecting stronger branches. The tendency of fostering development at different levels of regional development contributes to reducing variations in regional development, which further results in increased regional and national competitiveness. In addition, through the development, implementation and monitoring of the indicators of quadruple helix model, the analysis and synthesis of the relationship and mobility in the quadruple helix institutional sphere (at the local, national, international level), we can have a clearer picture of the reality of measuring the efficiency of innovation processes and the use of knowledge.

Conclusions

Data analysis confirmed the first hypothesis that investment in research and development by the business sector has affected the position on the list of Countries Innovative Performances of European Innovation Scoreboard. Investing in innovations and it is implementation has led to huge economic growth and development, people's wellbeing and countries prosperity, but also to enormous degradation of natural environment. Today, we're struggling to push innovation which will be sustainable for human society, as well as survival of natural environment. The question is who will finance more radical turnover towards sustainable renewable energy resources, private or public.

On the other hand, the second hypothesis - state-funded research and development funding is dominant in lower-ranked countries - has not been confirmed, but the result has provided us with additional insight into the overall funding of R&D in developing countries, which is at an extremely low level by both the business and public sectors.

The proposal of a new model for investing in eco-innovations would be oriented towards predominantly higher investment from the business sector, because in the case of the global innovation index it was shown that the best performers had a structural difference compared to the less successful ones. And that is - more investment in R&D by the business sector. Under the condition that the state and all public institutions provide stable legal frameworks and correctly defined intellectual property rights.

For societies and countries in former (or not well done) transition, in developing countries, investing in the use of knowledge and innovation can regain the confidence of society in state institutions, and strengthen the influence of civil society organizations (including universities, businesses and state institutions) as the fourth pillar in the long process of building an innovative knowledge-based society and creating a stable regional and national innovation systems. In order to examine the development of innovation capacities in Moderate and Modest Innovators countries from the Quadruple Helix perspective, the results of work emphasize the necessity of understanding the context of regional/national innovation systems of countries in transition. Transition and transformation in a society induced by integration into the European Union, as well as the preparation of this process, have the main goal of assessing the impact of EU integration on reforms and implementation of superior national policies of the R&D, new programs, actors, infrastructure, institutional framework, strengthening links in scientific research industry, commercialization of research, internationalization, etc. Investing – but not only finances - in the use of knowledge and innovation can regain the confidence of society in state institutions, and strengthen the influence of civil society organizations (including universities, businesses and state institutions) as the fourth pillar in the long process of building an innovative knowledge-based society and creating a stable national innovation system.

Global challenges in the information and digital sphere, health, environmental protection and all areas affected by disruptive forces can be turned into opportunities for economic growth, through the implementation and joint complementary action of the main elements of the quadruple helix model. As such, the quadruple helix model can create a better way of coordination to improve productivity, production volume and innovation. With a positive attitude towards the use of knowledge and innovation, we can create more economic, state and financial institutions interested in investing in innovation, especially in the SME sector.

As pointed out by World Intellectual Property Organisation, every crisis brings opportunities and room for creative disruption. One side effect of the current crisis has been to stimulate interest in innovative solutions for health, naturally, but also for areas such as remote work, distance education, e-commerce, and mobility solutions. Unleashing these positive forces may well support societal goals, including reducing or reversing long-term climate change.

The shortcoming of this analysis - the unavailability of information on eco-innovation indicators in the Western Balkans countries is precisely the chance to expand and deepen the topic of investing in eco-innovation. By correctly measuring and monitoring the level of eco-innovation in the countries of the Western Balkans, it is possible to contribute to the global goal of reaching net zero emissions by 2050. Another important challenge and necessary factor is to motivate the business sector to invest in eco-innovation. Not only because of new inflows and more sustainable products, but also because of the long-term impact on our own environment and mitigation of the consequences of climate change.

Abbreviations

R&D (Research and Development)
Eco-IS (Eco-Innovation Scoreboard)
EIS (European Innovation Scoreboard)
WIPO (World Intellectual Property Organization)
Declarations

Ethics approval and consent to participate
Not applicable

Consent for publication
Not applicable

Availability of data and materials
Not applicable

Competing interests
The authors declare that they have no competing interests.

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Authors' contributions

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**Figures**
Figure 1
R&D expenditure for countries with the highest summary innovation index
Source: own research, based on European Innovation Scoreboard, Eurostat

Figure 2
R&D expenditure for countries with the lowest summary Innovation index
Source: own research, based on European Innovation Scoreboard, Eurostat
Figure 3
R&D expenditure for time period from 2012 to 2019 for summary Innovation index. Source: own research, based on European Innovation Scoreboard, Eurostat.

Figure 4
Total Innovation index in relation to investment in the public sector. Source: own research, based on European Innovation Scoreboard, Eurostat.
Figure 5

Total Innovation index in relation to investment in the business sector
Source: own research, based on European Innovation Scoreboard, Eurostat

Figure 6

Total innovation index in relation to investment in public and business sector
Source: own research, based on European Innovation Scoreboard, Eurostat