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**SUSTAINABLE DEVELOPMENT DISPARITIES IN THE EU-27
BASED ON R&D AND INNOVATION FACTORS****Marius Constantin^{1*}, Mihai Dinu², Simona Roxana Pătărlăgeanu³
and Cristian Chelariu⁴**^{1),2),3)} *Bucharest University of Economic Studies, Bucharest, Romania*⁴⁾ *Suffolk University, Boston, Massachusetts, USA***Please cite this article as:**Constantin, M., Dinu, M., Pătărlăgeanu, S.R. and Chelariu, C., 2021. Sustainable Development Disparities in the EU-27 Based on R&D and Innovation Factors. *Amfiteatru Economic*, 23(Special Issue No. 15), pp. 948-963.**DOI: 10.24818/EA/2021/S15/948****Article History**

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Abstract

Ever since it was adopted in 2015 by the United Nations, the 2030 Agenda for Sustainable Development has acted as the main guideline for European Union Member States in regard to achieving economic prosperity, environmental sustainability and peaceful, inclusive and innovative societies. However, in the race for sustainable development, some European Union Member States are ahead of the others – not only as far as meeting the Sustainable Development Goals is concerned, but from the perspective of the R&D and innovation factors as well. In this context, the objective of this research was to explore sustainable development disparities between the EU-27 Members, based on the previously mentioned factors. A cross-sectional multiple linear regression model was constructed to facilitate an in-depth look at the observations. The econometric analysis was carried out based on the Global SDG Index, the Global Innovation Index and on the percentage of the GDP allocated to R&D activities. Although the transition to the sustainable development model requires modern and disruptive approaches at country level, the literature is not rich on papers fully covering the nature of the existing links between the variables analyzed in the proposed econometric model. Results show that countries from Northern and Western Europe are leading the change to a more innovative and sustainable path for the European Union. This implies the responsibility of high levels of R&D expenditure. Although no European country is on track on meeting the Sustainable Development Goals, Central and Eastern European Countries have made a lot of catching up to the Northwestern European leaders. The results of this research help decision-makers improve their strategies by understanding the impact of R&D and innovation factors on meeting sustainable development throughout EU-27 at an equitable pace for all European members.

Keywords: sustainability, sustainable development disparities, research and development, innovation, budgetary allocation, policy harmonization

JEL Classification: Q01, C21

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Introduction

In September 2015, the United Nations agreed and approved the 2030 Agenda for Sustainable Development, a document that contains a well-thought set of measures aimed to balance economic progress and environmental protection, all while considering the necessity to address the existing disparities between highly industrialised countries and those that are still developing. In the Agenda, 17 Sustainable Development Goals (SDGs) were formulated, each with its own specific.

For the European Union (EU), entrepreneurship, innovation and R&D activities are essential factors that help overcoming global societal challenges and set the path to economic prosperity in a sustainable manner (Vollenbroek, 2002). This is also instilled in the 2030 Agenda for Sustainable Development (United Nations, 2015), as many of the 169 indicators refer to the innovation and R&D factors, in tight connection with sustainable development progress (Popescu, 2020).

Horizon Europe 2021-2027 has a total budget of 95.5 billion EUR, structured as it follows: more than half is allocated to increasing industrial competitiveness and global challenges in Europe; 25% is dedicated to research and scientific excellence; 13.6% is allocated for an innovative Europe and 3.4% is dedicated to widening participation and strengthening the European research area. The program focuses on cutting-edge research and innovation in Europe, being directly linked to the goals of sustainable development by funding research on climate change, soil and food health, sustainable natural capital management, smart and climate-neutral cities, management of oceans, seas, waters, etc (European Commission, 2021). By implementing this program of research-development-innovation, on the one hand, achieving the goals of the 2030 Agenda for Sustainable Development is pursued, and, on the other hand, economic growth and competitiveness are pursued as well.

The EU supports the Just Transition through various strategies (Voicu-Dorobanțu et al., 2021) that call for a more resource-efficient and decarbonized economy, achievable by resorting education, innovation and R&D activities (Dinu et al., 2020; Istudor et al., 2020). Innovation and R&D are the main pillars that foster and connect new ideas with market realities, enabling societal and economic development, especially through entrepreneurship, sustainable competitive advantages (Olaru et al., 2015).

However, besides the improved living conditions in EU countries brought by innovation and the exacerbated development rhythm of new technologies, these factors have also intensified socio-economic development disparities (Billon et al., 2017). Reducing development disparities between EU Member States is one of the strategic goals of integration: cohesion (Istudor, 2006; Bachtler and McMaster, 2008). Considering the importance of EU cohesion into account, the objective of this research was to carry out an econometric analysis on the sustainable development disparities in the EU-27 based on R&D and innovation factors.

The originality of this paper resides in the fact that sustainable development disparities were highlighted based on the country-level impact of R&D and innovation factors in the EU-27, as well as on the fact that results are based on a methodological econometric framework specific to linear cross-sectional regression models. The paper emphasized the need for cohesion in countries that encounter issues in converging towards the EU-27 average. Also regarding the factor related to the novelty of the paper, its results bring new perspectives and provide answers to the following questions: (a) How profound are the

existing disparities between the EU-27 members in terms of the degree of sustainable development progress and what is the impact of the R&D and innovation factors on these the generation of these disparities?; (b) Which EU-27 members lead the change to the sustainable development model and which members encounter issues in keeping up with the average EU-27 sustainable development performance? Consequently, the objective of this research was to comparatively study sustainable development disparities in the EU-27 based on R&D and innovation factors.

The article is structured in three sections: (a) literature review, section in which papers approaching the topic specific to the relation between research-development-innovation and sustainable development are discussed, (b) research methodology, a section that explains the econometric approach, the source and method of data collection and processing, (c) the section dedicated to research results discussions, which explains the implications of allocating funds for research-development-innovation in relation to the existence of sustainable development disparities among the EU-27 states. Lastly, the conclusions of the study are discussed, as well as the limits of this research and future future avenues.

1. Literature review

Sustainable development and innovation are topics often addressed in the literature, especially after 2015. There is convergence towards the view that performance, from the perspective of sustainable development, cannot be achieved without innovation (Silvestre and Țircă, 2019). The complexity of sustainable development and the multitude of its dimensions involve creativity in the process of adapting to new societal changes, economic systems, consumption and production models. In this context, innovation is a bridge that facilitates the continuous transition to a more sustainable future.

At the same time, the literature contains many papers that explain the need for equity and cohesion, including in the field of sustainable development (Walkowiak, Usubiaga and Schepelmann, 2012; Bădîrcea et al., 2021). Since the early 1980s, the EU's operational programs dedicated to R&D and innovation have aimed at economic growth and improving the EU's competitiveness. Over the last decades, the two above-mentioned objectives have been pursued in EU policies, but the emphasis has also been on the sustainable development component and on harmonizing these policies in relation with the public goods management, protecting the natural capital, natural resources management and other elements related to sustainable development (Constantin et al., 2021). Integrating and harmonizing sustainable development goals in programs, such in the case of Horizon Europe, represents an evolution in broadening EU's vision and goals for sustainable development (Kastrinos and Weber, 2020; Calabrese et al., 2021).

The issue of disparities in the EU is a topic of interest in the literature (Medeiros, 2017; Vintar Mally, 2018; Védrine and Gallo, 2021), but disparities in sustainable development are not often addressed in terms of the impact of R&D and innovation factors on generating disparities for sustainable development. In the context of the COVID-19 pandemic, sustainable development disparities are accentuated due to the socio-economic and sanitary time of crisis characterized by job insecurity, instability (Nemteanu, Dinu and Dabija, 2021), food insecurity (Wolfson and Leung, 2020), transportation issues (Sy et al., 2021). Transitioning to new sustainable economic models and the cohesion towards a more sustainable and prosperous future were already complex and long-lasting processes before

COVID-19's outbreak in 2020. However, there are signs of economic (Cifuentes-Faura, 2021; Wang and Zhang, 2021) and societal recovery (Denny-Smith et al., 2021; Luo, 2021).

The literature convergences towards the importance of understanding the necessity of equity and cohesion, including in the field of sustainable development. Szopik-Depczyńska et al. (2017) conducted a comparative analysis of the disparities between EU members regarding sustainable development through the lens of ten indicators specific to eight themes: socio-economic development, sustainable production and consumption, sustainable transport, public health, social inclusion, demographic changes, climate change and energy, global partnership. The results of their study brought into the spotlight the following: (a) the greatest deterioration was noticed between Southern European; (b) the Kingdom of the Netherlands and France were in the top of rankings and stood out in favor of the other European countries; (c) Bulgaria and Malta were placed on the least favorable positions, at the bottom of all rankings. However, none of the indicators analyzed in the research carried out by Szopik-Depczyńska et al. refer to the innovation and R&D factors as the vectors of sustainable development.

Turcea (2020) studied the performance of the Danish and Romanian sustainable development strategies through the lens of the progress made towards meetings the SDGs, aiming to highlight the disparities between Denmark, a pioneer in terms of implementing the 2030 Agenda, and Romania, one of the countries situated at the bottom of the performance ranking in the field of sustainable development. Xu et al. (2020) conducted a systematic quantitative research to measure the progress towards meeting the 17 SDGs at national levels, arguing for the importance of tracking spatial-temporal dynamics aspects related to the implementation of the 2030 Agenda, as that helps identifying sustainable development disparities. Pîrvu et al. (2019) developed an hierarchical cluster analysis on the implementation of the EU cohesion policy the context of sustainable development, through the lens of national performance in this regard. The authors concluded that the EU cohesion policy should be reoriented from investing in infrastructure and providing social support in underdeveloped regions to focusing on innovation and R&D.

Another comparison-based analysis of the existing disparities between European countries can be found in the study of Fura et al. (2017). The authors pointed to the fact that the most noticeable disparities in terms of sustainable development were observed between the 'old' and 'new' European members, similar to the disparities observed between the highly developed Western European countries and Southern European ones. The quantitative research carried out by Fura et al. (2017) involved the analysis of 16 indicators meant to assess the progress towards sustainable development, but only one of them touched the subject of the importance of the gross domestic expenditure on R&D (% of GDP).

The research carried out in this paper differs from the others in that the disparities in sustainable development are addressed in a quantitative way, in terms of the impact of the budget allocation on research-development-innovation and in terms of the culture of innovation within the EU-27. Moreover, this research focuses on identifying the links that generate the extremities of disparity in sustainable development.

2. Research methodology

This research was conducted based on the multiple cross-sectional linear regression model: least squares method. The main reasons for choosing this research method are (a) it enabled establishing what is the proportion of variance of the selected exogenous variables (specific to innovation and R&D activities) that explains the variance of the endogenous variable (SDG index); (b) it facilitated focusing on each particular observation (each EU-27 member) and its deviation from the linear model – therefore signalling sustainable development disparities. This type of econometric analysis is often resorted to in the literature (Sarafidis and Wansbeek, 2012), as it is well-grounded. There are cross-sectional quantitative studies aimed at approaching the topic of sustainable development from different angles: in relation to the impact of economic activities on natural capital (Khan, 2020); in relation to the impact of digital transformations on globalization and natural capital management (Ulucak, Danish and Khan, 2020) and in relation to other similar issues. By resorting to the cross-sectional regression methodology as well, this quantitative research approaches sustainable development from the perspective of the existing disparities within the EU-27 from the perspective of the R&D and factors factors.

Three datasets from different sources were extracted and used to construct the econometric model. In order to assess the degree of meeting the SDGs in the case of the selected European countries in this econometric model, the SDG index was used from the 2020 Sustainable Development Report, prepared by Sachs et al. (2020) at the Sustainable Development Solutions Network and the Bertelsmann Stiftung. This index was calculated using a mix of data from FAO, WHO, World Bank, OECD, UNICEF, which undertook an extensive data-validation process. The SDG index undergone through different stages: (a) censoring extreme values; (b) rescaling data to ensure indicator compatibility; (c) aggregating indicators within and across SDGs, (d) making data comparable: rescaled from 0 (proxy for worst performance) to 100 (proxy for optimum in relation with the SDGs and specific targets). The second dataset included in this quantitative analysis refers to the innovation factor. Data were extracted from the 2020 Global Innovation Index Report (Cornell University et al., 2020). This index encapsulates innovation through the lens of five pillars of national economies: (a) institutions; (b) human capital & research; (c) “business sophistication”; (d) infrastructure; (e) “market sophistication”. Additionally, other elements such as knowledge management, technology and creativity were considered when composing the innovation index. Data were treated and normalized: an index value closer to 0 is proxy for a poor performance in terms of innovation, whereas values closer to 100 are proxy to highly innovative economies. Regarding the R&D factor, data were extracted from Eurostat (2021) and refer to the following indicator: percentage of the GDP expenditure allocated to R&D activities (indicator code: SDG_09_10). Designed to monitor progress towards EU’s target of fostering innovation, research and development in proper adequate conditions, this indicator measures the gross domestic expenditure on R&D as a percentage of the gross domestic product (GDP). There are numerous studies arguing for the importance of R&D, entrepreneurship and innovation for empowering sustainable development in the EU (Banacu et al., 2019; Ionescu et al., 2020; Popescu et al., 2020).

Diaz- Sarachaga et al. (2018) carried out a research focused on evaluating the nature of the SDG index, aiming to ascertain its credibility as metric of high accuracy and representativeness at country-scale. While there are some limitations of such an index: (a) unquantifiable metrics undermine the greater sustainability extent of the 2030 Agenda;

(b) some socio-economic factors prevail over other sustainability-oriented factors, such as the natural capital; (c) the proportion of SDG index indicators approached per sustainability dimension could potentially alter the evaluation of sustainable development as described in the 2030 Agenda. In this regard, this is one of the reasons why research approaches per sustainability dimension are more adequate for studying the effects of multiple factors on only one dimension at a time. In the case of this research paper, the previously mentioned approach was transposed into practice – the impact of innovation and R&D on the sustainable development was studied in a quantitative manner. Frugoli et al. (2015) also consider that indices cannot fully encapsulate the full implications of sustainable development, which is why measuring it becomes difficult, especially in relation with goals, such as the ones undertaken in the 2030 Agenda. However, they contribute to generally describing the bigger picture of a complex phenomena, such as the one of sustainable development progress in the EU.

3. Results and discussions

The comparative analysis of sustainable development disparities in the EU-27 based on R&D and innovation factors began by analyzing the descriptive statistics of the relevant indices and indicators, included in Table 1. All three analyzed series follow similar distributions: (a) there is a tendency towards positive asymmetry (Startz, 2019) due to the 0.38 Skewness value in the case of the SDG and Innovation indices and 0.59 in the case of percentage of the GDP expenditure allocated to R&D activities; (b) there is a slight tendency towards a flat distribution (platykurtic) due to the 2.46 Kurtosis value in the case of the SDG Index, even more accentuated in the case of the Innovation index (2.13) and percentage of the GDP expenditure allocated to R&D activities (2.07). These statistics signal sustainable development disparities in the EU-27.

From the perspective of sustainable development, the maximum of 84.72 of the SDG index was recorded by Sweden, followed by Denmark (84.56) and Finland (83.77). The minimum (74.31) was recorded by Luxembourg, followed by Greece (74.33) and Bulgaria (74.77). Sweden's performance in this direction is explained by a number of factors: (a) the Swedish government has published the first national strategy on sustainable development in 2002 (Ahlberg, 2009), while Bulgaria, for example, has transitioned to the market economy in 1989, after the fall of communism, thus partially explaining the disparities in sustainable development between the extremities identified in Table 1; (b) the cultural differences and people's preferences (or aversion) for the sustainable consumption of goods and services; different levels of personal responsibility assumed in the case of the many EU-27 typologies of citizens (Berglund et al., 2020); and other similar factors.

Regarding the index that quantifies the culture of innovation among the EU-27 Member States, Sweden was also in first place (maximum: 62.47), followed by the Kingdom of the Netherlands (58.76) and Denmark (57.53). At the end of the ranking are Romania (minimum: 35.95), Greece (36.79) and Croatia (37.27). Sweden's concern for innovation dates back to the middle of the twentieth century, gradually increasing in intensity, as well as the concern for stimulating the spirit of innovation among Swedish entrepreneurs (Grillitsch et al., 2019); while in Romania, the inclination towards innovation suffered from the inhibition of the entrepreneurial spirit during the same period of time (Păunescu, Popescu and Duennweber, 2018), which has generated the gaps highlighted by statistics.

Table no. 1. The descriptive statistics of the analyzed indicators

	SDG Index	Innovation Index	Percentage of the GDP expenditure Allocated to R&D activities
Mean	78.59	46.93	1.65
Median	78.11	45.74	1.40
Maximum	84.72	62.47	3.39
Minimum	74.31	35.95	0.48
Std. Dev.	3.00	7.41	0.90
Skewness	0.38	0.38	0.59
Kurtosis	2.46	2.13	2.07
Jarque–Bera	0.96	1.50	2.54

The percentage of GDP allocated to R&D activities is also the highest in the case of Sweden (3.39%), followed by Austria (3.19%) and Germany (3.17%). Romania (minimum: 0.48%), Malta (0.61%) and Cyprus (0.63%) allocate the lowest shares of GDP to research and development among all EU-27 Member States. The budgetary allocation for R&D has a significant effect on sustainable development, but differs depending on the priorities and specifics of each country (Dima et al., 2018).

The cross-sectional regression model based on the least-squares method was built considering the SDG index as the endogenous variable, while the innovation index and the percentage of the GDP expenditure allocated to R&D activities were considered exogenous variables. The econometric results of carrying out the quantitative analysis in EViews 11 were included in Table 2.

Table no. 2. The results of the cross-sectional linear regression model

Formula of the method				
LS SDG Index C Innovation Index Percentage of the GDP expenditure allocated to R&D activities				
Formula of the equation of the model				
SDG Index = C(1) + C(2) × Innovation Index + C(3) × Percentage of the GDP expenditure allocated to R&D activities				
Equation of the model and coefficients obtained				
SDG Index = 68.7473 + (0.1437 × Innovation Index) + (1.8758 × Percentage of the GDP expenditure allocated to R&D activities)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	68.7473	2.3827	28.8527	0.0000
Innovation Index	0.1437	0.0620	2.3191	0.0292
Percentage of the GDP expenditure allocated to R&D activities	1.8758	0.5094	3.6827	0.0012
R ²	0.7387	Mean dependent var		78.5915
Adjusted R ²	0.7170	S.D. dependent var		2.9963
S.E. of regression	1.5941	Akaike info criterion		3.8749
Sum squared resid	60.9876	Schwarz criterion		4.0189

Variable	Coefficient	Std. Error	t-Statistic
Log likelihood	-49.3116	Hannan-Quinn criter.	3.9177
F-statistic	33.9297	Durbin-Watson stat	1.6163
Prob (F-statistic)	0.0000		

Note: All variable coefficients have an associated Prob. below the threshold of 0.05, validating the results.

The coefficient of determination proves that the constructed econometric model successfully (73.87%) predicts the values of the SDG index within the sample. More precisely, in the case of the EU-27 members, results confirm that 73.87% of the variance of the SDG index is successfully explained by the variation of the innovation index and the percentage of the GDP expenditure allocated to R&D activities. The adjusted coefficient of determination penalizes R^2 for its potential growth if additional exogenous variables were to be added to the model (Miles, 2014). Results validate the model (71.70%), since there is a drop of only 2.17% between the coefficient of determination and the adjusted coefficient of determination. As calculated in the t-Statistic column in Table 2, the Student-t values of the parameters validate the estimation model, considering that the Prob. values are close to zero. They need to be minimum, ideally zero, allowing the parameters of the variables to significantly differ from zero, which happens in the case of the econometric model constructed in this research paper.

The model confirms that should the EU-27 members implement policies that harness the innovation factor, obtain better performance in this regard, as well as allocate significant volumes of the GDP expenditure to R&D activities, then this mix of factors contributes to meeting the goals of the Sustainable Development Agenda more rapidly and efficiently, quantified through the lens of the SDG index. In the EU-27, the average of the SDG index was 78.59. Should the average innovation index scored by any country be above the mean with 10% (51.62) and the percentage of the GDP expenditure allocated to R&D activities be situated around the mean in the EU-27 (1.65%), then the model estimates that that respective county scores a better SDG index than the EU-27 average: 79.26 (increase by 0.85%). Yet, should the average innovation index scored by any EU-27 country be situated around the mean (46.93) and the percentage of the GDP expenditure allocated to R&D activities be 10% above the EU-27 average (1.65%), then the model estimates that that respective county scores an SDG index of 78.90 (increase by 0.39%). Therefore, econometric results confirm that policy makers should prioritize strategies that empower innovative economic activities, since they contribute the most to achieving better sustainable development results. Validating the regression model was an essential step followed in this research paper. Consequently, the White test for homoscedasticity of the residuals was performed and the results were presented in Table 3.

Table no. 3. The White test for homoscedasticity of the residuals

F-statistic	0.2144	Prob. F (5,21)	0.9525
Obs \times R^2	1.3115	Prob. χ^2 (5)	0.9337
Scaled explained SS	0.9122	Prob. χ^2 (5)	0.9693

Based on the White test results, the null hypothesis was rejected and the homoskedasticity of the residuals was accepted, on the grounds that the p-value is above 0.05 threshold. Taking this into account, the variance of the residuals was further studied by plotting the residuals in Table 3. Moreover, the share of residuals in mudolo from total was calculated and included in Table 4 with the aim of highlighting the greatest sustainable development disparities identified in the case of the EU-27 members.

As calculated in Table 4, Denmark encounters issues in fitting into the model (5.79% residuals in mudolo) due to its great performance towards sustainable development: 2.96% of its GDP expenditure was allocated to R&D (almost double EU-27's average) and the innovation index is greater than EU-27's average by 10.41%. In this regard, the most significant sustainable development disparities based on the R&D and innovation factors were observed in relation with the following countries: Luxembourg, Greece, Croatia, Latvia, Slovakia. Luxembourg was at the bottom of the EU-27 ranking as far as sustainable development is concerned: the country scored 74.31 (EU-27 average was 78.59). Yet, based on the innovation factor, Luxembourg scored a better position than in the case of sustainable development if compared to the EU-27 average, despite the fact that the percentage of the GDP expenditure allocated to R&D activities was almost 0.5% smaller than the one registered in the case of the EU-27 average (1.65%).

The residuals from the econometric model were visually represented in column 5 of Table 4, according to the calculated shares of residuals in mudolo from total (column 4). The "*" sign from column 5 shows the individual (EU-27 Member) deviation from the mean: to the left of the residual plot if the residual value is below and value of the residual mean and to the right of the residual plot if the residual value is above the value of the residual mean.

Table no. 4. The residual plot

Observations	SDG Index	Residuals	Share of residuals in mudolo from total	Residual Plot
Austria	80.70	-1.2371	3.60%	.* .
Belgium	79.96	-1.2706	3.70%	.* .
Bulgaria	74.77	-1.2999	3.78%	.* .
Croatia	78.40	2.2131	6.44%	. .*
Cyprus	75.21	-1.2839	3.74%	.* .
Czechia	80.58	1.2449	3.62%	. .*
Denmark	84.56	1.9906	5.79%	. .*
Estonia	80.06	1.3526	3.94%	. .*
Finland	83.77	1.5928	4.64%	. *
France	81.13	0.5612	1.63%	. * .
Germany	80.77	-2.0524	5.97%	.* .
Greece	74.33	-2.0879	6.08%	.* .
Hungary	77.34	-0.1532	0.45%	. * .
Ireland	79.38	1.5438	4.49%	. *
Italy	77.01	-1.0321	3.00%	.* .
Latvia	77.73	1.8727	5.45%	. .*

Observations	SDG Index	Residuals	Share of residuals in mudolo from total	Residual Plot
Lithuania	74.95	-1.2863	3.74%	. * .
Luxembourg	74.31	-3.9775	11.57%	* . .
Malta	75.97	-0.5899	1.72%	. * .
Netherlands	80.37	-0.8755	2.55%	. * .
Poland	78.10	1.1339	3.30%	. *
Portugal	77.65	0.0221	0.06%	. * .
Romania	74.78	-0.0353	0.10%	. * .
Slovakia	77.51	1.4990	4.36%	. *
Slovenia	79.80	1.0579	3.08%	. *
Spain	78.11	0.4631	1.35%	. *
Sweden	84.72	0.6338	1.84%	. *

The visual representation of the three variables included in the econometric model and the corresponding values recorded in the case of the EU-27 Member States was elaborated in Figure 1. In a certain degree, this figure explains how profound are the existing disparities between the EU-27 Member States in terms of sustainable development, in comparison with the degree of R&D and innovation. Moreover, Figure 1 places the EU-27 Member States that lead the change to the sustainable development model at left side of the figure, while countries with the worst performance in the same regard are placed at the left of Figure 1.

Table no. 5. Analysis of Variance Inflation Factors

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
SDG Index	5.677	60.322	
Innovation Index	0.004	92.049	2.158
Percentage of the GDP expenditure allocated to R&D activities	0.259	9.679	2.158

Testing the constructed model also called for quantifying the severity of multicollinearity in the least-squares regression. This test was performed and results were included in Table 5. The variance inflation factor provides an index for measuring the variance of an estimated regression coefficient increased due to collinearity. Performing this test is relevant because detecting the lack of multicollinearity implies that: (a) the explanatory power of the model is the same; (b) the statistical significance of the independent variables is not reduced. Based on the results from Table 5, the constructed econometric model is free from multicollinearity, since the variance inflation factor (VIF) for the independent variables (innovation index and the percentage of the GDP expenditure allocated to R&D activities) are within acceptable limits.

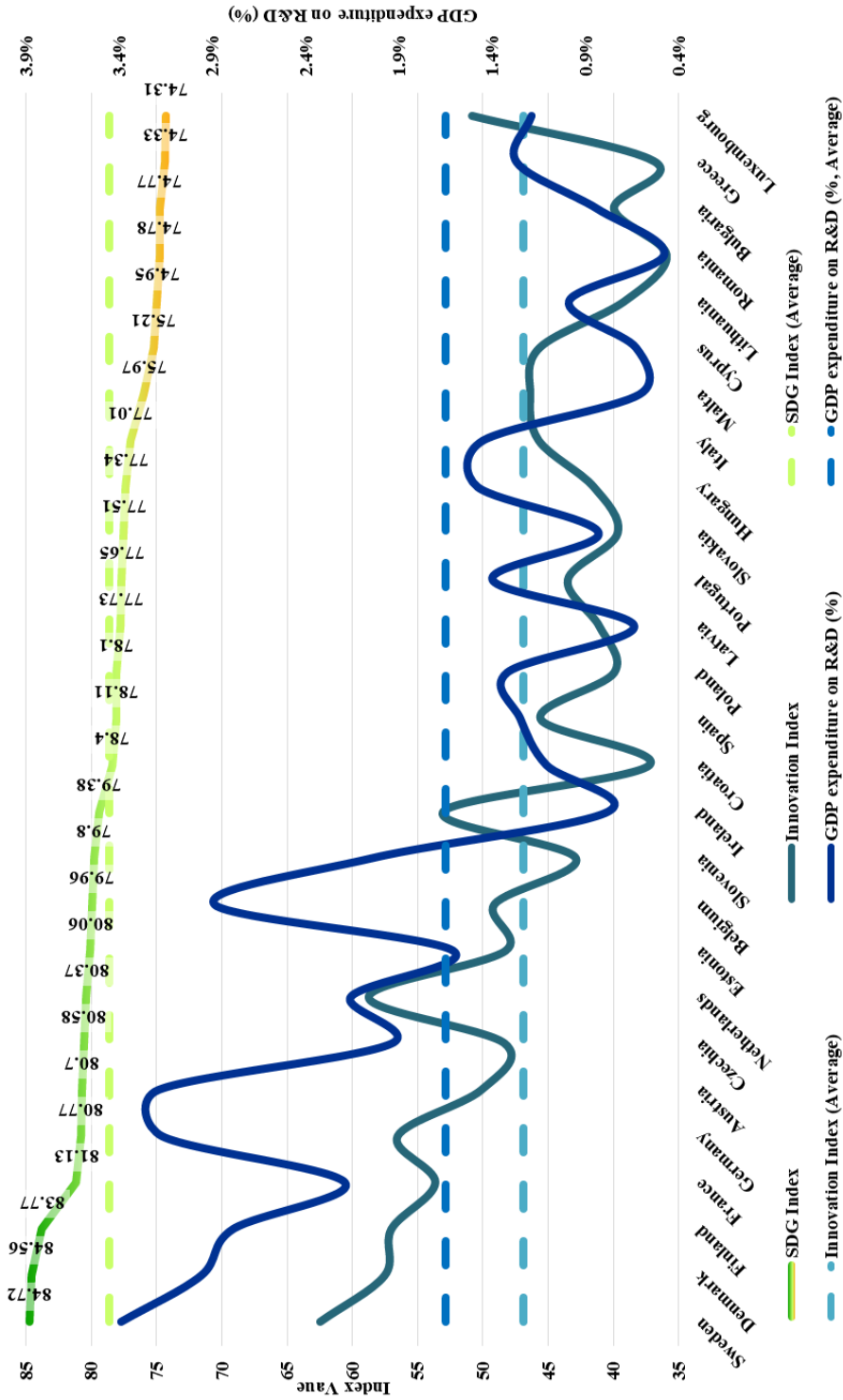


Figure no. 1. SDG and Innovation indices in report with the percentage of the GDP expenditure allocated to R&D activities

Source: Authors' own representation of data

Conclusions

Among others, achieving the goals and targets of the 2030 Agenda for Sustainable Development requires maximizing the potential of R&D activities and harnessing the spirit of innovation & entrepreneurship. Beyond their crucial roles for economic competitiveness, innovation and R&D are essential for providing pertinent answers to issues specific to ensuring socio-economic progress, simultaneously with environmental preservation and sustainable development. At the level of each EU-27 Member State, becoming fully sustainable all throughout the EU-27 calls for much more work to help the transition to equitable societies that understand and empower the spirit of innovation and R&D.

Besides the fact that the COVID-19 pandemic has acted as a setback for the recent advance of sustainable development in the European Union, it has also caused a series of major sanitary and socio-economic issues. This 'lost momentum' for sustainable development can be harnessed and used to redesign policies and projects in the direction of mitigating sustainable development disparities. This study provides alternatives for decision makers and explains the impact of R&D budgetary allocation on the objective of coherence. In order to reduce sustainable development disparities, the volume and nature of R&D financing represent factors that should be taken into consideration.

This paper brings its contribution to the scientific literature specific to sustainable development by approaching it through the lens of the existing disparities in the EU-27, based on the analyzed variables: (a) the GDP expenditure on R&D activities; (b) the innovation factor. This paper's uniqueness resides in the considered variables, which were used to construct the cross-sectional linear regression model in the case of the EU-27 Member States.

Based on the innovation and R&D factors, the linear regression model results highlight that the greatest sustainable development disparities were observed between Denmark, Finland, Sweden (EU-27 Members States that lead the change to the sustainable development model) and Luxembourg, Greece, Croatia, Latvia, Slovakia – a group of EU-27 countries that have to catch up to the latter.

This paper complements the existing scientific literature concerning sustainable development through the lens of the innovation and R&D factors. Moreover, this research fills a gap in the literature by econometrically tapping into the exploration of sustainable development disparities in the EU-27. As far as managerial implications are concerned, this research was aimed at providing insight for decision makers regarding positive and negative sustainable development implications, based on R&D budgetary allocation in EU-27, corroborated with the cultural factor (approached through the lens of the EU citizens' predisposition to innovation). In perspective, the research findings from this article can help decision makers find pathways to cohesion through better budgetary allocation models.

Regarding to the limits of this research, the constructed econometric model is well-suited for identifying the most sensible links in the face of sustainable development disparities in the EU-27, the most positively impacted by the GDP expenditure on R&D activities. However, this cross-sectional regression model does not explain how these sustainable development disparities occurred, which can be the topic of future research avenues. Moreover, this research can be improved by testing and integrating new variables in the validated cross-sectional econometric model.

Fostering innovation and stimulating the intensity of R&D activities based on sustainable principles represent the mix of factors that can ensure the successful transition to a prosperous economy. This research paper can help decision-makers better understand the nature of sustainable development disparities in the EU-27, through the lens of the impact of R&D and innovation factors have on meeting the SDGs in a timely manner.

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