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THE IMPLEMENTATION OF THE REGIONAL DEVELOPMENT INDEX IN THE NEW GEO-POLITICAL CONTEXT

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Abstract. The opportunity of this research topic lies in the current extremely challenging geo-political context that has led to the outbreak of multiple crises: energy, economic, social, financial, food, etc. The European Union has thus positioned itself in the face of these phenomena by creating several instruments to manage crises and increase resilience: civil protection mechanism, integrated mechanism for political response to crises, cross-border cooperation and solidarity mechanisms, food security crisis plans, resilience measures against physical and digital risks.The paper aims to analyse the necessity of changing the regional approach across the EU under the impact of the pandemic. Specific regional socio-economic indicators for EU NUTS2 regions are analysed during 2010–2021. The main objective of this research is to quantify the regional socio-economic and to realise comparative analysis related to three moments in time: the latest EU enlargement, the economic crisis and the pandemic. The novelty of the study was the building of a new dynamic multi-criteria model assessing the strategic perspective, which was built to offer pertinent solutions for the regional decision makers in order to ensure cohesion and sustainable development on short and medium term.

Keywords: regional disparities, regional economy, regional development index, regional sustainable development.

JEL Classification: R10, R11, R12, R13.

Introduction

With the outbreak of war in Ukraine, the political context changed and Europe reacted by adopting packages of economic, diplomatic and political restrictive measures. 5 packages of economic sanctions as well as restrictive measures to facilitate humanitarian activities were adopted (European Council, 2022).

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These measures have had an impact on the regional economy by increasing the need for financing and public debt as part of economic efforts to support Ukraine, as well as by reducing Russia's supplies of energy products to Europe. These developments have affected the energy market, triggering an energy crisis in Europe manifested by rising consumer prices and inflation, leading to the erosion of the regional economy in the current geo-political context.

Another aspect of the Russian-Ukrainian conflict is the refugee crisis that has affected the regional economies of Poland, Romania and Latvia, which have had to adopt additional humanitarian and social measures.

Poland, for example, had prepared to receive an estimated number of up to one million refugees (Pallokat, 2022), but the number exceeded 1.2 million by the end of July 2022, as stated on the Polish government's website for Ukrainian migrants (Website of the Republic of Poland, 2022). The Polish government has adopted measures to simplify border crossing formalities for Ukrainian refugees, implemented social measures for them and eased their access to the labour market. The Polish government must also face new challenges related to the changing urban demographic structure in large Polish cities where Ukrainians make up between 15% and 30% of the population (Wojdat & Cywiński, 2022).

At the end of December 2022, 102039 persons were registered for temporary protection or similar national protection schemes in Romania, while 106629 Ukrainian refugees were registered in the country (United Nations High Commissioner for Refugees, 2022). Most of the 989,357 Ukrainians who entered Romania transited the country to other destinations, as the Romanian government said it was ready to receive 500,000 refugees if necessary. The support given to Ukrainian refugees was medical, humanitarian and economic.

Latvia has a much smaller capacity to receive refugees estimated at 10,000 people (Latvian Public Broadcasting, 2022). The support given to Ukrainian refugees consisted of accommodation, transport and food. The Latvian authorities' estimates were exceeded by the large number of Ukrainian refugees (31,960 persons), which created some dysfunctions in the management of refugee assistance (Delfi, 2022).

For all three countries mentioned above, information on the financing of aid to Ukrainian refugees is considered secret (Spotmedia.ro, 2022).

In this context, regional integration offers, in the view of the World Bank, an efficient management in flow of goods, services, capital, people and ideas. As a result of this process, geographical and infrastructure barriers between countries, which are by definition an impediment to economic growth, are overcome (The World Bank Group, 2022).

In Europe, regional development is the subject of European policies, with 240 NUTS2 regions and 16 regions of EFTA countries currently identified. The demographic increase is moderate to low at European level (Eurostat, 2022b), with an average population growth of up to 10‰. Sporadically, in the northern regions of Europe (Flevoland) and in the southern regions (Illes Balears, Corse), in Bratislavský kraj, Luxembourg the population growth is up to 15‰.

Across EU27, life expectancy at birth shows an increasing trend over the period analysed, even if the last two years (2020 and 2021) were marked by a decrease in the rate due to pandemic crises (see Figure 1).

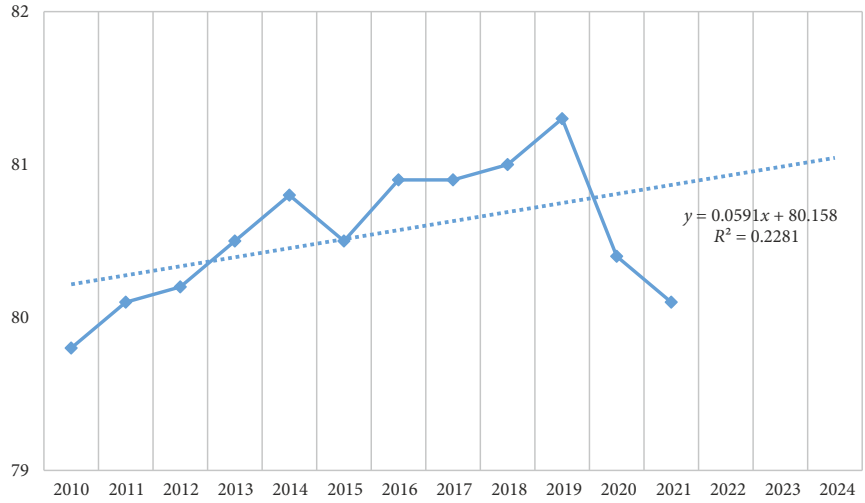


Figure 1. Predicted trend in life expectancy evolution across EU27 (years)

During the crisis of 2010–2013, there was an upward trend in the indicator, with a downturn in 2015. The period 2020–2021 is marked by a further decrease in the values of the indicator due to pandemic-induced issues. In terms of life expectancy at birth, it fluctuates differently according to sex (Eurostat, 2021), with a difference of 5–6 years between sexes and a regional difference of 13 years for men and 12 years for women. Regions with high life expectancy for men are in Spain, France and Italy, while regions with low life expectancy are in Romania, Hungary, and Bulgaria. In the case of women, regions from Spain, France, Italy and Finland are at the top of the ranking, while Mayotte (France), Bulgaria and Hungary are at the opposite pole.

The European population accessing tertiary education shows a positive trend over the period analysed, a trend that will continue over the forecast period (Eurostat, 2022l), (see Figure 2).

Education levels are high in western and northern European regions, while southern Spain, Italy and Greece, parts of eastern Romania, Bulgaria, Normandy and northern France have problems with school drop-outs (Low level of education: no more than a primary or lower secondary education; medium level of education: upper secondary or post-secondary non-tertiary education; high level of education: tertiary education), (Eurostat, 2022j).

During the crisis of 2010–2013, there was an upward trend in the indicator, with a turning point in 2014. The period 2020–2021 is marked by a further increase in the values of the indicator, which is not directly influenced by the pandemic. Problems with access to the labour market for young graduates are recorded in regions of Greece (Sterea Ellada), Italy (Calabria, Campania, and Sicily), France (Reunion) and Spain (Canarias), where the percentage of young graduates in employment does not exceed 50%. At the opposite pole, with a percentage of over 97%, are regions in Germany, the Czech Republic, Luxembourg and the Netherlands.

The male labour factor has additional employment opportunities in the labour market, which proves the lack of equal employment opportunities. For example, in Calabria (Italy), the employment rate for women is 31.3%, while that for men is 57.7%. The same situation is found in France, in the Mayotte region, where the lowest employment rate for women is 29.2%, compared to an employment rate for men of 52.3%. A significant difference (almost 30%) in employment rates is also found in the Puglia region (Italy), (Eurostat, 2022c).

In the case of unemployment, the EU27 has experienced an oscillating evolution of the indicator (influenced by economic crises), but the projected trend is positive (Eurostat, 2022m), (see Figure 3).

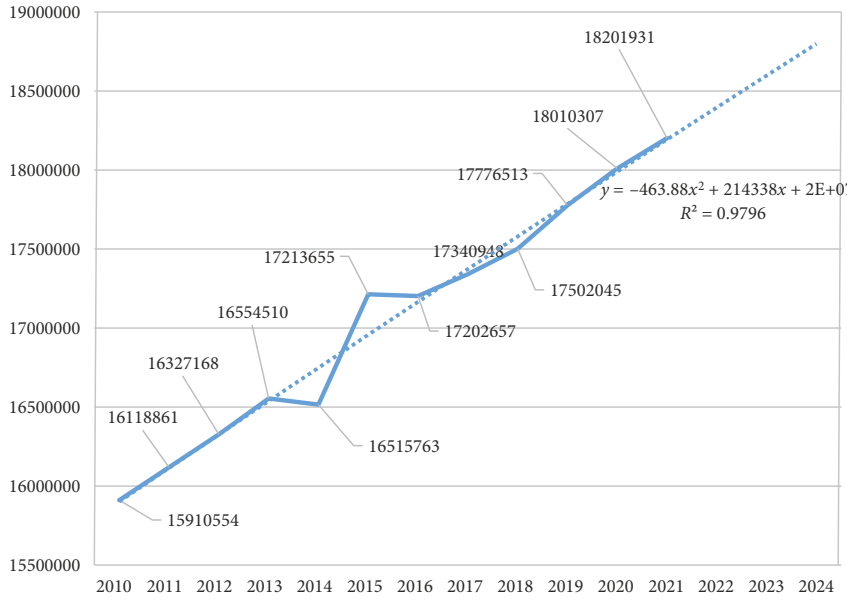


Figure 2. Predicted trend of students enrolled in tertiary education across EU27 (persons)

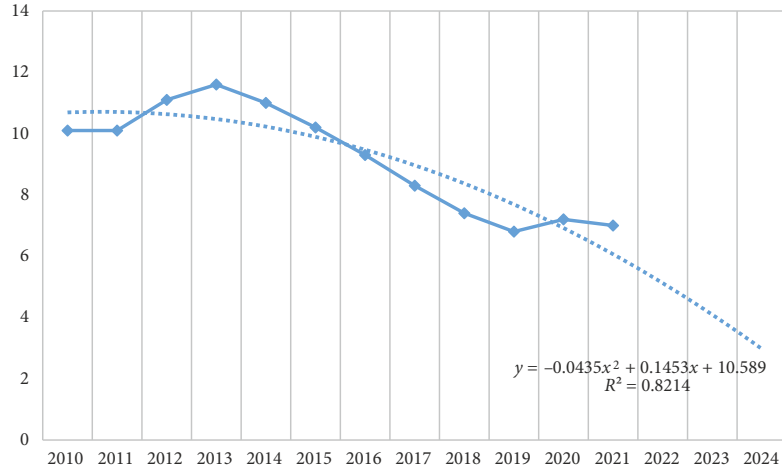


Figure 3. Predicted trend in total unemployment rate (EU27 labour force in total population, %)

During the crisis period of 2010–2013, there is an unfavourable upward trend of the indicator, with a turning point in 2013. The period 2020–2021 is marked by a real decrease in the values of the indicator as the pandemic is coming to an end. Unemployment is a particularly strong indicator in regions with problematic schooling, such as southern Spain and south-eastern Europe (Andalusia has an unemployment rate of 22.3%). In the case of young people, the unemployment rate reaches 49.5% in Extremadura, Calabria, Dytiki Ellada, Dytiki Makedonia, Campagnia), (Eurostat, 2022n).

The EU regional economy is marked by significant economic disparities in regional income and purchasing power. At EU economy the level, the evolution of the deflator over the period under review shows a growth rate of 35% (Eurostat, 2022i), (see Figure 4).

During the 2010–2013 crisis, the indicator shows an upward trend. The period 2020–2021 is marked by a steep decline in the indicator values due to pandemic-related economic contraction, followed by a post-pandemic economic recovery. Compared to the overall evolution of the indicator, there are large disparities at regional level. Thus, the most developed regional economies are Luxembourg (79600 euros PPS/inhabitant), Ile – de – France (GDP = 56700 Euro), Oberbayern (54900 euro), Noord – Holland (53600 euro). At the opposite pole, regions with less than 20000 euro PPS/inhabitant are: Sicilia, Calabria, Puglia (Italy), NE, SE, S, V, SV (Romania), Attiki, Kentriki Makedonia, Dytiki Makedonia (Greece), Valencia and Murcia (Spain), (Eurostat, 2022e).

EU27 shows a revitalisation of the Intramural R&D expenditure (GERD) indicator after 2019 (Eurostat, 2022g), (see Figure 5).

During the 2010–2013 crisis, the indicator shows a downward trend. The period 2020–2021 is marked by a relative increase in the values of the indicator against the background of the development of the digital economy associated with the pandemic. From the R&D impact

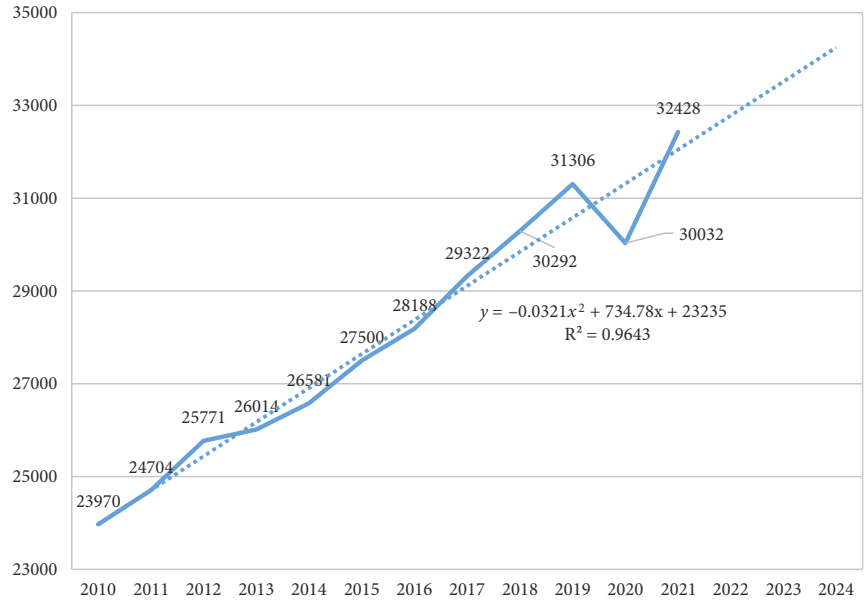


Figure 4. Projected trend in EU27 GDP/capita evolution (purchasing power standard – PPS)

point of view, it can be seen that it is unevenly intensified across Europe's regions. The best performances in this area were obtained in Germany, Sweden, Belgium and Austria. The weakest R&D development is found in the SE region (Romania), (Eurostat, 2022d).

At EU level, 2/5 of the total area is agricultural land. The livestock sector can have a considerable environmental impact. On the other hand, live animal populations in the EU27 have often been affected by various epidemics that have reduced animal numbers. In the case of bovine population, the evolution of the cattle population is shown in Figure 6.

During the 2010–2013 crisis, the indicator shows an unfavourable downward trend, with an inflection point in 2013. The period 2020–2021 is marked by a further decline in the

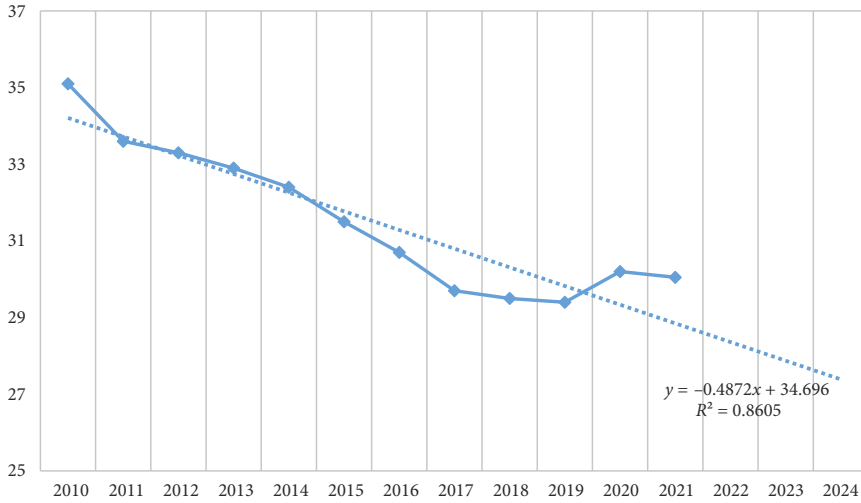


Figure 5. Predicted trend in Intramural R&D expenditure (GERD) for EU27 (%)

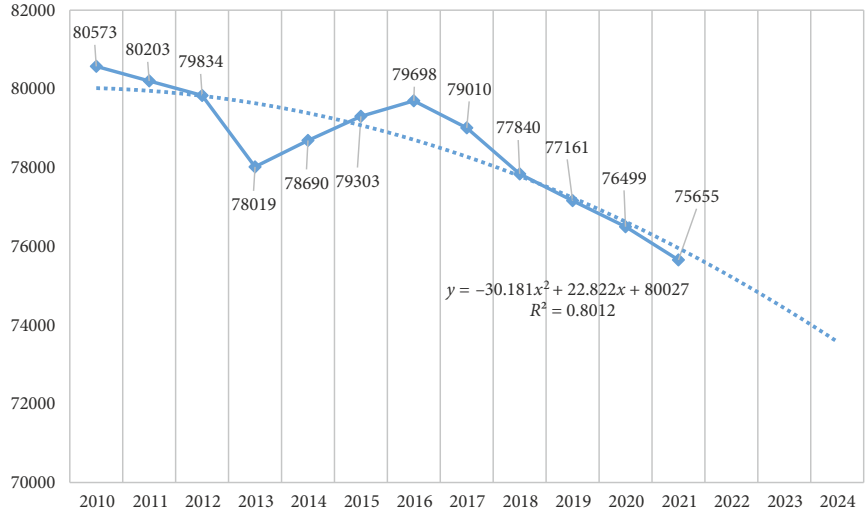


Figure 6. Predicted bovine population trend for EU27 (thousand heads animals)

indicator values related to the economic slowdown due to the pandemic. The production of cereals is important for the EU regions, as well. Animal farms are extremely important in achieving regional food security (Eurostat, 2022a). In this context, a relevant indicator for ensuring food security is production of cow's milk. At EU27 level, the evolution of this indicator was as shown in Figure 7.

During the crisis period of 2010–2013, the indicator shows an upward trend, with a turning point in 2013. The period 2020–2021 is marked by a further increase in the values of the indicator as the pandemic is coming to an end. The analysis of the current economic, social and geo-political context supports our scientific approach. The paper aims to analyse the necessity of changing the regional approach across the EU under the impact of the present geo-political context.

In order to realise it, specific regional socio-economic indicators are analysed during 2010–2021. The analysis covers EU NUTS2 regions.

The main objective of this research is to quantify the socio-economic trend of the NUTS2 regions and to realise a comparative analysis related to three moments in time: the latest EU enlargement, the economic crisis and the pandemic.

The specific objectives of the research relate to:

O1. Study of regional development dynamics in the period 2010–2021 and assessment of prospects in the light of new geo-political risks.

O2. Study of regional development models in the literature in order to identify the influential components of regional development in crisis situations.

O3. Development of a dynamic multi-criteria model assessing the strategic perspective.

O4. Identify solutions to identify the new regional development index.

The implementation of this model will be able to offer pertinent solutions for the regional decision makers in order to ensure cohesion and sustainable development on short and medium term.

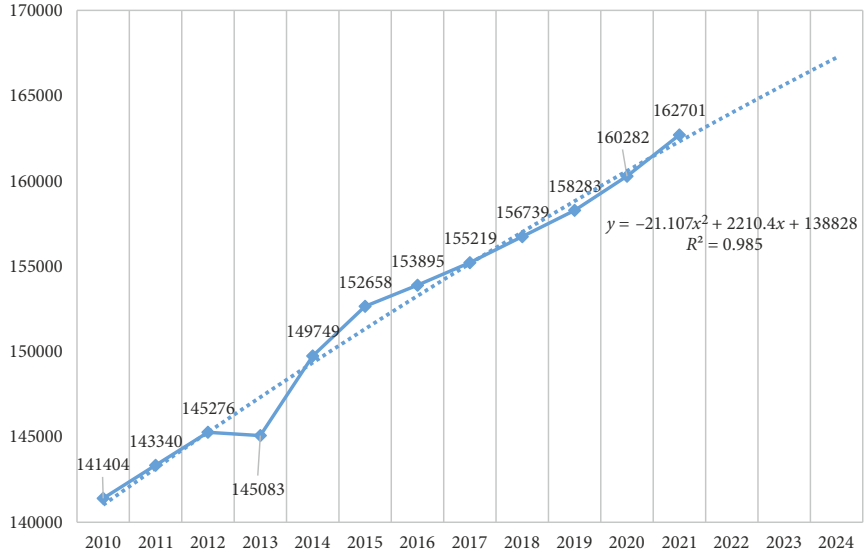


Figure 7. Predicted trend in production of cow's milk for EU27 (1000 t)

1. Literature review

Regional development is a topic intensively addressed in the literature, given the concern of experts for improving economic resilience and reducing regional disparities. After studying the literature, we have grouped this section into the following themes.

1.1. Regional disparities and trends of unemployment

Some authors (Filippetti et al., 2019) show that labour factor preparation can lead to regional disparities. The analysis takes into account the recent financial crisis and is based on statistical research covering 3983 individuals for the period 2008–2011. The authors highlight the differences in labour force preparation between regions in the South and the North of Italy and across workers with different levels of education.

The connection between regional net in-migration rates and local labour market conditions is addressed by Mitze (2019). The analysis is focused on global economic crisis. The author concludes that variations in local labour market conditions reprezint only 11% of the total variation in regional migration rates across NUTS3 regions. This share increased to 32% in the post-crisis period. At NUTS 2 level, the value of this coefficient is 40–50%.

The application of econometric models at the regional level by Kamar et al. (2019) confirms the existence of a positive impact of growth on employment. Role of FDI on employment is negative in Africa and Middle East and North Africa (MENA). As a result, countries in these regions should implement a privatisation policy that includes FDI for train the employees. Domestic investment has a negative impact on employment in Africa and Eastern Europe.

In a research conducted by Giannakis and Bruggeman (2020), it is shown that the above mentioned issues can be addressed through multilevel logistic and multinomial regression models. The analysis is carried out at NUTS-3 level and covers the EU. The authors point out that the resilience of regions is negatively impacted by national borders, and the greatest disparities are in rural areas. As a result, migration from urban to rural areas is an element that supports economic resilience.

The EU approach from the perspective of regionalized economic structures is realized by Puiu and Necula (2020). The research takes into account regional aggregation of research and innovation activities, uses the analysis indicator region's total factor productivity performance of knowledge production and covers the period 2009–2018, under a cluster approach. These clusters are delimited according to their innovative potential and their total factor productivity. The research procedure used is the Malmquist Index and the data used are provided by Eurostat. The inputs related to the research method are the total research and development expenditures and the number of researchers involved in this activity, while the outputs are number of patents applied at the European Patent Office.

According to the sources cited above, there is a clear trend at EU27 level to implement policies dedicated to alleviating unemployment and promoting easier access to the labour market. On the other hand, the disparities related to these phenomena are much greater at regional level than at national level.

1.2. Regional disparities and trends of technological progress

The rising spatial imbalances and economic divergence in post-1970s' Europe is realised by Mykhnenko and Wolff (2019), based on an econometric analysis covering the EU28, 11 OECD countries and the BRICS countries. The carried out analysis cannot fully support the theory about Europe's increasing spatial disparities. As a result, the authors provide alternative explanations in support of European economic convergence.

Regional convergence from the perspective of technological capabilities of economies is the subject of research by Barrios et al. (2019). The study covers European regions during the 2000s and uses innovation data of a non-linear model developed under a cluster approach. The authors explain the formation of innovation convergence clubs. The less innovative clubs are formed by regions belonging to Eastern European countries and Portugal, the intermediate innovation clubs are formed by regions belonging to Spain and Italy, while the high innovation clubs are placed in regions from France, Germany, Belgium, Austria, UK, and Ireland. An interesting conclusion of this study is that the different clubs tend to converge toward the average, diminishing the distances between them at the end of the analysed period.

An interesting research starts from the need to find direct quantitative validation between the allocation of regional assets and regional inequalities (Capello & Cerisola, 2021). The analysis takes into account the relative weight of each economic resource in the process of decreasing regional disparities. The research results support the regional productive specialization theory and converge towards Smart Specialization Strategy.

A study conducted from the perspective of Cohesion Policy at regional level by Ehrlich and Overman (2020) looks at the causes of regional disparities in Europe. The research is very comprehensive and covers a wide range of regional development issues such as Disparities in Productivity and Land Prices, Agglomeration and Urban Costs and Changes in Disparities over Time. The authors use specific indicators (elasticity of GDP per worker, share of population with a tertiary education, agglomeration elasticities) on the basis of which they analyze Spatial Disparities in Worklessness, Mobility and EU Policies. The proposed solutions by the authors to mitigate spatial disparities aim at investments in transport infrastructure and in local public goods and services, employment training and efficient use of European funds.

The plethora of studies, research and policy approaches related to regional disparities is highlighted by Cartone et al. (2021). The authors review theoretical achievements in the field and note that the Gini index approach is highly appropriate. This approach allows the delimitation between the spatial and the non-spatial component of inequality and defining a proximity structure. The analysis is carried out at the European NUTS 3 regions level. A similar approach is taken by Widuto (Widuto, 2019), who stresses the importance of using the Gini coefficient to compare each household's income position to that of all other households in order to measure income distribution. According to the authors, the Gini coefficient value was 30.7% in 2017 at EU level, while the highest income disparities (35%) were recorded in Bulgaria and Lithuania. Member States with the lowest coefficient values (less than 26%) are: Slovakia, Slovenia, the Czech Republic, Finland and Belgium.

The use of different statistical methods of analysis and econometric models highlights that the introduction of technical progress in the economy can be a relevant solution to mitigate regional disparities in socio-economic development.

The development of today's regional economy cannot be achieved without digitisation. As a result, Capello et al. (2022) considers that firms based on digital platforms are redesigning the boundaries of production towards services. The analysis makes a conceptual separation between digital service development models and the assessment of regional socio-economic effects. The building and development of economies cannot be achieved in the absence of smart specialisation of regions. Authors such as Rigby et al. (2022) use regional cost-benefit analysis as a tool. The analysis covers the period 1980–2021 and focuses on urban centres as the quintessence of regional economic growth. The authors highlight the link between economic performance and the level of complexity and connectedness of related technologies. An analysis on the same topic is by Barbero and Rodríguez-Crespo (2022), which links information and communication technologies, institutional technologies and institutional and geographical factors. The analysis covers 229 European regions over the period 2007–2018. A higher quality of these technologies, institutional and geographical factors supports economic development and reduces the risk of exclusion.

A significant aspect of regional economic development is innovation in EU regions. According to Beynon et al. (2023), this is analysed using principal component analysis (PCA) and the constellation graph index. Innovation is studied as an aggregate indicator comprising innovation system, absorptive capacity and IP protection. A first observation is that innovation differs across European regions. A second observation is related to the positive impact of this innovation on the economic performance of regions. Technological innovation to support sustainable regional development is presented by Ahmad et al. (2022) as an argument for the development of international non-linear tourism. The related mathematical analysis covers 30 regions in China over the period 2000–2018 and aims at calculating international tourism development and technological innovation indices. One conclusion of the analysis is that in 8 regions of the sample analysed international tourism development has promoted CO_2 emissions. The impact of information and communication technologies on regional development is addressed by Samara et al. (2022) in connection with the global competitiveness of economic regions. The authors use several scenarios with which, through modelling, the importance of smart technologies in regional development is explained for some regions in Greece.

European innovation policies are analysed in relation to sustainable economic development at regional level by Kuzior et al. (2022). The analysis covers the EU27 and Ukraine and uses the Global Innovation Index to identify policy solutions on accelerating regional economic development in the EU27 and rapid post-war reconstruction in Ukraine.

1.3. Regional disparities and trends regarding labour and life expectancy

A particular research conducted by Gardiner et al. (2020) targets regional disparities in economic performance and addresses the UK economy. The analysis takes labour productivity as an approach indicator, and covers human capital and the stock of physical capital per worker. The authors were faced with the difficulty of obtaining data for the entire period under analysis (2001–2015). As they state, the authors applied a state-of-the-art modelling approach. The results of the analysis point out a true elasticities and simulation of outcomes

due to possible policy interventions. Moreover, an increase in the regional stock of human capital strongly influences the productivity variations across regions.

The use of regional social indicators into a composite, summary indicator is made by Rogge and Self (2018). This approach compares regions based on strongest social inclusion determinants. The study concerns Scandinavian and the Central European countries as countries with the most socially inclusive regions, while Continental and Balkan States are considered worst-performing regions. The main conclusion of this study is that NUTS regions with low education levels and high age dependency on average performance are the weakest in social inclusion.

The issue of regional disparities at the European level by appealing to the gravity model is addressed by Camagni et al. (2020). The authors analyse in parallel the European integration and the historical evolution of the regions of Central and Eastern European area. The authors distinguish between intra- and inter-regional disparities in the national and international context based on the application of a dedicated econometric model. The conclusion of this study is that the current "normality" is the increasing disparities between European regions.

There are large regional disparities in population, labour force and life expectancy. These disparities are underpinned on the one hand by unfavourable demographic developments especially in the northern European Member States and on the other hand by the socio-economic situation in the southern and eastern EU27 Member States. The impact of socio-economic development on labour migration is quantified by Mitrică et al. (2022) using three categories of indicators: social development indicators, social and technological disadvantage index and emigration rate. The analysis is carried out at NUTS3 level and concludes that there is a direct connection between the high magnitude of emigration and the low level of social and technological attainment.

The labour factor in terms of human capital is considered by Jagódka and Snarska (2023b) as an element supporting development disparities between regions and the achievement of a higher quality of life. The authors attempt to quantify the speed of catching up with more developed regions through unequal accumulation of human capital. The labour factor from the perspective of exogenous technological change and substitution by capital is the subject of a study by (7, 2022). The analysis covers the EU27 and is based on regional input-output models for NUTS2. The authors find that a higher level of industrial concentration and a development of the construction sector can mitigate the negative effects of economic crises and better support the recovery of the social economy. In the case of capital investment, it leads to increased regional labour productivity. Inequalities in population income at national and regional level are the subject of an analysis by Jagódka and Snarska (2023a), which finds that they lead to unsustainable and unbalanced economic growth, regardless of the development model supported by policy makers. The authors examine European cohesion policy in terms of efficiency and regional disparities due to the misallocation of human capital at regional level. The analysis covers regions in Poland and covers the period 2004–2018. Using modelling (Wilcoxon test), the authors try to solve the regional development dilemma: helping large metropolises and cities to develop more or supporting the development of smaller and economically weaker territorial units.

1.4. Regional disparities and trends regarding economic stability

The connection between EU core and its southern and eastern peripheries from the perspective of European policies to reduce regional disparities is analysed by Börzel and Langbein (2019). The authors point out that in Member States where corruption reaches high levels and economic divergence is high, political divergence is promoted. As a result, the authors propose a separation between economic convergence and political convergence.

Evolution of spatial inequalities and structural change in Europe from the perspective of the concept of lack of global convergence is realized by Cutrini (2019). The author uses only five economically distinct clubs that are analyzed based on regression equations. The author concludes that specialization in high-productivity service activities forms the basis of regional disparities.

An analysis of the EU economy at three levels (EU-28, EU-15 and EU-13) is carried out by Pietrzykowski (2019). The analysis is carried out from the perspective of pace of β-convergence and is based on the indicator real GDP per capita (at PPS). The analysis shows much greater regional divergences in the Member States that joined the EU in 2004 compared to the other Member States.

According to the above approaches, the lack of economic stability affects the unified development of the EU27 and creates conditions for increasing regional disparities. Starting from the idea of unbalanced economic growth, Piętak (2022) question the role of regional stratification in the national economy. The level of regional disparities within EU countries at NUTS-2 level was quantified using the control function (CFA) under economic polarization. The analysis of statistical data showed that overall regional disparities negatively affect economic growth and economic stability. An interesting approach by Bolea et al. (2022) makes the connection between global value chains and the development of regional economies. Using I-E analysis, the authors quantify the share of EU NUTS2 regions in global value chains. A first conclusion of the analysis is that global production processes are influenced by regional and local factors. This process is enhanced by the geographical proximity and similarity of the production structures of the regions analysed. Ensuring economic stability at regional level involves assessing the sustainability of investments. One such study was carried out by Cavalli et al. (2023) and covers the Autonomous Region of Sardinia over the period 2019–2021. The analysis covers Regional Operational Programmes (ROPs) and the degree of achievement of the UN Sustainable Development Goals in the context of the Italian National Rural Development Programme. The main objective of the research is to develop a methodology to implement sustainable investments at regional level, compatible with different EU investment policies. An approach on the same theme is taken by Kostetckaia and Hametner (2022), which focuses on the connection between the SDGs and the Agenda 2030 targets. The authors conduct a longitudinal assessment of the progress made by EU27 Member State regions towards regional economic sustainability goals using the Spearman method, regression analysis and Eurostat database. The authors argue for the need to eliminate all trade-offs in achieving the 2030 Agenda targets. In this context, Xu et al. (2023) argues that EU27 sustainable innovation strategies should increasingly be based on sustainable innovation efficiency, which the authors quantify through a DEA-SBM model. The analysis notes wide disparities in technological innovation, energy saving and environmental protection between European regions, but with converging trends at regional level.

1.5. Regional disparities and trends in purchasing power

The EU enlargement process and the implications of the use of European funds for the new Member States are analysed by Bourdin (2019). The analysis is carried out at NUTS 3 region level and is based on the geographically weighted regression method (GWR). The author notes a multipolar convergence, which supports the proposal to refocus cohesion policy towards a more territorialized policy.

A preliminary approach to the present study, which shows that there is a significant level of disparity at EU level based on regional and national development differences accounted for by GDP at the level of 272 regions covers the period 1996–2010 and is carried out by Ezcurra (Ezcurra, 2019). The authors consider that the level of macroeconomic development has a direct impact on regional disparities, even if the implication is not linear. Moreover, the opening of the national borders to international markets can leads to higher regional inequality in the EU countries. The authors appreciate that good governance at the national level can contribute to narrowing inter-regional gaps.

An interesting article focusing on the impact of the social disadvantage index is by Mitrică et al. (2020). The authors focus their research on rural Romania starting from its social characteristics. The authors define and implement the Social Disadvantage Index (SDI), which quantifies: unemployment, employment in agriculture, dwellings quality, education, health. The research results show that the most disadvantaged rural areas are those in the north-eastern, south-eastern, south and south-western parts of Romania. These disadvantaged areas contrast with metropolitan areas in the same geographical regions such as: Iași, Galați-Brăila, Constanța, Bucharest, Pitești, Ploiești, and Craiova. The research itself is intended to support Romania's Territorial Development Strategy.

The Gini coefficient is used in another research by Lipps and Schraff (2021) linking inequality to supranational governance. The research takes into account income inequality and regional inequality. The research is intended to support Europe's multi-level governance system. A similar approach is taken by some authors (McCann, 2020; Panzera & Postiglione, 2022).

According to the above-mentioned studies, in the framework of European social policies aimed at mitigating regional disparities, emphasis should be placed on increasing the purchasing power of the population on the one hand, but also on reducing financial inequalities between regions.

1.6. Regional disparities and spatial justice

EU cohesion policy at regional level is studied by Madanipour et al. (2022) through the development of the concept of spatial justice. According to the authors, spatial justice is based on spatiality, integration of distributive and procedural justice, and inclusiveness. The authors carry out an analysis of seven European treaties related to cohesion and point out that the spatial focus has been added to, rather than integrated with, the social and societal approach, which can lead to spatial imbalances and social inequalities.

Regional disparities affect the improvement of the prosperity of the inhabitants Diemer et al. (2022) starts from the concept of the average income trap in development theory and

adapts it to the regional development trap. The authors focus on European regions and discuss indicators such as productivity and employment performance. The main conclusion of the analysis is that European regions facing development traps generate economic, social and political risks on a national and continental scale.

2. Materials and methods

Based on the proposed objectives, we proceeded to the methodological foundation of the research. To this end, a database was built and consolidated, consisting of the specific indicators whose trend of evolution was evaluated in the 2010–2021 dynamic. Am convenit asupra acestei perioade de analiza din urmatoarele considerente:

- period covers the end of the economic crisis across the EU27 in terms of regional risks regarding the increasing of regional socio-economic disparities (deflation, failure of critical infrastructure, failure of financial mechanism or institution, fiscal crises, illicit trade, unemployment or underunemployment, inflation, biodiversity loss and biosystems collapse, extreme weather events, failure of climate-change adaptation, human-made environmental catastrophes, natural catastrophes, critical information infrastructure breakdown, cyber attacks, misuse of technologies, water crises, failure of urban playning, food crises, large scale involuntary migration, profund social instability, spread infection deseases, weapons of mass destruction).
- the economic recovery in 2021 compared to previous year, element mentionat in Recovery plan for Europe (European Commission, 2021);
- multiple health and medical crises culminating in the pandemic, determinat de an ageing population, more long-term illnesses, a continuing recruitment and retainment crisis plus post-Covid exhaustion (The Guardian, 2022);
- the transformation of regional economies in relation to the objectives of sustainability and transition to the green economy. The EU27 economic sustainability objective was implemented in 2015 in 2030 Agenda for Sustainable Development and the SDGs (European Commission, 2022).

The representative regional indicators that are addressed in this scientific approach are presented in Table 1.

The collected data were analysed dynamically and regionally using the dedicated software IBM-SPSS 25, obtaining frequency distributions, standard deviations and frequency distribution means that allowed later critical evaluation of the forecasts by two procedures autocorrelation and cross-correlation.

For these indicators the following calculation of absolute indicators as relative averages in relation to the overall average was done. These mean values of variation were entered into the multiple linear regression, and the annual patterns of sustainable regional development were projected.

The literature review led to the following research hypotheses:

H1. The unemployment rate is reflective of disparities due to social policies implemented by the EU (Filippetti et al., 2019; Gardiner et al., 2020; Giannakis & Bruggeman, 2020;

Kamar et al., 2019; McCann, 2020; Mitrică et al., 2020; Mitze, 2019; Mykhnenko & Wolff, 2019; Panzera & Postiglione, 2022; Puiu & Necula, 2020; Rogge & Self, 2018).

H2. Increasing regional disparities are influenced by differential technological progress and access to technology through speculative labour (Agasisti & Bertoletti, 2022; Bailey & De Propris, 2019; Barrios et al., 2019; Capello & Cerisola, 2021; Cartone et al., 2021; Ehrlich & Overman, 2020; Gardiner et al., 2020; Iammarino et al., 2019; Mykhnenko & Wolff, 2019; Panzera & Postiglione, 2022).

H3. In times of crisis, life expectancy is a vulnerability factor of regional disparity by involving resources to manage social problems (Agasisti & Bertoletti, 2022; Filippetti et al., 2019; Gardiner et al., 2020; Iammarino et al., 2019; McCann, 2020; Rogge & Self, 2018).

H4. Accelerating regional economic development in the absence of economic stability leads to increased regional disparities (Cutrini, 2019; Ezcurra, 2019; Gardiner et al., 2020; Iammarino et al., 2019; Kamar et al., 2019; Panzera & Postiglione, 2022; Widuto, 2019).

H5. Purchasing power as an exponent of disparities has an oscillating trend that follows economic developments (Bourdin, 2019; Capello & Cerisola, 2020; Cutrini, 2019; Ezcurra, 2019; Lipps & Schraff, 2021; Mitrică et al., 2020; Mykhnenko & Wolff, 2019; Panzera & Postiglione, 2022; Pietrzykowski, 2019; Rogge & Self, 2018).

Table 1. Indicators and their relevance for research

Symbol	Indicator (data source)	Relevance
RGDP	Regional gross domestic product (PPS per inhabitant) by NUTS 2 regions (Eurostat, 2022e)	It is the most important indicator for assessing regional economic development.
RUNE	Unemployment rate by NUTS 2 regions (Eurostat, 2022n)	Characterises regional disparities in labour utilisation.
RPTE	Persons with tertiary education (ISCED) and/or employed in science and technology (Eurostat, 2022f)	Highlights the potential for regional economic development and is an important argument in accentuating regional disparities.
RRD	Intramural R&D expenditure (GERD) by NUTS 2 regions (Eurostat, 2022d)	Investment in R&D is a multiplier for regional development.
RTEA	Tertiary educational attainment, age group 25–64 by sex and NUTS 2 regions (Eurostat, 2022j)	Indicator highlighting the increased contribution of the labour factor to regional development.
RAP	Animal populations by NUTS 2 regions (Eurostat, 2022a)	In regional agriculture, live animal production is a significant element in providing food for the population and has an impact on the environment.
RCWM	Production of cow's milk on farms by NUTS 2 regions (Eurostat, 2022k)	Food security at European level is quantified by this indicator which shows large disparities at regional level.
RLIFE	Life expectancy at birth by sex and NUTS 2 regions (Eurostat, 2022h)	Indicator highlighting the effects of the other indicators analysed in the table and showing important regional disparities.

The analysed data were centralised and regression functions on regional development against the analysed sustainability indicators were obtained. In dynamics, the multiple linear regression function of regional development is defined as follows:

$$RGDP_{2010} = -1.2*RUNE_{2010} + 3.23*RPTE_{2010} + 1.42*RRD_{2010} - 1.14*RTEA_{2010} - 0.01*RAP_{2010} - 0.01*RCWM_{2010} + 3.85*RLIFE_{2010} - 364.81; \quad (1)$$

$$RGDP_{2011} = -1.13*RUNE_{2011} + 3.53*RPTE_{2011} + 0.51*RRD_{2011} - 1.18*RTEA_{2011} + 0*RAP_{2011} - 0.01*RCWM_{2011} + 3.57*RLIFE_{2011} - 347.27; \quad (2)$$

$$RGDP_{2012} = -0.9*RUNE_{2012} + 3.62*RPTE_{2012} - 0.03*RRD_{2012} - 1.24*RTEA_{2012} - 0.01*RAP_{2012} - 0.01*RCWM_{2012} + 3.53*RLIFE_{2012} - 347.4; \quad (3)$$

$$RGDP_{2013} = -0.97*RUNE_{2013} + 3.73*RPTE_{2013} + 0*RRD_{2013} - 1.33*RTEA_{2013} - 0.01*RAP_{2013} - 0.01*RCWM_{2013} + 3.57*RLIFE_{2013} - 353.73; \quad (4)$$

$$RGDP_{2014} = -0.92*RUNE_{2014} + 3.47*RPTE_{2014} + 1.09*RRD_{2014} - 1.15*RTEA_{2014} - 0.01*RAP_{2014} - 0.01*RCWM_{2014} + 3.28*RLIFE_{2014} - 323.32; \quad (5)$$

$$RGDP_{2015} = -1.32*RUNE_{2015} + 2.71*RPTE_{2015} + 0.13*RRD_{2015} - 0.39*RTEA_{2015} + 0.02*RAP_{2015} - 0.01*RCWM_{2015} + 3.72*RLIFE_{2015} - 357.61; \quad (6)$$

$$RGDP_{2016} = -1.32*RUNE_{2016} + 2.6*RPTE_{2016} + 1.96*RRD_{2016} - 0.46*RTEA_{2016} + 0.01*RAP_{2016} + 0*RCWM_{2016} + 3.62*RLIFE_{2016} - 347.33; \quad (7)$$

$$RGDP_{2017} = -1.44*RUNE_{2017} + 2.54*RPTE_{2017} + 1.74*RRD_{2017} - 0.5*RTEA_{2017} + 0.02*RAP_{2017} + 0*RCWM_{2017} + 3.44*RLIFE_{2017} - 328.31; \quad (8)$$

$$RGDP_{2018} = -1.34*RUNE_{2018} + 2.66*RPTE_{2018} + 1.88*RRD_{2018} + 0.57*RTEA_{2018} + 0.02*RAP_{2018} + 0*RCWM_{2018} + 3.05*RLIFE_{2018} - 295.41; \quad (9)$$

$$RGDP_{2019} = -1.53*RUNE_{2019} + 2.29*RPTE_{2019} + 1.76*RRD_{2019} - 0.28*RTEA_{2019} + 0.02*RAP_{2019} + 0*RCWM_{2019} + 3.07*RLIFE_{2019} - 292.21; \quad (10)$$

$$RGDP_{2020} = -1.38*RUNE_{2020} + 2.87*RPTE_{2020} + 1.24*RRD_{2020} - 0.62*RTEA_{2020} + 0.02*RAP_{2020} + 0.01*RCWM_{2020} + 1.76*RLIFE_{2020} - 178.73; \quad (11)$$

$$RGDP_{2021} = -1.21*RUNE_{2021} + 2.96*RPTE_{2021} + 1.45*RRD_{2021} - 0.86*RTEA_{2021} + 0.03*RAP_{2021} + 0.01*RCWM_{2021} + 2.29*RLIFE_{2021} - 232.37, \quad (12)$$

where:

$RGDP_i$: Annual regional gross domestic product (PPS per inhabitant) by NUTS 2 regions (dependent variable), $i \in [2010, 2021]$;

$RUNE_i$: Unemployment rate by NUTS 2 regions (independent variable), $i \in [2010, 2021]$;

$RPTE_i$: Persons with tertiary education (ISCED) and/or employed in science and technology (independent variable), $i \in [2010, 2021]$;

RRD_i: Intramural R&D expenditure (GERD) by NUTS 2 regions (independent variable), $i \in [2010, 2021]$;

$RTEA_i$: Tertiary educational attainment, age group 25–64 by sex and NUTS 2 regions (independent variable), $i \in [2010, 2021]$;
RAP_i: Animal populations by NUTS 2 regions (independent variable), $i \in [2010, 2021]$;
$RCWM_i$: Production of cow's milk on farms by NUTS 2 regions (independent variable), $i \in [2010, 2021]$;
$RLIFE_i$: Life expectancy at birth by sex and NUTS 2 regions (independent variable), $i \in [2010, 2021]$.

The definition of regression equations based on non-standardized β-coefficients generated using IBM-SPSS 25, allowed to find correlations of regional sustainability indicators with regional economic development in the EU, as follows:

- unemployment as a risk factor for regional economic development varies inversely with the level of economic development throughout the period analysed, which is an attribute of sustainable economic development. In this sense, the regional economic growth was based on the decrease in unemployment by 1 to 1.5 percentage points, with an intensification of the sustainable effect from 2015 to 2019. Thereafter, at EU level, the sustainability of economic growth has been affected by rising unemployment, with the inverse correlation falling from 1.5 percentage points in 2019 (one monetary unit of regional economic growth is based on a 1.5 percentage point fall in unemployment) to 1.38% in 2020 and 1.21 in 2021, a level that was reached in 2010, the year of economic crisis in the EU. This approach allows validation of hypothesis H1: The unemployment rate is reflective of disparities due to social policies implemented by the EU;
- the increase in tertiary education specialisation of R&D employees supporting innovation is unfavourable from a sustainable point of view, in the sense that the correlation level of the indicator Persons with tertiary education (ISCED) and/or employed in science and technology) has fallen from 3.7% in 2013 to 2.29% in 2019. Against the backdrop of intensifying digitisation, the indicator tends to return to a favourable contribution to sustainable economic growth in EU regions. In 2021, it reaches 2.96% impact for a monetary unit of regional economic growth;
- the contribution of the Intramural R&D expenditure (GERD) by NUTS 2 regions indicator to regional economic development during the period under analysis is fluctuating, with 2012 being the year when the correlation trend reverses, which means that R&D effort contributed negatively to economic growth. In 2013, there was no direct correlation between the indicator analysed and sustainable regional development. Since 2016, under the impact of policies developed by the EU through funding programmes allocated to the sector, the impact of R&D on sustainable development has been gradually increasing, although less than the impact of training specialists in science and technology. Thus, in 2019, the last year of economic stability, the influence of R&D development on sustainable economic growth was 1.76%, it declines in 2020 to 1.24% and slightly falls back under the impact of digitalization to 1.45% in 2021, the impact for a monetary unit of regional economic growth. These developments allow the validation of hypothesis H2: Increasing regional disparities are influenced by differential technological progress and access to technology through speculative labour;

– as regards the Food Security indicators (Animal populations by NUTS 2 regions and Production of cow's milk on farms by NUTS 2 regions), there is a low inverse correlation, reflecting the food security risk which is having an impact on sustainable regional development. Negative correlation values maximize in the crisis period 2020–2021 for the Animal populations indicator, while for the Production of cow's milk on farms indicator they stagnate around 0, a marker of the indicator's non-correlation with sustainable regional growth;
– from the life expectancy point of view, it is found that it is at its highest level of direct positive correlation of over 3% per monetary unit of regional economic growth until 2019, after which, under the impact of the pandemic, the impact is reduced by 50% (1.76% per monetary unit of regional economic growth), the indicator showing a rebound in 2021 to 2.29%. This approach validates hypothesis H3: In times of crisis, life expectancy is a vulnerability factor of regional disparity by involving resources to manage social problems.

3. Results

From the homogeneity and statistical representativeness of the regional development model point of view, it can be seen from Table 2 that the proposed model has an unadjusted representativeness of 70% at the beginning of the analysis period, which gradually decreases as the elements of risk and economic disparity analysed in the Introduction section manifest themselves in the regional context.

The ANOVA table shows a decrease in the homogeneity of the data for the annual models presented under the impact of regional sustainability risks, which can be seen from the increase in the degree of representation of the residual values and the decrease in the sum of the squares of the regression variables in the dynamics over the period 2010–2021.

Table 2. Model Summary [ab]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
2010	0.837	0.701	0.692	21.28916	0.701	77.924	7	233	0.000	1.291
2011	0.826	0.682	0.672	22.64131	0.682	71.534	7	234	0.000	1.177
2012	0.825	0.680	0.671	22.76992	0.680	71.166	7	234	0.000	1.151
2013	0.825	0.680	0.671	22.76420	0.680	71.186	7	234	0.000	1.227
2014	0.827	0.683	0.674	22.54104	0.683	72.103	7	234	0.000	1.242
2015	0.792	0.628	0.617	24.86797	0.628	56.432	7	234	0.000	1.303
2016	0.795	0.632	0.621	24.45065	0.632	57.396	7	234	0.000	1.276
2017	0.793	0.629	0.618	24.33276	0.629	56.635	7	234	0.000	1.264
2018	0.787	0.620	0.608	24.60526	0.620	54.477	7	234	0.000	1.245
2019	0.782	0.612	0.600	24.59217	0.612	52.690	7	234	0.000	1.264
2020	0.772	0.595	0.583	25.92161	0.595	49.165	7	234	0.000	1.225
2021	0.770	0.592	0.580	26.00640	0.592	48.531	7	234	0.000	1.299

Note: a. Predictors: (Constant), RLIFE, RUNE, RCWM, RTEA, RRD, RAP, RPTE; b. Dependent Variable: RGDP.

The model is valid by applying the one-sided critical probability test, obtaining over the entire period analyzed Sig coefficients of the correlation function F lower than the chosen significance threshold of 0.05, which allows rejecting the null hypothesis, validating the alternative hypothesis and indirectly validating the model (see Table 3).

Table 3. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
2010	Regression	247220.952	7	35317.279	77.924	0.000[b]
	Residual	105602.157	233	453.228		
	Total	352823.109	240			
2011	Regression	256693.954	7	36670.565	71.534	0.000[b]
	Residual	119955.180	234	512.629		
	Total	376649.133	241			
2012	Regression	258279.994	7	36897.142	71.166	0.000[b]
	Residual	121321.855	234	518.469		
	Total	379601.849	241			
2013	Regression	258224.394	7	36889.199	71.186	0.000[b]
	Residual	121260.876	234	518.209		
	Total	379485.271	241			
2014	Regression	256447.591	7	36635.370	72.103	0.000[b]
	Residual	118895.075	234	508.099		
	Total	375342.666	241			
2015	Regression	244290.307	7	34898.615	56.432	0.000[b]
	Residual	144709.354	234	618.416		
	Total	388999.661	241			
2016	Regression	240193.170	7	34313.310	57.396	0.000[b]
	Residual	139893.279	234	597.835		
	Total	380086.449	241			
2017	Regression	234727.096	7	33532.442	56.635	0.000[b]
	Residual	138547.423	234	592.083		
	Total	373274.519	241			
2018	Regression	230867.926	7	32981.132	54.477	0.000[b]
	Residual	141668.054	234	605.419		
	Total	372535.980	241			
2019	Regression	223060.842	7	31865.835	52.690	0.000[b]
	Residual	141517.255	234	604.775		
	Total	364578.096	241			
2020	Regression	231249.142	7	33035.592	49.165	0.000[b]
	Residual	157231.580	234	671.930		
	Total	388480.722	241			
2021	Regression	229762.458	7	32823.208	48.531	0.000[b]
	Residual	158261.899	234	676.333		
	Total	388024.357	241			

Note: a. Dependent Variable: RGDP; b. Predictors: (Constant), RLIFE, RCWM, RRD, RTEA, RUNE, RAP, RPTE.

The design of residual statistics using IBM-SPSS 25 software allowed forecasting the range of variation of the regional economic sustainability function, which varies between –7% and 181% disparity of economic development relative to the overall average economic development at the regional level (see Figure 8).

In terms of dynamics, it can be seen from Figure 1 that the highest level of disparity represented by the widening of the range of variation and reaching negative values on the minimum is achieved in 2021, the year in which the geo-political context becomes unfavourable and the problems of food and energy security become more acute at regional level in the EU.

At the opposite pole, the smallest size of the disparity range was reached in 2010, demonstrating hypotheses H4 (Accelerating regional economic development in the absence of a climate of economic stability leads to an intensification of regional disparities) and H5 (Purchasing power as an exponent of disparities has an oscillating trend that follows economic developments).

The disparity index was determined on the basis of the analysis of the range of regional economic development, applying a dedicated methodology, according to the relationship:

$$DI_i = \frac{\sum_{j=1}^{7}\left(\sqrt{\sum_{r=1}^{242}\left(x_{ir}-\overline{X}_i\right)^2}\right)_j \cdot \sqrt{\sum_{r=1}^{242}\left(RGDP_{ir}-\overline{RGDP}\right)^2}}{\sum_{r=1}^{242}\left(RGDP_{ir}-\overline{RGDP}\right)\cdot\sum_{j=1}^{7}\left(\sum_{r=1}^{242}\left(x_{ir}-\overline{X}_i\right)\right)_j}, \quad (13)$$

where: x – the 7 independent variables of the model; r – number of analysed NUTS 2 regions; i – number of years.

Based on formula 13, we calculated regional disparity indices whose graphical representation is shown in Figure 9.

It can be seen that the regional disparity index over the period 2010–2021 has increased by approximately 20%, which at EU level implies the need to review key public policies such as regional and cohesion policy.

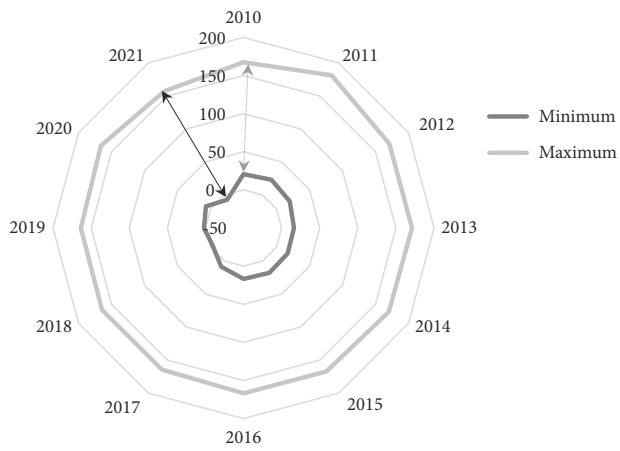
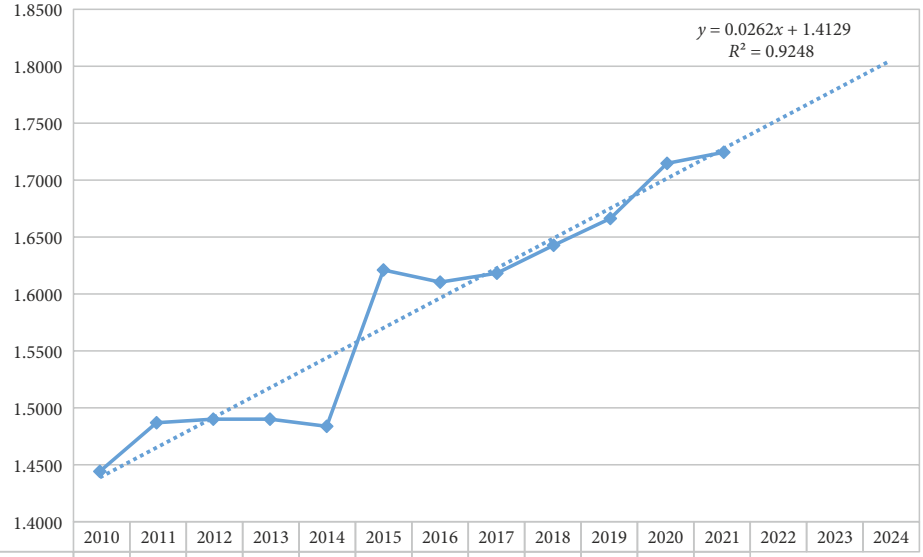


Figure 8. Predicted dependent variable value



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Regional disparity index	1.4457	1.4881	1.4907	1.4905	1.4842	1.6211	1.6105	1.6188	1.6438	1.6661	1.7148	1.7243			

Figure 9. Evolution of the regional disparity index

Each risk event has had implications for increasing disparities, but from Figure 2 it emerges that the greatest challenges arise from an unstable geo-political and economic context (2010–2012) and 2019–2021.

4. Discussion

Cohesion policy adopted under the Treaty on the Functioning of the EU supports sustainable economic growth based on axiological pillars such as equal opportunities, economic competitiveness, environmental protection and regional cohesion.

Thus, although faced with numerous challenges, economic and social cohesion policy has developed in Europe, and after the European Union (2008) this policy has taken on a three-dimensional aspect, seeing the economic, social and regional cohesion sectors. European bodies have set up control and monitoring mechanisms for cohesion initiatives, and in 2014 the Cohesion Fund, the European Agricultural Fund for Rural Development, the Fund for a Just Transition and the European Fund for Fisheries and Maritime Affairs were established.

Their operating principles are based on the targeting of investments through regional analyses and the concentration of funding on disadvantaged regions in particular, with measures to increase social, economic and regional cohesion, programming and planning of activities, complementarity of national contributions, and cross-border, transnational and interregional cooperation.

Significant for the EU's effort to achieve cohesion objectives is the budget al.ocated, which for the period 2014–2020 has been quantified at 32.5% of the overall EU budget. In the under

review period, 2010–2021, the multiple challenges of economic instability and crises, food security issues, health and pandemic crises and the uneven development of Industry 4.0 have created a climate unfavourable to social, economic and regional cohesion (Fina et al., 2021).

Our proposed model addresses the elements of cohesion policy stipulated for the period 2021–2027 in terms of innovative and smart economic transformation, social Europe and integrated sustainable development of regions through local initiatives. According to the presented above analyses, the trend of disparities is increasing. Thus, we believe that the "Smarter Europe" initiative, which implies innovative and intelligent economic transformation, should first and foremost focus on creating digital infrastructure and stimulating R&D in disadvantaged areas (Spain, Italy, Greece, Romania, Bulgaria), including by stimulating technology transfer and attracting young people to science and technology specialisations. From the carried-out study, it appears that this regional stimulation of innovative and smart economic transformation needs to be linked to the medium-term reality, as failures have been observed in maintaining the sustainability of economic activities after the monitoring period.

Regarding the "Social Europe" initiatives, i.e. the implementation of the European pillar of social rights, we believe that there will be multiple challenges arising from the diffuse distribution of equal opportunities. This is in conjunction with the geo-political risk that Europe is currently facing, the energy risks and the economic risks, in particular hyperinflation and rising unemployment. In an objective approach, we believe that disadvantaged regions with a high rate of youth unemployment (in Greece, Spain, Italy and the overseas territories of France) should be supported by changing the prioritisation in relation to regional development, including the criterion of regional disparity index to highlight regional components in need of increased funding in the social sector.

The "Europe closer to citizens" initiative, which foresees integrated sustainable development of regions through local initiatives, should be adjusted to the food security risks arising from the current geo-political risk. Thus, stimulating local initiatives in agricultural basins such as increasing the community contribution to improving agricultural infrastructure and facilitating the implementation of non-conventional technologies could solve some

Table 4. Summary and validation of research hypotheses

Hypothesis number	Content	Validation
H1.	The unemployment rate is reflective of disparities due to social policies implemented by the EU	Yes, acceptance
H2.	Increasing regional disparities are influenced by differential technological progress and access to technology through speculative labour	Yes, acceptance
H3.	In times of crisis, life expectancy is a vulnerability factor of regional disparity by involving resources to manage social problems	Yes, acceptance
H4.	Accelerating regional economic development in the absence of economic stability leads to increased regional disparities	Yes, acceptance
H5.	Purchasing power as an exponent of disparities has an oscillating trend that follows economic developments	Yes, acceptance

food security problems, improve the cohesion of local rural communities and those with predominantly agricultural activity, some instruments being closely linked to the reduction of bureaucracy, and making the local administrative apparatus more flexible in the interest of citizens (Kolodziejski, 2022).

In this scientific approach, the 5 hypotheses put forward in the Materials and methods section were validated as follows (see Table 4).

Based on these assumptions and the selected regional indicators, we determined the disparity index, which is an extremely useful tool for national and regional policy makers to define and subsequently implement socio-economic development policies at regional level.

Conclusions

The objectives of the research were to study the dynamics of regional economic, social and territorial disparities over the period 2010–2021 and to develop an index of economic disparities at EU level by econometrically quantifying the dynamics of sustainable regional development indicators. According to the main objective of the paper we find that the three moments of the analysis led to different trends of the socio-economic disparities. These moments reffer to the following moments: 2013, 2010–2013 and 2020–2021.

The objective has been achieved, as the authors have produced an evolving picture of disparities and assessed the range dynamics of sustainable economic growth using econometric techniques and methods. From a methodological point of view, the authors developed a dynamic model of regional development that confirmed the working hypotheses supported by the literature in the sense of the risks that affect the correlation of sustainability indicators with regional economic development supported by cohesion policy.

From the point of view of the policies and programmes planned for the period 2021–2027, based on the results of the research, the authors made recommendations to improve allocations based on specific regional vulnerabilities, correcting the current approach based on the level of economic development of the regions. The recommendations of the "Smarter Europe", "More Social Europe", "Europe Closer to Citizens" projects and some of the own opinions expressed during the research call for a closer study of the threats linked to the current geo-political context and the disparities accumulated during the 11 years of analysis in terms of sustainable regional economic development.

Bringing these results closer to decision-makers would contribute to improving the prospects for cohesion strategies and help to achieve the proposed objectives more quickly. We appreciate the study as being innovative, impactful in the current context, useful for supranational decision-makers to achieve the proposed objectives.

The limitations of the study lie in the relatively small number of variables, as the authors encountered major difficulties in accessing and collecting official statistical data to inform policies for a greener Europe (carbon emissions) and a more connected Europe (mobility and regional ICT connectivity). To the extent that these data can be consolidated, the authors will return to broader modelling to improve the solutions proposed to policy makers. Official statistics covering all EU27 regions, including Croatia, stop in 2010. Extending the analysis period to at least 20 years would eliminate the regional information for the regions of Romania and Bulgaria (countries that joined in 2007) and the 10 former communist countries

that joined in 2004. In this way, homogeneity and comparability of statistical data would disappear. As a result, we have to limit ourselves to the period 2010–2021 for which correct official information exists for all EU27 regions.

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