ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2023 Volume 11 Number 2 (December)
http://doi.org/10.9770/jesi.2023.11.2(29)

Publisher
http://jssidoi.org/esc/home

MEASURING THE SUSTAINABILITY OF ECONOMIC DEVELOPMENT IN THE EU COUNTRIES: A COMPARATIVE ANALYSIS OF THE EXISTING TOOLS*

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Received 11 September 2023; accepted 5 December 2023; published 30 December 2023

Abstract. This article aims to analyze and compare the existing tools for measuring the sustainability of economic development in EU countries. The primary method of empirical data processing in the framework of this study is a comparative analysis of the ranks of EU countries by new measurement tools in relation to the traditional ones, GDP and HDI). Sources of empirical data are analytical reports of international organizations, international statistical information from various institutions, open-access databases, and individual researchers' publications. The results of a comparison of the ranks of EU countries by GDP, HDI, Green GDP, Sustainable Development Goals Index (SDG Index), Green Economy Index (GEI), Green Growth Index (GGI), Sustainable Development Green Index (SDGI) show that basically, the ranks of each specific country within all ratings analyzed in this study are similar. Still, there are some exceptions (for example, Luxembourg). Given these results, developing multiple 'green' indices instead of one traditional GDP from a practical point of view seems completely unjustified and unnecessary. However, the author believes that the main driving force behind individual researchers and entire organizations' search for new tools is the real need for more comprehensive and multidimensional approaches to measuring economic progress and sustainable development. The many proposed tools for measuring the sustainability of territorial development provide a broader picture. It is unlikely that one instrument is most suitable for measuring the sustainability of economic development of the EU countries since each of them allows evaluating the sustainability of development (both economic and general) from its unique discourse.

Keywords: sustainability of economic development; sustainability of territorial development; measurement tools; comparative analysis; green economy; circular economy; the European Union countries.

Reference to this paper should be made as follows: Vītola, Z. 2023. Measuring the sustainability of economic development in the EU countries; a comparative analysis of the existing tools. *Entrepreneurship and Sustainability Issues*, 11(2), 433-451. http://doi.org/10.9770/jesi.2023.11.2(29)

JEL Classifications: Q56, O44, R11

1. Introduction

The sustainability of economic development of any territory is based on the so-called 'Hartwick rule' (Hartwick, 1990), which refers to the sustainable use of natural resources in the economy and is a key element in the context of long-term development (Hamilton, 1995). The 'Hartwick rule' states that if an economy compensates for the depletion of natural resources (e.g., oil, gas, minerals) by adequate investment in produced capital (e.g., machinery, buildings, infrastructure, technology), then the level of consumption can be

* *This research was funded by Daugavpils University (Latvia) within the ESF project No. 8.2.2.0/20/I/003 "To Strengthen Professional Competence of the Academic Staff of Daugavpils University in the Areas of Strategic Specialization, 3rd round"*

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maintained at a constant level almost indefinitely (Hartwick, 1990). This means that income from exhaustible resources must be reinvested in other forms of capital (including human capital) to compensate for declining natural resource supplies (Hartwick, 1990; Hamilton, 1995). Sustainability of economic development, therefore aims to ensure that the economic benefits from using these resources extend to future generations.

In the international scientific space, there is a complete agreement that the traditional measurement tools of a country's achieved level of economic development, such as Gross Domestic Product (GDP) or Gross National Product (GNP), fail to account for the environmental issues and cannot measure whether the economy is developing towards a sustainable path (Hartwick, 1990; Hamilton, 1994, 1995; Costanza et al., 2014a, 2014b; Pokharel & Bhandari, 2017; Stjepanović et al., 2019; Ma et al., 2020, Wang et al., 2021 and many others). Instead, many other tools are proposed and used to assess the sustainability of economic development of the world's countries and their internal regions – for example, Green GDP, Gross Ecosystem Product (GEP), Gross Economic-Ecological Product (GEEP), Sustainable Development Goals Index (SDG Index), Green Economy Index (GEI), Green Growth Index (GGI), Global Green Economy Index (GGEI), Sustainable Development Green Index (SDGI), System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA-EA) (Hamilton, 1994; Li & Lang, 2010; Rauch & Chi, 2010; Ryszawska, 2013, 2015; Pokharel & Bhandari, 2017; Vimochana, 2017; Stjepanović et al., 2019, 2022; Ouyang et al., 2020; Ma et al., 2020; Niu et al., 2021; Wang et al., 2021; Wang et al., 2022; Lange et al., 2022; Sustainable Development Solutions Network, 2022; Zhao et al., 2023; Rybalkin, 2022, 2023; Global Green Growth Institute, 2023; Dual Citizen, 2023; United Nations. 2023a, 2023b).

Measurement of the sustainability of economic development, considering the impact of the economy on the environment, is also crucial for the EU countries, since, firstly, EU countries strive to reduce their carbon footprint and combat climate change (Rybalkin, 2020; Cifuentes-Faura, 2022; European Commission, 2023a). Secondly, the EU is actively implementing environmental standards and legislation (for example, the Paris Agreement, the European Green Deal). Thirdly, the EU emphasizes the importance of social responsibility and equity in economic growth (European Committee for Social Cohesion, 2004; Mikušová, 2017; Gkorezis & Petridou, 2017; MacGregor Pelikánová, 2019). Fourthly, the EU strives to be a world leader in environmentally sustainable development (Sustainable Development Solutions Network, 2022; European Parliament, 2023; Mentes, 2023), and then evaluating the impact of the economy on the environment emphasizes its role in promoting global environmental standards and cooperation with other countries and regions. Thus, integrating environmental aspects into the evaluation of sustainability of economic development is essential for the long-term prosperity and health of society, the economy and the environment in EU countries.

This article aims to analyze and compare the existing tools for measuring the sustainability of economic development in EU countries. The result of such a comparative analysis should be a conclusion about which of the existing tools is more suitable for measuring the sustainability of economic development in the EU countries, as well as the answer to the question of why so many new measurement tools have replaced one GDP. In the next section of the article, the author will review the literature on the sustainability of economic development of territories and existing measurement tools for evaluating the sustainability of economic development of territories. The research methodology will then be presented, followed by the study results and discussion. In the article's final section, the author will highlight the main findings of the study, as well as the limitations, and possible directions for future research in the relevant area.

2. Literature review

The transition from the conception of quantitative economic growth (Kuznets, 1949) to the idea of sustainable economic development (based on the conceptions of green economy and circular economy – Ryszawska, 2013; Kasztelan, 2017; Razminienė et al., 2021; Rybalkin, 2023) began in the second half of the 20th century (Barbier, 1987; Wang, 1996), mainly in developed countries, including Western Europe, North America and also some Asian countries such as Japan. This process was determined by several key factors: (1) in Western Europe and North America, where industrialization began earlier, environmental problems such as air and water pollution became apparent by the 1970s, leading to increased public and political attention to

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environmental issues; (2) significant economic development has been achieved in these regions, which has brought attention to issues related to the sustainability of the economic growth, including natural resource depletion and inequality; (3) developed countries played a key role in international efforts to promote sustainable development, including signing international treaties and participating in global conferences; (4) in these countries, there was significant academic and research interest in the environmental and social aspects of economic development, which contributed to the formation and dissemination of the conception of sustainable development; (5) the active participation of non-governmental organizations, environmental movements and the public in these countries also contributed to the rethinking of traditional approaches to economic development. Subsequently, the idea of economic development focused on sustainability, social justice and environmental responsibility, and not just traditional economic growth, gained widespread acceptance and began to permeate economic development policies and practices around the world, including in developing countries, where it was adapted to local conditions and challenges (Huambachano, 2011; Markard et al., 2012; Boronenko & Drezgic, 2014; Boronenko et al., 2015; Lonska & Boronenko, 2015; Komarova, 2016; Komarova & Drezgic, 2016; Carbonnier et al., 2017; Kasztelan, 2017; Sánchez Garcia & Díez Sanz, 2018; Okunevičiūtė Neverauskienė et al., 2020; Beirne & Fernandez, 2022; Focardi & Fabozzi, 2023).

In the 1970s, studies emerged, such as the report "The Limits to Growth" published by the Club of Rome, which emphasized that unlimited economic growth was impossible due to limited natural resources and the environmental impact of human industrial activities (Meadows et al., 1972). This message has been noted as an effective antecedent to the conception of 'post-growth economy' – an economic system in which the emphasis is not so much on quantitative economic growth, measured by traditional indicators such as GDP, but on sustainable qualitative development and social well-being, environmental sustainability and equitable distribution of resources (D'Allessandro et al., 2018), as well as to the 'degrowth' movement – a radical economic theory born in the 1970s, which broadly means shrinking rather than growing economies, to use less of the world's dwindling resources, or a planned reduction of energy and resource use designed to bring the economy back into balance with the living world in a way that reduces inequality and improves human well-being (Hickel, 2019, 2021).

In 1972, the first UN Conference on the Human Environment took place in Stockholm, which became a turning point in the discussion of global environmental problems. One of the major results of the Stockholm conference was the creation of the United Nations Environment Program (UNEP) (United Nations, 2023c). In 1987, the report "Our Common Future" (also known as the Brundtland report) introduced the notion of sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 1987). The growing global connectivity and interdependence of countries (especially since the collapse of the socialist bloc in the 1990s) has shown that many environmental and social problems are global and require coordinated efforts (Wu et al., 2022; Xia et al., 2022; Zhang et al., 2022). Furthermore, growing awareness of global inequality and social issues has led to the understanding that economic development must be inclusive (Rauniyar & Kanbur, 2010; Zhu, 2022) and should involve a combination of mutually reinforcing measures including (Rauniyar & Kanbur, 2010): (1) promoting efficient and sustainable economic growth, (2) ensuring a level political playing field and (3) strengthening capacities and providing for social safety nets. Thus, the conception of sustainable economic development is the result of a profound revision of traditional approaches to economic growth, including the consideration of environmental and social issues in the planning and implementation of development policies (Pearce & Atkinson, 1993).

Recognizing the vital need for sustainable economic development, however, the question of how to measure the achievements of different countries of the world on the path to sustainable economic development in a situation where traditional GDP is unanimously rejected by the international scientific community remains unclear. What is proposed instead as measuring tools for the sustainability of economic development? In the international scientific literature, the author was able to find many relevant measurement tools – for example, such as Green GDP (Li & Lang, 2010; Pokharel & Bhandari, 2017; Vimochana, 2017; Stjepanović et al., 2019. 2022; United Nations, 2023a), Gross Ecosystem Product (GEP) (Ouyang et al., 2020; Wang L et al., 2022; Zhao et al., 2023), Gross Economic-Ecological Product (GEEP) (Ma et al., 2020; Niu et al., 2021; Wang et al., 2021), Sustainable Development Goals Index (SDG Index) (Sustainable Development Solutions

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Network, 2022); Green Economy Index (GEI) (Ryszawska, 2013, 2015), Green Growth Index (GGI) (Global Green Growth Institute, 2023), Global Green Economy Index (GGEI) (Dual Citizen, 2023), Sustainable Development Green Index (SDGI) (Rybalkin, 2022, 2023), System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA-EA) (Lange et al., 2022; United Nations. 2023b).

First of them, Green GDP (GGDP) (or environmentally adjusted GDP) derived from Net Domestic Product (NDP) is an alternative indicator of economic activity that considers the impact of economic activity on the natural environment and resources (Hamilton, 1994; Li & Lang, 2010; Rauch & Chi, 2010; Pokharel & Bhandari, 2017; Vimochana, 2017; Stjepanović et al., 2019, 2022). The conception of Green GDP emerged in the late 1980s as a response to growing concerns about environmental sustainability and the shortcomings of traditional GDP in measuring economic well-being (Hamilton, 1994). Green GDP has been supported and used by international organizations such as the UN and the World Bank (United Nations, 2023b). Unlike traditional GDP, Green GDP includes adjustments for losses from pollution, natural resource depletion, and other environmental variables. Despite significant efforts, the application of the Green GDP in practice has encountered a number of problems related to methodology, data accuracy and political will (Jiang, 2007; Rauch & Chi, 2010; Vimochana, 2017). This has meant that Green GDP has not been widely adopted as a standard indicator of economic well-being, but has contributed to developing other sustainable economic development measurement tools. However, there is an open access database containing Green GDP values versus traditional GDP values for 160 countries from 1970 to 2019 (Škare et al., 2021).

In the 2000s, the conception of Gross Ecosystem Product (GEP) began to be developed in China, which, like Green GDP, was a response to the growing awareness that traditional tools for measuring economic development (such as GDP) do not take into account the full cost of depreciation of ecosystems and used natural resources. One of the pioneers in this field is Chinese ecologist Ouyang, who played a key role in developing and implementing GEP in China. "GDP fails to fully capture nature's contributions to economic activity and human well-being. To address this critical omission, we develop a measure of GEP that summarizes the value of ecosystem services in a single monetary metric" (Ouyang et al., 2020). China was one of the first countries to (and continues to this day) actively use GEP as a tool for evaluating environmental achievements and the impact of environmental policies at the national and regional levels, especially in regions rich in natural resources (Ouyang et al., 2020; Wang et al., 2022; Zhao et al., 2023). At the same time, Chinese researchers do not claim that GEP can completely replace GDP in measuring the economic development of a territory. Rather, they emphasize that GEP is an important complement to traditional economic development measurement tools (such as GDP) (Wang et al., 2022; Zhao et al., 2023).

Another conception for evaluating economic activity considering its impact on the environment is Gross Economic-Ecological Product (GEEP), developed and tested by scientists from the Chinese Academy of Environmental Planning in order to obtain a more complete picture of economic progress in China, including its environmental impacts and sustainability (Ma et al., 2020; Niu et al., 2021; Wang et al., 2021). According to the creators of the GEEP, this tool can help governments and organizations make more evidence-based decisions, striving for a balance between economic growth and environmental safety. “The development of this new accounting system is an important step toward a more accurate measure to capture the change of ecosystem services in national accounts and a policy instrument to grow the economy within the means of the environment” (Wang et al., 2021). For the authors of the GEEP, the ultimate goal of this tool is to become a satellite national account parallel with GDP to measure sustainable economic development. “Many improvements are needed to achieve that goal. Notably, considerable uncertainties exist in the GEEP accounting, especially in various aspects of the valuation of ecosystem services and environmental degradation” (Wang et al., 2021).

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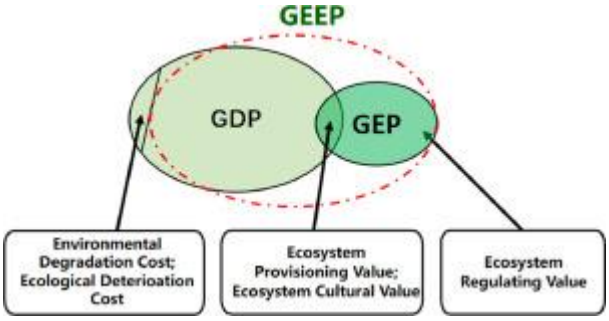

Fig. 1. Conceptual framework of the Gross Economic-Ecological Product (GEEP)
Source: Wang et al., 2021.

Unlike Green GDP, which always adjusts the territory's GDP downward (Škare et al., 2021), the GEEP value exceeds the territory's GDP, since it also includes the value of services provided by ecosystems. For example, in 2016, China's GEEP was 126.6 trillion RMB, 1.6 times of GDP (Ma et al., 2020). Currently, in China, the conceptions of GEP and GEEP are to a certain extent competitors in the field of measuring the sustainability of economic development of the country's regions and are used in parallel (Ma et al., 2020; Ouyang et al., 2020; Niu et al., 2021; Wang et al., 2021; Wang et al., 2022; Zhao et al., 2023). Although GEP and GEEP have overlapping goals of integrating environmental considerations into economic accounting, they serve different functions and are not interchangeable. GEP focuses on accounting for the value of ecosystem services, while GEEP is a broader accounting tool that incorporates and adjusts traditional GDP to add an environmental dimension.

GEP and GEEP are the result of China's efforts to integrate environmental factors into traditional measurement tools of the economic development and the pursuit of more sustainable development, and are not used in other countries and regions of the world to evaluate the sustainability of economic development of territories. However, there is significant global interest in integrating environmental indicators and ecosystem services into economic planning and policy development (Sustainable Development Solutions Network, 2022). This includes the development and use of various tools and approaches aimed at evaluating environmental sustainability and environmental impact of an economy. In the EU, efforts to develop and use different tools for measuring the sustainability of economic development are often carried out within the framework of broad strategies (Mentes, 2023), such as the European Green Deal, which aim to promote sustainable development and a green economy (Ryszawska, 2013, 2015).

One of the newest tools for measuring sustainability of development of the European countries is the Sustainable Development Goals (SDG) Index, first issued in 2016. SDG Index is an initiative of the UN Sustainable Development Solutions Network (SDSN) in collaboration with SDSN Europe and Bertelsmann Stiftung. It aims to measure human welfare beyond the traditional GDP metric by incorporating 110 indicators that cover social and economic prosperity, as well as environmental sustainability. This index also penalizes countries for negative social and environmental impacts caused by unsustainable supply chains, consumption, profit shifting, and tax evasion (Sustainable Development Solutions Network, 2022). The SDG Index differs from traditional GDP in several ways. While GDP focuses on economic activity, the SDG Index provides a more comprehensive assessment of a country's performance in achieving sustainable development. This includes social and environmental factors, thus offering a broader perspective on national well-being and progress (Our World in Data team, 2023).

The next measurement tool, Green Economy Index (GEI)**,** created by Ryszawska, was developed through an iterative process that began with an overview of the definitions of a green economy presented in selected strategic documents. The approach involved outlining and specifying areas and objectives of the green economy, distinguishing specific objectives and variables for measuring the implementation of these individual objectives (Ryszawska, 2013). The GEI was proposed in response to the growing need to measure

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the actual implementation of green economy policies. It was developed amidst various approaches by international organizations like OECD, UNEP, World Bank, and Global Green Growth Institute, and consulting companies like Dual Citizen (Ryszawska, 2015). According to its creator, GEI is a critical tool for understanding and evaluating the implementation of green economy practices globally, providing insights into how nations are transitioning towards more sustainable economic practices. This includes analysis of aspects such as green economy leadership, domestic policies, investments in green technologies and green tourism (Ryszawska, 2013, 2015; Rybalkin, 2023).

Another measurement tool, the Green Growth Index (GGI) was developed as a collaborative effort among several international organizations, namely the Global Green Growth Institute (GGGI), Organisation for Economic Cooperation and Development (OECD), United Nations Environment Programme (UNEP) and the World Bank. This initiative was aimed at standardizing and integrating the measurement of green economy and green growth, reflecting the collective effort to develop a comprehensive framework for assessing such policies and practices (Global Green Growth Institute, 2023). GGI includes four dimensions, one of which is directly related to economic development, and the others to territorial development in a broader sense: (1) efficient and sustainable resource use; (2) natural capital protection; (3) green economic opportunities; (4) social inclusion. GGi and the previously reviewed Green Economy Index (GEI) are related in their focus on sustainable development and green economy, but they were developed independently by different authors and organizations (Ryszawska, 2013, 2015; Global Green Growth Institute, 2023), with their own unique methodologies and objectives. Moreover, we have also the Global Green Economy Index (GGEI) developed by Dual Citizen LLC, a consulting firm. It is an analytical tool that measures the green economic performance, focusing on aspects like leadership and climate change, environmental sectors, and green tourism. This index was first calculated in 2010 and is designed to evaluate the green economy performance of various countries (although it is not an open access tool) (Dual Citizen, 2023).

One more tool for measuring the sustainability of economic development and development in a broader sense, Sustainable Development Green Index (SDGI), was created by Rybalkin within the Ph.D. thesis at Daugavpils University (Latvia) (Rybalkin, 2023). SDGI is based on the Quintuple Helix Model, which consists of five subsystems: educational, economic, political, societal and environmental. Particular attention is paid to the educational subsystem, since its inclusion is methodologically innovative as compared to other similar indexes and allows to perform interdisciplinary analysis of green economy in the context of sustainable development (Rybalkin, 2022, 2023). Based on his analysis for the EU countries, Rybalkin concluded that the economic subsystem of SDGI does not possess a high differentiating significance dividing the EU countries by the performance of green economy in the context of sustainable development. This conclusion makes it impossible for some countries to appeal to so-called split between Central-Eastern and Western Europe, as well as to a pronounced North-South divide, according to which the new EU members supposedly do not have necessary resources to develop green economy because of lower level of economic development. Just the reverse: the results of analysis with the help of SDGI show that countries can improve the sustainability of economic development by focusing on educational (primarily), social and political factors (Rybalkin, 2023).

The last tool for measuring the sustainability of economic development of territories reviewed within this study is the System of Environmental-Economic Accounting (SEEA) (Lange et al., 2022; United Nations, 2023b), The System of Environmental Economic Accounting (SEEA) is the international statistical standard for natural capital accounting, organizing environmental data and linking them to economic data. The SEEA provides a statistical framework from which aggregated 'green' economic indicators can be calculated (United Nations, 2023b). In March 2021, the UN Statistical Commission adopted the revised ecosystem accounting framework (System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA-EA)) (UN 2021).

This new framework builds on an earlier adopted experimental approach (SEEA-EEA), UN, 2012, UN, 2017) and forms the foundation for a transformation in the national accounting and economic reporting aiming for a better recognition of our natural capital (Lange et al., 2022). In combination with the growing relevance and increasing awareness of ecosystem accounting in policy- and decision-making in the countries and within supranational bodies like the UN and the EU, it is expected a significant increase in completed ecosystem accounts in the foreseeable future (Lange et al., 2022).

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In the scientific literature there are quite rare attempts to compare many relevant tools for measuring the sustainability of economic development - for example, Stjepanović and his colleagues compared alternative tools for measuring socio-economic well-being (20 in total, including such as Index of Sustainable Economic Welfare, Genuine Progress Indicator, Environmentally-Adjusted Net Domestic Product and many others) in relation to traditional GDP and concluded about each of them in terms of whether a particular alternative measurement tool complements, replaces or corrects traditional GDP (Stjepanović et al., 2022). In turn, Rybalkin in his Ph.D. thesis "Green Economy in the Context of the European Union's Sustainable Development in 2017–2020" (2023) compared tools for measuring sustainable development in a broader sense than just the economic one, and came to the need to create a new index consisting of five subsystems (economic, environmental, political, societal and educational) and further expanding the meaning of sustainable development of territories (Rybalkin, 2023). However, none of the above-mentioned and other authors, who compared current tools for measuring the sustainability of economic development and territorial development in a broader sense, compared the positions of countries (in particular, the EU countries) on all these indices and did not conclude about the real practical need to create such a variety of tools for measuring sustainability of development instead of one traditional GDP. With this study, the author hopes to fill this research gap.

3. Research methodology

To achieve the aim of this study to analyze and compare the existing tools for measuring the sustainability of economic development in the EU countries, the author uses data from various sources to assess and compare the positions of the EU countries according to various tools for measuring the sustainability of development. Despite the fact that the subject of this study is measuring the sustainability of economic development specifically, the author also touches on the topic of measuring the sustainability of territorial development in a broader sense (traditionally it is measured using the Human Development Index (HDI), which evaluates the quality of human capital in a certain territory). This makes it possible to create a broader and more realistic context for a comparative analysis of existing measurement tools, which are sometimes most suitable for measuring the sustainability of economic development specifically, and sometimes for measuring the sustainability of territorial development in a broader sense. The following figure presents those specific tools for measuring the sustainability of territorial development (both economic and more general), which were analyzed by the author in the previous section of the article during the literature review and for which ratings of EU countries are available.

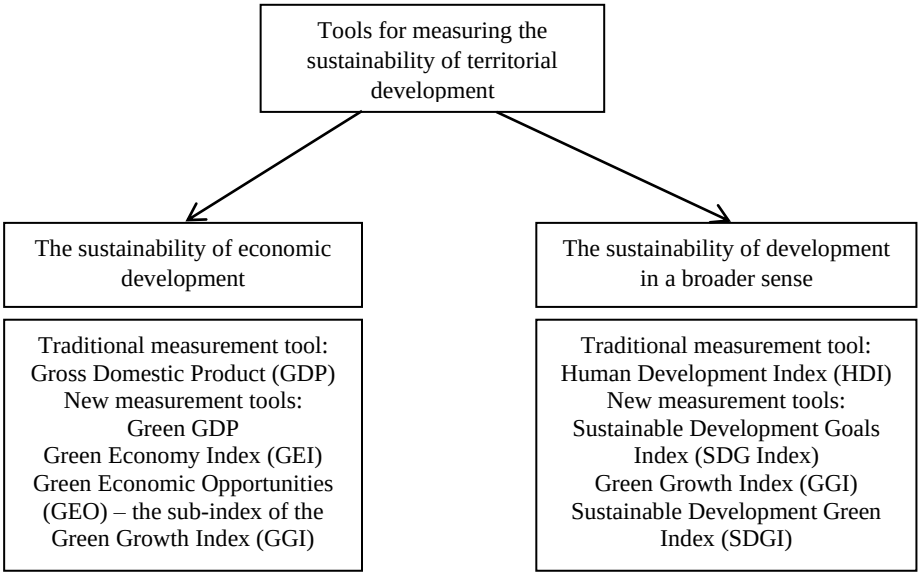

Fig. 2. Specific tools for measuring the sustainability of territorial development available for the EU countries
Source: elaborated by the author based on literature review

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The main method of empirical data processing in the framework of this study is a comparative analysis of the positions of EU countries in the ratings of existing new measurement tools of the sustainability of economic development and the sustainability of development in a broader sense, in relation to the traditional measurement tools (GDP and HDI). Sources of empirical data are analytical reports of international organizations (for example, Human Development Report 2021/2022 (Human Development Report Office. 2022)), international statistical information from various institutions (for example, European Commission, Eurostat, United Nations Economic Commission for Europe (UNECE), open access databases (for example, International Database on Green GDP 1970-2019 (Škare et al., 2021)), as well as publications by individual researchers (for example, Ryszawska, 2015; Stjepanović et al., 2019; Rybalkin, 2023).

4. Study results and discussion

The main result of this study is a comparison of the tools proposed in the international scientific literature (and reviewed in the Section 2 of this article) for measuring the sustainability of economic development (as well as development in a broader sense) of a territory and their relationship with such a traditional tool for measuring the economic development of a territory as GDP (and in some cases with HDI). The author will begin presenting the research results with a comparative analysis of Green GDP and traditional GDP in the EU countries.

Table 1. Ranking EU countries by Green GDP in comparison with traditional GDP, n = 26 countries,* 2019

EU country**	Difference between GDP and Green GDP, %	GDP per capita (current US$)	Rank by GDP per capita	Green GDP per capita	Rank by Green GDP per capita
Luxembourg	0,2	115826	1	115631	1
Ireland	0,2	79258	2	79111	2
Denmark	0,5	59951	3	59622	3
Netherlands	0,5	52602	4	52335	4
Sweden	0,2	51889	5	51761	5
Austria	0,3	50381	6	50252	6
Finland	0,4	48707	7	48529	7
Germany	0,2	46322	8	46213	8
Belgium	0,2	46232	9	46125	9
United Kingdom	0,6	42419	10	42175	10
France	0,2	40355	11	40290	11
Italy	0,3	33456	12	33370	12
Spain	0,3	29702	13	29621	13
Cyprus	0,4	28045	14	27940	14
Slovenia	0,3	25826	15	25746	15
Estonia	0,9	23691	16	23485	16
Portugal	0,4	23129	18	23040	17
Czechia	0,6	23145	17	22996	18
Greece	0,4	19567	19	19484	19
Lithuania	0,4	19404	20	19335	20
Slovakia	0,4	19342	21	19263	21
Hungary	0,5	16471	22	16388	22
Poland	1,0	15594	23	15441	23
Croatia	0,8	14821	24	14702	24
Romania	0,7	12881	25	12788	25
Bulgaria	1,4	9704	26	9565	26

* Latvia and Malta are not included in the database on Green GDP (Škare et al., 2021).
** EU countries are listed by the Green GDP rank.
Source: calculated and compiled by the author based on the data from Škare et al., 2021; European Commission, 2023b.

As the data in Table 1 shows, the values of Green GDP in most EU countries differ by only tenths of a percent, and the rankings of EU countries in terms of traditional GDP and Green GDP are almost completely identical (with one minor exception for Portugal and Czechia). Even though Green GDP is an improved modified version of traditional GDP, countries with a comparatively high GDP also have a comparatively

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high Green GDP, and vice versa. Thus, in the empirical practice of measuring the sustainability of economic development in the EU countries, additional efforts to calculate Green GDP are methodologically sound and meet the requirements of the time, but say little new about the economic development of countries (except, perhaps, that the Bulgarian economy is the most unfriendly in relation to the environment).

Table 2. Ranking EU countries by the Sustainable Development Goals (SDG) Index in comparison with traditional GDP and HDI, n = 27 countries, 2022

EU country*	GDP per capita, %, EU=100	Rank by GDP per capita	HDI,** score 0–1	Rank by HDI	SDG Index, score 0–100	Rank by SDG Index
Finland	109	9	0.940	6	81.7	1
Sweden	120	6–7	0.947	2	80.6	2
Denmark	137	3	0.948	1	79.2	3
Austria	125	4	0.916	11	78.2	4
Germany	117	8	0.942	4	74.8	5
Czechia	91	15	0.889	17	74.2	6
Slovenia	92	13–14	0.918	9–10	74.0	7
Estonia	87	17	0.890	16	73.2	8
France	102	10–11	0.903	13	73.1	9
Poland	80	19	0.876	19	72.4	10
Ireland	233	2	0.945	3	72.2	11
Belgium	120	6–7	0.937	7	71.7	12
Netherlands	129	4	0.941	5	71.6	13
Croatia	73	24	0.858	23	70.7	14
Portugal	77	20–22	0.866	21	70.6	15–16
Italy	96	12	0.895	15	70.6	15–16
Slovakia	68	25–26	0.848	24	70.2	17
Spain	85	18	0.905	12	70.1	18
Hungary	77	20–22	0.846	25	69.9	19
Latvia	74	23	0.863	22	69.5	20
Luxembourg	261	1	0.930	8	68.7	21
Lithuania	89	16	0.875	20	66.1	22
Greece	68	25–26	0.887	18	65.7	23
Malta	102	10–11	0.918	9–10	64.9	24
Romania	77	20–22	0.821	26	63.4	25
Cyprus	92	13–14	0.896	14	60.7	26–27
Bulgaria	59	27	0.795	27	60.7	26–27

* EU countries are listed by SDG Index rank.

** Human Development Index (HDI) values 2021 (Human Development Report Office, 2022).

Source: compiled by the author based on the data from Sustainable Development Solutions Network, 2022; Human Development Report Office, 2022; Eurostat Statistics Explained, 2023.

As the data in Table 2 shows, the 2022 SDG Index for the EU countries is topped by Northern European countries. Finland ranks first, followed by Sweden and Denmark, which all have scores close to or above 80 (out of 100). Yet the SDG dashboards show that even these countries face major challenges in achieving at least two goals (Sustainable Development Solutions Network, 2022): (1) unsustainable diets and food systems (for example, typical diets are to a large extent composed of meat, fish or dairy products, with a low consumption of vegetables); (2) inequalities within countries (there are persisting gaps in access to and quality of services and opportunities across population groups). The last positions in the ranking of SDG Index are already usually occupied by Romania and Bulgaria (which occupy the last positions in almost all rankings for the EU countries), but in this case Cyprus is also ‘squeezed’ between them. As for the ranking of traditional GDP, according to Table 2 you can see that it does not coincide with SDG Index ranking, as was the case with Green GDP, although here Bulgaria usually ranks last, and Northern and Western European countries are usually in the first ten.

Since SDG Index measures the sustainability of development in a broader sense rather than sustainability of economic development, its ranking can be expected to be more similar to the ranking of countries by traditional tool for measuring the sustainability of development of a territory in a broader sense, namely the Human Development Index (HDI). The results of correlation analysis using Spearman's rank correlation

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coefficient show that the relationship between the ranks of EU countries by SDG Index and GDP is quite strong and statistically significant (p = 0.532, r = 0.004, probability 99%), but is slightly weaker than the relationship between the ranks EU countries by SDG Index and HDI (p = 0.603, r < 0.001, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 2), although this difference (0.532/0.603) in the strength of the relationship between the ranks of EU countries by SDG Index and GDP and between the ranks of EU countries by SDG Index and HDI cannot be considered significant. Interestingly, the ranks of EU countries by traditional instruments for measuring economic development (GDP) and development in a broader sense (HDI) are very strongly correlated with each other (p = 0.899, r < 0.001, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 2). Thus, we can say that the ranking of EU countries by SDG Index, much more than by Green GDP, differs from the ranking by traditional tools for measuring territorial development – GDP and HDI. For example, Latvia has a higher rank by SDG Index than by GDP and HDI, and Lithuania – vice versa (Table 2).

Table 3. Ranking EU countries by the Green Economy Index (GEI) in comparison with traditional GDP and HDI, n = 27 countries,* 2013

EU country**	GDP per capita, USD adjusted by PPP	Rank by GDP per capita	Standardized GEI, score 0–1	GEI, score 0–1	Rank by GEI
Sweden	46312.4	6	1.00	0.66	1
Netherlands	49242.5	2	1.00	0.66	2
Denmark	46742.9	5	0.96	0.65	3
Austria	47936.8	3	0.96	0.65	4
Germany	44993.9	7	0.88	0.62	5
United Kingdom	39989.2	10	0.81	0.60	6
Belgium	43670.9	8	0.69	0.56	7
Ireland	47836.1	4	0.68	0.56	8
France	39528.6	11	0.66	0.55	9
Finland	41492.8	9	0.66	0.55	10
Slovenia	29979.4	17	0.53	0.52	11
Luxembourg	100927.3	1	0.52	0.51	12
Latvia	22637.3	25	0.52	0.51	13
Malta	32297.3	14	0.50	0.51	14
Italy	36267.9	12	0.48	0.50	15
Lithuania	26721.4	21	0.43	0.48	16
Hungary	24548.0	23	0.40	0.48	17
Estonia	27418.9	20	0.40	0.47	18
Czechia	30828.5	15	0.37	0.47	19
Poland	24028.1	24	0.36	0.47	20
Slovakia	28021.3	18	0.34	0.46	21
Spain	32463.1	13	0.34	0.46	22
Romania	19678.0	26	0.21	0.42	23
Cyprus	30460.7	16	0.20	0.41	24
Portugal	27935.9	19	0.16	0.40	25
Bulgaria	16654.2	27	0.03	0.36	26
Greece	25986.5	22	0.00	0.36	27

* Croatia is not included in the 2013 list of countries because it was a member of the EU for only an incomplete year – from 1 July 2013.
** EU countries are listed by GEI rank.
Source: compiled by the author based on the data from Ryszawska, 2015; United Nations Economic Commission for Europe (UNECE), 2023.

As the data in Table 3 shows, in the ranking of EU countries according to the Green Economy Index (GEI) the countries of Northern and Western Europe are still in the lead, and Bulgaria usually closes the ranking, but this time together with Greece and Portugal, i.e. countries of Southern Europe. The results of the correlation analysis using the Spearman rank correlation coefficient show that the relationship between the ranks of EU countries by GEI and GDP is strong and statistically significant (p = 0.785, r < 0.001, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 3). At the same time, in the ranking of EU countries by GEI, the top three are the countries of Northern Europe, and in the ranking by traditional GDP – the countries of Western Europe. In turn, in the last three of the ranking of EU countries by GEI are only the countries of Southern Europe (Portugal, Bulgaria and Greece), and in the ranking of EU

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countries by traditional GDP in the last three are the countries of Southern Europe (Romania and Bulgaria), as well as Latvia. The position of some EU countries in these two ratings is radically different – for example, Luxembourg and Latvia occupy, respectively, 12th and 13th positions in the ranking of EU countries by GEI, although in terms of traditional GDP, Luxembourg is the leader in the ranking, and Latvia is in the last three countries. Thus, despite the strong and statistically significant correlation between the rankings of EU countries by GEI and GDP, the positions of some countries in these rankings are very different from each other and require additional study (considering, for example, the fact that in Luxembourg the difference between traditional GDP and Green GDP is minimal, and it is the leader in the ranking of EU countries by Green GDP – Table 1).

Table 4. Ranking EU countries by the Green Growth Index (GGI) and Green Economic Opportunities (GEO)* in comparison with traditional GDP and HDI, n = 26 countries,** 2022

EU country***	GDP per capita, %, EU=100	Rank by GDP per capita	HDI,**** score 0–1	Rank by HDI	GEO, score 0–100	Rank by GEO	GGI, score 0–100	Rank by GGI
Denmark	137	3	0.948	1	63.84	1	75.32	1
Sweden	120	6–7	0.947	2	57.96	6	75,09	2
Austria	125	4	0.916	11	52.27	11	72.32	3
Finland	109	9	0.940	6	58.86	5	71.69	4
Czechia	91	14	0.889	16	61.85	2	71.29	5
Italy	96	12	0.895	14	57.63	7	70.22	6
Germany	117	8	0.942	4	60.55	3	70.04	7
Estonia	87	16	0.890	15	59.12	4	68.50	8
Latvia	74	22	0.863	21	49.40	13	68.24	9
Slovakia	68	24–25	0.848	23	49.51	12	67.60	10
Portugal	77	19–21	0.866	20	47.25	15	66.32	11
Belgium	120	6–7	0.937	7	55.88	8	64.94	12
Hungary	77	19–21	0.846	24	55.10	9	64.82	13
France	102	10–11	0.903	13	45.39	18	64.66	14
Croatia	73	23	0.858	22	44.29	20	64.49	15
Slovenia	92	13	0.918	9–10	41.78	21	64.00	16
Spain	85	17	0.905	12	47.61	14	63.67	17
Lithuania	89	15	0.875	19	46.47	17	63.65	18
Netherlands	129	4	0.941	5	46.76	16	63.38	19
Poland	80	18	0.876	18	52.48	10	62.00	20
Romania	77	19–21	0.821	25	44.56	19	59.00	21
Ireland	233	2	0.945	3	38.15	23	59.00	22
Luxembourg	261	1	0.930	8	33.19	24	59.00	23
Greece	68	24–25	0.887	17	30.95	25	57.00	24
Bulgaria	59	26	0.795	26	40.67	22	57.00	25
Malta	102	10–11	0.918	9–10	2.45	26	28.00	26

* Green Economic Opportunities (GEO) is an economic dimension of the green growth, sub-index of GGI (Global Green Growth Institute, 2023).
** Cyprus is not included in the database on GGI (Global Green Growth Institute, 2023).
*** EU countries are listed by GGI rank.
**** Human Development Index (HDI) values 2021 (Human Development Report Office, 2022).
Source: compiled by the author based on the data from Global Green Growth Institute, 2023; Human Development Report Office, 2022; Eurostat Statistics Explained, 2023.

As the data in Table 4 shows, the ranks of EU countries in the Green Growth Index (GGI) and its most economic sub-index, Green Economic Opportunities (GEO), are already quite different from their ranks in the ratings of traditional instruments for measuring territorial development (GDP and HDI), although the opposition between the leading North and the lagging South remains here too. The results of correlation analysis using Spearman's rank correlation coefficient show that there is no statistically significant relationship between the ranks of EU countries by GGI / GEO and GDP ($p = 0.263 / 0.205$, $r = 0.194 / 0.315$), and there is also no relationship between the ranks of EU countries by GGI / GEO and HDI ($p = 0.288 / 0.243$, $r = 0.154 / 0.231$) (the author's calculations with the IBM SPSS Statistics based on the data from Table 4).

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The case of Latvia: in contrast to the relatively low level of economic development and development in a broader sense (22nd rank by GDP and 21st rank by HDI), Latvia occupies a relatively high 9th rank by GGI and 13th rank by its economic sub-index (GEO), which shows the opportunities for a green economy. In turn, Luxembourg, which has a high level of economic development and development in a broader sense (1st rank by GDP and 8th rank by HDI), occupies a very low 23rd rank by GGI and 24th rank by its economic sub-index (GEO).

Table 5. Ranking EU countries by the Sustainable Development Green Index (SDGI) in comparison with traditional GDP and HDI, n = 27 countries, 2020

EU country*	GDP per capita, USD adjusted by PPP	Rank by GDP per capita	HDI, score 0–1	Rank by HDI	SDGI, score 0–100	Rank by SDGI
Sweden	55631.0	6	0.942	4	58.97	1
Denmark	60020.7	3	0.947	1	57.75	2
Germany	55433.6	7	0.944	2	56.42	3
Finland	50935.4	9	0.938	6	56.02	4
France	46864.1	10	0.898	13	54.69	5
Netherlands	59001.0	4	0.939	5	54.38	6
Austria	55916.3	5	0.913	9–10	52.22	7
Luxembourg	118401.8	1	0.924	8	52.14	8
Spain	37663.8	19	0.899	12	51.37	9
Estonia	38497.7	18	0.892	15–16	51.07	10
Italy	42103.5	12	0.889	17	50.82	11
Belgium	53536.2	8	0.928	7	50.55	12
Ireland	94046.5	2	0.943	3	50.08	13
Slovenia	39825.7	15	0.913	9–10	48.59	14–15
Czechia	41706.8	13	0.892	15–16	48.59	14–15
Portugal	34250.9	20	0.863	22	48.47	16
Latvia	32114.1	24	0.871	21	48.29	17
Lithuania	39167.7	16	0.879	19	47.82	18
Greece	27901.2	26	0.886	18	47.60	19
Slovakia	31811.6	25	0.857	23	45.95	20
Croatia	38720.6	17	0.855	24	45.53	21
Malta	44600.1	11	0.911	11	45.46	22
Romania	32628.7	23	0.824	26	45.25	23
Hungary	33377.1	22	0.849	25	44.95	24
Cyprus	40967.5	14	0.894	14	43.50	25
Bulgaria	24786.4	27	0.802	27	43.46	26
Poland	34040.7	21	0.876	20	43.21	27

* EU countries are listed by SDGI rank.

Source: compiled by the author based on the data from Rybalkin, 2023; Human Development Report Office, 2022; United Nations Economic Commission for Europe (UNECE). 2023.

As the data in Table 5 shows, in general, in the SDGI ranking, the countries of Northern and Western Europe expectedly occupy leading positions, and Bulgaria, as usual, is at the bottom of the list of the EU countries. But there are also surprises in the SDGI rating – for example, Poland has the lowest rank, which has not happened to it in any other ranking. According to the calculations of the creator of the SDGI, Poland got the lowest rank in the ranking mainly due to the relatively low level of development of the political subsystem of the SDGI (37.50 points in comparison even with Bulgaria, which was ahead of it with 42.14 points in the political subsystem) (Rybalkin, 2023). The results of correlation analysis using Spearman's rank correlation coefficient show that the relationship between the ranks of EU countries by SDGI and GDP is strong and statistically significant ($p = 0.726$, $r < 0.001$, probability 99%), but is slightly weaker than the relationship between the ranks EU countries by SDGI and HDI ($p = 0.795$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 5), although this difference (0.726/0.795) in the strength of the relationship between the ranks of EU countries by SDGI and GDP and between the ranks of EU countries by SDGI and HDI cannot be considered significant.

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Table 6. Comparison of new measurement tools of the sustainability of economic development and the sustainability of development with traditional measurement tools – Gross Domestic Product (GDP) and Human Development Index (HDI)

Measurement tools	Sustainable economic development	Sustainable development
Traditional measurement tools	Gross Domestic Product (GDP)	Human Development Index (HDI)
New measurement tools in relation to traditional ones		
Green GDP	The rankings of EU countries in terms of traditional GDP and Green GDP are almost completely identical (with one minor exception) (Table 1).	-
Sustainable Development Goals Index (SDG Index)	The relationship between the ranks of EU countries by SDG Index and GDP is quite strong and statistically significant ($p = 0.532$, $r = 0.004$, probability 99%) – a slightly weaker than the relationship between the ranks EU countries by SDG Index and HDI (the author's calculations with the IBM SPSS Statistics based on the data from Table 2).	The relationship between the ranks of EU countries by SDG Index and HDI is quite strong and statistically significant ($p = 0.603$, $r < 0.001$, probability 99%) – a slightly stronger than the relationship between the ranks EU countries by SDG Index and GDP (the author's calculations with the IBM SPSS Statistics based on the data from Table 2).
	The difference (0.532/0.603) in the strength of the relationship between the ranks of EU countries by SDG Index and GDP and between the ranks of EU countries by SDG Index and HDI cannot be considered significant; the ranks of EU countries in traditional instruments for measuring economic development (GDP) and development in a broader sense (HDI) are very strongly correlated with each other ($p = 0.899$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 2).	
Green Economy Index (GEI)	The relationship between the ranks of EU countries by GEI and GDP is strong and statistically significant ($p = 0.785$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 3). At the same time, the position of some EU countries (for example, Luxembourg and Latvia) in these two ratings is radically different, which requires additional case study.	-
Green Growth Index (GGI) and its sub-index – Green Economic Opportunities (GEO)	There is no statistically significant relationship between the ranks of EU countries by GGI/GEO and GDP ($p = 0.263/0.205$, $r = 0.194/0.315$) (the author's calculations with the IBM SPSS Statistics based on the data from Table 4).	There is no statistically significant relationship between the ranks of EU countries by GGI/GEO and HDI ($p = 0.288/0.243$, $r = 0.154/0.231$) (the author's calculations with the IBM SPSS Statistics based on the data from Table 4).
Sustainable Development Green Index (SDGI)	The relationship between the ranks of EU countries by SDGI and GDP is quite strong and statistically significant ($p = 0.726$, $r < 0.001$, probability 99%) – a slightly weaker than the relationship between the ranks EU countries by SDGI and HDI (the author's calculations with the IBM SPSS Statistics based on the data from Table 5).	The relationship between the ranks of EU countries by SDGI and HDI is quite strong and statistically significant ($p = 0.795$, $r < 0.001$, probability 99%) – a slightly stronger than the relationship between the ranks EU countries by SDGI and GDP (the author's calculations with the IBM SPSS Statistics based on the data from Table 5).
	The difference (0.726/0.795) in the strength of the relationship between the ranks of EU countries by SDGI and GDP and between the ranks of EU countries by SDGI and HDI cannot be considered significant	

Source: elaborated by the author based on the data from Tables 1–5.

As the data in summarizing Table 6 shows, the ranks of EU countries by continuously developing new tools for measuring the sustainability of economic development of territories (as well as tools for measuring the sustainability of their development in a broader sense) generally correlate quite strongly with the ranks of these countries by traditional measurement tools – GDP and HDI, which, in turn, are strongly correlated with each other. But the author also managed to find those tools for measuring the sustainability of economic development of territories (such as the Green Growth Index (GGI) and its sub-index - Green Economic Opportunities (GEO)), according to which the ranks of EU countries are completely different from their ranks by traditional tools for measuring the sustainability of territorial development. For example, Luxembourg traditionally has a leading rank among the EU countries by GDP and Green GDP, is in the top ten according to HDI and Sustainable Development Green Index (SDGI), but is at the bottom of the ranking in Green

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Growth Index (GGI) and its sub-index – Green Economic Opportunities (GEO) (Table 7). According to Rybalkin, key challenges of the indicator approach, which also included data availability, right balance between different indicator selection criteria, systemic understanding of the relationships between indicators and the context of their use could lead to different results (Rybalkin, 2023).

Table 7. Comparison of ranks of the selected EU countries (as an example) according to the new and traditional measurement tools of sustainability of economic development and sustainability of development in a broader sense

Measurement tools	Finland	Austria	Bulgaria	Latvia	Lithuania	Poland	Luxembourg
Gross Domestic Product (GDP)							
- 2013	9	3	27	25	21	23	1
- 2019	7	6	26	-	20	23	1
- 2020	9	5	27	24	16	21	1
- 2022	9	4	27	23	16	19	1
Human Development Index (HDI)							
- 2020	6	9–10	27	21	19	20	8
- 2021	6	11	27	22	20	19	8
Green GDP 2019	7	6	26	-	20	23	1
Sustainable Development Goals Index (SDG Index) 2022	1	4	26–27	21	22	10	21
Green Economy Index (GEI) 2013	10	4	26	13	16	20	12
Green Growth Index (GGI) / its sub-index – Green Economic Opportunities (GEO) 2022	4 / 5	3 / 11	25 / 22	9 / 13	18 / 17	20 / 10	23 / 24
Sustainable Development Green Index (SDGI) 2020	4	7	26	17	18	27	8

Source: elaborated by the author based on the data from Tables 1–5.

As shown by the results of a comparison of the ranks of the seven EU countries representing Northern, Eastern, Central, Western and Southern Europe, basically the ranks of each specific country for all ratings analyzed in this study are similar. For example, Finland, according to any instrument for measuring the sustainability of economic development and development in a broader sense, is in the top ten among the EU countries, and Bulgaria ranks last also according to any measurement instrument (Table 7). Given these results, the development of multiple 'green' indices instead of one traditional GDP (conditioned by a number of important factors reflecting changing priorities and understanding of economic development) from a practical point of view seems completely unjustified and unnecessary. However, the author believes that the main driving force behind the activity of individual researchers and entire organizations in the search for new tools is the real need for more comprehensive and multidimensional approaches to measuring economic progress and sustainable development. The many proposed tools for measuring the sustainability of territorial development provide a broader picture, helping to shape policies and development strategies for both individual countries and their internal regions, and regions of the world (for example, the EU). The author agrees with Pearce and Atkinson that "the measurement of sustainable development is not without considerable difficulties, yet this should not detract from the positive advances that can be made in this direction" (Pearce & Atkinson, 1993). Thus, it is unlikely that one instrument is most suitable for measuring the sustainability of economic development of the EU countries, since each of them allows assessing the sustainability of economic development from its own unique perspective.

5. Conclusions

Currently, most scientists agree that traditional tools for measuring the economic development of territories, as well as the development of territories in a broader 'human' sense (namely, GDP and HDI) are not suitable for evaluating the sustainability of development (economic and more general) of the world's countries. Instead, many other tools for measuring the sustainability of territorial development are being developed and tested, including environmental and political, educational, and cultural components. Their creators argue that new measurement tools correspond to the modern need to evaluate territorial development from the point of view of quantitative economic growth and long-term qualitative development or inclusive growth.

Having carried out a comparative analysis of the ranks of EU countries by both traditional and some of the new tools for measuring the sustainability of territorial development, the author concludes that, despite the versatility and smarter structure of the newly created indices, the ranks of EU countries in these rankings mostly similar. Thus, the countries of Northern and Western Europe have leading ranks both by traditional GDP and HDI, and by new tools for measuring sustainable development - such as Green GDP, Sustainable Development Goals Index (SDG Index), Green Economy Index (GEI), Green Growth Index (GGI), Sustainable Development Green Index (SDGI). In turn, the countries of Southern Europe (especially Bulgaria) are at the bottom of the rankings for almost all instruments for measuring the sustainability of development of the EU countries. But there are exceptions, the most striking of which is Luxembourg, which has a leading rank by traditional measurement tools of the territorial development (GDP and HDI) and is close to the last ranks in 'green' ratings.

The main limitation of this study is the incomplete list of analyzed tools for measuring the sustainability of economic development and territorial development in a broader sense. Furthermore, some measurement tools do not have open access data (e.g. Global Green Economy Index (GGEI) and the System of Environmental Economic Accounting (SEEA)) or are not used in Europe (e.g. Gross Ecosystem Product (GEP) and Gross Economic-Ecological Product (GEEP)). The latter circumstance may become a direction for further research in this area, namely, testing the GEP and GEEP developed by Chinese scientists as tools for measuring the sustainability of economic development of the EU countries and their internal regions.

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