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A THEORETICAL APPROACH TO MEASURING ENVIRONMENTALLY SUSTAINABLE GROWTH OF AGRICULTURE

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Abstract

In recent years, the economic growth has resulted in the depletion of natural resources and degradation of ecosystems. Therefore, the environmentally sustainable growth was accepted, as a new mode for economics, that prevents environmental deterioration and loss of biodiversity. The idea of environmentally sustainable growth has been widely discussed not only by experts in environmental economics, but also in the international and national policy scene. However, the measurement of environmentally sustainable growth still remains a challenge, especially in agriculture. In this paper, available academic literature is reviewed and summarized to provide a theoretical baseline for creating a measure of environmentally sustainable growth of agriculture.

Key words: *environmentally sustainable growth, green growth, agriculture*

INTRODUCTION

Over recent years the concept of environmentally sustainable growth or green growth, or environmentally sustainable economic growth, or ecologically sustainable growth has attracted much attention not only in the international but also in the national policy scene. The guidelines for environmentally sustainable growth we can follow since 1987 in Brundtland report. Although Jacobs [16] claimed that a term was rarely heard before 2008. Several steps of the concept of environmentally sustainable growth can be distinguished.

First step - the need of new era of economic growth that provides the right kind of growth. Starting with 1987 it has been increasingly recognized that growth should be not only forceful but at the same time environmentally and socially sustainable. Once the world's population continues to grow fast, to meet the projected food demands, diet shifts, and increased biofuel consumption, the world agricultural production alone needs to double by 2050, unless there occur dramatic changes in agricultural consumption patterns [42; 43]. These environmental pressures if not addressed and tackled, will undermine the world's ability to meet these demands. Therefore, to meet the world's future of food and biofuels demand and environmental sustainability needs, agricultural production must increase significantly, while the environmental footprint of agriculture must shrink dramatically, i.e. sustainable intensification of agricultural production, lower specialization of agroecosystems, and lower or balance the use of mineral fertilizers and pesticides per unit area.

Second step - the era of sustainable development concept. Although there is more discussion about right kind of economic growth, but the whole environment continues under pressure (for example, loss of biodiversity, fish stocks, desertification, climate change) [10; 11]. The concept of sustainable development is too broad.

Third step - the beginning of environmentally sustainable growth concept. The Organization for Economic Cooperation and Development (OECD) take responsibility to help countries' policy assess and determination of best practices, which assist in their efforts to respond to the growing policy demands to foster environmentally sustainable growth and develop measures to build sustainable economies [41]. Therefore, measurable environmental and natural resource indicators are needed to promote sustainable growth.

Fourth step the work on environmentally sustainable growth indicators. Internationally comparable data shows a lack in environmentally sustainable growth indicators. Especially, the indicators that show economic growth within the environmental damages [27]. Therefore, new measurement systems of environmentally sustainable growth are under development.

The key issues of environmentally sustainable growth first applied by the 5th Ministerial Conference on Environment and Development in Asia and the Pacific of the Economic and Social Commission for Asia and the Pacific of the United Nations Economic and Social Council in 2005. In this conference, environmentally sustainable growth (author named it as green growth) was proposed as a way to seek for further economic growth with respect to environmental sustainability, without putting significant pressure on environmental capacity and without compromising environment sustainability. Moreover, further economic growth was necessary to reduce poverty in this region. Besides, since 2009 OECD, World Bank and other organizations more and more focused on environmental issues, including environmentally sustainable growth. As a result, various terms such as environmentally sustainable growth, green growth, green economy, green jobs, green economic growth and other are gaining popularity in the political and community space [45].

Previous studies showed that, there is no single recognized and commonly used definition of environmentally sustainable growth. There are several equivalents of this concept, for example, environmentally sustainable growth, green growth, environmentally sustainable economic growth, ecologically sustainable growth, inclusive green growth, genuine green growth, green economy, green new deal, low-carbon growth. Some authors, previously used concepts, used as synonyms, and other – as separate concepts. InterActive Terminology for Europe (IATE) gives preference to concept of environmentally sustainable growth which also is used in this study. Jacobs [16] argues that sustainable environmental growth contributes not only to economic growth but also ensures environmental protection and sustainable use of natural resources. Consequently, the idea of environmentally sustainable growth has emerged as a dominant policy response to environmental crises. However, according to Stoknes and Rockström [35], the notion of environmentally sustainable growth is still notoriously vague and elusive.

Besides, there are noticeable links between the concept of environmentally sustainable growth with the concept of sustainable development. According to Choi [7], first is more practical concept and second – more abstract. Also, Mishra [24] argued that, environmentally sustainable growth is a subset of sustainable development, which gives more attention to the necessary innovation, competition and investment.

Moreover, it is important to emphasize that the most common definition of environmentally sustainable growth focuses on environmental and economic issues [16] and social issues are only the result of the integration of environmental and economic objectives and their implementation [17; 28].

Finally, the definition of environmentally sustainable growth does not explain how green growth can be achieved. According to Stoknes and Rockström [35], there is a lack of simple and clear indicators of whether economic growth at different scales is green enough. This is the relevance of environmentally sustainable growth assessment by the academic literature.

This article aims to provide a baseline for measurement of environmentally sustainable growth of agriculture using the available academic literature review.

MATERIALS AND METHODS

Literature overview method was used in this study to obtain information associated with environmentally sustainable growth and its measures. A literature overview method also obtains a robust conclusion on the measurement of environmentally sustainable growth. According to Snyder [33] literature

overviews are foundation for all types of research, due to a literature overview may be the best methodological tool for topic, to provide an overview of a relevant issue or research problem. Keywords were used as a most common method of identifying literature [8]. The keywords used in this paper fell into the following two categories:

Growth related keywords such as environmentally sustainable growth and green growth;

Growth measures related keywords such as green GDP growth, environmentally adjusted multifactor productivity, green multi-factor productivity and green total factor productivity.

In the measurement methodology of the environmentally sustainable growth, terms "total factor productivity" (TFP) and "multifactor productivity" (MFP) often used as synonyms [19; 31]. In this article, both terms are used as synonyms as well.

RESULTS AND DISCUSSIONS

The available academic literature on environmentally sustainable growth highlights that: economic growth reduces natural capital and risks for development are still rising [24]; there is not enough literature about environmentally sustainable economic development, although this development has been a worldwide concern [46]; harmonizing environmental issues for land use with the need to produce more food is an established concern of scientific and policy discourses on sustainable agriculture [12], i.e. literature have been undertaken investigating the relationship between the environment and the economy as whole or its respective sectors [18].

It is recognized that the discussion on environment versus growth continues to the recent day, therefore the environmentally sustainable growth is imperative in further economic growth, that contributes to lower resource use and lower negative environmental impact [3; 36], helps to solve environmental and economic problems [3].

Table 1 illustrate environmentally sustainable growth measurement based on literature review, which distinguish five ways for its measurement. It was determined that environmentally sustainable growth may be measured by single indicators, footprints, adjusted or expanded economic indicators, dashboards or composite indicators.

As mentioned Tilsted et al. [39], typically, claims of environmentally sustainable growth are assessed with respect to decoupling rates, consisting of two metrics: value added (at the national level – gross domestic product, GDP) and national emissions. According to Lundquist [22], decoupling emissions from growth submit a sustainability path where pressure on the environment can be prevented without compromising economic development.

It is widely recognized that environmentally sustainable growth is mostly measured by systems of indicators that shows the progress of the environmentally sustainable growth, for example, dashboards, headline indicators. However, the sets of indicators are not only without hierarchy, but also often measured in different units. Moreover, mostly environmentally sustainable growth is compared in terms of estimating adjusted MFP, which is usually measured through the prism of output and pollution, especially at national level [6; 38; 46]. For example, Tzouvelekas et al., [40] involve emissions as an input in the production process. Authors also measure the contribution from the use of environment in total output growth. Wang et al., [46], estimate the potentials of industrial growth, greenhouse gas (GHG) reduction and energy saving based on the green productivity measurement. Also, the assessment of environmentally sustainable growth takes into account not only pollution but also natural resources [6; 32], therefore the assessment has been extended to include the input of natural capital.

Besides, Table 1 illustrates, that many studies have aimed their attention at measuring the environmentally sustainable growth of the whole economy and there are still a few studies measuring environmentally sustainable growth of agriculture.

Based on literature overview, adjusted economic indicators measure environmentally

sustainable growth in monetary terms (one metric) and are better compared with each other, especially at national level.

Table 1. Literature overview on environmentally sustainable growth measurement

Author (s)	Indicator/ Dimension	Research area
Single indicators		
Antal and van den Bergh [3]	GDP and GHG emissions decoupling rate	whole economy
Ipate et al. [15]	Water exploitation index	whole economy
Footprints (how much the existing biological capacity is used to support economic activities and human needs)		
Vanham and Bidoglio [44]	Water	whole economy
Tian et al. [38]	Environmental and resource	whole economy
Al-Mansour and Jejcic [2]	Carbon	agriculture
Bauwens [5]	Material	whole economy
Adjusted or expanded economic measures (A monetary metric derived by adjusting a conventional economic variable for broader environmental and social sustainability values)		
Tzouvelekas et al. [40]	Total factor productivity growth and the environment	whole economy
Škare et al. [34]	Green GDP	whole economy
Brandt et al. [6]	Green multi-factor productivity growth	whole economy
Baldoni et al. [4]	Farm-level TFP and EI indices	agriculture
Rodríguez et al. [32]	Environmentally adjusted multifactor productivity	whole economy
Hamilton et al. [13]	TFP including natural resources	agriculture
Liu et al. [21]	Green TFP	agriculture
Li et al. [20]	Green GDP	agriculture
Coli and Colucci [9]	Total factor productivity adjusted for GHGs emissions	agriculture
Dashboards (a set of indicators without hierarchy, often measured in different units)		
Lyytimäki et al. [23]	Green growth indicators	whole economy
OECD [28]	Green growth indicators for agriculture	agriculture
Acosta et al. [1]	Natural capital protection	whole economy
Composite indicators (aggregated measure that combine indicators through rescaling the components and weighting, often measured in different units)		
Ou [30]	Green competitiveness analysis index	whole economy
Tamanini [37]	Global green economy index	whole economy
Nahman et al. [25]	Green economy index	whole economy

Source: Own elaboration based on the literature mentioned above.

Although changes in productivity are usually measured as MFP, the environmentally adjusted MFP (one of adjusted economic measure) is a better driver of growth in agriculture than conventional MFP. Table 2 illustrates the comparison between those productivity measures.

Table 2. Comparison between conventional and environmentally adjusted multifactor productivity

	Conventional MFP	Environmentally adjusted MFP
Output	Gross value added	Real gross value added (or good output); Pollutant emissions (bad output)
Input	Labour; Capital	Labour; Capital; Natural capital
Elasticity	Inputs elasticity	Inputs elasticity; Bad output elasticity

Source: Own elaboration based on Brant, Schreyer and Zipper [6], Rodríguez, Haščič and Souchier [32].

The disadvantages of conventional MFP versus the environmentally adjusted MFP are follows:

(i)the conventional MFP is a measure of productivity growth where the underlying production function traditionally accounts for the labour and produced capital inputs [32] and do not accounts for nonmarketable inputs and outputs;

(ii) the role of natural capital as a factor input in conventional MFP is generally ignored, although short-term economic growth leads to the loss of natural capital [6; 14];

(iii) the conventional estimates of productivity ignore nonmarketable outputs, i.e. negative and/or positive externalities.

It was established that conventional approach of productivity ignores adverse agricultural production effects on the environment, such

as soil erosion, pollution from nitrate leaching, greenhouse gas emissions, etc. [26]. This may result to incorrect policy conclusions and a systematic bias in productivity calculations [4; 29]. Meanwhile, environmentally adjusted MFP measure explicitly accounts for natural capital as an input factor and for negative externalities (or undesirable goods) as an output of the production process [6].

CONCLUSIONS

An increasing number of studies have sought to measure the environmentally sustainable growth of whole economy, but still studies which measure this growth for agriculture are lacking. Most of these studies are based on OECD measurement of green growth indicators and include several indicators helping to measure environmentally sustainable growth in agriculture.

Conventional MFP measure do not take into account those inputs and outputs with environmental externalities in the production process, although, the concept of environmentally sustainable growth emphasis the need to measure them [3; 27].

However, environmental externalities are usually ignored in conventional measurement of MFP in agriculture. Therefore, this issue can be solved by creating a measure of MFP that takes into account natural capital.

Environmentally adjusted MFP not measured yet. However, the OECD organization is exploring ways to include bad output and natural resource inputs in the assessment of MFP in agriculture.

The OECD [28] argue, that there is a lack of agreement among experts on the research for measuring MFP. Moreover, existing researches show heterogeneity of measurements. Besides, all studies are mainly of a methodological approach.

Therefore, the OECD created a network on agricultural MFP and the environment in 2017, where experiences and good practices are shared.

Besides, they seek to develop a comparable system of environmentally adjusted MFP indicators.

REFERENCES

[1]Acosta, L.A., Maharjan, P., Peyriere, H.M., Mamiit, R.J., 2020, Natural capital protection indicators: Measuring performance in achieving the Sustainable Development Goals for green growth transition. Environmental and Sustainability Indicators, 8, 100069.

[2]Al-Mansour, F., Jejcic, V., 2017, A model calculation of the carbon footprint of agricultural products: The case of Slovenia. Energy, 136, pp. 7-15.

[3]Antal, M., Van Den Bergh, J.C., 2016, Green growth and climate change: conceptual and empirical considerations. Climate Policy, 16 (2), pp. 165-177.

[4]Baldoni, E., Coderoni, S., Esposti, R., 2017, The productivity and environment nexus with farm level data. The Case of Carbon Footprint in Lombardy FADN farms. Bio-based and Applied Economics, 6 (2), pp. 119-137.

[5]Bauwens, T., 2021, Are the circular economy and economic growth compatible? A case for post-growth circularity. Resources, Conservation and Recycling, 175, 105852.

[6]Brandt, N., Schreyer, P., Zipperer, V., 2014, Productivity Measurement with Natural Capital and Bad Outputs. OECD Economics Department Working Papers, No. 1154. https://dx.doi.org/10.1787/5jz0wh5t0ztd-en, Accessed on 24.07.2014.

[7]Choi, Y., 2015, Intermediary propositions for green growth with sustainable governance. Sustainability, 7 (11), pp. 14785-14801.

[8]Cronin, P., Ryan, F., Coughlan, M., 2008, Undertaking a literature review: a step-by-step approach. British journal of nursing, 17(1), 38-43.

[9]Coli, A., Colucci, D., 2021, Total Factor Productivity Growth in Agriculture, Adjusted for Greenhouse Gas Emissions: Trends in Developed and Developing Countries over the 1992-2016 period. 36th IARIW Virtual General Conference, August 23-27, 2021 Session 9: Economic Growth and Productivity with Special Emphasis on Developing Economies II, https://iariw.org/wp-content/uploads/2021/08/Coli_colucci_paper.pdf, Accessed on 25.08.2021.

[10]Commission of the European Communities, 2001, Communication from the commission: A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52001DC0264&from=PL, Accessed on 15.05.2001.

[11]Commission of the European Communities, 2008, COM (2008) 397: Communication from the commission of the European parliament, the council, the European economic and social committee and the committee of the regions: on the Sustainable Consumption and Production and Sustainable Industrial Policy. Action Plan, https://www.eea.europa.eu/policy-documents/com-2008-397, Accessed on 25-26.09.2008.

[12]Fish, R., Winter, M., Lobley, M., 2014, Sustainable intensification and ecosystem services: new directions in agricultural governance. Policy Sciences, 47 (1), pp. 51-67.
[13]Hamilton, K., Naikal, E.G., Lange, G.M., 2019, Natural Resources and Total Factor Productivity Growth in Developing Countries: Testing New Methodology. World Bank Policy Research Working Paper, (8704). https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-8704, Accessed on 19.06.2019.
[14] Hoang, K.V., 2018, Accounting for natural capital in mining MFP: Comparing user costs for non-renewable resources. In IARIW General Conference, Copenhagen (pp. 25-30).
[15]Ipate, I., Bogdan, A., Ipate, N., Trandafir, M., Trandafir, M., Claudiu, N., 2015, Green Grown-Bases of Bioeconomy Models in Correlation with Danubian Projects. Journal of Danubian Studies and Research, Vol. 5 (1):114-122.
[16]Jacobs, M., 2012, Green growth: economic theory and political discourse. Centre for climate change economics and policy working paper, 108.
[17]Kasztelan, A., 2017, Green growth, green economy and sustainable development: terminological and relational discourse. Prague Economic Papers. 26 (4), pp. 487–499.
[18]Kasztelan, A., Nowak, A., 2021, Construction and Empirical Verification of the Agri-Environmental Index as a Tool for Assessing the Green Performance of Agriculture. Energies, 14 (1), 45.
[19]Lee, J.W., Xuan, Y., 2019, Effects of technology and innovation management and total factor productivity on the economic growth of China. The Journal of Asian Finance, Economics, and Business, 6(2), 63-73.
[20]Li, Z., Jin, M., Cheng, J., 2021, Economic growth of green agriculture and its influencing factors in China: Based on emergy theory and spatial econometric model. Environment, Development and Sustainability, 23, 15494- 15512, https://doi.org/10.1007/s10668-021-01307-1, Accessed on 06.03.2021.
[21]Liu, D., Zhu, X., Wang, Y., 2021, China's agricultural green total factor productivity based on carbon emission: An analysis of evolution trend and influencing factors. Journal of Cleaner Production, 278(1), 123692, DOI: 10.1016/j.jclepro.2020.123692, Accessed on 1.01.2021.
[22]Lundquist, S., 2021, Explaining events of strong decoupling from CO_2 and NO_x emissions in the OECD 1994–2016. Science of The Total Environment, 148390.
[23]Lyytimäki, J., Antikainen, R., Hokkanen, J., Koskela, S., Kurppa, S., Känkänen, R., Seppälä, J., 2018, Developing Key Indicators of Green Growth. Sustainable Development, 26 (1), pp. 51-64.
[24]Mishra, M.K., 2020, The Kuznets Curve for the Sustainable Environment and Economic Growth. Working Paper. ZBW – Leibniz Information Centre for Economics, Kiel, Hamburg. https://www.econstor.eu/bitstream/10419/216734/1/Green%20Economics%20.pdf, Accessed on 08.06.2009.
[25]Nahman, A., Mahumani, B.K., De Lange, W.J., 2016, Beyond GDP: towards a green economy index. Development Southern Africa, 33 (2), pp. 215-233.
[26]Nanere, M., Fraser, I., Quazi, A., D'Souza, C., 2007, Environmentally adjusted productivity measurement: An Australian case study. Journal of environmental management, 85 (2), pp. 350-362.
[27]OECD, 2011, Towards green growth: monitoring progress. OECD indicators. https://www.oecd.org/greengrowth/48224574.pdf, Accessed on 15-17.06.2011.
[28]OECD, 2014, Green Growth Indicators for Agriculture: A Preliminary Assessment, OECD Green Growth Studies, OECD Publishing. https://www.oecd.org/publications/green-growth-indicators-for-agriculture-9789264223202-en.htm, Accessed on 02.10.2014.
[29]OECD, 2021, Network on Agricultural Total Factor Productivity and the Environment. https://www.oecd.org/agriculture/topics/network-agricultural-productivity-and-environment/, Accessed on 27-28.05.2021.
[30]Ou, J.J.R., 2012, Construction of green competitiveness analysis index-a case study of export procession zone. International Journal of Electronic Business Management, 10 (2), 140.
[31]Peneder, M., Rammer, C., 2018, Measuring Competitiveness. ZEW-Gutachten und Forschungsberichte. https://www.econstor.eu/handle/10419/181906, Accessed on 01.03.2018
[32]Rodríguez, M.C., Haščič, I., Souchier, M., 2018, Environmentally Adjusted Multifactor Productivity: Methodology and Empirical results for OECD and G20 countries. Ecological Economics, 153, pp. 147-160.
[33]Snyder, H., 2019, Literature review as a research methodology: An overview and guidelines. Journal of business research, 104, 333-339.
[34]Škare, M., Tomić, D., Stjepanović, S., 2020, Energy Consumption and Green GDP in Europe: Panel Cointegration Analysis 2008-2016. Acta Montanistica Slovaca, 25 (1):46-56.
[35]Stoknes, P.E., Rockström, J., 2018, Redefining green growth within planetary boundaries. Energy Research & Social Science, 44, pp. 41-49.
[36]Sun, Y., Ding, W., Yang, Z., Yang, G., Du, J., 2020, Measuring China's regional inclusive green growth. Science of the Total Environment, 713, 136367.
[37]Tamanini, J., 2016, The global green economy index. Measuring national performance in the green economy. 5th Edition.
[38]Tian, X., Wu, R., Geng, Y., Bleischwitz, R., Chen, Y., 2017, Environmental and resources footprints between China and EU countries. Journal of Cleaner Production, 168, pp. 322-330.
[39]Tilsted, J.P., Bjørn, A., Majeau-Bettez, G., Lund, J.F., 2021, Accounting matters: Revisiting claims of

decoupling and genuine green growth in Nordic countries. Ecological Economics, 187, 107101.
[40]Tzouvelekas, E., Vouvaki, D., Xepapadeas, A., 2006, Total factor productivity growth and the environment: case for green growth accounting. Beijer International Institute of Ecological Economics. Working Papers 0617, University of Crete, Department of Economics.
[41]United Nations Department of Economic and Social Affairs, 2009, A Global Green New Deal for Climate, Energy, and Development. https://sustainabledevelopment.un.org/content/documents/cc_global_green_new_deal.pdf, Accessed on 21.12.2009
[42]United Nations, 1987, Report of the World Commission on Environment and Development: Our Common Future.
[43]Valin, H., Sands, R.D., van der Mensbrugghe, D., Nelson, G.C., Ahammad, H., Blanc, E., ... Heyhoe, E., 2014, The future of food demand: understanding differences in global economic models. Agricultural Economics 45 (1), 51–67. doi: 10.1111/agec.12089., Accessed on 10.12.2013.
[44]Vanham, D., Bidoglio, G., 2013, A review on the indicator water footprint for the EU28. Ecological indicators, 26, pp. 61-75.
[45]Vavouras, I., 2011, From sustainable development to green growth: The abandonment of the social character of development. Social Cohesion and Development, 6 (1):27-35.
[46]Wang, Y., Sun, X., Wang, B., Liu, X., 2020, Energy saving, GHG abatement and industrial growth in OECD countries: green productivity approach. Energy, 194, 116833.