THE ROLE OF ENERGY PRODUCTIVITY IN ECONOMICS GROWTH

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Abstract

Economic growth and resource productivity are interlinked and influence each other. Increasing resource productivity can support economic growth by allowing the economy to achieve higher output with fewer resources. One of the most important resources is energy. Energy efficiency is measured using energy productivity. More efficient use of energy can reduce the costs of businesses and thus increase their international competitiveness. The aim of the paper is to assess the role of energy productivity in the economic growth of EU countries. The analysis will also look at the impact of cyclical development of economies. The analysis focuses on all countries of the European Union. Improvements in energy productivity can contribute to better economic and at the same time sustainable growth with less environmental impact. The study does not confirm the original assumption of a link between economic growth and energy productivity. On the contrary, it showed that even during economic recessions, states increased their energy productivity.

Key words: energy productivity, economics growth, EU countries

JEL Code: O44, Q57

Introduction

More efficient use of raw materials and materials is closely linked to the economic growth of countries. Higher resource productivity means that a country can produce more goods and services with fewer inputs, leading to lower costs and greater competitiveness in global markets. More efficient use of resources (factors of production) contributes to environmental protection, which is increasingly important for sustainable growth. One of the basic factors of production is energy. High energy productivity means that a country can generate more economic value with less energy consumption, leading to a more efficient use of resources. Therefore, improving energy productivity is a key element for the long-term economic prosperity and sustainability of countries. The aim of the paper is to assess the role of energy productivity in the economic growth of EU countries.

Productivity is a key factor influencing economic growth and the competitiveness of economies. It reflects the efficiency with which resources are used to produce goods and

services. Resource productivity focuses on the efficient use of natural resources such as energy, water and raw materials. Productivity, resource productivity and economic growth are therefore closely interlinked and interact. On the other hand, there are other factors affecting economic growth such as wars and epidemics (Kislingerova, 2023)

Energy is one of the key elements of an economy. Maintaining daily economic activities would not be possible without ensuring energy security, which also contributes significantly to sustainable energy (Gökgöz & Yalçın, 2023). According to a study by Steinberger and Krausmann (2011), resource productivity for energy indicators is strongly correlated with income. The rationale for using energy productivity as an indicator of environmental sustainability assumes that higher economic performance on resource use implies more sustainable economic activity.

The macroeconomic determinants of energy productivity are key factors that influence how efficiently countries use energy to support their economic growth. According to (Zhao et al., 2022), the main macroeconomic determinants of energy productivity include structural changes in the sectoral composition of the economy and industry, availability of fossil energy resources, increased international trade, or technological innovation in the use of energy resources. Other determinants may include the business cycle (Cermakova el al., 2021)., regional (Mura & Hajduová, 2021) or sectoral changes.

A study by Atalla and Bean (2017) looking at energy productivity in 39 countries indicated that increases in sectoral energy productivity were the primary driver behind improvements in energy productivity. Structural economic shifts away from industry and towards service-oriented sectors played a minor role in improving overall energy productivity. In particular, higher energy prices and income levels are associated with improvements in sectoral energy productivity. Fundamental innovation in the energy sector is a necessary condition of the modern world, and energy continues to play a large role in the economy, as is intuitively understandable from the continued widespread interest in the geopolitics of energy. The field of energy productivity is related to three interrelated research questions: the relationship between energy and economic growth; the scope and drivers of any historical energy transition; and the economic efficiency of energy use (Kander et al., 2014).

Empirical results of Azama (2019) from the Asian economies showed that energy consumption has a significant positive impact on economic growth through real GDP per capita. The study suggests that governments should look for ways to create or acquire cheap but environmentally friendly energy alternatives such as renewable energy.

Resource efficiency and continuous productivity improvements are essential for sustainable growth and rising living standards. The increasing specialization of countries into suppliers and users of materials has created very different environmental and social challenges in exporting and importing countries and resulted in a very different policy context for sustainable use of natural resources and decoupling economic growth from materials use (Schandl et al., 2017).

1 Data and methodology

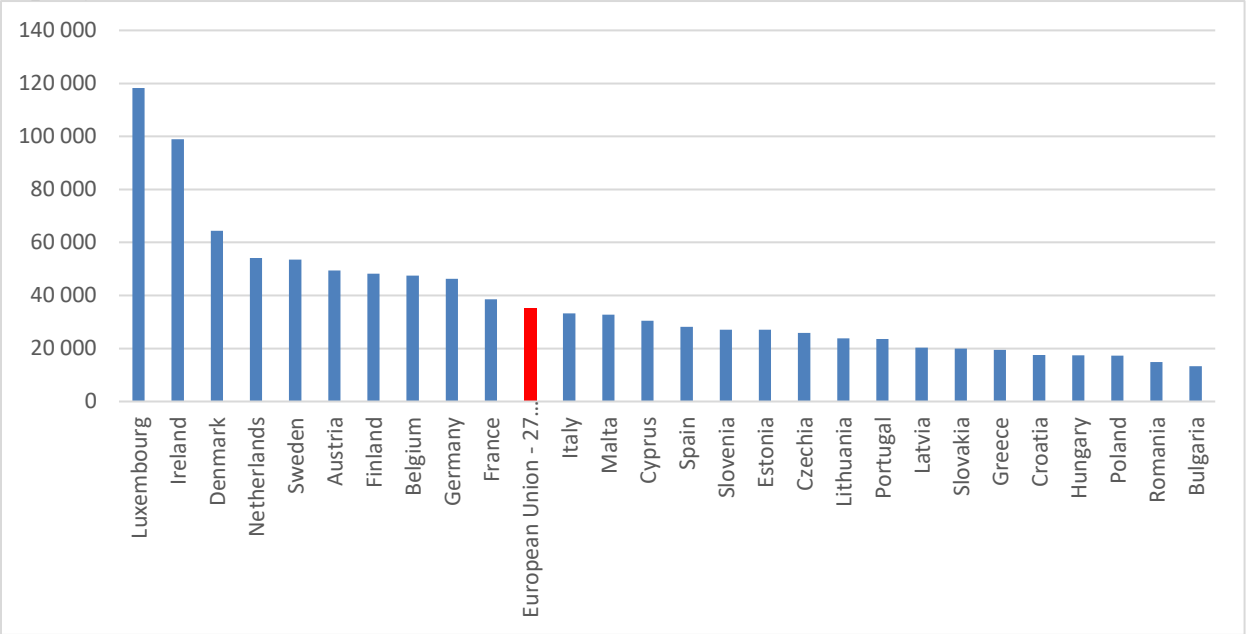
The paper is measured in the area of energy productivity in EU countries. The aim was to analyse whether countries according to their GDP per capita levels have different levels of energy efficiency also with respect to the cyclical development of the economy. The data was drawn from Eurostat for the EU countries i.e. EU 27. The countries were divided into four groups according to the size of GDP per capita in 2022, based on quartiles. Subsequently, the economic growth based on real GDP in these groups from 2013-2021 was examined. Energy efficiency in these countries was monitored during this interval.

Energy efficiency was surveyed based on the part of the composite indicator Eco-innovation index. One of the parts is resource efficiency which consists of material productivity, water productivity and energy productivity. Overall, the eco-innovation index is a composite indicator derived from an unweighted average of 16 indicators divided into five thematic areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes and socio-economic outcomes.

2 Results

The first part focused on the definition of countries into quartiles according to GDP per capita. Figure 1 illustrates the level of GDP per capita values in the EU Member States (EU27) in 2022. The average GDP per capita value is 35 450 Euro per capita. In particular, the founding EU members have a higher GDP per capita than the EU average, while Romania and Bulgaria are expected to have the lowest level.

Fig. 1: Gross domestic product at market prices per capita 2022 (current prices, euro per capita)



Source: Own calculations based on the data Eurostat

Based on the quartiles of GDP per capita, the EU countries were divided into four groups (Table 1). The first quartile (Q1) separates the first quarter of the data from the rest of the dataset, i.e. those countries with a GDP per capita value in 2022 of less than €20,262.5. The second quartile (Q2) is also the median dividing the data into two halves. The third quartile (Q3) separates the last quarter of the data.

Tab. 1: Groups by 2022 GDP per capita

Group 1	Bulgaria, Romania, Poland, Hungary, Croatia, Greece, Slovakia
Group 2	Latvia, Portugal, Lithuania, Czechia, Estonia, Slovenia, Spain, Cyprus
Group 3	Malta, Italy, France, Germany, Belgium
Group 4	Finland, Austria, Sweden, Netherlands, Denmark, Ireland, Luxembourg

Source: Own calculations based on the data Eurostat

Ireland and Luxembourg show high levels of GDP per capita and further examination could bias the results due to these high (extreme) values. These countries have been excluded from the calculation of the averages. Table 2 illustrates the average values of GDP per capita and the average value of Energy productivity in each group in 2022.

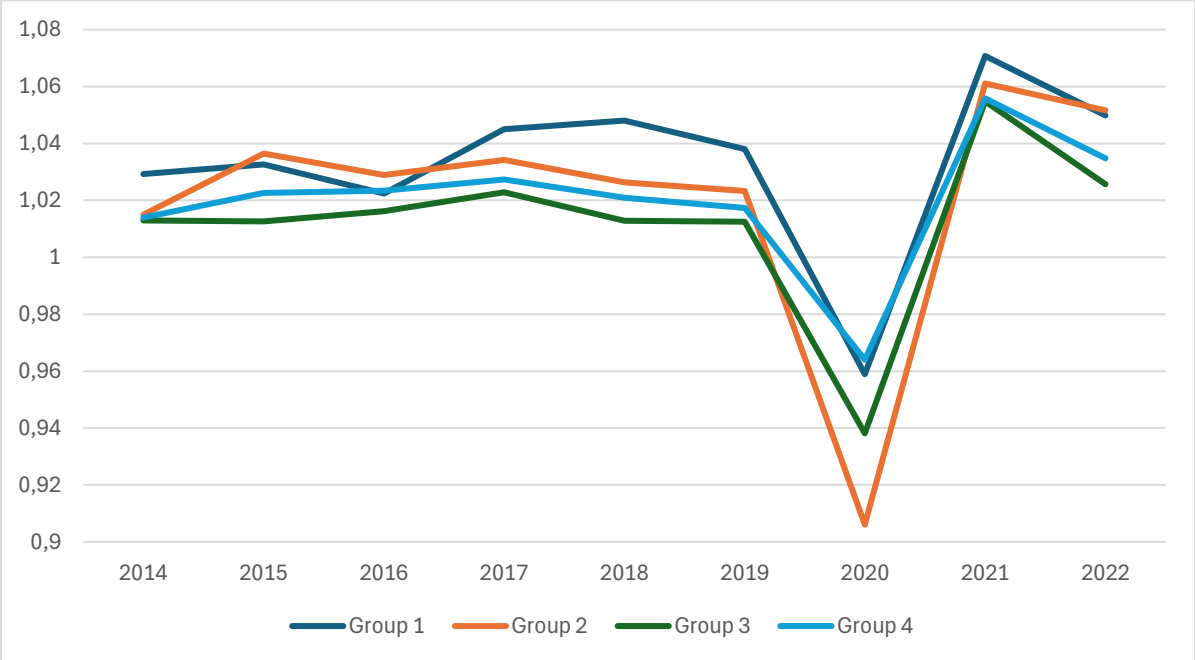
Tab. 2: Average values of selected indicators in 2022

	Average GDP per capita	Average energy productivity
Group 1	17140	82,24
Group 2	26554	108,53
Group 3	39658	116,15
Group 4	53948	159,82

Source: Own calculations based on the data Eurostat

From the values of the monitored indicators for the country groups, it is evident that the first group of countries, which reaches a quarter of the lowest GDP per capita values in 2022, also has the lowest level of Energy productivity in that year. And the fourth group of countries, which achieves the highest level of GDP per capita, also has a significantly higher Energy productivity value. This is influenced not only by the high level of GDP but also by the higher factor of production energy efficiency achieved due to technologies that are energy efficient (Bertoldi & Mosconi, 2020). For the cyclical analysis, the evolution of real GDP for each country group from 2013 to 2022 was examined. The aim was to reveal how efficiently each country group used energy in times of growth, stagnation or crisis. The trends in GDP were the same for each country group, only their intensity varied (Figure 2).

Fig. 2: Development of real GDP by country group from 2013 to 2022

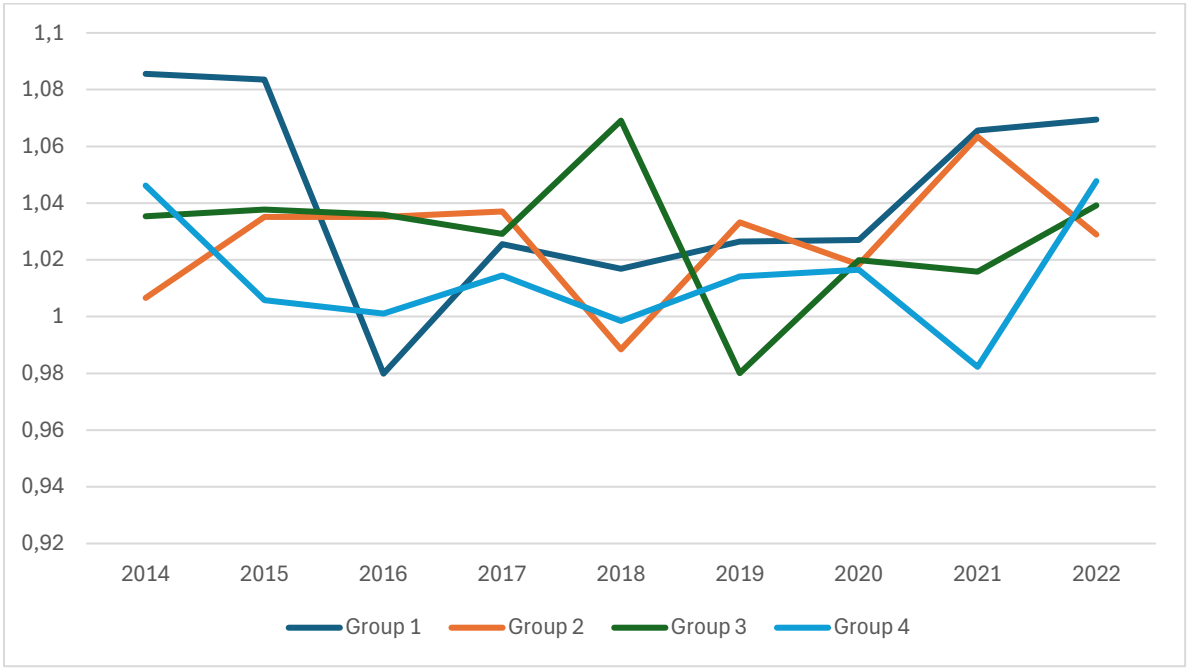


Source: Own calculations based on the data Eurostat

The highest decline in GDP in 2020 was recorded for Group 2, which includes the Czech Republic. On the other hand, Group 1 shows the highest GDP growth during the period under review (although the level of GDP per capita is the lowest in these countries) and the decline in real GDP in 2020 was comparable to Group 4, in which countries reach the highest level of GDP per capita. In 2022, the highest real GDP growth is then achieved by the groups of countries (Group 1 and 2). This situation is typical of convergence, i.e. the countries with the lowest GDP per capita levels achieve higher growth rates, i.e. there is a tendency for convergence of GDP levels between countries.

In the next step, the level and evolution of energy productivity for the different groups of EU countries was monitored (Figure 3). Here again, it is evident that the countries belonging to the group generating the highest GDP per capita (in particular Group 4) achieve the highest energy productivity. The level of energy productivity is significantly higher in this group of countries compared to the other groups. They are able to use energy resources more efficiently.

Fig. 3: Development of Energy productivity from 2013 to 2022 (index)



Source: Own calculations based on the data Eurostat

The year-on-year development of energy productivity no longer confirms the same tendencies and intensity of development for individual groups of countries. Countries in group 4 have the most stable development of energy productivity. The decrease in 2021 of about 1.8% was probably due to the energy crisis (reference lit. would be appropriate) However, all other

country groups still recorded an increase in this year (Group 1 and 2 the highest). Group 3 recorded a year-on-year decrease in energy productivity in 2019, which was probably due to the higher increase in the level of energy productivity in 2018.

Conclusion

The aim of the paper is to assess the role of energy productivity in the economic growth of EU countries. The study found that countries with higher real gross domestic product per capita achieved higher levels of average energy productivity such as Finland, Austria, Sweden, Netherlands, Denmark, Ireland. In terms of cyclical development, the trends in GDP were the same for each group of countries, only their intensity varied, with the lowest decline in the crisis year 2020 being achieved by countries in the first group (Bulgaria, Romania, Poland, Hungary, Croatia, Greece, Slovakia). The year-on-year evolution of energy productivity no longer confirms the same tendencies and intensity of development for each group of countries. The most stable development of energy productivity with a minimal impact of economic growth are in particular the countries of the first category. From the above comparison, the original assumption of a link between economic growth and energy productivity cannot be confirmed. On the contrary, it turned out that even in the period of economic recession, countries experienced an increase in energy productivity. This is most pronounced for the states with the lowest levels of GDP per capita. The main limitations of the study include the short time period and the focus on the whole economy rather than sectors. Overall, energy productivity is crucial for the competitiveness not only of companies but also of all economies (Bertoldi & Mosconi, 2020). Improving energy productivity should be a priority for governments and companies seeking long-term economic prosperity and sustainability.

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