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# ECONOMIC GROWTH, INCOME DISPARITY AND GREENHOUSE GAS EMISSIONS: THE CASE OF BULGARIA[3]

*The objective of this research is to perform an empirical analysis of the nexuses between real per capita output growth, income disparity and greenhouse gases in Bulgaria. To accomplish this goal, the original and the environmental Kuznets curves for Bulgaria were constructed. The results from the study indicate that in Bulgaria social resilience declines as economic sustainability increases. This demands tax and income policies for alleviating income disparity. It is advisable that progressive income taxation and tax-free minimum income be installed in order to diminish social instability in Bulgaria. Another inference from the empirical investigation is that Bulgaria ought to have a minimum real per capita output growth of 5.8% so that a decrease in carbon emissions is achieved.*
*Keywords: Sustainability; Kuznets curves; Bulgaria; income disparity; greenhouse gas emissions*
*JEL: F63; O20; Q01; Q56*

## 1. Introduction

Sustainable development consists of three components: economic, social and environmental. Economic sustainability can be approximated by the real GDP per capita, social resilience may be measured by the Gini coefficient and environmental sustainability is indicated by greenhouse gas emissions per person.

The goal of this study is to estimate the nexuses between real per capita output growth, income disparity and green. The hypotheses of the existence of the OKC and EKC for Bulgaria were tested, the former being refuted and the latter being confirmed. The original and the environmental Kuznets curves for Bulgaria were produced. The original Kuznets curve (OKC) portrays the relationship between real economic growth per capita and income disparity, whereas the environmental Kuznets curve (EKC) depicts the nexus between economic growth and greenhouse gas emissions.

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The purpose of the research was achieved by the fulfilment of the following tasks:

- Make the reader familiar with the research problem;
- Systematize the theoretical fundamentals of sustainability and the empirical investigations on the Kuznets curves;
- Estimate the relationship between real per capita output growth and income disparity;
- Assess the nexus between real per capita output growth and greenhouse gas amounts in Bulgaria;
- Discuss the empirical results and recommend macroeconomic policies for achieving sustainability in Bulgaria.

The limitations of the investigation are related to data availability and short time series (the number of observations is below 30).

## 2. Literature Review

Brundtland (1987) defined sustainability as "development, which meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development comprises two interdependent facets – sustainability and development. Sustainability has environmental and social aspects, while development concerns economic growth. Global trends in the modern world cover all the main spheres of public life - economic, social, science, education and ecology (Tsvetanova, 2022).

Kuznets (1955) claimed that in the long term economic growth results in a decline in income disparity. He described the economic growth-income disparity nexus via a U-shaped curve referred to as the original Kuznets curve. An alike curve portrays the relationship between output growth and carbon emissions. According to Grossman and Krueger (1995) in the beginning, accelerated economic growth causes a decline in carbon gases but this trend is reversed after a threshold level of per capita GDP is accomplished. The nexus between greenhouse gas emissions and economic welfare is expressed by an inverted curved line known as the environmental Kuznets curve. This term was coined by Panayotou (1993) and Seldon and Song (1994).

The nexuses between the aspects of sustainability, depicted by the two Kuznets curves, are a subject of incessant debate and argument by researchers, government officials, politicians, business circles and civil society.

The factors affecting the original Kuznets curve were examined by Rötheli (2011). They ascertained that with high-income disparity and low savings rates, economic growth does not always result in a more equitable income allocation. However, well-functioning capital markets may contribute to reducing income disparity.

Customarily, a well-developed financial sector favours accelerated economic growth and lower income disparity (Levine, 2005; Beck et al., 2007). However, in some cases, the

influence of the financial system on economic growth and social resilience may be controversial (Rousseau and Wachtel, 2011).

Okun (2015) asserted that the strife between income disparity and economic efficiency is inevitable. Increased equality discourages economic efficiency, but enhanced economic efficiency leads to higher disparity.

Piketty (2014) and Mavrov (2021) inferred that developed market economies tend to have higher return rates than economic growth rates, which stimulates wealth and income concentration. Ostry et al. (2014) and Stiglitz (2013) concluded that greater equality encourages economic efficiency.

Shahbaz and Sinha (2019) systematized the empirical research on the environmental Kuznets curve during 1991-2017. They found out, that study results and recommendations significantly differ because of great variations in research methodology, period and location. Shahbaz and Sinha (2019) advised that perfected and uniform methodology and data be employed in future investigations to raise the results' robustness and accuracy.

Howell et al. (2014) argued that most of the studies identified economic growth as a reason for the rise in greenhouse gas emissions (assumption one). The developments in green innovation and the environmental Kuznets curves (assumption two) showed that after a certain level of per-person income, greenhouse gas amounts drop. Boyce (1994) claimed that the general public may value more social resilience than economic prosperity (assumption three). Howell et al. (2014) verified the three assumptions for the USA and ascertained a positive correlation between carbon emissions and per capita output growth, confirming assumption 1. With other indicators used (poisonous gases), assumption two of the environmental Kuznets curve was supported. Assumption three regarding income disparity was also proved.

Singhania and Saini (2020) found proof in favour of the environmental Kuznets curve for different income-level countries. They discovered that output growth and energy production are the key drivers of the increase in carbon emissions.

Rajpurohit and Sharma (2021) verified the environmental Kuznets curve existence for Malaysia, India, Sri Lanka, Bangladesh and Pakistan during 1980-2014. They advised of greater output growth in spite of the rise in greenhouse gas amounts in the beginning. When economic growth occurs at a greater pace, air pollution will decline in the end.

Alshubiri and Elheddad (2020) checked the environmental Kuznets curve availability for thirty-two OECD states. At first, overseas investment, assets and remittances result in a significant increase in greenhouse gas amounts. However, after a certain threshold, investments, assets and remittances from abroad tend to reduce carbon dioxide amounts. Unlike foreign capital inflows, output growth initially generates more carbon gases but the trend is reversed when society becomes sufficiently well-off. A second turning point appears to make the nexus between output growth and greenhouse gases N-shaped.

Sajeev and Kaur (2020) confirmed the existence of the U-shaped EKC in the short run, but denied it in the long run for India in 1980–2012. They recommended that India introduce adequate environmental protection regulations and enforce their strict obedience.

Sen and Abedin (2021) confirmed the environmental Kuznets curve hypothesis for China and India during 1972–2017. They concluded that after a certain threshold output growth will decrease greenhouse gas amounts faster in India than in China.

Ahmed and Qazi (2014) confirmed the existence of short- and long-run EKCs for Mongolia. As a result, adequate measures were taken to maintain an acceptable combination between the economic and ecological dimensions of sustainability.

Ansari et al. (2020) ascertained a long-run nexus between greenhouse gases, per capita output growth, foreign commerce and energy use in Australia, Canada, the United States, Saudi Arabia, Iran, Great Britain, France, Italy and Spain. The energy mix was found to be a crucial long-term factor of greenhouse gas amounts. The above-mentioned countries can decrease their energy use and greenhouse gases without impeding economic growth.

Bader and Ganguli (2019) validated the existence of a U-shaped EKC for Bahrain and Saudi Arabia. They recommended that the two countries rely less on fossil fuels as increased amounts of carbon emissions lower productivity and hamper GDP increase.

Borhan and Ahmed (2010) tested the EKC assumption for eight pollutants in Malaysia and found it valid for two pollutants only.

Cialani (2007) found no significant U-shaped nexus between greenhouse gas emissions and per-head output growth in Italy during 1861-2002.

Dar and Asif (2018) studied the long-term impact of financialization, energy consumption and per capita output growth on air pollution over 1960-2013. The amount of carbon emissions was found to be negatively correlated with financialization and positively correlated with energy consumption and GDP growth.

Hua and Boateng (2015) confirmed the existence of the EKC for a sample of 167 states during 1970-2007. The authors concluded that free trade and capital mobility contribute to reducing greenhouse gases on the global scale.

Lau et al. (2018) established an inverted nexus between per capita output growth and greenhouse gas amounts in developed states but refuted the EKC hypothesis for developing ones. In developing countries, corruption is a crucial determinant of carbon emissions whereas in developed states, institutional quality hinders the increase in greenhouse gas amounts.

Dimitrova (2019) tested the availability of the EKC for three small towns in Bulgaria – Krumovgrad, Breznik and Tran. No proof was discovered in favour of the EKC assumption in the three towns under investigation.

Kalchev (2016) studied the relationship between 5 air pollutants and per capita output growth in Bulgaria over 1970-2008 and proved the availability of an EKC for four out of five pollutants.

Tsiantikoudis et al. (2019) confirmed the validity of the N-shaped environmental Kuznets curve hypothesis for Bulgaria and recommended that landscaping and horticulture be adequately managed.

From the review of the literature, it may be concluded that a group of researchers (Levine, 2005; Beck et al., 2007; Rötheli, 2011; Stiglitz, 2013; Ostry, 2014) confirmed the validity of the OKC hypothesis, while other authors (Piketty, 2014; Okun, 2015) denied the OKC assumption. Our inferences are in agreement with the findings of Piketty (2014) and Okun (2015) and in contrast with the conclusions of Levine (2005), Beck et al. (2007), Rötheli (2011), Stiglitz (2013) and Ostry (2014).

The existence of the EKC was proved for many countries – the United States of America, Great Britain, Bahrain, Saudi Arabia and Mongolia. The environmental Kuznets curve assumption was found valid for Bangladesh, India, Malaysia, Pakistan and Sri Lanka provided that output grew at an increased rate. However, in some states (most of the Gulf Cooperation Council and Organization for Economic Cooperation and Development countries, Turkey, Italy, and China), no proof of an inverted nexus between per capita GDP increase and greenhouse gas emissions was ascertained. Our empirical findings confirmed the validity of the environmental Kuznets curve assumption in Bulgaria for the period 2001-2020.

It may be concluded that the empirical research on the OKC and EKC have ambiguous outcomes, which can be attributed to various methodologies, time intervals and geographical ranges.

## 3. Empirical Assessment of the Nexus Between Real per Capita Output Growth and Income Disparity

### *3.1. Methodology*

The nexus between the growth of real GDP per capita and the Gini coefficient in Bulgaria is estimated by an ordinary least squares (OLS) regression, which involves the following variables:

$\mathbf{Y_t}$ – percentage change in real per capita output in Bulgaria in year **t** on year **t-1**;

**G –** percentage change of the Gini coefficient in Bulgaria in year **t** on year **t-1**.

The target variable is **G,** while the explanatory variable is **Y.** To correct for a possible non-linear nexus between the target and the explanatory variable, the square of **Y** participates in the regression too.

### *3.2. Data*

Yearly Eurostat data for the interval 2007 – 2021 are employed in the research.

### *3.3. Results*

The group stationarity tests indicate that jointly **Y** and **G** are integrated of order zero (see Table 1), which permits the implementation of the OLS methodology.

***Table 1. Group Unit Root Tests on Y and G***

| Method | Statistic | Probability | Cross-sections | Observations |
|---|---|---|---|---|
| Null: Unit root (implies common non-stationarity) | | | | |
| Levin, Lin and Chut* | -5.50 | 0.00 | 2 | 28 |
| Null: Unit root (implies individual non-stationarity) | | | | |
| Im, Pesaran and Shin W-statistic | -4.90 | 0.00 | 2 | 28 |
| ADF-Fisher Chi-square | 24.55 | 0.00 | 2 | 28 |
| PP-Fisher Chi-square | 38.60 | 0.00 | 2 | 28 |

*Source: Authors' estimation*

The nexus between **Y** and **G** is shown by Equation (1):

$$G = C(1) + C(2)*Y + C(3)*Y^2 + \Sigma \quad (1)$$

The results from the assessment of Equation (1) are displayed in Table 2. The absence of significant variables in Equation (1) means a lack of linear and non-linear impact of real growth per person on income disparity in Bulgaria.

***Table 2. Econometric Assessment of Equation (1)***

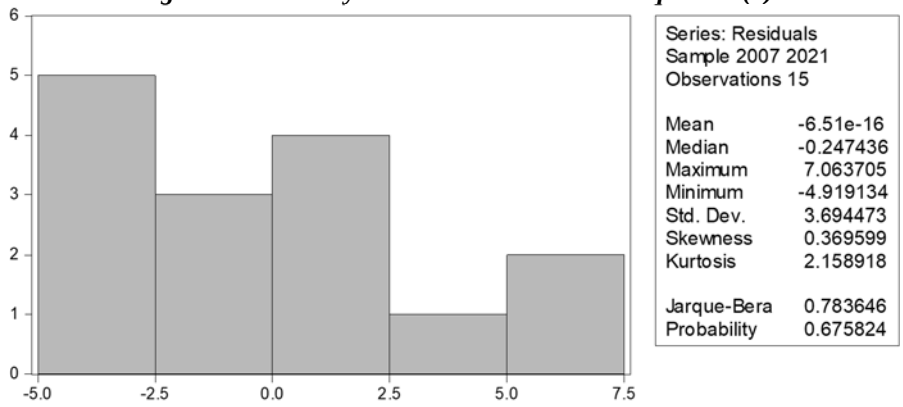
| Variable | Coefficient | Standard Error | t-Statistic | Probability |
|---|---|---|---|---|
| C | -1.71 | 1.61 | -1.07 | 0.31 |
| Y | 0.72 | 0.48 | 1.51 | 0.16 |
| Y^2 | 0.09 | 0.11 | 0.87 | 0.41 |
| R-squared | 0.44 | Mean of dependent variable | | 1.73 |
| Adjusted R-squared | 0.34 | Standard deviation of dependent variable | | 4.91 |
| S.E. of regression | 4.00 | Akaike info criterion | | 5.79 |
| Sum squared residual | 191.09 | Schwarz criterion | | 5.93 |
| Log likelihood | -40.37 | Hannan-Quinn criterion | | 5.79 |
| F-statistic | 4.60 | Durbin-Watson statistic | | 2.29 |
| Probability of F-statistic | 0.04 | | | |

*Source: Authors' estimation*

The determination coefficient value (0.44) suggests that 44% from the changes in **G** can be attributed to the variation in **Y**. The probability of the F-statistic of 0.032 means that Equation (1) properly expresses the nexus between **G** and **Y**.

The residuals in Equation (1) are characterized by normal distribution (see Figure 1), lack of serial correlation (see Table 3) and non-heteroscedasticity (see Table 4). The Regression Specification Error Test (RESET) indicates an absence of errors in the construction of Equation (1) (see Table 5). The CUSUM test (see Figure 2) displays that Equation (1) possesses dynamic stability.

***Figure 1. Normality Test on the Residuals in Equation (1)***




*Source: Authors' estimation.*

***Table 3. Serial Correlation Test on the Residuals in Equation (1)***

| | | | |
|---|---|---|---|
| F-statistic | 0.54 | Probability F(2,10) | 0.61 |
| Observations R-squared | 1.45 | Probability Chi-Square(2) | 0.49 |

*Source: Authors' estimation.*

***Table 4. Test for Heteroskedasticity of the Residuals in Equation (1)***

| | | | |
|---|---|---|---|
| F-statistic | 0.17 | Probability F(2,12) | 0.86 |
| Observations R-squared | 0.39 | Probability Chi-Square(2) | 0.82 |

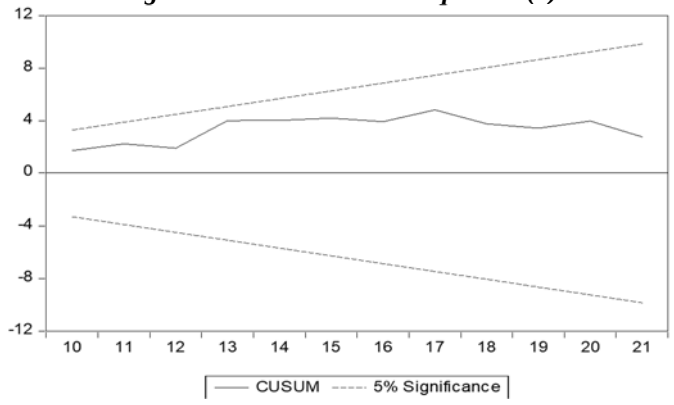
*Source: Authors' estimation.*

***Table 5. RESET on Equation (1)***

| | Value | Degree of freedom | Probability |
|---|---|---|---|
| t-statistic | 0.89 | 11 | 0.39 |
| F-statistic | 0.83 | (1, 11) | 0.39 |
| Likelihood ratio | 1.09 | 1 | 0.30 |

*Source: Authors' estimation.*

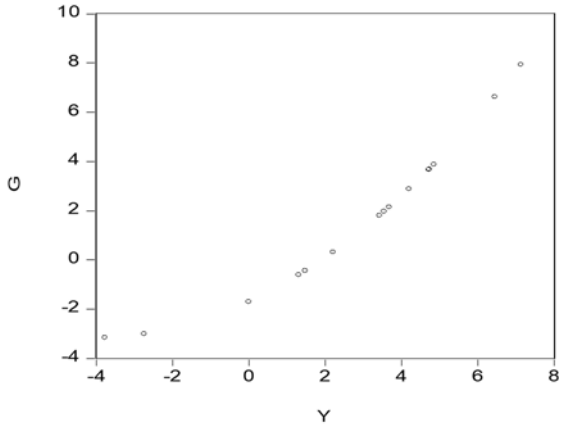
***Figure 2. CUSUM Test on Equation (1)***




*Source: Authors' estimation.*

The original Kuznets curve for Bulgaria during 2007-2021 (see Figure 3) is constructed using Equation (1). This curve displays that the acceleration of real per capita economic growth is combined with a rise in income disparity.

***Figure 3. Nexus between real per capita output growth and income disparity in Bulgaria during 2007-2021***




*Source: Authors' estimation.*

## 4. Empirical Estimation of the Nexus between Real per Capita Output Growth and Greenhouse Gas Amounts

### *4.1. Methodology*

The nexus between real economic growth per person and carbon gases in Bulgaria is explored via an OLS model specification, which includes the variables mentioned below:

$\mathbf{Y_t}$ – percentage change in real per capita output in Bulgaria in year t on year t-1;

**E –** percentage change in greenhouse gas emissions per capita in Bulgaria in year **t** on year **t-1**.

The variable of interest is **E,** whereas the regressor is **Y.** To reflect a possible non-linearity between **E** and **Y**, the square of **Y** is also presented in the model specification.

### *4.2. Data*

Yearly Eurostat data for the interval 2001 – 2020 are employed in the analysis.

### *4.3. Results*

The group stationarity tests indicate that jointly **Y** and **E** are integrated of order zero (see Table 6), which permits the immediate implementation of the OLS methodology.

***Table 6. Group Unit Root Tests on Y and E***

| Method | Statistic | Probability | Cross-sections | Observations |
|---|---|---|---|---|
| Null: Unit root (implies common non-stationarity) | | | | |
| Levin, Lin and Chut* | -1.75 | 0.03 | 2 | 37 |
| Null: Unit root (implies individual non-stationarity) | | | | |
| Im, Pesaran and Shin W-statistic | -1.79 | 0.03 | 2 | 37 |
| ADF-Fisher Chi-square | 9.93 | 0.03 | 2 | 37 |
| PP-Fisher Chi-square | 12.3 | 0.02 | 2 | 38 |

*Source: Authors' estimation.*

The nexus between **Y** and **E** is described by Equation (2):

$$E = C(1) + C(2)*Y + C(3)*Y^2 + \Sigma \quad (2).$$

The results from the assessment of Equation (2) are displayed in Table 7. The availability of significant predictors in Equation (2) implies that **Y** has both linear and non-linear impact on **E** in Bulgaria.

***Table 7. Econometric Assessment of Equation (2)***

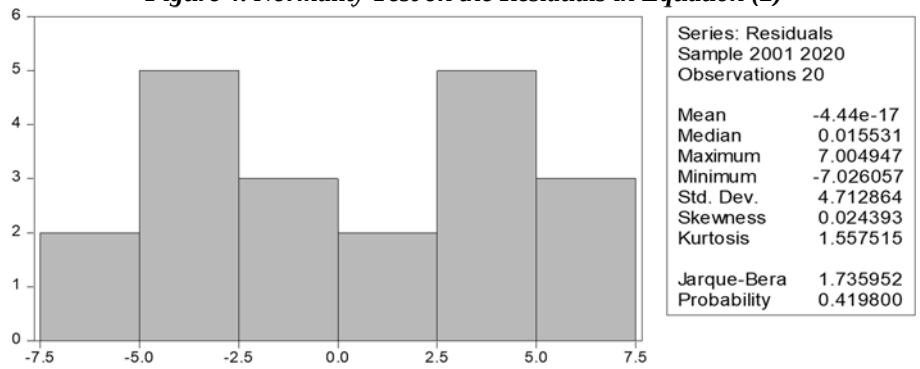
| Variable | Coefficient | Standard Error | t-Statistic | Probability |
|---|---|---|---|---|
| Y^2 | -0.23 | 0.10 | -2.33 | 0.02 |
| Y | 2.58 | 0.60 | 4.35 | 0.01 |
| C | -3.84 | 1.86 | -2.08 | 0.04 |
| R-squared | 0.58 | Mean of dependent variable | | 0.40 |
| Adjusted R-squared | 0.53 | Standard deviation of dependent variable | | 7.25 |
| Standard error of regression | 4.97 | Akaike info criterion | | 6.17 |
| Sum squared residual | 422.00 | Schwarz criterion | | 6.32 |
| Log likelihood | -58.88 | Hannan-Quinn criterion | | 6.20 |
| F-statistic | 11.68 | Durbin-Watson statistic | | 2.58 |
| Probability of F-statistic | 0.01 | | | |

*Source: Authors' estimation.*

The determination coefficient value (0.58) suggests that 58% from the changes in **E** can be attributed to the variation in **Y**. The probability of the F-statistic of 0.01 means that Equation (2) properly expresses the nexus between **E** and **Y**.

The residuals in Equation (2) are characterized by normal distribution (see Figure 4), lack of serial correlation (see Table 8) and non-heteroscedasticity (see Table 9). The Regression Specification Error Test (RESET) indicates an absence of errors in the construction of Equation (2) (see Table 10). The CUSUM test (see Figure 4) displays that Equation (2) possesses dynamic stability.

***Figure 4. Normality Test on the Residuals in Equation (2)***




*Source: Authors' estimation*

***Table 8. Serial Correlation Test on the Residuals in Equation (2)***

| | | | |
|---|---|---|---|
| F-statistic | 2.22 | Probability F(1,16) | 0.16 |
| Observations R-squared | 2.44 | Probability Chi-Square(1) | 0.12 |

*Source: Authors' estimation*

***Table 9. Test for Heteroskedasticity of the Residuals in Equation (2)***

| | | | |
|---|---|---|---|
| F-statistic | 0.02 | Probability F(1,17) | 0.91 |
| Observations R-squared | 0.02 | Probability Chi-Square(1) | 0.90 |

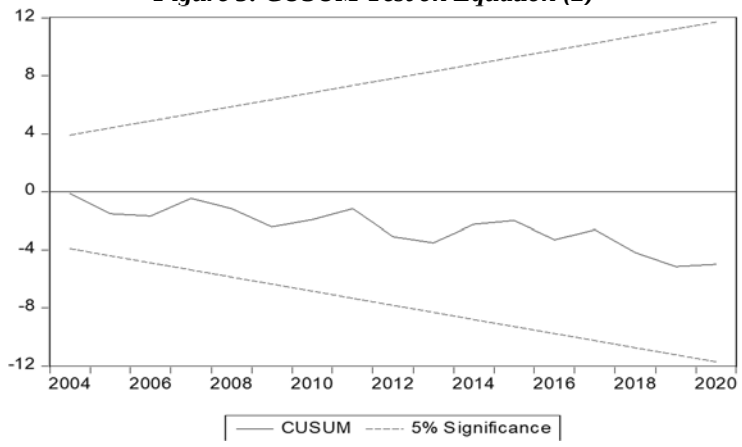
*Source: Authors' estimation*

***Table 10. RESET on Equation (2)***

| | Value | Degree of freedom | Probability |
|---|---|---|---|
| t-statistic | 0.24 | 16 | 0.82 |
| F-statistic | 0.06 | (1,16) | 0.82 |
| Likelihood ratio | 0.08 | 1 | 0.80 |

*Source: Authors' estimation*

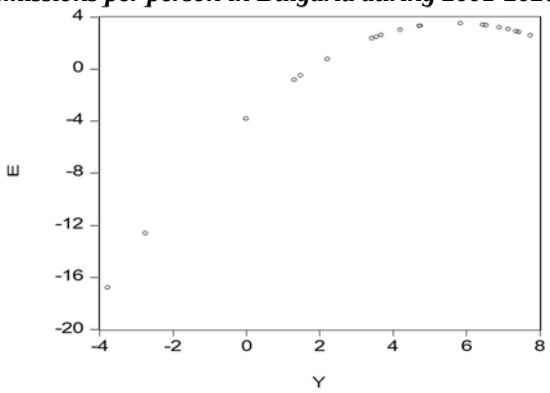
***Figure 5: CUSUM Test on Equation (2)***




*Source: Authors' estimation*

The ecological Kuznets curve for Bulgaria during 2001-2020 (see Figure 6) is constructed using Equation (2). This curve displays that the amount of carbon emissions in Bulgaria rises until the real per capita output growth rate reaches 5.8% per annum. After this threshold, the acceleration of real economic growth per person results in a decline in greenhouse gas amounts.

***Figure 6: Relationship between real per capita output growth and greenhouse gas emissions per person in Bulgaria during 2001-2020***




*Source: Authors' estimation*

## Conclusion

The results from the study indicate that in Bulgaria in the period 2007 – 2021, the acceleration in real per capita output growth was coupled with a decline in social resilience. The results also show that in Bulgaria in the interval 2001 – 2020 the rise in real GDP per capita growth was paired with a rise in carbon emissions to the threshold of 5.8% after which the trend was reversed. When real economic growth exceeded 5.8%, a fall in greenhouse gas amounts occurred.

It can be concluded that in Bulgaria income disparity increases as economic growth accelerates. This requires tax and income policies to alleviate income disparity. It is advised that progressive income taxation and tax-free minimum income be implemented to enhance social stability in Bulgaria.

Another inference is that Bulgaria ought to reach a minimum real economic growth per head of 5.8% in order to achieve a decline in carbon emissions. Bulgarian policymakers ought to implement policies for moving the EKC to the right by making investments in sustainability and fostering green innovations for a smoother transition to net-zero greenhouse gas emissions by 2050.

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