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ASSESSING ECONOMIC CONVERGENCE BETWEEN BULGARIA AND THE EU: THE ROLE OF GREEN TRANSITION IN UNEMPLOYMENT AND GDP PER CAPITA DYNAMICS

Abstract:

This study investigates Bulgaria's economic convergence with the EU27, focusing on unemployment rates and GDP per capita from 2012 to 2022. Employing Beta, Gamma, Sigma, and Delta convergence measures, the research assesses the extent of Bulgaria's alignment with the economic performance of its EU counterparts. Additionally, the study critically examines the impact of Bulgaria's green transition—measured through recycling rates and renewable energy usage—on these convergence processes. The findings reveal a complex picture: while Bulgaria demonstrates strong Gamma and Delta convergence, suggesting improvements in its relative economic standing and a reduction in absolute disparities with the EU27, the absence of Beta and Sigma convergence indicates that overall economic growth and variability reduction remain insufficient for full integration. Furthermore, the analysis shows that although green transition efforts have positively influenced certain convergence aspects, they have not significantly contributed to broader economic alignment with the EU27. The study concludes that while Bulgaria is making notable progress in some convergence metrics, achieving comprehensive economic integration with the EU27 will require more robust and diversified policy interventions. The findings underscore the necessity for Bulgaria to enhance its environmental strategies with broader economic policies to effectively close the remaining gaps with its EU counterparts.

Keywords:

Economic Convergence, Bulgaria, EU27, Unemployment Rates, GDP per Capita, Beta Convergence, Gamma Convergence, Sigma Convergence, Delta Convergence, Green Transition, Recycling Rates, Renewable Energy, Economic Integration

JEL Classification: O47, Q56, E24

1 Introduction

Economic convergence is a critical aspect of the European Union's (EU) policy framework, aiming to reduce disparities between member states and promote uniform economic development. For countries like Bulgaria, which joined the EU in 2007, achieving economic convergence with the more developed EU27 members remains a significant challenge. This study explores the convergence dynamics of Bulgaria relative to the EU27, focusing on unemployment rates and GDP per capita from 2012 to 2022. The analysis is enriched by examining the impact of Bulgaria's green transition policies, particularly recycling rates and renewable energy usage, on its convergence progress. Bulgaria, as a member of the EU, needs to ensure a convergent policy with the EU countries to improve recycling rates and renewable energy usage.

Economic convergence is analyzed through four key types: Beta, Gamma, Sigma, and Delta. Each offers a unique perspective on the alignment between Bulgaria and the EU27 in economic terms. In addition to these convergence measures, the study investigates how Bulgaria's environmental efforts, particularly in recycling and renewable energy, influence its economic alignment with the EU27. This research contributes to the broader understanding of how environmental policies intersect with economic convergence, offering insights into the effectiveness of green transition strategies in fostering economic growth and reducing disparities within the EU.

2 Literature review

The analysis of modern theoretical approaches in the existing literature dealing with the assessment of the relationship between environmental sustainability and economic growth is an adequate opportunity to assess the role of the green transition on the dynamics of gross domestic product per capita. For the purposes of the analysis, it is assumed that there is a causal relationship between the considered factors and that the role of the green transition is evaluated from the point of view of environmental sustainability, which is due to the achieved recycling rates and renewable energy usage.

The analysis of the relationship between the environment and economic growth is represented in the works of a number of authors. Grossman and Krueger (1991, 1994) are considered seminal works. They examine the relationship between air quality and economic growth and hypothesize that the environment, and in particular air quality, deteriorates as GDP per capita increases in countries with low levels of national income, but at the same time improves with growth of GDP in countries with higher levels of national income.

The green transition to low-carbon economies has directed government policies in the area towards achieving energy efficiency, the expected benefits of which are reductions in energy costs and carbon dioxide emissions. Therefore, the role of renewable energy for the energy future is becoming greater. Research on the relationship between renewable energy consumption and GDP shows that countries with higher GDP have a stronger correlation between RES and economic growth than those with lower GDP. This highlights the decisive role of RES consumption in economic growth (Ntanos et al., 2018; Al-Mulali, et al;, 2013).

Other authors such as Apergis and Payne (2010) also analyze the relationships between renewable energy consumption and economic growth, but the findings they reach are that there is a two-way causality between renewable energy consumption and economic growth in the short

run and in the long run. period. By using heterogeneous panel cointegration techniques, they prove a positive and significant long-run equilibrium relationship between real GDP, renewable energy consumption, real gross fixed capital formation and labor force (Omri, A., et. al, 2014). Through an empirical Sadorsky model (2009) found that, in the long run, a 1% increase in real per capita income increases per capita renewable energy consumption in developing economies by approximately 3.5%.

However, the level of development and implementation of RE is different in different countries and this necessitates an assessment of the quantitative determinants of the development of RE. Bourcet (2020) points out that the main determinants of RE development are regulatory, political and demographic.

Other determinants that have a positive impact on the demand for renewable energy are economic growth and climate policy uncertainty. Conversely, among the determinants that limit the demand for renewable energy are falling crude oil prices (Shang, 2022).
The literature review reveals the relationship between the environment and economic growth, but shows that it is of variable impact. The empirical analysis of the present study actually shows that the achievement of environmental sustainability through the green transition and the achieved recycling rates and renewable energy usage is insufficient to stimulate growth.

3 Methodology

This study employs a comprehensive econometric analysis to explore the convergence of Bulgaria with the EU27 in terms of unemployment rates and GDP per capita, focusing particularly on the impact of the green transition, represented by recycling rates and renewable energy usage. The analysis covers the period from 2012 to 2022 and applies four types of convergence measures: Beta, Gamma, Sigma, and Delta, each providing a different perspective on economic alignment between Bulgaria and the EU27.

Convergence Measures:

Beta Convergence: This analysis examines whether Bulgaria’s unemployment rate and GDP per capita are converging towards the EU27 average. A simple linear regression is employed, where the growth rate of Bulgaria is regressed against the EU27 growth rate. A negative slope (Beta coefficient) would indicate convergence, whereas a positive slope suggests divergence.

Gamma Convergence: This measure evaluates the rank correlation between Bulgaria and the EU27 over time. Pearson's rank correlation coefficient is used to assess whether the relative position of Bulgaria’s unemployment rate and GDP per capita within the EU27 is becoming more aligned. A strong positive correlation would indicate convergence in rank order.

Sigma Convergence: This approach assesses the reduction in the dispersion of unemployment rates and GDP per capita between Bulgaria and the EU27. The standard deviation of the differences between Bulgaria and the EU27 is calculated over time. A decreasing trend in this standard deviation suggests convergence.

Delta Convergence: Delta convergence examines whether the absolute differences in unemployment rates and GDP per capita between Bulgaria and the EU27 are diminishing. A

regression model is used where the difference between Bulgaria's and the EU27's rates is the dependent variable. A negative Delta coefficient indicates convergence.

Green Transition Factors:

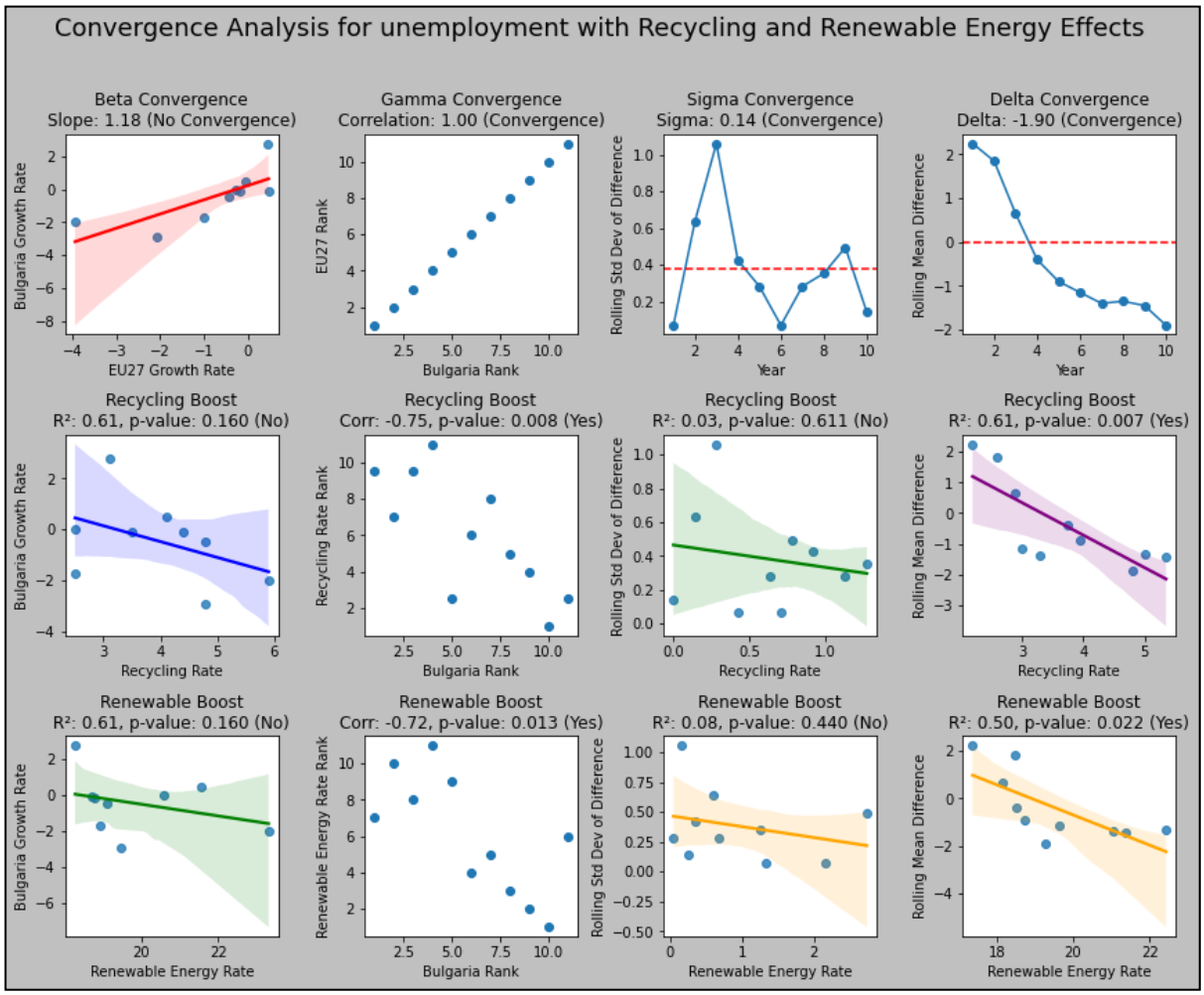
The effects of recycling rates and renewable energy usage on these convergence measures are analyzed by including these factors as independent variables in the regression models for Beta, Sigma, and Delta convergence. The coefficients of these green transition factors are examined to determine their impact on economic convergence.

Overall, the methodology integrates statistical tools and regression models to capture the dynamic interaction between Bulgaria's economic indicators and the EU27 average, with a special emphasis on the role of green transition policies in driving this convergence.

4 Research Procedure and Results

Figure 1 illustrates the different types of economic convergence (Beta, Gamma, Sigma, and Delta) between Bulgaria and the EU27 in terms of unemployment rates, with an additional focus on the effects of recycling and renewable energy rates for the period 2012 – 2022 year.

Figure 2: Convergence Analysis for GDP per Capita with Recycling and Renewable Energy Effects *Source: Eurostat and own calculations*.



The regression analysis for Beta convergence between Bulgaria and the EU27 in unemployment rates resulted in a slope (Indicator) of 1.18, with an R-squared value of 0.61 and a model p-value of 0.16. The positive slope indicates that there is no evidence of Beta convergence in unemployment rates; instead, Bulgaria's unemployment rate changes do not demonstrate a significant catch-up effect relative to the EU27.

The effects of the green transition, represented by recycling rates and renewable energy usage, did not show a significant impact on Beta convergence. The Recycling Boost and Renewable Boost were both marked as "No," indicating that increases in recycling and renewable energy rates did not contribute to a faster reduction in Bulgaria's unemployment relative to the EU27.

Gamma convergence assesses whether the rank order of unemployment rates among Bulgaria and the EU27 countries is becoming more similar over time. The analysis revealed a strong positive Gamma convergence, with an Indicator value of 1.00 and significant negative coefficients for both recycling (-0.75) and renewable energy rates (-0.72). These results suggest that not only is Bulgaria's rank in unemployment rates becoming more aligned with the EU27, but that improvements in recycling and renewable energy usage are significantly associated with this alignment. The p-values for the Gamma convergence models were 0.00, further confirming the strong statistical significance of these findings.

Sigma convergence focuses on the dispersion of unemployment rates across countries, measuring whether the variability of unemployment rates between Bulgaria and the EU27 is decreasing over time. The Sigma convergence analysis yielded a low R-squared value (0.03 for recycling and 0.07 for renewable energy) and non-significant p-values (0.61 and 0.44, respectively). The small and negative coefficients for recycling (-0.13) and renewable energy (-0.09) suggest that while there is some reduction in the dispersion of unemployment rates, the effect is weak and not significantly influenced by the green transition factors.

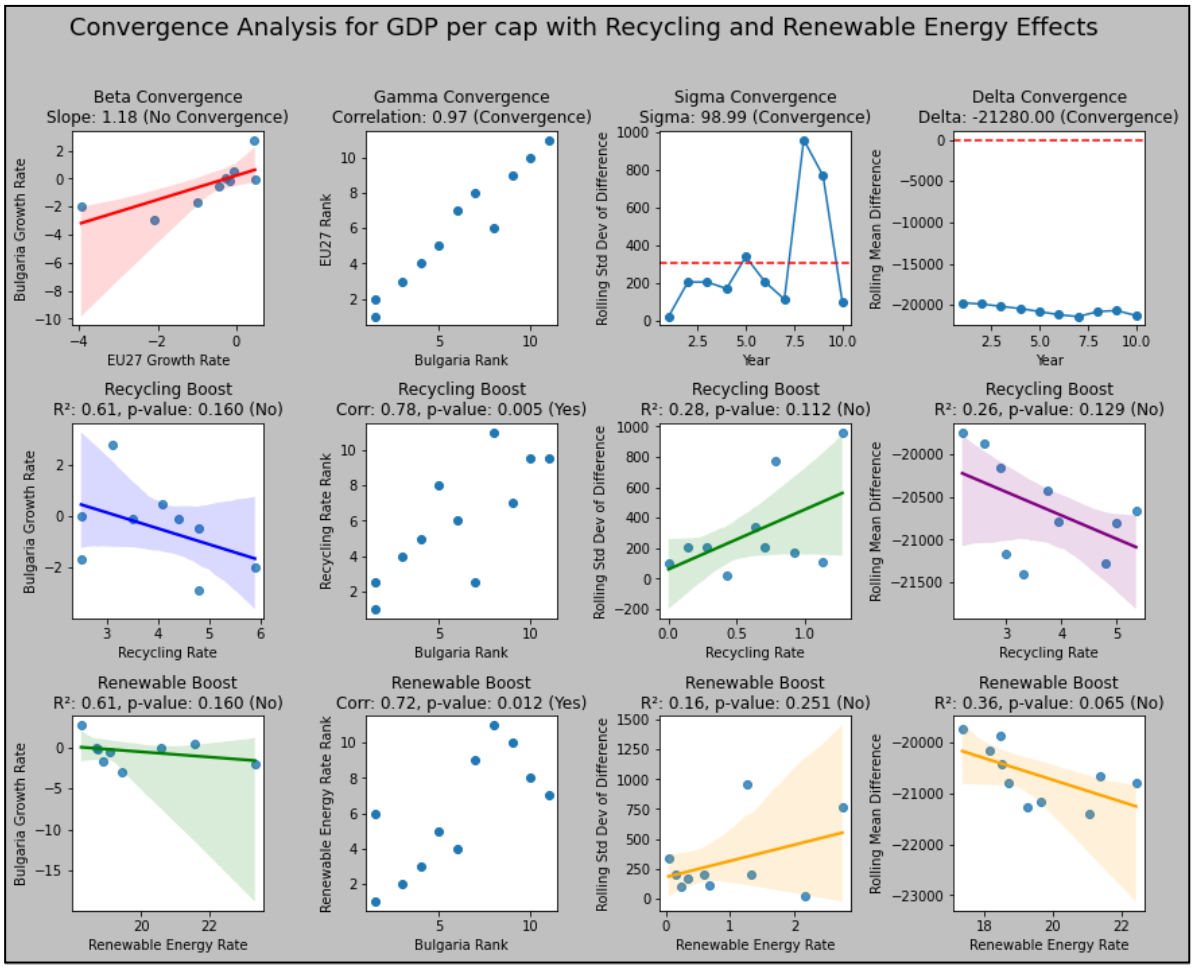
This weak Sigma convergence indicates that the variability in unemployment rates between Bulgaria and the EU27 remains relatively high, and the current levels of recycling and renewable energy usage have not substantially contributed to reducing this variability.

Delta convergence examines whether the differences in unemployment rates between Bulgaria and the EU27 are decreasing over time. The Delta convergence analysis showed significant results, with an Indicator value of -1.90 and strong negative coefficients for both recycling (-1.06) and renewable energy (-0.63). These findings suggest that Bulgaria's unemployment rate is converging towards the EU27 average, and this convergence is significantly enhanced by the green transition efforts. The R-squared values (0.61 for recycling and 0.50 for renewable energy) indicate that a substantial portion of the variability in unemployment rate differences can be explained by these green transition variables.

The p-values for Delta convergence (0.007 and 0.022) further underscore the statistical significance of these results, confirming that the improvements in recycling and renewable energy usage are closely linked to the reduction in the unemployment rate gap between Bulgaria and the EU27.

Figure 2 illustrates the analysis of convergence types—Beta, Gamma, Sigma, and Delta—between Bulgaria and the EU27 concerning GDP per capita, along with the effects of recycling and renewable energy rates.

Figure 2: Convergence Analysis for GDP per Capita with Recycling and Renewable Energy Effects



Source: Eurostat and own calculations.

The analysis revealed a positive slope (Indicator) of 1.18 with an R-squared value of 0.61, suggesting that there is no Beta convergence in GDP per capita between Bulgaria and the EU27. The lack of a significant catch-up effect is further confirmed by the model p-value (0.16), which does not support the hypothesis of convergence.

Regarding the influence of Bulgaria's green transition, neither the Recycling Boost nor the Renewable Boost showed a significant impact. The coefficients for recycling (0.09) and renewable energy (0.34) were positive but not statistically significant, indicating that these environmental factors did not contribute to accelerating Bulgaria's GDP per capita growth relative to the EU27.

The analysis indicated a strong positive Gamma convergence with an Indicator value of 0.97.This suggests that Bulgaria's rank in GDP per capita is increasingly aligning with the EU27.

The green transition variables demonstrated a significant positive effect on Gamma convergence. Both the recycling (0.78) and renewable energy (0.72) coefficients were positive and significant, suggesting that improvements in these areas are associated with Bulgaria's enhanced alignment in GDP per capita rankings with the EU27. This indicates that Bulgaria's green policies are contributing to its economic standing relative to other EU27 countries.

The analysis showed positive but modest results for Sigma convergence, with an R-squared value of 0.28 for recycling and 0.16 for renewable energy, and corresponding p-values of 0.11 and 0.25. The relatively high Sigma values (98.99) suggest that while there is some reduction in dispersion, the variability remains significant.

Interestingly, the coefficients for recycling (393.68) and renewable energy (136.26) were positive, indicating that higher rates of recycling and renewable energy usage did not reduce the variability in GDP per capita between Bulgaria and the EU27. This suggests that while Bulgaria is improving its environmental performance, these efforts have not yet translated into a more uniform economic performance relative to the EU27.

The analysis indicated strong Delta convergence, with an Indicator value of -21,280 and significant negative coefficients for both recycling (-274.51) and renewable energy (-213.85). The R-squared values were 0.26 and 0.36, respectively, with the model p-values suggesting a trend towards significance (0.13 and 0.065).

These results suggest that Bulgaria's GDP per capita is converging towards the EU27 average, and this convergence is partly driven by improvements in recycling and renewable energy usage. However, the statistical significance of these green transition effects is marginal, indicating that while environmental policies may contribute to economic convergence, other factors may also play a critical role.

5 Conclusion

Overall, the findings suggest that while Bulgaria's environmental policies are positively influencing its economic integration with the EU27, particularly in terms of rank alignment (Gamma convergence), more robust economic growth and reduction in variability (Sigma convergence) require broader policy interventions beyond environmental measures. The green transition, through initiatives like recycling and renewable energy, has not played a supporting role in Bulgaria's convergence with the EU27. While these environmental policies have shown some positive effects on Bulgaria's relative standing (Gamma and Delta convergence), they have failed to contribute significantly to overall economic growth (Beta convergence) or to reduce economic variability (Sigma convergence). This indicates that while environmental policies may help Bulgaria improve its position relative to the EU27, they are insufficient to drive comprehensive economic convergence.

In summary, Bulgaria's progress in Gamma and Delta convergence shows that the country is improving its relative economic standing within the EU27, but the lack of Beta and Sigma convergence indicates that deeper structural changes are needed to achieve full economic integration. The green transition efforts, while beneficial in some respects, have not been effective in bridging the broader economic gaps between Bulgaria and the EU27. To achieve more

comprehensive convergence, Bulgaria will need to implement broader economic policies that address growth and stability in conjunction with its environmental goals.
Bulgaria, as a member of the EU, needs to ensure a convergent policy with the EU countries to improve recycling rates and renewable energy usage, and from there to improve the effect of the green transition on real convergence.

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