Analyzing the Threshold Relationship between Public Debt and Economic Growth in New EU Member States from Central and South Eastern Europe

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Abstract

This paper examines the relationship between public debt and economic growth in 11 EU new member states (NMS) from Central and South Eastern Europe during the period 2000 – 2021. We explore the potential non-linear (quadratic) nature of this relationship in the context of these diverse countries with varying economic, institutional, and financial backgrounds. To account for their heterogeneity, we divide them into three more homogeneous sub-groups: South Eastern European, Baltic, and Visegrad countries. The findings suggest the existence of a "U"-inverted relationship, indicating that public debt has a positive effect on growth up to a certain threshold, beyond which a negative effect prevails. The estimated debt-to-GDP tipping point ranges from 58.5% to 73.5% of GDP, depending on the sub-group. These results contribute to a deeper understanding of the implications of high public debt levels in NMS and provide valuable insights for the ongoing discussions on the design of a new EU fiscal rules framework.

Keywords: *public debt, economic growth, EU, debt threshold*

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Introduction

The surge in public debt levels in Europe, especially during and after the Global Financial Crisis (GFC) of 2008 – 2009, has raised concerns about fiscal sustainability and its potential impact on financial markets and economic growth. Excessively high debt levels can lead to increased borrowing costs, resource diversion from productive investment to debt service, and macro-financial instability. Understanding the relationship between public debt and economic growth is crucial for designing effective fiscal policies.

The empirical investigation of the impact of public debt on economic growth was initiated by Sachs (1984), Cohen and Sachs (1986), and Krugman (1988) who advocated that countries with higher debt levels face difficulties in taking additional or new loans and therefore need to increase taxes to finance their debt obligations. In turn, the increased taxes will hurt investments, and accumulation of capital and thus will deteriorate the economic growth of the country. The deterioration of financial performance due to an increase in public debt of the country is known as public debt overhang theory (Reinhart and Rogoff, 2012) In the coming decades, many authors addressed the issue of the optimal debt level and its macroeconomic implications, whether by introducing theoretical models or conducting empirical analysis. Among the first group of economists, Aiyagari and McGrattan (1998) developed a model for the US economy. They concluded that governments should maintain an optimal public debt level of about two-thirds of the gross domestic product. Their finding was later confirmed, among others, by Flodén (2001), Desbonnet and Weitzenblum (2012).

On the other hand, Rohrs and Winter (2016) and Chatterjee, Gibson and Rioja (2017) argued that more beneficial government behavior is to accumulate funds instead of generating public debt. The second group of economists has come to the general conclusion that the debt-to-growth relationship is non-linear, as debt has a positive impact on economic growth until a certain threshold, and after that begins to decrease the economic growth. In line with this, Reinhart and Rogoff (2010) found that across both developed countries and emerging markets, a high debt level (90 percent and above) is associated with notably lower growth rates. Similar results were found by Afonso and Jalles (2011), Cecchetti, Mohanty and Zampolli, (2011), and Baum, Checherita-Westphal and Rother (2012).

While the impact of public debt on economic growth has been extensively studied in peripheral euro area countries, less attention has been given to the new EU member states (NMS). Our study aims to fill this gap and empirically examine the effects of public debt on growth performance in 11 NMS, including Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, and Slovenia. These countries exhibited high economic growth

and relatively low indebtedness before the GFC, but the crisis led to growth deceleration and increased public debt levels despite fiscal consolidation efforts. This downturn notably affected labor-intensive sectors such as construction, manufacturing, and retail services, albeit some countries, like the Czech Republic, initially retained surplus staff on payrolls until the severity of the crisis became apparent (Petkovski et al., 2018).

All of the mentioned countries in 2023 had significantly lower public debt than the European average of 88.6% of GDP. Specifically, in the last quarter of 2023, according to Eurostat data, Bulgaria had a public debt of 22.6%, Czechia 44.2%, Estonia 18.5%, Croatia 67.8%, Latvia 41.8%, Lithuania 38.1%, Hungary 74.1%, Poland 49.2%, Romania 47.2%, Slovenia 72.5%, and Slovakia 57.7%.

To account for differences in economic and financial development, as well as cultural and geographical factors, we split the NMS into three more homogenous groups: South Eastern European countries (SEE-4), Baltic countries (BAL-3), and Visegrad countries (VIS-4).

Our study contributes to the academic literature by expanding the geographical coverage and enriching the empirical literature on NMS from Central, Eastern, and South Eastern Europe. While several studies have examined similar topics, our research introduces new insights by providing comprehensive regional comparisons and by incorporating a more recent dataset that reflects the latest economic developments. In particular, our study differentiates itself by focusing on the heterogeneity within NMS countries, analyzing subsamples based on economic, historical, and cultural contexts. This nuanced approach allows us to uncover region-specific dynamics that are often overlooked in broader studies. Furthermore, the study enhances methodological rigor by applying advanced econometric techniques tailored to the specificities of these regions, including more robust controls for endogeneity and the use of dynamic panel data models. Our findings offer valuable input for designing effective public debt management policies and fostering inter-generational solidarity, which are increasingly relevant in light of the new EU fiscal rules' architecture. Additionally, the study critically evaluates and addresses the limitations of previous research, ensuring that our contribution is distinct and relevant to ongoing policy debates. By filling the identified gaps and providing a clearer understanding of the debt-growth relationship in NMS, our work lays the groundwork for more targeted and effective policy interventions in these countries.

The structure of the paper is as follows: Section 1 reviews relevant studies on the public debt-growth nexus, and Section 2 introduces model specification and data sources. Section 3, explains our empirical strategy, while in Section 4 we

present and interpret the estimation results. Finally, in Section 5 we conclude the study and discuss policy implications.

1. Literature Review

The empirical literature on the relationship between public debt and economic growth in the new EU member states (NMS) yields inconclusive results, with sensitivity to the country grouping, period, and methodology employed.

The estimation of debt thresholds has evolved significantly over the years, driven by the increasing complexity of econometric models and the availability of more sophisticated estimation techniques. Early studies focused on simple linear models, often using cross-country regressions to identify a threshold for public debt beyond which economic growth is negatively impacted. For instance, Reinhart and Rogoff (2010) used a threshold of 90% debt-to-GDP, arguing that countries with higher debt ratios experience slower growth. However, this approach, while influential, faced criticism for its oversimplification and inability to capture the dynamics of debt-growth relationships in a nuanced manner.

As the literature advanced, more sophisticated panel data methods were introduced to account for heterogeneity across countries. The Generalized Method of Moments (GMM) became a popular technique due to its ability to address endogeneity and the use of instrumental variables. Arellano and Bond (1991) pioneered the system GMM approach, which allows for dynamic models of panel data, enabling a more accurate estimation of the relationship between public debt and economic growth by controlling for country-specific effects and temporal dependencies. System GMM proved particularly valuable when examining the causal relationship between public debt and economic growth, as it offers a robust framework for dealing with potential biases in dynamic panel data models (Dumitrescu and Hurlin, 2012).

However, more recent advancements have introduced newer techniques that aim to further refine the estimation of debt thresholds and address the limitations of system GMM. These methods include Threshold GMM (e.g., Jain et al., 2021) and Panel Smooth Transition Regression (PSTR) models, which allow for non-linear effects of public debt on economic growth, a feature that system GMM cannot capture adequately. Jain et al. (2021), for example, use threshold GMM to estimate the point at which public debt negatively impacts growth in developing countries, showing that the effect is more pronounced at higher debt levels. This non-linear approach is more consistent with economic theory, which suggests that debt may have a different impact at varying levels depending on a country's initial conditions.

Another technique gaining traction is the Dynamic Panel Smooth Transition Regression (DPSTR) model, which combines the flexibility of smooth transitions with the robustness of dynamic panel data models. Pesaran (2007) argues that this technique is particularly advantageous for estimating relationships where the effect of an independent variable, such as public debt, varies across different regimes, which is often the case with economic growth.

While system GMM remains a standard tool in empirical research due to its simplicity and robustness in handling endogeneity, newer techniques like threshold GMM and PSTR offer more flexible and theoretically grounded approaches. These newer models can accommodate the varying effects of public debt on growth across different countries or time periods, providing a more comprehensive understanding of the debt-growth nexus.

Noteworthy recent panel data studies shed light on this complex nexus:

Panizza and Presbitero (2014) find a negative association between public debt and growth in a sample of OECD countries. However, once endogeneity issues are addressed, the causal effect of public debt on GDP growth becomes less evident.

Checherita-Westphal and Rother (2012) analyze 12 European countries and identify a non-linear relationship between debt and economic growth. They suggest that when debt exceeds approximately 90 – 100% of GDP, it negatively affects long-term growth.

Misztal (2010) employs a VAR methodology and Granger causality test on EU member states from 2000 to 2010. A 1% increase in public debt relative to GDP led to a 0.3 percentage point reduction in GDP growth, and vice versa.

Časni et al. (2014) investigate Central, Eastern, and Southeastern European countries between 2000 and 2011. They find statistically significant negative effects of public debt on growth rates in both the short and long term. They recommend policies promoting exports, investments, and fiscal consolidation to boost economic growth.

Mencinger, Aristovnik and Verbic (2014) analyze a panel dataset of 25 EU member states and find a statistically significant non-linear impact of public debt on GDP growth. The threshold value for NMS is lower than for the 'old' member states.

Bilan (2015) investigates a panel of 33 European countries from 1990 to 2011. Their results reveal a debt threshold of 45 – 55% of GDP, lower in less developed countries.

Gál and Babos (2014) compare public debt effects on growth in Western European countries and NMS from 2000 to 2013. They emphasize that high levels of public debt are more harmful to NMS, necessitating effective debt management.

Globan and Matošec (2016) used quarterly data from 13 NMS between 2000 and 2015. Their analysis indicates that balancing government budgets decelerates debt growth, but GDP growth parameters have a more substantial effect.

Simeonovski et al. (2022) studied 16 Central and Southeast European countries from 2009 – 2018. They identify a concave growth function concerning government debt, and the debt threshold ranges from 69.4 to 74.1% of GDP when considering fiscal balances.

The paper of Heimberger, (2023) analyzes the impact of higher public debt levels on economic growth by providing the first comprehensive quantitative synthesis of the existing literature. It applies meta-regression methods to a novel dataset consisting of 816 estimates from 47 different primary studies. The findings indicate that the unweighted mean of the results reported in the literature suggests a negative association between higher public debt-to-GDP ratios and real GDP growth. Specifically, a 10-percentage point increase in the debt-to-GDP ratio is associated with a 0.14 percentage point decline in annual economic growth rates, with a 95% confidence interval ranging from 0.09 to 0.19 percentage points. However, this relationship is unlikely to represent a causal effect of public debt on real GDP growth, as the literature shows fewer instances of zero or positive growth effects from higher public debt than expected according to econometric theory. This suggests substantial publication selectivity in favor of negative growth effects. After correcting for this bias, the paper finds no evidence to reject a zero average effect. Furthermore, the meta-regression results demonstrate that addressing endogeneity between public debt and growth is crucial, as it leads to fewer adverse estimates.

Despite these studies, several gaps remain in the literature on the debt-growth nexus in NMS. Many existing studies are repetitive, often differing only in the periods analyzed or the estimation methods employed, which limits their ability to offer fresh insights. A significant portion of the research has centered around identifying debt thresholds, but there has been considerably less focus on understanding the complex transmission mechanisms through which debt impacts growth. Moreover, the issue of endogeneity, particularly reverse causality and omitted variable bias, has not been sufficiently addressed in previous analyses, leading to potential inaccuracies in the findings. Additionally, while some studies have explored the relationship between debt and growth, they often overlook the heterogeneity among NMS countries, treating them as a homogeneous group despite their diverse economic and historical backgrounds. This lack of differentiation undermines the applicability of their conclusions across the region. Furthermore, the existing literature frequently fails to incorporate the latest data and economic developments, resulting in analyses that may no longer reflect the current realities of these economies. These gaps highlight the need for a more nuanced and methodologically robust approach, which our study seeks to provide by offering a comprehensive and updated examination of the debt-growth relationship in NMS.

2. Model and Data

2.1. Model

The empirical literature investigating the impact of public debt on economic growth is voluminous and rapidly increasing (e.g., Nguyen et al., 2003; Woo and Kumar, 2010; Checherita and Rother, 2012; Pescatori et al., 2014; Dinca and Dinca, 2015). In line with precursor studies, as a dependent variable, we use the annual growth rate of real GDP per capita (*GR*). As control determinants, we use public debt total (% of GDP) (PD), trade openness (% of GDP) (*TRADE*), gross fixed capital formation expressed in percent of GDP (*GFCF)*, the annual rate of inflation (*INF*), and population growth (*PG*). The data is obtained from the World Development Indicators (WDI) database. Table 1 presents the descriptive statistics for all the variables used in the regressions.

T a b l e 1
Descriptive Statistics

Statistics	***GR***	***PD***	***GFCF***	***INF***	***TRADE***	***PG***
Mean	3.6	39.5	4.3	3.6	118.8	–0.399
Median	4.1	38.1	3.9	2.5	122.2	–0.268
Maximum	14.7	89.0	51.0	45.7	190.4	0.904
Minimum	–14.3	3.7	–38.9	–1.5	48.5	–3.848
Standard deviation	4.3	21.2	11.3	4.6	33.2	0.647
Number of observations	242	242	242	242	242	242

Source: Authors' calculations.

The annual growth rate of real GDP per capita shows remarkable differences among the 11 NMS, ranging from –14.3% to 14.7%. To better understand the complex relationship between public debt and real GDP growth, we divided the sample into three more homogeneous groups. The Baltic countries exhibited the highest average GDP growth at 4.89%, followed by the Visegrad Group countries at 3.50%, while the average growth was the lowest in South Eastern Europe at 3.32%.

There are also stark variations in the level of public debt across the NMS, with Estonia having the lowest at 3.7% of GDP and Croatia the highest at 86.6% of GDP. Analyzing across groups, we find that South Eastern European countries have the highest average public debt level at 48.3% of GDP, followed by the Visegrad Group at 40.83% of GDP, and the Baltic countries with the lowest average public debt of only 21.03% of GDP.

Trade openness is a crucial explanatory variable in the context of economic growth. It has been widely studied as a major determinant of growth performance (e.g., Sachs and Warner, 1997). According to Edwards (1998) and Romer (1993),

trade plays a significant role in influencing economic growth through various channels. These include technology transfer, exploiting comparative advantage, knowledge diffusion, increasing scale economies, and exposure to competition. Romer (1993) also emphasized that countries with open trade policies have a higher probability of implementing leading technologies from other nations. Additionally, trade promotes efficient resource allocation through comparative advantage, facilitates the dissemination of knowledge and technological progress, and encourages competition both domestically and internationally. Given these insights, we anticipate a positive effect of trade openness on economic growth.

The relationship between population growth and economic output has been extensively studied (Heady and Hodge, 2009). Many analysts suggest that economic growth in high-income countries is likely to be relatively slow in the coming years, partly due to the anticipated slowdown in population growth in these regions (Baker, Delong and Krugman, 2005). Some argue that population growth could be problematic, as an increasing population consumes more of the earth's finite resources, potentially limiting long-term growth prospects (Linden, 2017). This aligns with the "pessimistic" view proposed by Bloom et al. (2016), which suggests that population growth may restrict economic development.

Conversely, advocates of population growth view it as beneficial to economic progress and development. They argue that demographic expansion can enhance human capital through increased specialization and large-scale production, leading to technological improvements that contribute to economic progress (Barro, 1991; 2001; Klasen and Nestmann, 2006; Kuznets, 1973; Sibe et al., 2016; Alemu, 2020).

A third perspective, held by revisionists or neutralists, presents a more moderate stance on the impact of population growth on economic development. Neutralists contend that there is little evidence linking demographic expansion to economic growth (Gallup et al., 1998; Bloom et al., 2003). However, recent empirical studies on the subject have largely supported the positions of pessimists or optimists, leaving the neutralist viewpoint mostly unsubstantiated (Hamza, 2015).

Gross domestic investment is another determinant that is likely to exhibit a positive impact on economic growth. Capital accumulation, as defined by Ugochukwu and Chinyere (2013), involves amassing or stocking assets of value, leading to increased wealth creation. The addition to the capital stock enhances production capacity, thereby increasing national income. In macroeconomics, consumption and fixed investment are crucial indicators that encourage aggregate expenditure. Consequently, increased aggregate expenditure contributes to fueling economic growth. In this study, we will adopt the measure of gross fixed capital formation (expressed as a percentage of GDP) to represent investments, following the approach taken by Bilan (2015).

By considering these determinants in the analysis, we aim to gain a comprehensive understanding of their respective impacts on economic growth and to identify potential factors that can facilitate or hinder growth in the NMS from Central and South Eastern Europe.

The annual rate of inflation, measured by consumer prices' annual rate of change, is an important variable to consider in our analysis as it reflects the contribution of monetary policy to creating a growth-conducive environment. Numerous studies have explored the significant effects of inflation and reforms on economic growth in transition countries (e.g., De Melo et al., 1996).

Inflation can have both positive and negative impacts on economic growth, depending on its level and stability. Moderate and stable inflation rates are generally considered beneficial for economic growth, as they provide price stability and predictability for businesses and consumers, encouraging investment and spending. On the other hand, high or volatile inflation rates can distort economic decisions, erode purchasing power, and create uncertainty, which may hinder economic growth.

Transition countries, which experienced significant economic and institutional changes during their transition from planned economies to market-based systems, are particularly sensitive to inflationary pressures. The effectiveness of monetary policy in controlling inflation is crucial for creating a stable and conducive environment for economic growth in these countries.

Additionally, initial conditions at the beginning of the transition process can also play a role in determining later economic development. However, in this study, we have decided to exclude initial conditions as a control variable due to their negative correlation with economic growth. By focusing on other macroeconomic variables and structural reforms, we aim to isolate their impacts on economic growth and gain deeper insights into the relationship between inflation and economic performance in the NMS from Central and South Eastern Europe.

The interaction between public debt and economic growth is intricate, with the issue of reverse causality playing a significant role. Higher rates of economic growth can ease the burden of public debt. However, private sector defaults and discretionary fiscal policy can adversely affect economic activity and lead to an increase in public debt. Public debt can have both positive and negative impacts on economic growth. In less developed countries, public debt is used as a necessary tool to finance essential expenditures, and effective utilization of resources can boost economic growth. However, if public debt is mismanaged, it can hinder economic growth and become a burden for the economy. The relationship between public debt and economic growth needs to be carefully analyzed to understand its implications and potential policy measures.

2.2. Data

Our study utilizes a dataset comprising 11 New Member States (NMS) from Central and South Eastern Europe. These countries include Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia. The data covers the period from 2000 to 2021, allowing us to analyze the economic dynamics over more than two decades.

Although these countries share a socialist past, they are not a homogeneous group. On the contrary, they exhibit significant disparities in key variables such as public debt levels, GDP per capita growth, and institutional quality. To address this heterogeneity and ensure a more focused analysis, we divide them into three relatively more homogenous subgroups:

1. South Eastern European countries (SEE-4): This group includes Bulgaria, Croatia, Romania, and Slovenia.
2. Baltic countries (BAL-3): Lithuania, Latvia, and Estonia form the Baltic group.
3. Visegrad countries (VIS-4): Hungary, Slovakia, the Czech Republic, and Poland constitute the Visegrad Group.

By categorizing the NMS into these subgroups, we can gain deeper insights into the specific economic dynamics and trends within each subset. This approach allows for a more targeted analysis and facilitates the identification of potential differences and similarities in the impact of government debt on economic growth among these distinct groups of countries.

3. Empirical Strategy

3.1. Selection of the Estimation Technique

To assess the impact of public debt and other variables on GDP per capita growth in 11 NMS from Central, Eastern, and Southeastern Europe, we employ panel data analysis. Panel data, as noted by Maddala (2003) and Hsiao (2014), offers advantages such as testing assumptions in cross-sectional analysis, increasing degrees of freedom, reducing multicollinearity, and enabling more realistic behavioral models. It also reduces estimation bias, leading to precise estimates and accurate predictions.

Our empirical strategy examines the non-linear impact of government debt on GDP growth using a quadratic equation in the debt-to-GDP ratio, following Checherita and Rother (2012). While Pooled OLS is a potential approach, it may suffer from heterogeneity and endogeneity issues, resulting in biased estimates. Therefore, we consider fixed effects (FEM) and random effects (REM) models.

Given our focus on specific countries, the fixed-effects model is more appropriate. We also perform the Hausman test (Hausman, 1978) to determine the preferred model between FEM and REM.

The empirical model specification (1) using fixed effects is as follows: [followed by the specific model specification].

$$y_{i,t} = x_{i,t} + \tau_t + \delta_i + \varepsilon_{i,t} \tag{1}$$

where i and t are the indices of countries and years, respectively; τ_t denotes time effects to capture macroeconomic circumstances; δ_i's are unobserved country fixed effects; $\varepsilon_{i,t}$ are the unobserved idiosyncratic errors, $x_{i,t}$ contains a vector of control variables, and β is the coefficient vector that we are interested in. Thus, we estimate models with a fixed effects estimator, allowing for the correlation between δ_i and $x_{i,t}$.

Given the potential bias introduced by the correlation between the lagged endogenous variable and the residuals in fixed effects panel estimation, we acknowledge that the use of OLS, FEM, and REM may not be suitable in this case. As a result, we are inclined to adopt a dynamic panel estimation approach to address this issue.

The dynamic panel estimation model (2) can be expressed as follows:

$$y_{i,t} = \sum_{j=1}^{p} \alpha_j y_{i,t-j} + x_{i,t-j}\beta + \tau_t + \delta_i + \varepsilon_{i,t} \tag{2}$$

In this study, we employ the differenced Generalized Method of Moments (GMM) to address endogeneity and account for the persistence of the dependent variable while removing fixed effects and their correlations. We use the one-step GMM estimator developed by Arellano and Bond (1991), as it produces less bias and smaller standard deviations compared to the two-step estimator, according to Judson and Owen (1999).

The differenced model handles the correlation between the lagged dependent variable $\Delta y_{i,t-j}$ and the differenced errors, $\Delta\varepsilon_{i,t}$, which can lead to biased estimates when using standard fixed effects estimators (Nickell, 1981). To mitigate this issue, we apply the system-GMM estimator as proposed by Arellano and Bover (1995) and Blundell and Bond (1998).

To ensure valid instrument selection and avoid the issue of too many instruments relative to cross-sectional units, we follow Roodman's (2009) recommendation to limit the number of instruments by focusing on the second lag. The Hansen test is used to verify the validity of the instruments, and we check for first-order [AR1] and second-order [AR2] serial correlations in the differenced residuals. As noted by Arellano and Bond (1991), first-order autocorrelation in differenced residuals does not imply inconsistency, but second-order autocorrelation would indicate inconsistency.

By utilizing the differenced GMM approach, we aim to achieve robust and reliable estimates of the impact of public debt and other variables on GDP per capita growth in the 11 NMS from Central, Eastern, and South Eastern Europe.

The instrumental variable (IV) dynamic panel regression specification that we use to control for endogeneity and assess the impact of public debt on real GDP growth is as follows:

$$gr_{i,t} = \alpha_i + \beta gr_{i,t-1} + \gamma_1 CGD_{i,t} + \gamma_2 CGD_{i,t}^2 + \delta X_{i,t} + \eta_i + \varepsilon_{i,t} \tag{3}$$

where $gr_{i,t}$ is the growth of real GDP per capita, $CGD_{i,t}$ stands for the government debt as a share of GDP (note that subscripts i and t denote the country and time). By introducing the quadratic term CGD^2 in the model, we allow for a non-linear relationship between government debt and economic growth. The coefficients β_1 and β_2 will indicate the direction and magnitude of the impact of government debt and its squared term on economic growth, respectively. We expect β_1 to be positive and β_2 to be negative based on our theoretical assumptions of a concave functional form.

To address potential endogeneity concerns, we treat contemporaneous public debt as an endogenous variable in the model. This approach helps mitigate reverse causality issues that might arise between public debt and economic growth, providing more robust estimates of the debt-growth relationship.

Our main objective is to identify a potential threshold value for the debt-to-GDP ratio beyond which government debt starts to have negative effects on economic growth. We draw on existing empirical literature suggesting this critical threshold might lie within the range of 40 – 70% of GDP for the New Member States (NMS) (e.g., Mencinger, Aristovnik and Verbic, 2014). Our analysis will apply and test these hypotheses across all NMS subgroups to gain a comprehensive understanding of the short-term effects of public debt on economic activity in each subgroup. By exploring potential differences in the debt-growth relationship among these subgroups, we can derive valuable insights for policy-making and economic management.

3.2. Testing for Cross-Sectional Dependence

In our analysis, before testing for causality in a panel framework, we first check for possible cross-sectional dependence across countries. Ignoring cross-sectional dependence can lead to biased results, as shocks may not be purely idiosyncratic but may also have common effects across countries. To address this concern and ensure the robustness of our analysis, we conduct three tests to examine cross-sectional dependence (CD).

Breusch-Pagan LM Test: This test, proposed by Breusch and Pagan (1980), assesses the presence of cross-sectional dependence in the panel data. It tests the null hypothesis that there is no cross-sectional dependence in the residuals. A rejection of the null hypothesis indicates the existence of cross-sectional dependence.

Pesaran's Cross-Sectional Dependence Test: Pesaran (2004; 2021) developed a test specifically designed for large-dimensional panel data. This test examines the null hypothesis of no cross-sectional dependence across countries. A rejection of the null hypothesis suggests the presence of cross-sectional dependence.

Bias-Adjusted LM Test: To further account for potential cross-sectional dependence, we use the bias-adjusted LM test proposed by Pesaran, Ullah and Yamagata (2008). This test adjusts for the presence of cross-sectional dependence to obtain more accurate results.

By conducting these three tests, we aim to determine whether there is significant cross-sectional dependence in our panel data. If we find evidence of cross-sectional dependence, we can take appropriate steps to address it in our analysis to ensure the validity of our results. Accounting for cross-sectional dependence is crucial, as it allows us to better understand the relationships between variables and avoid potential biases that might arise from overlooking common effects shared among countries. Once we have addressed cross-sectional dependence, we can proceed with testing for causality in the panel data to examine the potential relationships between government debt and economic growth in the New Member States.

3.3. Testing for Non-Stationarity

In the next stage of our research, we will apply panel unit root tests to assess the stationarity of the variables in our panel data. Specifically, we will utilize the panel unit root test proposed by Im, Pesaran and Shin (2003) as well as the Fischer-type ADF test and the PP test as suggested by Maddala and Wu (1999).

The panel unit root tests allow for deterministic and dynamic effects that may differ across the countries included in the panel. By considering these effects, we can account for potential heterogeneity in the data, which is essential for obtaining accurate and reliable results. Baltagi (2021) highlights several advantages of the Fisher test compared to the IPS test: (1) it accommodates both finite and infinite cross-sectional dimensions, (2) each group in the panel can have non-stochastic and stochastic components, and (3) the time-series dimension can vary for each cross-section. Additionally, the Fisher test does not require a balanced panel and allows for different lag lengths in the individual ADF regressions.

Given these advantages, we prefer to use the Fisher-type test in our study. However, to ensure robustness, we will also report the results of the IPS tests as an additional check.

By conducting panel unit root tests, we will be able to determine the stationarity of the variables, which is crucial for valid panel data analysis. This step will provide essential insights into the long-run relationships between government debt and economic growth in the New Member States.

To examine the causality between variables, we will employ the panel causality test proposed by Dumitrescu and Hurlin (2012). This test is an advanced version of the Granger causality test and is suitable for heterogeneous panels with or without cross-sectional dependence, making it applicable in scenarios where T > N or N > T.

The test utilizes two distinct Homogeneous Non-Causality (HNC) distributions - asymptotic and semi-asymptotic. The asymptotic HNC distribution is employed when the time dimension (T) is greater than the cross-sectional dimension (N), while the semi-asymptotic HNC distribution is used when N > T.

Under this panel data model, we will calculate three separate statistics to assess causality between the variables in our study. By conducting the panel causality test, we can gain valuable insights into the direction and strength of causal relationships between government debt and economic growth in the New Member States. This analysis will help us determine if there is a significant causal link between these variables and contribute to a deeper understanding of the economic dynamics in the region.

$$y_{i,t} = \sum_{k=1}^{K} Y_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t}$$

where K indicates the lag length, $Y_i^{(k)}$ is the autoregressive coefficient and $\beta_i^{(k)}$ is the regression coefficient. It is assumed that the two parameters are constant over time, but they may vary concerning units. The null hypothesis assumes that there is no Granger causality from x_i to y_i in all cross-sectional units, while the alternative hypothesis assumes that Granger causality from x_i to y_i exists in at least one cross-sectional unit.

4. Empirical Results

4.1. Cross-Sectional Dependence, Stationarity and Panel Causality Results

The cross-sectional dependence test results, as shown in Table 2, indicate that p-values for all models are less than 0.01, leading to the rejection of the null hypothesis at a 1% significance level. This suggests significant cross-sectional dependence among the variables, meaning that economic factors and public debt in one country can influence or be influenced by those in other countries. Such interdependence underscores the importance of considering these relationships in econometric modeling to avoid biased results.

T a b l e 2
Cross-Sectional Dependence Results

Cross-sectional dependence test	NMS-11	SEE-4	BAL-3	VIS-4
Breusch-Pagan LM	295.0882***	50.94039	6.914056**	25.19033***
Pesaran scaled LM	22.89151***	12.97317	1.597906	5.539772***
Pesaran CD	14.87420***	6.239401	2.591934***	4.644523***
Slope Homogeneity Tests				
$\tilde{\Delta}$	2.109***	3.158***	5.917***	4.349***
$\tilde{\Delta}_{adj}$	2.555***	4.537***	6.254***	4.891***

Notes: The symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively.
Source: Authors' calculations.

The presence of cross-sectional dependence implies that shocks in one country may affect others through trade, financial linkages, and spillover effects. This has critical implications for policymakers, highlighting the need for coordinated efforts to stabilize regional economies. Slope homogeneity tests ($\tilde{\Delta}$ and $\tilde{\Delta}$_adj) also reject the null hypothesis at all significance levels, confirming country-specific heterogeneity. This means that economic relationships are not uniformly transmitted across countries, supporting the use of panel causality approaches.

Panel unit root tests reveal that all variables exhibit unit root behavior, becoming stationary only after differencing once (I(1)). This finding is crucial as non-stationary time series can lead to spurious regression results. Ensuring stationarity at first differences provides a stable basis for further analysis.[1]

The panel Granger-causality test results (Table 3), using Dumitrescu and Hurlin's (2012) approach, suggest significant heterogeneity: for some countries, such as the Czech Republic, Latvia, Lithuania, Poland, and Slovakia, public debt significantly Granger-causes economic growth, while for others, including Bulgaria and Estonia, the relationship is not statistically significant. This suggests that while public debt influences economic growth at the panel level, the relationship may not hold uniformly across all countries.

T a b l e 3
Dumitrescu-Hurlin Panel Granger-Causality Test Results

Direction	NMS-11	SEE-4	BAL-3	VIS-4
PD→GDPPCG	5.3854***	5.3935***	8.4095***	3.1092***
GDPPCG→PD	1.1321	1.3595	0.7298	1.2066

Notes: The symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively.
Source: Authors' calculations.

Country-specific Wald statistics, summarized in Table 4 show consistent results across tests, reinforcing the reliability of the findings. The study identifies

[1] The results of panel unit tests are given in the Appendix.

bidirectional causality between public debt and economic growth in the Czech Republic, while in Latvia, Lithuania, Poland, and Slovakia, public debt causes economic growth. In contrast, no significant relationship was found in Bulgaria, Croatia, Estonia, Hungary, Romania, and Slovenia.

T a b l e 4
Panel Granger-Causality Results across Countries

Countries	**Direction**			
	PD→GDPPCG		GDPPCG→PD	
	W-stat.	Prob.	W-stat.	Prob.
Bulgaria	0.332	0.571	0.855	0.367
Croatia	3.104	0.095	0.627	0.439
Czech Republic	13.817	0.002	4.772	0.042
Estonia	1.397	0.253	0.166	0.688
Hungary	2.185	0.157	2.504	0.131
Latvia	10.804	0.004	2.444	0.135
Lithuania	5.818	0.027	0.376	0.547
Poland	9.661	0.006	0.262	0.615
Romania	0.784	0.388	1.034	0.322
Slovakia	9.506	0.006	2.949	0.103
Slovenia	2.029	0.171	0.057	0.814

Source: Authors' calculations.

These findings suggest that the impact of public debt on economic growth varies by country, and a one-size-fits-all policy approach may not be effective. Instead, tailored strategies should consider the specific economic conditions of each country.

4.2. Group Effect Using System General Method of Moments (S-GMM)

This section provides the estimation results based on different specifications and their interpretation (Table 5). Since our preferred specification is the system GMM estimation, we interpret only these results.

The study's findings demonstrate a high level of consistency in the results obtained across different empirical specifications, as the coefficients on variables maintain their economic and statistical significance. The Hausman test supports the use of static fixed effects estimation over random effects, indicating the relevance of certain characteristics being modeled as fixed effects.

Furthermore, the Hansen test confirms the validity of the chosen instruments, ensuring the reliability of the estimations. The estimator used in the study is efficient and consistent, provided that the residuals do not exhibit second-order autocorrelation. The rejection of second-order autocorrelation (AR(2) errors) validates the assumption that the estimator remains reliable.

Table 5
Empirical Results

Regions / Variables	South Eastern Europe (SEE-4)		Baltic group (BAL-3)		Visegrad group (VIS-4)		Total (11 NMS)	
	FEM	**S-GMM**	**FEM**	**S-GMM**	**FEM**	**S-GMM**	**FEM**	**S-GMM**
GR(t-1)		0.393**		0.329***		0.152**		0.125***
		(0.089)		(0.052)		(0.047)		(0.093)
PD	0.234**	0.189***	0.389**	0.142**	0.136	0.147	0.492**	0.273***
	(0.073)	(0.133)	(0.216)	(0.079)	(0.109)	(0.101)	(0.047)	(0.127)
PD^2	–0.002***	–0.0015***	–0.003	–0.001*	–0.001*	–0.001**	–0.004*	–0.003**
	(0.0008)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.0005)	(0.0011)
PG	–2.484***	–2.583***	–0.223	–1.546	–2.769***	–4.063***	–1.174***	–2.111***
	(0.491)	(0.256)	(0.888)	(0.644)	(1.243)	(1.872)	(0.398)	(0.301)
TRADE	0.045**	0.046**	0.035**	0.004	0.034*	0.023**	0.010	0.018***
	(0.021)	(0.009)	(0.032)	(0.006)	(0.016)	(0.010)	(0.011)	(0.012)
GFCF	0.208***	0.185***	0.300***	0.310	0.208***	0.260***	0.262***	0.248***
	(0.026)	(0.048)	(0.028)	(0.025)	(0.030)	(0.042)	(0.015)	(0.026)
INF	0.044	0.100	–0.181	–0.089***	–0.004	0.033	–0.007	0.112
	(0.054)	(0.025)	(0.154)	(0.136)	(0.105)	(0.063)	(0.043)	(0.068)
C	–3.284***	0.832	4.314***	2.641	6.228***	6.837	3.297 ***	–3.598
	(2.949)	(2.615)	(3.563)	(1.332)	(2.943)	(2.300)	(1.507)	(3.542)
Turning point	58.5%	63%	64.8%	71%	68%	73.5%	61.5%	62.16%
AR(1) test		0.080		0.091		0.090		0.007
AR(2) test		0.273		0.376		0.288		0.390
Hansen test (p-value)		0.542		0.497		0.270		0.136
Hausman test (p-value)	0.007		0.050		0.002		0.033	

Note: *, **and *** indicates test statistic is significant at the 10%, 5% and 1% level. Standard errors in ().

Source: Authors' calculations.

The central research question of this study examines the nature of the relationship between public debt and GDP per capita growth among the 11 New Member States (NMS) of the European Union. Specifically, it investigates whether this relationship is linear or non-linear.

The study reveals a highly statistically significant non-linear relationship between the government debt ratio and per-capita GDP growth for the 11 NMS. This finding indicates that the impact of public debt on economic growth is not constant but varies with different levels of debt. The results suggest a quadratic relationship, where the coefficients associated with public debt are positive up to a certain threshold. This implies that increasing public debt can positively affect economic growth within this range. However, beyond this threshold, further increases in the debt-to-GDP ratio hurt economic growth, as shown by the negative coefficients for the squared term of debt (Checherita and Rother, 2012). This supports the hypothesis of a concave relationship between public debt and economic growth.

Moreover, the study finds a significant positive effect of lagged GDP per capita on current growth rates, highlighting the persistence or inertia in economic growth. This suggests that past growth trends significantly influence current economic performance, reinforcing the notion of growth persistence observed by Mencinger, Aristovnik and Verbic (2014) and Fetai et al. (2020). Such persistence emphasizes the need to account for historical economic performance when analyzing current growth dynamics.

The evidence of a non-linear relationship between public debt and GDP growth aligns with theoretical perspectives that moderate levels of debt can support economic growth, while excessive debt levels may be detrimental. The turning point identified in the study, where the impact of debt shifts from positive to negative, provides critical insights into the optimal level of public debt that maximizes economic growth without leading to adverse effects. This finding corroborates the results of Checherita and Rother (2012) and supports the notion that there exists a threshold beyond which public debt becomes harmful to economic growth.

Overall, the study effectively addresses the research question by demonstrating that the relationship between public debt and economic growth is non-linear. It confirms that while moderate levels of public debt can enhance economic growth, high levels can have detrimental effects. The persistence of growth observed in the study further underscores the importance of considering historical economic performance when analyzing current growth trends.

The study estimates that the turning point, where the impact of public debt shifts from positive to negative, lies between 58.5% and 73.5% on average for different sub-samples of countries. On average for the 11 NMS of the EU, this turning point is found to be approximately 62.16%. Therefore, when the debt-to-

GDP ratio is below this level, it positively affects economic growth, but going above this threshold leads to negative consequences for economic performance. The turning point for all 11 NMS of the EU being smaller (approximately 62.16%) compared to the turning points for individual groups of countries can be explained by the way the S-GMM (System Generalized Method of Moments) model accounts for heterogeneity across different groups of countries.

Heterogeneity Across Groups: The NMS consists of countries with varying economic structures, levels of financial development, and fiscal policies. When these countries are analyzed as a whole, the S-GMM model seeks to find an average relationship that fits all countries, potentially smoothing out the more extreme or divergent characteristics found in individual groups. As a result, the turning point reflects a compromise that accounts for the diversity within the entire sample.

Aggregation Effect: When analyzing all 11 countries together, the aggregate relationship between public debt and economic growth might be less pronounced than within more homogenous sub-groups. For example, the SEE, Baltic, and Visegrad countries each have distinct economic and fiscal characteristics, which might lead to higher or lower debt thresholds individually. When combined, these thresholds are averaged out, leading to a lower overall turning point.

Smoothing of Outliers: In the combined sample of 11 countries, extreme cases or outliers within individual groups that might cause a higher turning point could be diluted when pooled with other countries. This can result in a lower turning point when considering the entire sample compared to specific groups.

Differential Sensitivity to Debt: Each sub-group might have a different sensitivity to debt based on their specific economic conditions. The S-GMM model, when applied to the entire sample, captures a broader, more generalized sensitivity, leading to a lower average turning point.

In summary, the smaller turning point for the entire 11 NMS group compared to the individual groups reflects the S-GMM model's balancing act between the diverse economic contexts of the countries within the full sample.

These findings are consistent with Keynesian theory, which suggests that a moderate level of public debt can stimulate economic growth, but excessive levels of debt can have detrimental effects on the economy. Such negative effects can manifest as tax increases, reduced private investment, and increased consumption spending.

The study's investigation into debt and economic growth in the NMS suggests that higher debt levels are detrimental to economic growth. Additionally, targeting a higher debt-to-GDP ratio as a policy measure to stimulate economic growth is not advisable, as it may lead to undesirable consequences like tax hikes, reduced private investment, and increased consumption.

Moreover, the results indicate that some countries within the NMS group may already be experiencing a negative impact on GDP growth due to their current debt levels. In particular, countries like Slovenia, Croatia, and Hungary have public debt levels as a percentage of GDP that exceed the identified threshold, suggesting a potentially adverse impact on their economic growth.

In contrast, other European transition countries, such as Estonia, Lithuania, Latvia, Czech Republic, Poland, Bulgaria, Romania, and Slovakia, have debt-to-GDP ratios below the identified threshold, implying a more favorable situation for their economic growth.

These findings align with similar studies conducted by Mencinger, Aristovnik and Verbic (2014) and Fetai et al. (2020), which reported debt thresholds for the NMS between 40% and 70% of GDP. Additionally, the results are consistent with studies that identified different debt thresholds for other regions, such as 81.6% of GDP for Central Europe Fetai et al. (2020), 71.9% of GDP for Eastern Europe Bilan (2015), and 58.2% of GDP for countries in the Western Balkans Fetai et al. (2020).

The study's findings suggest notable variations between sub-groups of countries concerning the critical threshold of public debt beyond which its impact on economic growth becomes negative. Specifically, in the Southeastern European (SEE) countries, which are generally less developed compared to the Visegrad and Baltic countries, the identified threshold is lower. This observation aligns with the outcomes of other empirical studies that also demonstrate that less developed NMS experience more rapid negative effects from high levels of public debt compared to their more developed counterparts. Bilan (2015) explores a group of Central and Eastern European countries and attributes the significant difference to lower credibility, increased vulnerability to shocks, and a higher dependency on external capital transfers in less developed nations.

Furthermore, the magnitude of public debt dynamics and the historical debt situation of a country, together with the structure and composition of its public debt, can influence the identified threshold. These factors can vary among different countries and may contribute to variations in the critical debt level at which adverse effects on economic growth emerge. Panizza and Presbitero (2014) discuss how the particular relationship and value of the debt threshold may depend on factors such as institutional quality, the size of the public sector, and the purposes for which public debt has been accumulated.

Various sources, including Bilan (2015) and Panizza and Presbitero (2014), support the evidence that the impact of public debt on economic growth varies between sub-groups of countries, with less developed NMS being more susceptible to negative effects at lower debt levels compared to their more developed counterparts. These findings highlight the importance of considering country-specific

characteristics and institutional factors when analyzing the relationship between public debt and economic growth.

The study's results, supported by sources such as Checherita and Rother (2012) and Woo and Kumar (2010), reveal that trade has a positive impact on GDP growth. The coefficients associated with trade variables were found to be significant in all groups of countries, with values ranging from 0.023 to 0.046. These findings are consistent with previous research by Bilan (2015), who reported values of trade between 0.017 and 0.138 for 28 EU countries and 5 EU candidates, and by Fetai et al. (2020), who found values ranging from –0.020 to 0.700 for 20 Central, Eastern, and Western South Eastern European countries. Similarly, Checherita and Rother (2012) reported values between 0.030 and 0.197 for 12 European countries.

The positive impact of trade on GDP growth can be attributed to its role in facilitating the transfer of advanced technologies from leading countries to emerging economies. As Edwards (1998) proposed, this technology transfer can enable emerging economies to grow faster than developed economies, as it may be more cost-effective to import new technologies rather than develop them domestically. Trade also helps allocate resources efficiently, especially when openness leads to increased trade, foreign direct investment (FDI), and other foreign capital inflows, which are generally beneficial for economic growth.

Encouraging regional trading agreements can further stimulate the free movement of goods and services among member countries. In the case of NMS from Eastern Europe, their open trade policy facilitated access to advanced technologies from Western EU countries, contributing to their economic growth. More developed NMS capitalized on this by allocating resources toward high-technology manufactured exports, allowing them to target Western EU markets and expand their market shares in high-income countries.

Foreign capital inflows, particularly FDI, played a significant role in upgrading the production facilities of NMS's manufacturing industries, fostering product innovation, and the production of high-value-added industrial exports. Importing advanced capital goods contributed to the production of high-quality manufactured goods and sustained their high economic growth. However, to maintain long-term economic growth, NMS needs to develop technology leadership and allocate more resources to research and innovation in high-technology export industries.

Market access to high-income consumer markets in Western EU countries is crucial for NMS's long-term economic growth. Strengthening market positions in these markets through product innovation and export specialization can be advantageous. For example, countries like the Czech Republic, Poland, Hungary, and Slovenia should concentrate on exporting manufactured goods with comparative advantages to enhance their economic growth.

Trade plays a pivotal role in promoting economic growth for emerging economies like NMS. Encouraging trade, foreign capital inflows, and strategic investments in research and innovation are vital for sustaining economic development and competitiveness in the global market. The sources cited in the study provide valuable evidence to support these findings.

The study finds that population growth is statistically significant in all models, with negative coefficients observed in the range of –1.2 to –4.0 for 12 European countries, as also reported in the studies of Checherita and Rother (2012). Rapid population growth can bring economic opportunities due to a swelling workforce, but it also poses risks, such as difficulties in absorbing new job market entrants and potential threats to social stability. On the other hand, population aging is expected to strain public finances, create labor shortages, and lead to significant shifts in consumption patterns. Governments play a critical role in managing these demographic fluctuations and their impacts on the economy. Historical data shows that population growth has generally been on a downward trend, partly due to programs of developed countries aimed at underdeveloped regions, especially in terms of youth education. To address population growth, it is recommended that NMS invest in empowerment programs for women, advancing their political, economic, and social status, as it can have a positive effect on reducing fertility rates.

Regarding inflation, the study finds that it is statistically significant only in the case of Baltic countries, with a negative sign. A 1% change in inflation is associated with a 0.89% decline in the growth rate in these countries. The relationship between inflation and economic growth is complex and not entirely conclusive. According to economic theory, mild or moderate inflation rates, such as those below 6%, can be conducive to economic growth as they can finance economic activity. However, high inflation rates can lead to distortions in the economy. The study's findings show that inflation does not have a clear and significant impact on economic growth in the selected countries. Some countries have experienced moderate inflation rates, while others have had double-digit inflation, leading to mixed effects on growth performance.

Empirical results also indicate a significant relationship between Gross Fixed Capital Formation (GFCFG) and economic growth in all models. This finding is consistent with previous studies by Mencinger, Aristovnik and Verbic (2014) and Bilan (2015), which reported positive effects of capital formation on economic growth. GFCFG refers to gross capital formation as a share of GDP, representing expenditures on additions to fixed assets and changes in inventory levels. High domestic investment, especially in countries with high institutional quality, can boost economic growth. Since EU accession, NMS has improved its investment environments for foreign investors, and lower labor costs have reduced total

production costs, leading to increased production activities and economic growth. Therefore, the capital formation variable has a positive impact on economic growth in NMS. Furthermore, to check the robustness of the results, we split the overall period (2000 – 2021) into two distinct periods: 2000 – 2009 and 2010 – 2021.

T a b l e 6
Empirical Results

Regions / **Variables**	**Total (11 NMS) 2000 – 2009**	**Total (11 NMS) 2010 – 2021**
	S-GMM	**S-GMM**
GR(t-1)	0.689***	0.408*
	(0.289)	(0.223)
PD	0.251***	0.427***
	(0.421)	(0.121)
PD^2	–0.002***	–0.004***
	(0.006)	(0.001)
PG	–0.189	–0.743***
	(0.222)	(0.267)
TRADE	0.011	0.030
	(0.012)	(0.020)
GFCF	0.236***	0.293***
	(0.026)	(0.027)
INF	–0.063	–0.006
	(0.159)	(0.020)
C	–4.327***	–10.73***
	(1.389)	(2.938)
Turning point	62.75%	53.37%
AR(1) test	0.066	0.096
AR(2) test	0.227	0.560
Hansen test (p-value)	0.327	0.343

Notes: The symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively.
Source: Authors' calculations.

When comparing the robustness results across the two periods (2000 – 2009 and 2010 – 2021) with the results for the entire period (2000 – 2021), several key observations emerge:

The coefficient for lagged GDP growth (GR(t-1)) in the analysis for the entire period (0.125) is positive and significant, but notably lower compared to the coefficients in the split periods (0.689 for 2000 – 2009 and 0.408 for 2010 – 2021). This suggests that the persistence of growth is weaker when considering the full period, potentially due to varying economic conditions or shocks that occurred across the two decades.

For public debt (PD) and its squared term (PD^2), the public debt coefficient for the full period (0.273) remains positive and significant, consistent with the split-period results. However, the coefficient for the squared term is slightly less negative (–0.003) compared to the split periods (–0.002 and –0.004). The turning point for public debt is 62.16% for the entire period, which is close to the turning

points identified in the split periods (62.75% for 2000 – 2009 and 53.37% for 2010 – 2021). This indicates that while the overall relationship between public debt and growth is nonlinear, the threshold at which debt begins to hurt growth is relatively consistent.

The coefficient for population growth (PG) is significantly negative for the full period (–2.111), which is more pronounced compared to the split periods (–0.189 and –0.743). This stronger negative impact over the entire period suggests that population growth had a consistently adverse effect on economic growth when considering the long-term horizon.

Trade openness (TRADE) shows a positive and significant effect on growth (0.018) for the entire period, which contrasts with the insignificant coefficients in the split periods. This implies that when considering the full period, trade openness played a more crucial role in fostering economic growth.

The impact of gross fixed capital formation (GFCF) on growth is positive and significant across all periods. However, the coefficient for the entire period (0.248) is slightly lower than in the split periods (0.236 and 0.293), suggesting that the effect of investment on growth may have varied across the two decades.

The effect of inflation (INF) on growth is positive but not significant in the full-period analysis (0.112), which aligns with the split-period results where the coefficients were also insignificant.

The constant term for the full period (–3.598) is less negative compared to the split periods (–4.327 and –10.73), reflecting a more stable baseline economic condition when considering the entire period.

The AR(1) and AR(2) test results, along with Hansen test p-values for the full period, confirm the robustness and validity of the instruments used, similar to the split-period analyses.

Overall, the comparison suggests that while the effects of public debt and capital formation are consistent across periods, the impact of lagged GDP growth, population growth, and trade openness shows some variation when considering the entire period versus the split periods. This highlights the importance of considering both short-term and long-term dynamics in understanding the determinants of economic growth in the NMS region.

Conclusion

Public debt sustainability is a crucial concept in today's economic landscape, applicable to both developed and transition countries. Although a high level of public debt does not necessarily hinder economic performance, some developed nations have achieved substantial growth despite their debt burden.

However, recent global financial crises have raised concerns about the significant and continuously growing debt levels in some transition economies, which may negatively impact economic growth.

The main objective of this study is to empirically investigate the relationship between public debt and economic growth in 11 New Member States (NMS) for the period 2000 to 2021. The study confirms the existence of a "U inverted" relationship between public debt and economic growth, with a maximum debt threshold of about 73.5% of GDP for the entire group. To conduct a comprehensive analysis, the NMS were divided into three more homogeneous groups: South Eastern European countries (SEE-4), Baltic countries (BAL-3), and Visegrad countries (VIS-4). Using a system GMM estimation technique, the study found that increasing debt levels hurt economic growth in both the short and long run in all specifications (except for the short run in the case of Baltic countries). Furthermore, the negative impact is more pronounced in the less developed South Eastern European countries compared to the other two subgroups, which can be attributed to lower credibility, higher vulnerability to shocks, and greater dependence on external capital transfers.

The study also found that trade and investments positively affect economic growth, while inflation has a negative impact, especially in Baltic states. Population growth was found to have a statistically significant negative effect in all models.

This research is motivated by the importance of the topic and the lessons learned during and after the crisis for macroeconomic policy. After the crisis, most NMS implemented restrictive fiscal policies, including restructuring the public sector and reducing social benefits, to control budget deficits. However, rising debt levels and other challenges such as the emigration crisis, rising inequality, and unstable labor markets pose serious difficulties for the NMS economies in the future.

The scientific contribution of this study is twofold. Firstly, only a few empirical studies have addressed the debt-to-GDP ratio threshold and its impact on economic growth in NMS of the EU. Secondly, the study reveals that different threshold values of the debt-to-GDP ratio exist among NMS, indicating that more developed economies may have higher thresholds than less developed transition economies. This is the first study to examine and assess the threshold value of the debt-to-GDP ratio across different NMS.

The study provides useful information for NMS governments about the critical level of public debt, beyond which the positive effects on economic growth turn negative. Policymakers are warned that targeting a higher debt level to support growth is not a viable option, and measures should be taken to stabilize and reduce public debt in the medium and long term.

However, the research has some limitations, including the short time series, lack of robustness tests, and not considering outliers in the data. Future research should address these limitations and explore the indirect channels through which public debt affects economic growth, such as interest rates, private investment, public investment, etc. Alternative econometric techniques may also be employed for further analysis, such as 2OLS, panel VAR, Panel ARDL model, or other estimation methods.

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Appendix

Table 1
Panel Unit Root Tests (South Eastern European countries)

Im, Pesaran and Shin W-stat			ADF-Fisher Chi square		PP-Fisher Chi square		Order of integration
Determinants	*At the level*	*First differentiation*	*At the level*	*First differentiation*			
Growth	0.153	–1.788***	7.53	14.99***	10.15	31.42***	I(1)
PD	–0.235	–3.943***	11.16	19.52***	10.73	17.73***	I(1)
PG	0.254	–4.153***	10.43	32.44***	11.41	23.39***	I(1)
TRADE	0.641	–4.968***	4.283	38.21***	3.823	58.28***	I(1)
GFCFGROWTH	0.328	–2.619***	5.437	20.67***	4.379	20.29***	I(1)
INF	0.143	–3.103***	6.283	24.69***	7.245	51.30***	I(1)

Note: *, **and***indicates test statistic is significant at the 10%, 5% and 1% level.

Source: Author's calculations.

Table 2
Panel Unit Root Tests (Baltic countries)

Im, Pesaran and Shin W-stat			ADF-Fisher Chi square		PP-Fisher Chi square		Order of integration
Determinants	*At the level*	*First differentiation*	*At the level*	*First differentiation*	*At the level*	*First differentiation*	
GDPPCGROW	1.458	–3.508***	7.814	23.18***	3.482	15.35***	I(1)
PD	1.224	–2.687***	1.978	17.82***	1.209	26.05***	I(1)
PG	–1.687	–3.817***	10.14	25.74***	10.73	39.84***	I(1)
TRADE	0.070	–3.155***	4.115	20.83***	4.237	28.36***	I(1)
GFCFGROWTH	1.459	–4.839***	2.435	32.48***	1.891	18.11***	I(1)
INF	0.159	–2.037***	3.453	13.81***	4.749	15.17***	I(1)

Note: *, ** and *** indicates test statistic is significant at the 10%, 5% and 1% level.

Source: Author's calculations.

Table 3
Panel Unit Root Tests (Višegrad countries)

Im, Pesaran and Shin W-stat			**ADF-Fisher Chi square**		**PP-Fisher Chi square**		**Order of integration**
Determinants	*At the level*	*First differentiation*	*At the level*	*First differentiation*	*At the level*	*First differentiation*	
GDPPCGROW	–0.243	–2.665***	9.597	20.93***	7.459	37.48***	I(1)
PD	–0.385	–2.087***	8.384	17.22***	8.214	39.42***	I(1)
PG	–0.351	–2.913***	9.438	22.95***	10.45	68.49***	I(1)
TRADE	0.554	–5.146***	4.665	39.72***	5.116	49.56***	I(1)
GFCFGROWTH	1.259	–4.754***	14.27	36.68***	11.27	49.75***	I(1)
INF	0.149	2.935***	7.453	22.50***	9.814	31.70***	I(1)

Note: *, **and***indicates test statistic is significant at the 10%, 5% and 1% level.

Source: Author's calculations.

Table 4
Panel Unit Root Tests (new 11 EU member countries)

Im, Pesaran and Shin W-stat			**ADF-Fisher Chi square**		**PP-Fisher Chi square**		**Order of integration**
Determinants	*At the level*	*First differentiation*	*At the level*	*First differentiation*	*At the level*	*First differentiation*	
Growth	0.158	–4.517***	21.57	59.11***	22.43	84.25***	I(1)
PD	0.264	–3.209***	9.491	44.69***	21.52	83.20***	I(1)
PG	0.359	–5.143***	35.51	67.95***	29.39	100.2***	I(1)
TRADE	0.757	–7.747***	13.06	98.84***	13.17	136.4***	I(1)
GFCFGROWTH	0.148	–6.162***	29.41	89.84***	27.34	89.84***	I(1)
INF	0.438	–4.705***	17.28	61.01***	14.28	98.16***	I(1)

Note: *, ** and *** indicates test statistic is significant at the 10%, 5% and 1% level.

Source: Author's calculations.