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# The Relationship Between Increased Debt Ratio and Economic Growth in the European Union: The Granger Causality Approach<sup>1</sup>

A megnövekedett adósságráta és a gazdasági növekedés kapcsolata az Európai Unióban:  
A Granger-féle oksági vizsgálat

*Increased government debt rates in recent years can be easily financed in the current global economic environment characterised by liquidity abundance. Nevertheless, the debt ratios represent a potential threat under the surface, which could lead to significant macroeconomic problems in the future. The purpose of the paper is to contribute to the debate in the empirical studies between public debt and economic growth, as well as external debt and economic growth. During the analyses, the relationship between variables was examined using the panel Granger causality test with the Dumitrescu–Hurlin test in the Member States of the European Union. The main findings of the study are that there is a unidirectional causal effect between public debt and economic growth, that is, only debt impacts on the economic growth. In case of external debt and economic growth there is also a unidirectional effect, but it is in the reverse direction. In addition, the pre-crisis and post-crisis period was also examined, on the basis of which it can be concluded that before the crisis, the nature of the relationship was bidirectional between public debt and economic growth, whereas after the crisis the debt had an impact on the economy growth, and the reverse effect does not exist.*

**Jel codes:** H63, C12, O40

**Keywords:** public debt, external debt, economic growth, Granger causality, European Union

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*Az elmúlt években megnövekedett államadóssági szinteket a likviditásbőséggel jellemzett világgazdasági környezetben könnyen lehet finanszírozni. Mindazonáltal a felszín alatt az adósságráták potenciális veszélyt jelentenek, ami a jövőben jelentős makrogazdasági problémákhoz vezethet. A tanulmány célja, hogy hozzájáruljon az államadósság és a gazdasági növekedés, valamint a külső adósság és a gazdasági növekedés között zajló empirikus tanulmányok vitáihoz. Az elemzések során a változók közötti kapcsolatpanel Granger oksági teszttel, hozzá kapcsolódóan Dumitrescu–Hurlin-teszttel került vizsgálatra az Európai Unió tagállamaiban. A tanulmány fő megállapítása, hogy az államadósság és a gazdasági növekedés között egyirányú oksági hatás mutatható ki, azaz csak az adósság gazdasági növekedésre gyakorolt hatása érvényesül. A külső adósság és a gazdasági növekedés esetében szintén egyirányú hatás áll fenn, de ennek iránya fordított. Ezen túlmutatóan a válság előtti és a válság utáni időszak külön-külön is górcső alá került, melynek eredményei alapján arra tudunk következtetni, hogy a válság előtti időintervallumban az államadósság és a gazdasági növekedés között a kapcsolat jellege kétirányú volt, míg a válságot követően az adósság gyakorolt hatást a gazdasági növekedésre, és a fordított hatás nem állt fenn.*

**JEL-kódok:** H63, C12, O40

**Kulcsszavak:** államadósság, külső adósság, gazdasági növekedés, Granger-okság, Európai Unió

## 1. Introduction

Barely a decade has passed since the financial crisis of 2008 and the sovereign debt crisis of 2010. Nevertheless, despite the declining trends of recent years, the increased debt ratios as a result of the crisis and crisis management are both systematic and country-specific problems in developed and developing economies. However, these sources of danger are obscured by the abundance of liquidity in the world economy, which is caused by non-conventional measures and zero bound interest rates. In addition, there are currently many factors in the world economy that can directly or indirectly affect economic growth. (In recent years, these included the negative effects of protectionist trade policy measures, the closely related China–U.S. customs war, the introduction of geopolitical punishment measures, or the structural problems of individual economies.) The turbulent effects may make more difficult the normalisation of monetary policy and generate additional expansionary actions instead of restrictive monetary policy measures. The latter processes may induce a further increase in liquidity in the global economy, which may further facilitate the financing and sustainability of sovereign debt. Nonetheless, as a result of imbalances under the surface, increased debt ratios can be considered a potential source of danger.

As consequences of the development of the sovereign debt crisis, a number of empirical analyses have been carried out to examine the negative effects of high government debt ratios. However, there is no consensus on the assessment of the role of public debt in theoretical contexts, and a distinction should be made between the Keynesian



(positive role), neoclassical (negative role) and Ricardian equivalence theory (neutral role) approaches. Empirical examination paid particular attention to the nature, direction and extent of the relationship between debt and economic growth. In addition, many papers have investigated the effect of high public debt growth sacrifices, that is, the increased debt ratio may result in a negative growth impact on a certain level. However, these threshold values are heterogeneous in the studies and there is no consensus on whether the growth sacrifice can be detected in each country/group of countries.

Nonetheless, in the 2000s, examining the evolution of public debt in the world economy, there is clearly an upward trend of indebtedness in both developed and developing countries (Figure 1). Stagnation and relative decline was typical of the evolution of the debt ratio in the advanced economies before the crisis, while in developing countries – due to faster output growth and the resulting growth effect – reduction in the debt ratio was significant.

The gap between the two country groups was relatively small in the debt ratios (the highest value was 36.8 per cent in 2006), but it was still rising in the pre-crisis period. In the aftermath of the crisis, sovereign debt has risen sharply in advanced and developing economies too, which was faster in developed countries. As a result, the debt ratio gap has also increased between the two country groups, which reached a maximum point at 69.5 per cent in 2012. This is almost double the difference in the years before the crisis. However, in recent years, the gap has declined, and in 2018 it was ‘only’ 52 per cent. This decline is due to two factors: 1. the economic slowdown in the developed economies, and the debt-reducing process, which can be traced back to the denominator effect; as well as 2. the continuous, slow growth of the indebtedness of developing economies. Hence, increased government debt ratios can be seen as an increasingly significant potential threat not only for developed economies but also for developing countries.

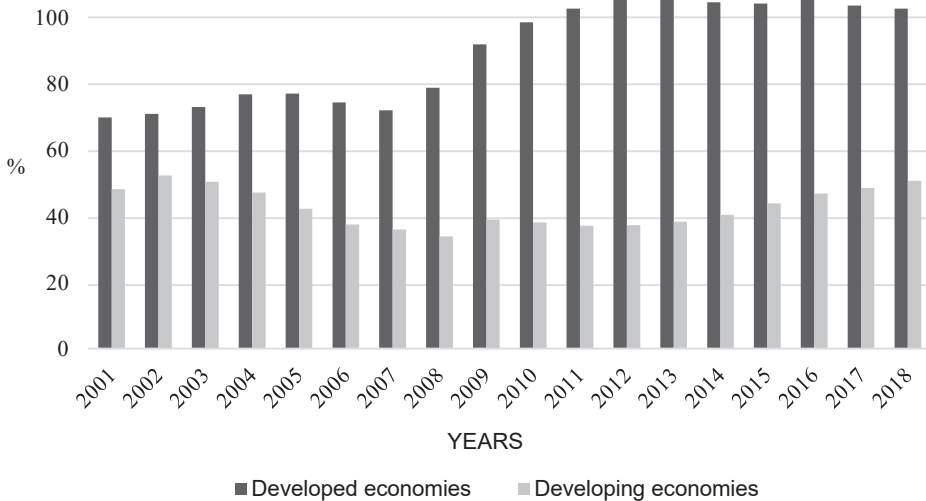


Figure 1  
Government debt developments in the world economy (per cent of GDP)

Source: Compiled by the author based on IMF (2019) data.



In this context, this paper aims to examine the relationship between the increased government debt ratios and the economic growth. Examining the role of public debt is also crucial for the future impact of an aging society. Indeed, aging can cause significant budgetary and growth costs. In this context, the already high level of implicit debt may further increase and put more pressure on public finances and EU Member States. Based on this approach, we cannot ignore other aspects of sovereign debt, such as the role of external debt and its relationship with economic growth. Accordingly, the study examines two major issues in the relationship between public debt and growth, and the nexus between external debt and economic growth. The possible causal relationship between debt and growth will be examined using the panel Granger causality test. The subject of the analyses is the European Union, which is being examined in the time horizon of 1995–2018. On the basis of the results, it can be concluded that there is only a unidirectional relationship between government debt and economic growth, as well as external debt and economic growth. It means that only public debt has a causal effect on economic growth, and there is no reverse relationship, that is, external debt does not have a causal effect on economic growth. Only economic growth impacts on external debt in the examined period and countries.

If we examine the pre-crisis and post-crisis phases, it can be stated that while there is a bidirectional relationship before the crisis, after the crisis there is only a unidirectional nexus, that is, only public debt leads to a causal relationship to economic growth. This connection can be traced back to the fact that the time series of the post-crisis period also includes the turbulent period of the crisis, which includes any other effects, such as crisis management measures (for example privatisation, bank rescue packages), which are not reflected in the primary balance.

The remainder of this paper is organised as follows. Discussion and review of existing theoretical and empirical literature includes an examination of the relationship between public debt and economic growth, as well as external debt and economic growth. In Section 3, the econometric assumptions and methodological issues of the established model and the panel database are presented. Then, main findings and economic policy implications are described in Section 4. Then the paper concludes with a brief summary.

## 2. Literature review and background

In this section, a review of the literature identifies the key relationships and effects between government debt and economic growth, as well as external debt and economic growth.

### 2.1. Public debt and economic growth

Public debt is one of the most important macroeconomic factors that can have a significant impact on the economy in the short and long term. This is due, *inter alia*, to the fact that public debt can exert its effects through a number of different channels. Égert (2012) identified three channels through which the negative effects of public debt on growth



may occur: 1. tax increases necessary for increased debt burdens will reduce private investment through crowding out effect; 2. the increased government debt rates rise the risk of incompliance and thus sovereign yields, too; 3. if the government tries to inflate away public debt it may have a detrimental effect on economic growth. Furthermore, additional channels can be identified. The effect of distorting taxes is emphasised by, for example, Barro (1979), while the role of inflation is highlighted by Sargent and Wallace (1981), Barro (1995), Cochrane (2010), as channels of negative growth effects of public debt. Kumar and Woo (2010) also emphasises the importance of the role of uncertainty in expectations and policies. Besides, a higher value of public debt and a higher deficit in the budget balance may lead to a significant increase in long-term interest rates. In addition, a number of structural factors can be identified that can cause negative growth effects, including for example institutional quality and the quality of domestic and outward policies.<sup>2</sup> However, Bulow and Rogoff (1990) emphasise that increasing public debt may be a phenomenon of economic slowdown, not a result and consequence of it in developing countries.

If we examine the effects of government debt from the perspective of the time horizon, it can be stated that the relationship between economic growth and public debt is dynamic, thus different mechanisms prevail between the two variables in the short and long term. Furthermore, long-term effects are significantly influenced by confidence factors.<sup>3</sup> In addition, it can be stated that a significant part of the previous papers confirm that public debt may have a positive effect in the short term; however, a negative growth effect will also occur in the long term.<sup>4</sup>

There are a number of studies showing that the positive (Keynesian or conventional) effect of public debt exists in the short term, which implies that debt can also have a positive effect on output by stimulating aggregate demand (see for example Elmen-dorf and Mankiw [1999]). Nevertheless, in the long run, the negative impact of public debt accumulation is already taking place.<sup>5</sup> Based on the neoclassical approach, public debt reduces savings and thus the investments through the crowding-out effect and the higher interest rates.<sup>6</sup> In addition, according to the Ricardian Equivalence Theory, public debt has no influence on real variables, also including economic growth.<sup>7</sup> Dombi and Dedák (2018) examined the effects of debt burden in a neoclassical framework, applying the Ramsey–Cass–Koopmans model, the Blanchard model, as well as the Solow model. On the basis of their results, it can be stated that the long-term economic

<sup>2</sup> César Calderón and J Rodrigo Fuentes, 'Government Debt and Economic Growth', *IDB Working Paper Series* no IDB-WP-424, 2013.

<sup>3</sup> Alexander Chudik, Kamiar Mohaddes, M Hashem Pesaran and Mehdi Raissi, 'Rising Public Debt to GDP Can Harm Economic Growth', *Federal Reserve Bank of Dallas, Economic Letter* 13, no 3 (2018), 1–4.

<sup>4</sup> Marta Gómez-Puig and Simón Sosvilla-Rivero, 'Public debt and economic growth: Further evidence for the euro area', *Research Institute of Applied Economics, Working Paper* no 2017/15, 2017.

<sup>5</sup> Robert J Barro, 'Inflation and Economic Growth', *NBER Working Paper* no 5326, 1995.

<sup>6</sup> Franco Modigliani, 'Long-run implications of alternative fiscal policies and the burden of the national debt', *Economic Journal* 71, no 284 (1961), 730–755; Peter A Diamond, 'National Debt in a Neoclassical Growth Model', *American Economic Review* 55, no 5 (1965), 1126–1150.

<sup>7</sup> Robert J Barro, 'Are Government Bonds Net Wealth?', *Journal of Political Economy* 82, no 6 (1974), 1095–1117; Ugo Panizza and Andrea F Presbitero, 'Public Debt and Economic Growth in Advanced Economies: A Survey', *Swiss Society of Economics and Statistics* 149, no 2 (2013), 175–204.



growth-moderating effect of public debt is exerted by crowding out effects, which is lower in the case of the estimation of the Blanchard model than in the case of the Solow model.

Among the empirical analyses, the study of Reinhart and Rogoff (2010) has produced the greatest resonance. It has been shown that at the point where the public debt-to-GDP ratio reaches and exceeds the 90 per cent threshold, the negative growth effect of the increased debt ratios has developed. That is, a non-linear relationship was shown. Nevertheless, their analyses have been severely criticised, including for example the homogeneous nature of the database and the fact that cross-sectional dependencies and feedback effects were not taken into account.<sup>8</sup> Nevertheless, a number of empirical examinations have found a threshold at 90 per cent of the GDP of the debt ratio over which the debt has had negative growth effects prevail. Checherita and Rother (2010) analysed 12 Member States of the euro area between 1970 and 2010, which showed that a 90 per cent threshold would surely lead to a growth sacrifice, but that this effect could already be 70–80 per cent of GDP. Similarly, Kumar and Woo (2010) has manifested the existence of a non-linear relationship above the 90 per cent of GDP ratio, above which adverse effects are already prevalent.

Égert (2012) examined the negative nature of the non-linear relationship between public debt and economic growth. His results have shown that the specified threshold above which a growth sacrifice is affected depends on the time horizon, the country group being examined, the frequency of the data, and the minimum number of observations. Similarly to the previous ones, Swamy (2015) also highlights the relevant role of selecting the examination unit and the time interval in determining the threshold. Eberhardt and Presbitero (2015) identified three factors that can be traced back to the differences in the thresholds of countries/groups of countries: 1. the differences in country production technologies; 2. the sustainability level of government debt in the country, which strongly depends on the institutional framework, completion of the previous debt agreements and macroeconomic performance; 3. as well as the vulnerability of public debt, which is significantly affected by its composition and maturity. Additionally, Dombi and Dedák (2018) emphasises that country-specific thresholds are significantly influenced by citizens' willingness to save and the extent of population growth. Consequently, the aging population could be affected along this mechanism for economic growth and government debt of both, which may result in future turbulences multiplicative effect.

However, based on the analysis by Égert (2012), the thresholds above which the adverse and the non-linear effect can be demonstrated are below the 90 per cent threshold of Reinhart and Rogoff (2010). A number of empirical studies is that set a threshold below the 90 per cent threshold during examinations. Afonso and Alves (2015) found a turning point of 75 per cent of GDP in the sample of 14 European countries between 1970 and 2012. Cecchetti et al. (2011) found that the same point over which government debt already has negative growth effects on government debt and household debt is 85 per cent, while corporate debt is 90 per cent, which was carried out with 18 OECD

<sup>8</sup> Alexander Chudik, Kamiar Mohaddes, M Hashem Pesaran and Mehdi Raissi, 'Is There a Debt-threshold Effect on Output Growth?', *IMF Working Paper* no 15/19, 2015.



member states between 1980 and 2010 interval. Moreover, there are a number of studies that have set a debt threshold above the 90 per cent threshold. The examinations conducted by Baum et al. (2012) with the involvement of 12 euro area Member States between 1990 and 2010 found a turning point at 95 per cent of GDP where the negative impact of public debt prevails. Bilan and Ihnatov (2015) also achieved a similar result, based on a sample of 33 European countries from 1990 to 2011, where 94 per cent of GDP had such a turning point. In contrast, Caner et al. (2010) has turned the threshold of non-linear effects into 100 per cent in case of the developed economies. In the previous study Marton (2019) surveyed and identified the empirical literature results in the context of the thresholds of the government debt and economic growth for European countries, on the basis of which the established thresholds vary between 75 and 114 per cent of GDP.<sup>9</sup>

However, a significant portion of research has found no evidence of a single, existing in each country regarding the threshold. The analysis of Eberhardt and Presbitero (2015), which is performed based on a panel database of 118 countries, did not find a threshold above which a non-linear effect of government debt would prevail in the long run, with negative growth effects. Based on the analyses of existing empirical studies, Panizza and Presbitero (2013) emphasise the determination of the threshold not to be robust, and that the causal effect between the two variables also needs to be further strengthened, that is whether public debt really affects economic growth.

The literature review provides a clear view of the fact that theoretical relationships and empirical studies also consider heterogeneously the relationship between public debt and economic growth. In addition to examining the relationship between these two variables, the role of external debt and indebtedness abroad can be considered a relevant factor.

## *2.2. The relationship between external debt and economic growth*

External debt is an important factor in analysing the sustainability of public debt and the examination of the relationship between public debt and economic growth. There have also been many analyses of the relationship between external debt and economic growth over the past few years, mainly focused on developing countries. This can be traced back to the fact that in these countries, development is often achieved through the involvement of foreign capital, and hence the increase in capital exposure.

However, the perception of the relationship between external debt and economic growth is equally heterogeneous in international literature, as between public debt and economic growth. The literature examines the relationship between the two variables and is limited to two large test units: a debt overhang trend and a liquidity constraint-related research.<sup>10</sup> The most prominent theory linking external debt and economic

<sup>9</sup> Ádám Marton, *A szuverén adósságválság és az adósságproblémák kérdésköre* (Budapest: Nemzeti Közszolgálati Egyetem, Közigazgatási Továbbképzési Intézet, 2019).

<sup>10</sup> Safia Shabbir, 'Does External Debt Affect Economic Growth: Evidence from Developing Countries', *SBP Working Paper Series* no 63, 2013.



growth is Krugman's (1988) theory of 'debt overhang'. In this context, the expected value of repayment of external debt falls short of the value of the debt contract, as a result of which the future debt service will be a burden of issuance, resulting in a 'debt overhang' and a negative relationship between external debt and economic growth.

The empirical studies of the relationship between external debt and economic growth are equally heterogeneous as the thresholds and results of the analysis of public debt and economic growth. Shabbir (2013) examined the long-term relationship between external debt and economic growth on a database covering 70 developing countries between 1976 and 2011. Based on their analysis, it can be stated that economic growth in these countries is significantly supported by foreign direct investment (FDI) and fixed capital formation. Consequently, increasing external debt may lead to a reduction in fiscal space, which may reduce availability of future space and ability to raise capital. These trends may ultimately lead to more moderate economic growth. Butts (2009) examined the short-term economic growth effects of external debt on a database of 27 Latin American and Caribbean countries between 1970 and 2003 using the Granger causality test. The empirical studies have shown that there are bidirectional relationships between the two variables in the examined panel database, and for 13 countries it can be shown that the two variables affect each other both in the short and long run. Similarly to previous research, Zouhaier and Fatma (2014) also showed a negative relationship between external debt and GDP growth and GNI; this analysis is based on a dynamic panel model covering 19 countries over the period 1990–2011. Patillo et al. (2002), with the involvement of 93 developing countries on a time series between 1969 and 1998, showed that external debt has a non-linear effect on economic growth, with an average effect above 35–40 per cent of GDP and 160–170 per cent of exports. Nevertheless, marginal effects may already occur at a low level of external debt. However, in terms of the nature of the relationship, Schclarek (2004) contradicts this finding, that is, he has not found evidence of inverted U-shaped or non-linear relationship. Nonetheless, a negative relationship can be proven by the fact that higher external debt leads to lower economic growth in developing economies.

Regarding the channels of the relationship between external debt and economic growth, Patillo et al. (2004) identified two main channels through which external debt exerts a negative growth effect: physical capital accumulation and total factor productivity. In contrast, Schclarek (2004) did not find a link with the negative impact of increased external debt, which occurs through productivity. Based on his analysis, the influencing factor may be the rate of capital accumulation.

Thus, it is clear that the analysis of external debt and economic growth has not reached a consensus; however, excessive external indebtedness may have a negative impact on output. Based on the literature review and their considerations, in the following empirical analyses the nexus between public debt and economic growth, as well as external debt and economic growth will be examined in the panel database established by the European Union Member States.





### 3. Methodology and quality of data

Based on the review of the results of theoretical and empirical literature, it can be stated that there is no unanimous consensus between the individual results (mainly in terms of thresholds); however, a negative relationship can be assumed between public debt and economic growth, as well as between external debt and economic growth. Nonetheless, it is necessary and indispensable to examine whether the relationship exists in the Member States of the European Union and the nature of the relationship: unidirectional or bidirectional. Determining the direction of the relationship is essential for establishing future research. In order to carry out these analyses, a panel Granger causality test is applied across the European Union countries. Besides, in the empirical analyses the effect of public debt on economic growth has also been identified in the pre-crisis and post-crisis period.

#### 3.1. Data and descriptive statistics

In order to carry out the tests, a panel database was created from the European Union Member States. The availability of data has been a limiting factor, and as a result, the length of the public debt and external debt database is different. Accordingly, two different databases have been developed to examine the two relationships. The database created from the country's annual data covers the time series of public debt and economic growth over the period 1995–2018. In contrast, external debt covers only 13 years between 2005 and 2017. In the latter case, further restrictions had to be introduced. The Granger causality test is extremely sensitive to the lack of observation units. Therefore, countries with missing data could not be included in the variables included in the examination. Accordingly, the established databases contain some restrictions on the countries involved in the analysis. For both databases, Croatia and Luxembourg are not included in the analyses units. The reason for it in case of Luxembourg is the fact that it can result in significant positive bias towards aggregate data due to the small size and significant positive macroeconomic factors of the country. Besides, after joining the EU in 2013, Croatia did not fully transpose and implement the ESA2010 statistical standards and directives. In the database underlying the analysis of the relationship between external debt and economic growth, further narrowing was needed in case of lack of available data. As a consequence Bulgaria, Cyprus, France, Italy and the United Kingdom are not included in the database.<sup>11</sup> Overall, 26 Member States have examined the causal relationship between public debt and economic growth, while 21 countries have been analysed as a nexus between external debt and economic growth. Table 1 represents the summary statistics of the variables involved in the analysis.

<sup>11</sup> External debt data are only available for Bulgaria from 2010, Cyprus since 2008, France for 2008, Italy since 2008, and it is unavailable for the United Kingdom. If these countries were involved in the examinations, it would have resulted in a narrowing of the length of the time series, which would have questioned the meaning of the result. Since it would have mainly involved the unusual and turbulent effects of the crisis and the post-crisis period.



Table 1  
Summary statistics of examined variables

Variable	Observation	Mean	Median	Standard Deviation	Min	Max
public debt	618	58.284	54.2	32.562	3.7	181.1
economic growth (in case of public debt database)	618	2.529	2.5	3.505	-14.6	23.9
external debt	294	-1.236	27.05	111.72	-496.1	137.1
economic growth (in case of external debt database)	294	2.061	2.2	4.026	-14.6	23.9

Source: Compiled by the author.

The source of the data was the Eurostat database. Within the framework of this analysis, public debt means the annual value of the gross consolidated government debt ratio relative to GDP (DEBT).<sup>12</sup> The determination of the external debt represents the annual value of net external debt expressed in GDP (EX\_DEBT). According to the definition of Eurostat, external debt is the sum of actual liabilities over the period and the related future interest payments that non-residents hold in that country.<sup>13</sup> Economic growth was a percentage change in per capita GDP compared to the previous year (GROWTH).

### 3.2. Methodology: The Granger causality test

The main direction of empirical analysis is based on the examination of the causal effect of public debt and economic growth, as well as external debt and economic growth. In this context, the panel Granger causality test is applied. There are relatively few examples of Granger causality test performed on the panel database in literature. The analytical framework and econometrics are based on the approaches of Ferreira (2009) and Erdil and Yetkiner (2008). The traditional Granger causality test can be written for two variables based on Granger (1969) and Ramanathan (2001) as follows:

$$X_t = \sum_{j=1}^m \alpha_j X_{t-j} + \sum_{j=1}^m \beta_j Y_{t-j} + \varepsilon_t \quad (1)$$

$$Y_t = \sum_{j=1}^m \gamma_j X_{t-j} + \sum_{j=1}^m \delta_j Y_{t-j} + \eta_t \quad (2)$$

<sup>12</sup> Analyses were also carried out in such a way that we considered the percentage point change the annual value of the gross consolidated government debt ratio relative to GDP compared to the previous year. This methodological consideration led to the same result as when the debt ratio was applied.

<sup>13</sup> Eurostat, 'Net external debt', 2019.



where  $X_t$  and  $Y_t$  are stationary time series, while  $\varepsilon_t$  and  $\eta_t$  denote white noise. Thus, the model assumes the stationary time series in its basic assumption, so the first examination of the database is the examination of the stationarity of time series. In addition, stationarity is an important factor in the generalisation of the model and the goodness of the forecasts.<sup>14</sup> Besides, the panel Granger causality test also requires the removal of unit roots from the time series.<sup>15</sup> In the framework of this analysis, three tests were used to examine the unit roots in the data series, the Augmented Dickey-Fuller (ADF) test, Im, Pesaran and Shin W-stat test, as well as the Levin, Lin and Chu test. Based on the tests conducted, the GROWTH variable is considered to be stationary, but the DEBT and EX\_DEBT variables are non-stationary, so in their case the first-differenced value was used in the rest of the analysis.

Yusuf (2018) summarises the Granger causality test process so that if the time series is stationary then a VAR model with an OLS estimate should be used. If the time series is used by non-stationary and first-differenced, the cointegration of time series should also be examined. If the time series are cointegrated, then the analysis of Granger causal relationship analysis should be performed in the VEC model framework, if the cointegration does not exist, then the causal relationship analysis should be analysed using the DVAR model.

Considering the above-mentioned methodological considerations, we also applied the cointegration test of the variables. The cointegration test shows whether there is a long-term relationship between the variables. In the cointegration analyses, two tests were used: Pedroni (Engle–Granger) and Johanson cointegration tests. The null hypothesis of both tests is that there is no cointegration between the variables. In all cases, we could not reject the null hypothesis, that is, there is no cointegration between the variables.

In addition, it is important to determine the appropriate lag length during the Granger causality test. The appropriate lag value is determined in the models based on Akaike information criterion (AIC) and Schwarz information criterion (SC). According to the tests carried out, its value was 2 lags in each case based on the recommendation of the two information criteria.

Among the approaches of the Granger causality test, Erdil and Yetkiner (2008) and Ferreira (2009) propose a fixed coefficients approach, which can be traced back to Hurlin and Vernet (2004) and Hurlin (2004). Nevertheless, based on Mohanty and Mishra's (2016) methodological approaches, the Granger causality test using the Dumitrescu–Hurlin test<sup>16</sup> approach has the advantage of heterogeneity in causality. Akbas et al. (2013) emphasises that the Dumitrescu–Hurlin test handles cross-sectional dependencies and can be applied to heterogeneous and balanced panel databases.

<sup>14</sup> Nityasundar Manik, 'Causal Nexus between Public Debt and Economic Growth: The Case of India', *International Affairs and Global Strategy* 46, 2016.

<sup>15</sup> Jan Behringer, Sabine Stephan and Thomas Theobald, 'Macroeconomic factors behind financial instability: Evidence from Granger causality tests', *IMK Working Paper* no 178, 2015.

<sup>16</sup> For a detailed econometric analysis of the Dumitrescu–Hurlin test, see Elena Ivona Dumitrescu and Christophe Hurlin, 'Testing for Granger non-causality in heterogeneous panels', *Economic Modelling* 29, no 4 (2012), 1450–1460.



Based on the results of the above preliminary tests, and taking into account the methodological considerations, the Granger causality model was applied with the Dumitrescu–Hurlin test, which can handle cross-sectional dependencies and is suitable for heterogeneous, balanced panel database. The analyses were carried out for three periods: the whole period, the pre-crisis and the post-crisis period.

## 4. Results

First of all, the results of the tests are presented for the whole period. Based on the results of the tests in the previous section, the Granger causality test for public debt and external debt has been applied for the whole period.

Table 2  
*The result of the Granger causality test in the countries of the European Union during the whole examined period*

Null hypothesis	W-stat	Zbar-stat	Probability
GDP does not homogeneously cause DEBT	3.11195	1.58982	0.1119
DEBT does not homogeneously cause GDP	4.07100	3.43932	0.0006
GDP does not homogeneously cause EX_DEBT	4.33724	1.17934	0.0089
EX_DEBT does not homogeneously cause GDP	5.96638	2.61610	0.2383

*Note:* The whole period includes the period between 1995 and 2018 for public debt and the years 2005–2017 for external debt. We can reject null hypothesis of Granger causality test if probability value is less than 5 per cent that is the independent variable has a causal effect on the dependent variable. If probability value is more than 5 per cent, we cannot reject the null hypothesis, that is, the explanatory variable does not affect the explained variable homogeneously.

*Source:* Compiled by the author.

Based on the results, many conclusions can be drawn. If we examine the relationship between public debt and economic growth, it is clear that causality runs in one direction. Accordingly, a unidirectional causal relationship was found between economic growth and public debt in the years of 1995 and 2018 in the European Union Member States. Since the null hypothesis of the Granger causality test can be rejected if the probability value is less than 5 per cent, it can be stated that the debt causes GDP homogeneously, that is, only public debt influences growth. GDP per capita growth has no causal nexus to debt. There are many interesting conclusions about this relationship. Despite the fact that the average value of the government debt ratio to GDP was 58.28 per cent, which is below the Maastricht threshold of 60 per cent, there is a negative growth effect. In addition, it should be pointed out that the standard deviation is high in the database, as the lowest value was 3.7 per cent (Estonia – 2007), while the highest value was 181.1 per cent (Greece – 2018). The average change in public debt during the period was –0.528 percentage points. In terms of the whole period, it can be clearly stated that there is a growth sacrifice in the EU Member States.



If the external debt is examined, there is a different view. Analysing the results, we can conclude that only the economic growth is supported by the existence of a causal relationship in terms of the nature of the relationship, that is, the relationship is unidirectional. Thus, only economic growth has a homogeneous effect on external debt, and has a decisive role in its development. Based on these analyses, negative relationship cannot be detected in terms of external debt and GDP growth, that is, external debt was not a growth sacrifice in the examined period.

As already highlighted in the analysis of public debt, the standard deviations for both databases are high. It can be traced back to the increase in government debt ratios in several Member States as a result of the 2008 financial crisis, the European sovereign debt crisis in 2010 and the crisis management. However, this can have a significant impact on the analysis for the entire period. Accordingly, it is worth separating the time series from pre-crisis (Model 2) and post-crisis periods (Model 3) in order to gain a more accurate view of the impact of public debt on economic growth.

The preliminary tests of the panel Granger causality test also led to a similar result for the two time series: in both periods, the first differenced value was used for the DEBT variable to ensure the stationarity of the time series. According to the Pedroni (Engle–Granger) and the Johansen cointegration test, there was no cointegration in any case. In addition, lag criteria used 2 lags in the pre-crisis period and 1 lag in the post-crisis period. The number of observations is 300 in Model 2, while in Model 3 it is 286. The results of the Granger causality test for the two periods are included in Table 3.

Table 3

The result of the Granger causality test in the countries of the European Union before and after the crisis

Null hypothesis	W-stat	Zbar-stat	Probability
<b>Before the crisis</b>			
GDP does not homogeneously cause DEBT	9.28827	3.99469	0.0000
DEBT does not homogeneously cause GDP	6.39202	2.05183	0.0402
<b>After the crisis</b>			
GDP does not homogeneously cause DEBT	1.80125	0.45798	0.6470
DEBT does not homogeneously cause GDP	3.29534	2.72934	0.0063

*Note:* The whole period considers the period between 1995–2018 for public debt and the years 2005–2017 for external debt. We can reject null hypothesis of the Granger causality test if the probability value is less than 5 per cent, that is, the independent variable has a causal effect on the dependent variable. If the probability value is more than 5 per cent, we cannot reject the null hypothesis, that is, the explanatory variable does not affect the explained variable homogeneously.

*Source:* Compiled by the author.



The results after the crisis are consistent with the experiences of the database over the entire period.<sup>17</sup> Accordingly, only the increased government debt ratios eventuate a causal link to economic growth, while growth (due to the econometric considerations of lag) does not clearly affect public debt. However, during the pre-crisis period there is a bidirectional causal effect between the two variables. Accordingly, economic growth is already having a significant impact on public debt. This can be explained, among other things, by the fact that the growth in previous periods may indirectly have a positive impact on debt sustainability and debt developments. Financing of public debt may be easier with a country's more favourable economic performance. The results are consistent with the consequences of earlier examination of debt accumulation analysis in Marton (2020) on the basis of which in the pre-crisis there was a significant growth effect, which is moderated after the crisis, and in the post-crisis period analyses the other factors played a greater role.<sup>18</sup> The lack of causality in case of economic growth can be traced back to the economic downturn during the crisis and the recovery period as relevant factors in the database. Nevertheless, based on Marton (2018) previous analyses, the debt reduction following the recovery was already attributable to the denominator effect that is the growth factor. Based on these consequences, it should be emphasised that Granger's causal test results are sensitive to the selected examined period and to outliers.

In addition, analyses for the pre-crisis and post-crisis period were applied on external debt. Nevertheless, in case of external debt, due to the limited availability of data, it is only possible to carry out the analysis for the post-crisis period. The methodology was the same as in the case of the post-crisis period examination of public debt. Based on the results, it can be concluded that the contrary effect was observed after the crisis, as in case of public debt. The causal effect of economic growth prevailed only in respect of external debt. This can be attributed, among other things, to a decrease in the external debt ratio in the examination period (in most countries). In addition, one of the reasons for the decline is that a risk-averse investor environment has developed in world economy, as a result of the crisis and crisis management.

## 5. Concluding remarks

Despite the declining trend in recent years, the increased public debt ratios of advanced and developing economies can be considered a potential source of danger. Notwithstanding the slow debt moderation process in developed economies, the imbalances persist, which may be exacerbated by further risk factors (for example slowdown in global

<sup>17</sup> To ensure the robustness of the results, analyses were performed using lags 1 and 3 for the entire time series, which led to similar results for each period, so the previously identified results can be considered robust.

<sup>18</sup> The database of Model 3, that is, the post-crisis period, includes the effects of the 2010 sovereign debt crisis as well as its delayed effects and the recovery period. Besides, other factors may contain some conventional and non conventional effects that occur during the crisis. These effects are the impact of the primary balance, interest rate effect and other factors (such as inflation, international investment environment and the context of crisis management measures: for example privatisation and applied bank rescue packages).



economic growth, negative budgetary and growth effects of an aging society, decline in liquidity in the global financial system). Research on the relationship between public debt and economic growth focuses on the nature, direction and extent of the nexus. However, there is no consensus on empirical results. According to many studies, the existence of a growth sacrifice is justified only above certain thresholds that are the nature of relationship is non-linear. In line with these findings, this paper aims to contribute to the empirical studies, which examine the relationship between public debt and economic growth. In the empirical analyses, the causal relationship between public debt and economic growth is analysed using a panel Granger causality test with the Dumitrescu–Hurlin test. The examination unit was the European Union, which is divided into three time periods: the whole period (1995–2018 – Model 1), the pre-crisis period (1995–2007 – Model 2), and the post-crisis period (2008–2018 – Model 3). Based on the results, it can be concluded that there is a unidirectional relationship between the two variables over the whole period, that is, only public debt has a causal effect on economic growth and the reverse effect does not exist. This can be attributed, inter alia, to the fact that before the crisis, the growth effect was greater than during the crisis and the recovery period, the influence of these turbulent years (for example, the impact of primary balance, interest rate or other factors) can conceal the growth effects in the database. Accordingly, it can be clearly stated that, despite the different levels of debt, public debt had a causal relationship with economic growth in all the periods under the examination unit. In addition, external debt has also been examined, which is closely related to public debt, and which is particularly important for future imbalances. However, the negative growth impact of external debt was not detected in the examination. As regards the nature of this causal relationship, the existence of a non-linear relationship and the analysis of the threshold will be the focus of the future analysis research directions.

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