Scientific Annals of Economics and Business
67 (3), 2020, 291-310

Public Debt and Economic Growth Nexus in the Euro Area: A Dynamic Panel ARDL Approach

Themba G. Chirwa*, **Nicholas M. Odhiambo****

Abstract

This study investigates the relationship between public debt and economic growth using panel data from 10 European Countries. Using a panel ARDL approach, the results show that public debt, government consumption, and the real exchange rate are negatively associated with economic growth both in the short- and long-run. Furthermore, investment and the real interest rate were found to be positively associated with economic growth both in the short- and long-run. Inflation and trade openness were found to have mixed results: both were negatively associated with economic growth in the long run while in the short run the relationship was positive and consistent across groups with a few exceptions. Second, the study results also showed that debt is nonlinear at the 70% threshold only in the long-run while in the short run the results were consistently negative and across groups. The study results have significant policy implications for the Stability and Growth Pact of the Euro area. It is recommended that member states should ensure fiscal sustainability by balancing their fiscal budgets to effectively reduce the accumulation of public debt as well as implementing structural reforms that will improve the efficiency of investment as well as macroeconomic stability.

Keywords: Euro Area; Panel ARDL Models; Cointegration; Public Debt; Economic Growth.

JEL classification: C23, F34, F43, H63, N14.

1. INTRODUCTION

The relationship between government debt and economic growth has recently become a major concern for policymakers, especially in the industrialized world. Empirical evidence has shown that high debt affects capital inflows if the market perception is negative. Such sudden stops to financing have also been associated with currency crises (e.g. the 1997 Asian crisis), balance of payment crises (e.g. Argentina in the early 2000s and Venezuela in 2014), and more recently, banking crises (e.g. the 2008 financial crisis that affected the USA and Ireland, among others).

* Department of Economics, University of South Africa, South Africa; e-mail: *tchirwa@gmail.com* (corresponding author).
** Department of Economics, University of South Africa, South Africa; e-mail: *odhianm@unisa.ac.za*.

An important aspect in public policy is to ensure that governments are able to promote and not hinder economic growth, and thus fiscal sustainability becomes an important policy area. In the Economic and Monetary Union (EMU) of the European Union (EU), for instance, this is an important area of cooperation between EU member states who have adopted the Excessive Deficit Procedure (EDP) and Stability and Growth Pact (SGP). Under the SGP, all member states are required to implement fiscal budgets that are close to a balanced budget over the medium term. Two important upper limits were set to give member states enough fiscal space to implement structural reforms that could enable them to enhance their growth potential in the medium to long run during bad times. Such stability-oriented fiscal policies state that a member state should strive to achieve a near-balanced budget or surplus and should not exceed a fiscal deficit of more than -3% p.a. or a public debt-to-GDP ratio of more than 60% (European Commission, 1997). If these conditions are violated, such member states will be required to implement structural reforms that would reduce such violations to their normal levels under the preventive arm of the SGP. Such measures that are implemented under the preventive arm of the SGP include the need to achieve fiscal balances that are less than 0.5% of GDP or even register fiscal surpluses, and the need to have expenditure benchmarks to ensure that the adjustment paths of the public debt is maintained (European Commission, 1997).

The most important research question that puzzles public debt economists is whether public debt accumulation at certain levels stimulates economic growth. This brings in a methodological challenge as to which approach is most appropriate to investigate such a phenomenon. Some schools of thought have come up with the nonlinear concept that the relationship between public debt and economic growth follows an inverted U-shape (see Pattillo *et al.*, 2004; Pattillo *et al.*, 2011; Clements *et al.*, 2003; Kumar and Woo, 2010, among others). However, some of these studies have encountered some methodological weaknesses that may have affected their findings. These include the lack of consideration to use appropriate dynamic models that take into account modern time-series properties and the omission-of-variable bias. The key question still remains as to whether debt either hinders or stimulates economic growth both in the short and long run. Of late, the presence of cross-sectional dependency and how it is expected to be dealt with to avoid inferential bias has also taken center stage in the econometric literature (see Bai and Ng, 2004; Chudik *et al.*, 2013, among others).

The aim of the study, therefore, is to investigate the relationship between public debt and economic growth by focusing on 10 European countries in the Euro area during the period 1970-2018. These countries include Portugal, Greece, Spain, Italy, the United Kingdom, France, Belgium, Finland, Germany and Ireland. The contribution of the study to literature is twofold. First, to investigate the relationship between the accumulation of debt and economic growth both in the short and long run, taking into account cross-sectional dependency between countries under one bloc. Second, to investigate at what threshold level debt stimulates or hinders economic growth. The approach adopted in the latter is to investigate the relationship between debt and economic growth conditioned on other variables by focusing on countries that experienced relatively low debt levels of less than 70% during the study period and to see whether a non-linear or inverted U-shape relationship exists between public debt and economic growth either in the short, long run or both. Third, to provide policy recommendations derived from the study on best approaches towards debt management in the study countries.

The approach adopted in this study is to apply a panel Autoregressive Distributed Lag (ARDL)-based error correction method proposed by Pesaran *et al.* (1999) and modified by Chudik *et al.* (2013) that factors in the presence of cross-sectional dependency. The panel

ARDL method has several advantages over the traditional panel data methods that have been studied in the public debt – economic growth nexus (see Pattillo *et al.*, 2004; Pattillo *et al.*, 2011; Clements *et al.*, 2003; Kumar and Woo, 2010). Firstly, growth effects become a short-run phenomenon with a focus on determining whether given any shock, the assumed economic relationship is non-explosive and converges towards its long-run equilibrium path: in addition, the long-run level relationships become the parameters of interest that would guide policymakers on how to formulate long-term economic policies.

Secondly, panel fixed and random effects estimators only allow the intercept to differ across groups while coefficients and error variances of other explanatory variables used are assumed to remain constant (Pesaran *et al.*, 1999). In a panel ARDL framework, all short-run coefficients and error variances differ across cross-sections, thereby signifying the importance that different independent short-run decisions may have on economic variables investigated. This is particularly important for the SGP as it advocates for differentiated Medium-Term Budgetary Objectives to be implemented by EU member states. Furthermore, the estimated long-run coefficients of a panel ARDL are assumed to converge towards a similar equilibrium path which may result from the desired arbitrage condition to be met (Pesaran *et al.*, 1999): for instance, the SGP in the Euro area that targets a debt-to-GDP ratio of not more than 60% of GDP and a budget deficit of not more than 3% can be regarded as one unified policy that the European Commission encourages countries in the Eurozone to adopt in the long run. Finally, the panel ARDL modelling approach has the advantage of correcting for endogeneity in the regressors by imposing a dynamic specification (inclusion of lags) on short-run coefficients that may differ across cross-sections.

The rest of the paper is structured as follows: Section 2 briefly summarises the trends of key macroeconomic factors in the Euro area based on data from the member states included in this study. Section 3 briefly reviews the available empirical literature on the relationship between public debt and economic growth in industrialised countries. Section 4 discusses the panel ARDL-based error correction framework as well as estimation techniques. Section 5 presents an empirical analysis of the regression results. Lastly, Section 6 provides conclusions and policy implications derived from the study.

2. KEY MACROECONOMIC TRENDS IN THE EURO AREA

The economies studied in this paper have experienced buoyant economic growth since the 1970s. In most of these economies real GDP per capita between 1970 and 2018 more than doubled and in some cases quadrupled. According to the World Bank (2019) database, the average per capita income rose from approximately US$18,900 per capita during the 1970-1979 period to an average of US$39,000 per capita during the 2010-2018 period. Figure no. 1 illustrates the calculated percentages between the two years.

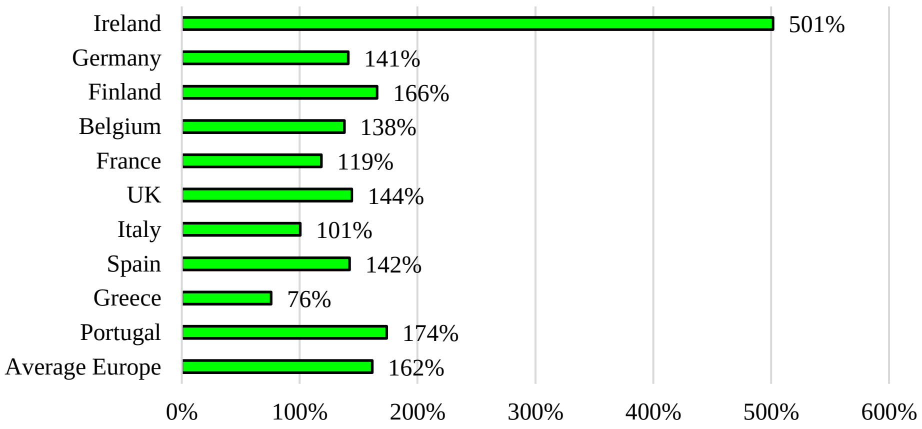

Figure no. 1 – Increase in Real GDP per Capital between 1970 and 2018

As illustrated in Figure no. 1, real GDP per capita more than doubled in Germany, Finland, Belgium, France, the United Kingdom, Italy, Spain, and Portugal while in Ireland it more than quintupled during the reference period. The growth miracle in Ireland has been linked to low corporation taxes and transfers of intellectual property rights that attracted a number of large multinational companies to the country who now contribute to the Irish GDP and not their origin (OECD, 2016). Figure no. 2, on the other hand, illustrates the growth of gross government domestic debt in the study countries. Interestingly, the study countries are perhaps one of the top countries in the world that borrowed extensively from national and international financial institutions. As illustrated in Figure no. 2, the growth rate between the minimum and the maximum debt-to-GDP ratios were significant: the highest being Greece with an estimated growth rate of over 1000% and the lowest being Belgium with an estimated gross government debt differential of 147% (European Union, 2019; Eurostat, 2019).

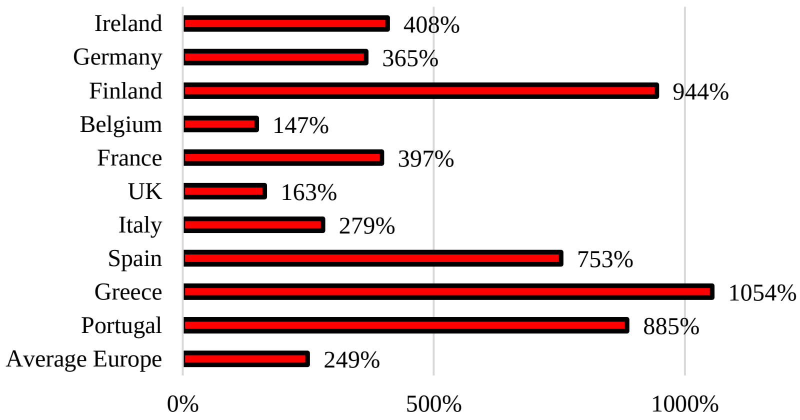

Figure no. 2 – Gross Government Debt Growth Differentials in the Euro Area

Figure no. 3 illustrates trends in gross government debt-to-GDP ratio during the study period, 1970-2018. As illustrated in Figure no. 3, the accumulation of gross government debt increased over time with almost all study countries starting off with a debt-to-GDP ratio that was below the European Union's (EU) SGP threshold of 60%. This threshold is regarded as the cut-off point where the accumulation of debt can stimulate economic growth and any values beyond such a threshold, debt becomes a hindrance towards economic growth (Reinhart and Rogoff, 2010). From Figure no. 3, the statistics show that for countries such as Portugal, Spain, the United Kingdom, France, Finland, and Germany, their debt levels resonated around the cut-off point relatively from 1970 to 2006.

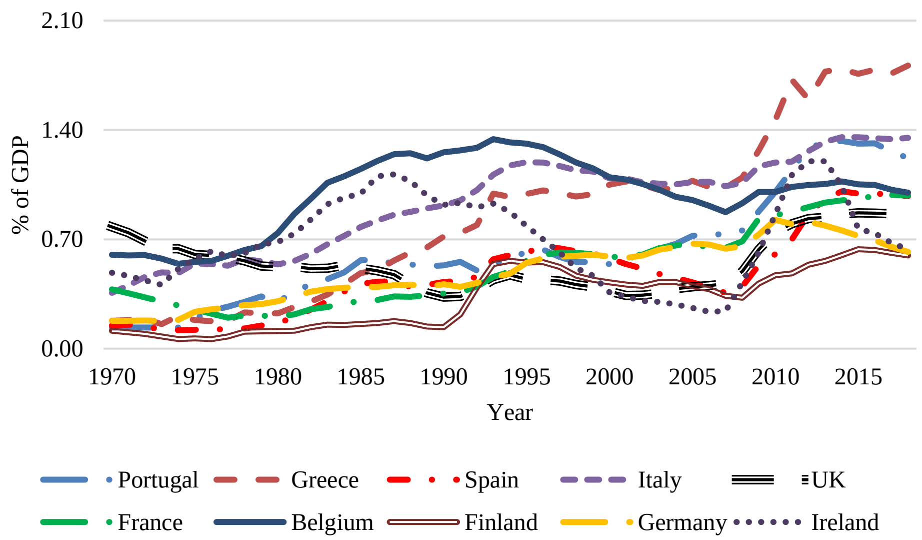

Figure no. 3 – Trends in Gross Government Debt in the Euro Area

Rather than introducing a linear spline function in our empirical model to determine the threshold at which debt stimulate economic growth (see Schclarek, 2004), we instead filter the dataset by isolating observations from the six countries that experienced a debt threshold of 70%. Based on these six countries, we estimate a panel ARDL by limiting the sample periods starting with 1970-2001 to 1970-2007 when the six countries violated the threshold.

Lastly, Figure no. 4 illustrates the trends in other key macroeconomic indicators such as real GDP per capita growth, population growth, inflation, real exchange rate growth, and the level of real interest rates. As illustrated in Figure no. 4, the study countries experienced on average deflation throughout the study period: the statistics actually show that inflation reached an average of 10.2% during the period 1970-79, fell to a single digit inflation of 9.4% during the 1980-1989 period, dropped further to an average of 4.4% in the 1990s and has been declining ever since especially when these countries joined the EMU in 1998 and reaching its lowest average value of 1.1% during the 2010-2018 period (World Bank, 2019).

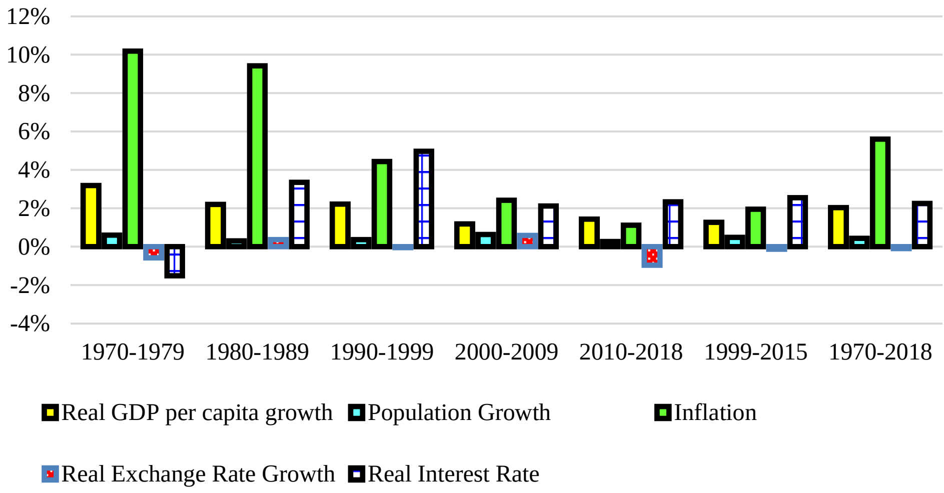

Figure no. 4 – Trends in Key Macroeconomic Variables

On the other hand, while inflation was declining, real interest rates improved over time: in the 1970s, the average real interest rate was negative with an average of -1.5%. In the 1980s this improved to an average of 3.4% and further rose to an average of 5.0% in the 1990s before collapsing to an average of 2.1% in the 2000s and to 2.3% during the 2010-2018 period. On the other hand, the evidence shows that the real effective exchange rate has been appreciating over time in the Euro area: in the 1970s the country-specific currencies appreciated at an average rate of -0.6% per annum and in the 1980s the currency baskets slightly depreciated to an average of 0.4% per annum and slightly appreciated in the 1990s. After joining the Eurozone in 1998, the currencies slightly depreciated averaging 0.6% per annum in the 2000s before collapsing again in the 2010s to -1.0% per annum owing to the introduction of the Euro as their main currency (World Bank, 2019).

Conversely, real GDP per capita growth has been declining over time: in the 1970s the average real GDP growth rate was 3.2% per annum and averaged 2.2% per annum during the 1980s and 1990s. The growth rate further declined when the EMU was introduced in 1998, thereby affecting real GDP growth rates during the period 2000-2009 that fell to an average of 1.2% per annum. The situation did not improve much during the period 2010-2018 as real GDP growth still averaged 1.4% per annum. As for population growth, the EU has always experienced low rates of population growth, averaging 0.4% per annum during the study period. The maximum population growth rate the EU experienced averaged 0.6% per annum in the 1970s and 2000s, and the lowest rates achieved during the 1980s and from 2010-2018 (World Bank, 2019).

3. REVIEW OF EMPIRICAL LITERATURE

The empirical literature on the public debt – economic growth nexus is scarce for industrialised economies: moreover, the relationship has also come with its own controversies. We identify four challenges in this paper. The first challenge is the concept that public debt exhibit threshold effects where scholars have argued that the relationship follows an inverted-U shaped affiliation whereby at certain low levels debt stimulates economic growth while at high levels the relationship is deleterious to growth (Clements *et al.*, 2003; Schclarek, 2004; Pattillo *et al.*, 2011). The challenge that these studies bring is the issue of determining the exact threshold for the inverted-U shaped relationship. Patillo *et al.* (2002; 2011) suggested threshold levels within 35-40% of GDP while Clements *et al.* (2003) found the threshold point to be 30-37% of GDP for developing economies. Reinhart and Rogoff (2010) found that the threshold for public debt was similar in advanced and emerging economies with a cut-off point of 60%. Kumar and Woo (2010) found the threshold to be at 90% of GDP and more interestingly found that the negative effect was smaller in advanced than emerging economies. Caner *et al.* (2010) found the threshold to be 77% for developed and developing countries. Baum *et al.* (2012) found the threshold to be between 60 – 70% of GDP for advanced economies. Lastly, Cesares (2015) found the inverted U-shaped relationship between external debt and economic growth to be at 100%. Recently, Baharumshah *et al.* (2017) found the threshold for Malaysia to be 55% of GDP.

The second challenge relates to the fact that most studies have employed a panel data approach with fixed or random effects and focused on panels with a small time-series but a large number of cross-sections. The conventional perspective with this approach is that the evidence found is that public debt does stimulate aggregate demand and output in the short run but crowds out investment in the long run (Elmendorf and Mankiw, 1999). New evidence, however, depicts that many macroeconomic variables even in a panel setup are nonstationary and hence the application of cointegration methods is important to ensure that the economic relationships being investigated are not spurious. The third challenge relates to the fact that the relationship between public debt and economic growth is likely to be endogenous especially when we consider automatic debt dynamics: much as high interest rates will increase debt, high debt is also likely to increase interest rates through negative market perceptions and rollover risks. Similarly, though high economic growth is likely to reduce debt, high debt has the potential of reducing economic growth.

The fourth challenge, and the core focus of this paper, relates to the fact that nonstationary variables can lead to a cointegrated relationship that is meaningful: thus, investigating both short- and long-run relationships is the right methodological approach to adopt as different economic strategies can be employed by policymakers that target either the short-run, long-run, or both. The empirical literature, though very scanty for advanced and emerging economies, have revealed mixed results. Schclarek (2004) using a panel of 24 industrialised economies covering the period 1970-2002 at 5-year period intervals found no significant relationship between gross government debt and economic growth. Conversely, Kumar and Woo (2010) also using panel data from 38 advanced and emerging market economies found a negative and significant relationship between initial debt and economic growth. Overall high public debt has an adverse impact on economic growth and happens through a number of channels. These include high public debt accumulation influencing high future tax burden (Dotsey, 1994), ineffective fiscal policies (Aghion and Kharroubi, 2007), inflationary pressures (Cochrane, 2010), high long-term interest rates (Baldacci and Kumar, 2010), as well as leading to banking and currency crises (Burnside *et al.*, 2001; Hemming *et al.*, 2003; Reinhart and Rogoff, 2009; Reinhart and Rogoff, 2010).

4. METHODOLOGY AND ESTIMATION TECHNIQUES

The study includes gross government debt as a factor that affects the efficiency of investment and thus economic growth. Assuming a Cobb-Douglas production function with labour-augmenting technology, the policy-augmented multivariate growth equation is an extension to earlier studies that adopted this approach (see among others, Fischer, 1993; Chirwa and Odhiambo, 2016; Chirwa and Odhiambo, 2017).

$$Y_t = K_t^{\alpha}(A_t\{GC_t, DSA_t, RER_t, INF_t, TRD_t, AID_t\}L_t)^{1-\alpha} \quad (1)$$

As illustrated in equation (1), the traditional exogenous growth model is augmented with policy variables that have been found to affect the efficiency of investment and thus economic growth (see among others Fischer, 1993, Bosworth and Collins, 2003; Chirwa and Odhiambo, 2016; Chirwa and Odhiambo, 2017). All variables are expressed in logarithm terms to ensure that the parameters of interest report elasticities which are meaningful in the economic literature. As depicted in equation (1), α is the partial elasticity of output with respect to physical capital while $1-\alpha$ represents the Solow residual.

Given this set-up, the panel $ARDL(\mathrm{p,q,q,\dots,q})$ growth dynamics equation can be represented as follows:

$$\begin{aligned} lnY_{it} = \beta_i &+ \sum_{j=1}^{p}\beta_{1,ij}lnY_{i,t-j} + \sum_{j=0}^{q}\beta_{2,ij}\,lnINV_{i,t-j} + \sum_{j=0}^{q}\beta_{3,ij}\,lnPOPG_{i,t-j} + \sum_{j=0}^{q}\beta_{4,ij}\,lnGC_{i,t-j} \\ &+ \sum_{j=0}^{q}\beta_{5,ij}\,lnDEBT_{i,t-j} + \sum_{j=0}^{q}\beta_{6,ij}\,lnRER_{i,t-j} + \sum_{j=0}^{q}\beta_{7,ij}\,lnRIR_{i,t-j} \\ &+ \sum_{j=0}^{q}\beta_{8,ij}\,lnINFL_{i,t-j} + \sum_{j=0}^{q}\beta_{9,ij}\,lnTRADE_{i,t-j} + \varepsilon_{it} \end{aligned} \quad (2)$$

In equation (2) the term β_i represent the fixed effects; while the coefficients of the lagged dependent variable and regressors are represented by $\beta_{1,ij},\dots,\beta_{9,ij}$ respectively. In a panel error correction representation, equation (2) can be represented as follows:

$$\begin{aligned} \Delta lnY_{it} = \beta_i &+ \sum_{j=1}^{p}\beta_{1,ij}\Delta lnY_{i,t-j} + \sum_{j=0}^{q}\beta_{2,ij}\,\Delta lnINV_{i,t-j} + \sum_{j=0}^{q}\beta_{3,ij}\,\Delta lnPOPG_{i,t-j} \\ &+ \sum_{j=0}^{q}\beta_{4,ij}\,\Delta lnGC_{i,t-j} + \sum_{j=0}^{q}\beta_{5,ij}\,\Delta lnDEBT_{i,t-j} + \sum_{j=0}^{q}\beta_{6,ij}\,\Delta lnRER_{i,t-j} \\ &+ \sum_{j=0}^{q}\beta_{7,ij}\,\Delta lnRIR_{i,t-j} + \sum_{j=0}^{q}\beta_{8,ij}\,\Delta lnINFL_{i,t-j} + \sum_{j=0}^{q}\beta_{9,ij}\,\Delta lnTRADE_{i,t-j} \\ &+ \alpha_{1,ij}lnY_{i,t-1} + \alpha_{2,ij}lnINV_{i,t-1} + \alpha_{3,ij}lnPOPG_{i,t-1} + \alpha_{4,ij}lnGC_{i,t-1} \\ &+ \alpha_{5,ij}lnDEBT_{i,t-1} + \alpha_{6,ij}lnRER_{i,t-1} + \alpha_{7,ij}lnINF_{i,t-1} + \alpha_{8,ij}lnTRADE_{i,t-1} \\ &+ \varepsilon_{it} \qquad (3) \end{aligned}$$

Equation (3) is used in a panel ARDL framework to test for cointegration. The parameters $\beta_{1,ij}, \dots, \beta_{9,ij}$ are short-run multipliers (elasticities) while $\alpha_{1,ij}, \dots, \alpha_{8,ij}$ are long-run multipliers (elasticities). Once a long-run relationship is established the error correction model (ECM) in a panel ARDL framework is specified as follows:

$$\begin{aligned}\Delta lnY_{it} = \beta_i &+ \sum_{j=1}^{p} \beta_{1,ij} \Delta lnY_{i,t-j} + \sum_{j=0}^{q} \beta_{2,ij}\, \Delta lnINV_{i,t-j} + \sum_{j=0}^{q} \beta_{3,ij}\, \Delta lnPOPG_{i,t-j} \\ &+ \sum_{j=0}^{q} \beta_{4,ij}\, \Delta lnGC_{i,t-j} + \sum_{j=0}^{q} \beta_{5,ij}\, \Delta lnDEBT_{i,t-j} + \sum_{j=0}^{q} \beta_{6,ij}\, \Delta lnRER_{i,t-j} \\ &+ \sum_{j=0}^{q} \beta_{7,ij}\, \Delta lnRIR_{i,t-j} + \sum_{j=0}^{q} \beta_{8,ij}\, \Delta lnINFL_{i,t-j} + \sum_{j=0}^{q} \beta_{9,ij}\, \Delta lnTRADE_{i,t-j} \\ &+ \rho_i ECM_{i,t-1} + \varepsilon_{it} \qquad (4)\end{aligned}$$

There are three crucial assumptions that Pesaran *et al.* (1999) put forward. First, the error term, ε_{it} is white noise or independently and identically distributed across the countries and over time. Second, the panel ARDL model is assumed to be stable or that the roots lie outside the unit circle to guarantee that the coefficient of the error correction term is less than zero or within the (0,-1) space and thus confirming the long-run relationship between the dependent variable and the explanatory variables. Furthermore, this also entails a stationary process and hence the need to ensure that all variables of interest are not integrated of a higher order greater than two or they are either $I(0)$ or $I(1)$ variables. Third, the panel ARDL model assumes long-run homogeneity where the coefficients of all explanatory variables are similar across the cross-sections in the long run.

Finally, the study has benefited from a number of data sources. The major one being the World Bank Development Indicators, 1970-2018 (World Bank, 2019); gross government debt data retrieved from the European Union AMECO database, 1970-2018 (European Union, 2019) and the Eurostat database, 1970-2018 (Eurostat, 2019). From these databases, a full dataset comprising of annual time-series data was retrieved covering the period 1970 – 2018[1]. The definition of the variables included are as follows: real GDP per capita (expressed in 2010 constant USD prices); investment (proxied by gross fixed capital formation as a share of GDP); population growth; government consumption share in GDP (General government final consumption expenditure expressed as a percentage of GDP); gross government debt as a share of GDP (general government consolidated gross debt, excessive deficit procedure based on ESA 2010 as a percentage of GDP); the real effective exchange rate (based on unit labour costs, total economy); real interest rate (real long-term interest rates, deflator GDP); inflation rate (growth of consumer price index); and international trade openness (proxied by the sum of exports and imports as a share of GDP). A dummy variable is also included to check if the study countries benefitted or were made worse-off when they joined the EMU in 1998.

4.1 Panel-Based Cross-Sectional Dependency and Unit Root Tests

Since the panel ARDL methodology cannot be applied when some variables are integrated of order two, it is important to perform panel unit root tests on all regressors. There are two types of panel-based unit root tests that depend on whether there is cross-sectional dependence or not in the estimated residuals of the panel-based error correction model. The first set of panel unit root tests are called the first generation that assumes no cross-sectional dependence among variables and residuals of the estimated error correction model. The main first-generation panel unit root tests in the literature include Breitung (2000) and Levin *et al.* (2002) $t-$statistics that assume a common unit root process; and the Im *et al.* (2003) $W-$statistic, and the Fisher-type tests using ADF and PP $chi-$square statistics that assume individual unit root processes (see Maddala and Wu, 1999; Choi, 2001). The second tests are known as the second-generation panel unit root tests and have been proposed by Maddala and Wu (1999); Pesaran *et al.* (1999); Breusch and Pagan (1980); Chudik and Pesaran (2015), among others. In order to perform the correct panel unit root tests, it is therefore important to test for cross-sectional dependency of the estimated panel regression.

Table no. 1 presents the estimated cross-sectional dependency tests based on estimated residuals of the growth equation.

Table no. 1 – Panel-Based Cross-Dependency Test

Variable	Breusch-Pagan (1980) LM Test	Pesaran (2004) CD Test	Pesaran *et al.* (2008) LM adjusted Test	Pesaran (2015) LM Test
Estimated Residuals	139.6* [0.000]	8.224* [0.000]	31.13* [0.000]	46.81* [0.000]

*Note: for all p-values: * 1% significance level; ** 5% significance level.*

As illustrated in Table no. 1, all test results show that for each test statistic and the associated p-values, we reject the null hypothesis of cross-sectional independence or no cross-sectional dependence at the conventional significance level of 1%. This informs the study to conduct second generation panel unit root tests.

Given that there is evidence of cross-sectional dependency, the second-generation panel unit root results are reported in Table no. 2 suggested by Pesaran (2007). In order to eliminate cross dependency, Pesaran (2007) suggest to augment the standard Dickey-Fuller (DF) or Augmented Dickey-Fuller (ADF) regressions with cross-section averages of lagged levels and first-differences of the individual series to estimate cross-sectional dependent ADF (CADF) statistics.

Conversely, Pesaran (2007) suggests another second-generation panel unit root test that modifies the Im, Pesaran and Shin (IPS, Im *et al.*, 2003) first-generation panel unit root test to account for heterogeneous panels with cross-sectional dependence. As illustrated in Table no. 2, the results reveal that the logs of real GDP per capita (LNRGDP) are strictly integrated of order one $I(1)$ while trade openness variable is strictly integrated of order zero, $I(0)$, regardless of which methodology applied. The other variables show mixed results when a constant or a constant and trend are included in the test equation. For instance, when the Pesaran (2003) CADF methodology is applied, the logs of debt, government consumption, real effective exchange rate are strictly integrated of order zero when only a constant is added to the test equation; while Pesaran (2007) CIPS approach shows that only the log of inflation is strictly integrated of order zero when a constant and trend are included in the test equation. Overall, the second-generation panel unit root results confirm that all variables used in this study are either integrated of order one or zero. Hence, we can proceed to test for panel cointegration of our model.

Table no. 2 – Second Generation Panel Stationarity Test

Variable	*Stationarity of all Variables in Levels*				*Stationarity of all Variables in 1st Difference*			
	Im et al. (2003) *CADF*		Pesaran (2007) *CIPS*		Im et al. (2003) *CADF*		Pesaran (2007) *CIPS*	
	Without Trend	*With Trend*	*Without Trend*	*With Trend*	*Without Trend*	*With Trend*	*Without Trend*	*With Trend*
LNRGDPC	-2.142 [0.112]	-2.525 [0.253]	-1.517 [-2.33]	-2.083 [-2.84]	-3.883* [0.000]	-4.201* [0.000]	-4.840* [-2.55]	-5.040* [-3.06]
LNDEBT	-2.725* [0.001]	-2.876** [0.027]	-2.267 [-2.33]	-2.385 [-2.84]	-	-	-5.285* [-2.55]	-5.280* [-3.06]
LNINV	-2.321** [0.034]	-2.287 [0.575]	-2.113 [-2.33]	-2.018 [-2.84]	-	-3.518* [0.000]	-4.068* [-2.55]	-4.332* [-3.06]
LNPOPG	-2.383** [0.021]	-2.451 [0.345]	-1.882 [-2.33]	-1.989 [-2.84]	-	-4.414* [0.000]	-4.988* [-2.55]	-5.060* [-3.06]
LNGC	2.363** [0.025]	-2.979* [0.011]	-1.796 [-2.33]	-2.256 [-2.84]	-	-	-5.021* [-2.55]	-5.041* [-3.06]
LNREER	-2.32** [0.035]	-2.097 [0.808]	-2.472** [-2.33]	-2.125 [-2.84]	-	-	-5.456* [-2.55]	-5.450* [-3.06]
LNRIR	-2.165 [0.097]	-2.693 [0.102]	-1.695 [-2.33]	-2.158 [-2.84]	-4.770* [0.000]	-4.750* [0.000]	-5.282* [-2.55]	-5.289* [-3.06]
LNINFL	-2.355** [0.027]	-2.731 [0.080]	-3.196* [-2.55]	-3.475* [-3.06]	-	-5.287* [0.000]	-	-
LNTRADE	-3.162* [0.000]	-3.203* [0.001]	-3.223* [-2.55]	-3.445* [-3.06]	-	-	-	-

*Note: for Pesaran (2003) CADF all p-values: * 1% significance level, ** 5% significance level. For Pesaran (2007) CIPS, critical values: 1% -2.55, 5% -2.33 without trend; 1% -3.06, 5% -2.84 with trend.*

4.2 Panel-Based Cointegration Tests

The use of the pooled mean group panel ARDL estimation method also requires that the study variables should be cointegrated. There are a number of panel cointegration tests that have been proposed in the literature and include Pedroni (1999, 2004) and Kao (1999) who extend the Engle and Granger (1987) cointegration test; and combined individual tests proposed by Fisher (1932) and extended by Maddala and Wu (1999) that combines tests from individual cross-sections. In this study, we employ Kao (1999) panel cointegration test that specifies cross-section intercepts and homogeneous coefficients on the first stage regressors. The Kao (1999) test null hypothesis the variables are not cointegrated in all panels. Kao (1999) reports five test statistics that include: a modified DF t-statistic; DF t-statistic; ADF t-statistic; unadjusted modified DF t-statistic; and unadjusted DF t-statistic. Table no. 3 report these test results.

Table no. 3 – Kao (1999) Panel Cointegration Test Results

Cointegration Test	Modified DF (t-statistic)	DF (t-statistic)	ADF (t-statistic)	Unadjusted modified DF (t-statistic)	Unadjusted DF (t-statistic)
Kao (1999)	-3.45* [0.000]	-1.62** [0.052]	-1.64** [0.051]	-1.46*** [0.072]	-0.88 [0.189]

*Note: Null Hypothesis: No cointegration in all panels; for all p-values: * 1% significance level; ** 5% significance level; *** 10% significance level.*

As illustrated in Table no. 3, the evidence shows that the null hypothesis of no long-run relationships is rejected for the augmented growth function at the 1%, 5% and 10% significance level of four of the five test statistics reported by Kao (1999). The empirical results of our panel cointegration test prove that a long-run level relationship exists between real GDP per capita conditioned on gross government debt, investment, population growth, government consumption, the real exchange rate, the real interest rate, inflation, and trade openness. Thus, based on the second-generation panel unit root as well as panel cointegration test results, we can proceed to use the pooled mean group panel ARDL estimation method suggested by Pesaran *et al.* (1999) and modified to account for cross-sectional dependency using a cross-sectional ARDL model proposed by Chudik *et al.* (2013).

5. EMPIRICAL ANALYSIS OF THE SECOND-GENERATION PANEL ARDL REGRESSION RESULTS

Table no. 4 presents the empirical results for the full sample period, 1970-2018 on the relationship between public debt and economic growth conditioned on other covariates in the Euro area. The Pooled Mean Group (PMG) estimation results from the panel ARDL that take into account cross-sectional dependency are illustrated under panel 1 while the country-specific short-run estimated results are presented in panel 2. As illustrated in Tables no. 4, the reported CD test is 1.54 and has a computed p-value of 0.1224, implying no cross-dependency among the residuals of the estimated panel ARDL equation.

Another important estimation result is the coefficient of the error-correction term for the entire model (-0.649) which is statistically significant at the 1% significance level and falls within the recommended speed of adjustment range of [0, -1). The long-run cointegration relationship is supported by six of the ten countries studied, namely Portugal, Spain, France, Ireland, Belgium, and Greece whose speed of adjustments are also negative and are statistically significant at the 1% and 5% significance levels. The closer is the speed of adjustment to -1 the quicker will the economy return back to its equilibrium path whenever a shock is experienced from any of the covariates included. In terms of long-run homogeneity the PMG estimation results reveal that only the real exchange rate and real interest rates are negatively and significantly associated with income per capita and the results are statistically significant at the 1% and 5% significance level.

While the coefficient of public debt has the right negative sign in the long run, it is insignificant. The same variables are also statistically significant in the short run, where the results reveal that the growth rates of real effective exchange rate and real interest rate are negatively associated with the growth of real GDP per capita when all countries are pooled. Both these results are found to be statistically significant at the 5% significance level in the short run. In terms of country-specific results, the study countries portray mixed outcomes, particularly for the growths of public debt, investment, government consumption, and inflation. Much as public debt is statistically insignificant when all countries are pooled, the results reveal that in Italy the growth of public debt is positively associated with the growth of real GDP per capita; while in Greece the growth of public debt is negatively associated with the growth of real GDP per capita. These results are statistically significant at the 5% and 1% significance level, respectively.

Table no. 4 – Pooled Mean Group Estimation Results – Full Sample (1970-2018)

Panel 1 – Estimated Long-Run Coefficients (Elasticities) [Dependent Variable: Log of Real GDP per capita $\log(RGDP)_t$]

Regressor	PMG	Standard Error	z-statistic	Probability		
INT	-0.521	0.826	-0.63	0.529	No. of observations	450
$\log(DEBT)_t$	-0.008	0.031	-0.26	0.798	Number of groups	10
$\log(INV)_t$	-0.004	0.014	-0.28	0.777	Observations per group	45
$\log(POPG)_t$	0.052	0.034	1.55	0.120	R-squared (MG)	0.84
$\log(GC)_t$	0.002	0.003	0.88	0.380	Root MSE	0.01
$\log(REER)_t$	**-0.069****	0.030	-2.27	**0.023**	CD statistic [p-value]	1.54 [0.1224]
$\log(RIR)_t$	**-0.064***	0.025	-2.59	**0.010**	D.f: Without cross-sectional averages	33
$\log(INFL)_t$	-0.001	0.002	-0.40	0.688	D.f: With cross-sectional averages	12
$\log(TRADE)_t$	-0.002	0.004	-0.56	0.578	Number of cross-sectional lags	1 to 3
					Variables in mean group regression	110

Panel 2 – Estimated Short-Run Coefficients (Elasticities) [Dependent Variable: change in log of Real GDP per capita $\Delta\log(RGDP)_t$]

	PMG	Portugal	Spain	United Kingdom	France	Finland	Germany	Ireland	Belgium	Italy	Greece
INT	-0.971 [0.520]	0.684 [0.670]	2.395 [0.339]	-1.337 [0.640]	-0.231 [0.914]	-1.894 [0.285]	0.722 [0.807]	3.856 [0.206]	-1.332 [0.435]	1.023 [0.711]	**-13.59*** **[0.005]**
$\Delta\log(DEBT)_t$	-0.016 [0.758]	-0.025 [0.832]	0.042 [0.703]	-0.172 [0.233]	-0.161 [0.413]	0.013 [0.927]	0.115 [0.615]	0.108 [0.448]	-0.027 [0.770]	**0.252**** **[0.035]**	**-0.303*** **[0.000]**
$\Delta\log(INV)_t$	-0.008 [0.715]	0.038 [0.538]	**0.094***** **[0.073]**	0.051 [0.467]	-0.029 [0.857]	-0.085 [0.201]	-0.053 [0.492]	-0.053 [0.610]	**-0.104*** **[0.011]**	0.074 [0.415]	-0.012 [0.787]
$\Delta\log(POPG)_t$	**0.091***** **[0.083]**	**0.256*** **[0.000]**	**0.141*** **[0.000]**	0.014 [0.890]	-0.277 [0.157]	0.121 [0.289]	-0.019 [0.913]	0.134 [0.195]	0.121 [0.319]	**0.335**** **[0.017]**	0.084 [0.271]
$\Delta\log(GC)_t$	0.003 [0.436]	**-0.018**** **[0.046]**	**0.023**** **[0.025]**	0.009 [0.468]	-0.006 [0.309]	-0.009 [0.358]	0.003 [0.904]	-0.006 [0.461]	0.025 [0.177]	0.002 [0.815]	**0.013***** **[0.095]**
$\Delta\log(REER)_t$	**-0.117**** **[0.022]**	0.105 [0.412]	-0.031 [0.791]	-0.227 [0.510]	0.096 [0.615]	0.008 [0.962]	-0.094 [0.816]	-0.203 [0.352]	-0.171 [0.424]	**-0.381***** **[0.068]**	**-0.273**** **[0.013]**
$\Delta\log(RIR)_t$	**-0.109**** **[0.015]**	0.012 [0.856]	0.011 [0.913]	-0.126 [0.346]	-0.138 [0.353]	-0.013 [0.846]	-0.044 [0.862]	-0.052 [0.691]	-0.214 [0.184]	-0.068 [0.642]	**-0.461*** **[0.000]**
$\Delta\log(INFL)_t$	-0.001 [0.894]	**0.010**** **[0.015]**	**-0.019*** **[0.000]**	0.002 [0.773]	-0.014 [0.150]	0.008 [0.225]	-0.008 [0.454]	0.017 [0.276]	0.003 [0.912]	0.000 [0.988]	-0.004 [0.532]
$\Delta\log(TRADE)_t$	-0.003 [0.643]	-0.007 [0.544]	**-0.041*** **[0.002]**	0.026 [0.247]	-0.016 [0.266]	0.009 [0.642]	-0.001 [0.934]	-0.006 [0.412]	0.008 [0.717]	-0.009 [0.420]	0.011 [0.249]
DUM_EURO	-0.003 [0.610]	0.022 [0.329]	-0.034 [0.150]	-0.001 [0.973]	0.021 [0.346]	-0.001 [0.959]	0.007 [0.774]	0.009 [0.646]	-0.005 [0.798]	-0.012 [0.562]	**-0.041***** **[0.062]**
ECM_{t-1}	**-0.649*** **[0.000]**	**-1.026*** **[0.000]**	**-0.306**** **[0.051]**	-0.618 [0.110]	**-0.452*** **[0.007]**	-0.369 [0.284]	-0.545 [0.305]	**-0.993**** **[0.033]**	**-0.738**** **[0.024]**	-0.583 [0.128]	**-0.863*** **[0.000]**

*Note: for all p-values: * 1% significance level; ** 5% significance level; *** 10% significance level*

Similarly, the growth of investment is mixed. While statistically insignificant when all countries are pooled, only Spain and Belgium reveal significant results where the growth of investment is positively associated with the growth of income in Spain but negatively associated with the growth of income in Belgium. These results are statistically significant at the 1% and 10% significance level. In terms of government consumption, the results show that the growth of government consumption is negatively and significantly associated with the growth of income in Portugal at the 5% significance level; and positively and significantly associated with the growth of income in Spain and Greece at the 5% and 10% significance levels. The volatility of inflation also portrays mixed results, where the results show that while the growth of inflation is positively and significantly associated with the growth of income in Portugal; it is negatively and significantly associated with the growth of income in Spain. These results are statistically significant at the 1% and 5% levels of significance.

Only population growth, real effective exchange rate, and real interest rates reveal consistent results across countries. While population growth is significantly positive when all countries are pooled in the short run at the 10% significance level, it is statistically significant in only three countries, namely Portugal, Spain and Italy. This is expected particularly when the growth of population is very low. The growth of the real effective exchange rate is also found to be negatively and significantly associated with the growth of income per capita when all countries are pooled; and in Italy and Greece in the short-run at the 5% and 10% significance level. Similarly, the growth of real interest rate is negatively and significantly associated with the growth of income when all countries are pooled and driven by Greece with results statistically significant at the 1% and 5% significance levels. While the growth of trade is insignificant when all countries are pooled in the short run, country-specific results show that the growth of trade in the short run is negatively and significantly associated with the growth of income in Spain at the 1% significance level. Lastly, the only country that was affected by the creation of the European Monetary Union in 1998 was Greece where the results show a negative and significant association between the dummy variable and the growth of income in the short-run at the 10% significance level.

The next question we investigate in this paper is whether indeed the relationship between public debt and income per capita is non-linear or follows an inverted U-shape. The results are reported in Table no. 5, where we display results on public debt nonlinearities for six subsamples from 1970-2005 to 1970-2010.

As illustrated in Figure no. 3, the graph showed that six out of the ten countries experienced a debt-to-GDP ratio that was below the 60-70% threshold for developed countries as promulgated by the IMF during the period 1970 to 2006. These countries include Portugal, Spain, the United Kingdom, France, Finland, and Germany. Rather than introducing a linear spline function as suggested by most studies (see Schclarek, 2004) or an interactive dummy variable (Kumar and Woo, 2010), we limit the sample to the period when the public debt-to-GDP ratio was less than 60-70% threshold in the six countries and this starts from the year 2005 onwards.

Table no. 5 – Pooled Mean Group Estimation Results – Reduced Samples (1970-2005; 1970-2006; 1970-2007)

Regressor	1970-2005	1970-2006	1970-2007	1970-2008	1970-2009	1970-2010
Panel 1 – Estimated Long-Run Coefficients (Elasticities) [Dependent Variable: Log of Real GDP per capita $\log(RGDP)_t$]						
INT	-16.76 [0.114]	-48.14 [0.366]	1.128 [0.554]	1.715 [0.422]	1.958 [0.241]	2.318 [0.247]
$\boldsymbol{log(DEBT)_t}$	***-2.238*** [0.101]***	***-1.243 [0.360]***	***-0.086 [0.482]***	***-0.065 [0.550]***	***-0.083 [0.371]***	***-0.003 [0.936]***
$\log(INV)_t$	-0.791 [0.171]	0.549 [0.152]	0.101 [0.244]	0.063 [0.331]	0.121 [0.097]	0.031 [0.240]
$\log(POPG)_t$	-0.288 [0.857]	3.025 [0.227]	0.268* [0.008]	0.204* [0.006]	0.248 [0.013]	0.183 [0.014]
$\log(GC)_t$	-0.077 [0.397]	-0.145 [0.267]	-0.013* [0.003]	-0.013*** [0.067]	-0.011 [0.156]	-0.006 [0.297]
$\log(REER)_t$	-0.479*** [0.067]	-2.083 [0.325]	-0.312 [0.148]	-0.214 [0.294]	-0.336 [0.125]	-0.218 [0.030]
$\log(RIR)_t$	-1.538*** [0.105]	-0.522 [0.498]	-0.019 [0.712]	-0.054 [0.229]	-0.008 [0.875]	0.026 [0.216]
$\log(INFL)_t$	-0.050 [0.157]	0.024** [0.020]	0.014** [0.027]	0.010*** [0.064]	0.014 [0.085]	0.008 [0.137]
$\log(TRADE)_t$	-0.098 [0.563]	0.046 [0.494]	-0.053 [0.187]	-0.061*** [0.072]	-0.045 [0.158]	-0.033 [0.174]
Panel 2 – Estimated Short-Run Coefficients (Elasticities) [Dependent Variable: change in log of Real GDP per capita $\Delta\log(RGDP)_t$]						
INT	19.80 [0.421]	2.701 [0.508]	1.147 [0.697]	0.468 [0.869]	0.559 [0.834]	1.070 [0.731]
$\boldsymbol{\Delta log(DEBT)_t}$	***1.617 [0.432]***	***0.043 [0.854]***	***-0.038 [0.755]***	***-0.031 [0.796]***	***-0.073 [0.422]***	***-0.013 [0.842]***
$\Delta\log(INV)_t$	1.125 [0.420]	0.171 [0.298]	0.071 [0.286]	0.029 [0.568]	0.073 [0.315]	0.002 [0.967]
$\Delta\log(POPG)_t$	2.737 [0.304]	0.567*** [0.052]	0.253* [0.003]	0.180* [0.007]	0.250 [0.001]	0.215 [0.002]
$\Delta\log(GC)_t$	-0.010 [0.717]	-0.021** [0.050]	-0.014* [0.001]	-0.008 [0.372]	-0.006 [0.412]	-0.003 [0.662]
$\Delta\log(REER)_t$	0.466 [0.498]	-0.022 [0.921]	-0.170 [0.325]	-0.078 [0.646]	-0.219 [0.247]	-0.177 [0.165]
$\Delta\log(RIR)_t$	1.735 [0.387]	0.124 [0.636]	-0.009 [0.914]	-0.049 [0.493]	-0.019 [0.768]	0.014 [0.723]
$\Delta\log(INFL)_t$	0.077 [0.242]	0.014*** [0.098]	0.011** [0.039]	0.007*** [0.092]	0.013 [0.022]	0.011 [0.049]
$\Delta\log(TRADE)_t$	0.307 [0.356]	0.001 [0.975]	-0.035 [0.261]	-0.050*** [0.057]	-0.033 [0.244]	-0.029 [0.295]
DUM_EURO	-0.053 [0.604]	0.006 [0.738]	0.004 [0.619]	0.002 [0.840]	0.003 [0.795]	0.006 [0.506]
ECM_{t-1}	-0.551 [0.614]	-0.378 [0.375]	-0.532 [0.135]	-0.318 [0.311]	-0.420 [0.249]	-0.486 [0.174]

*Note: for all p-values: *** 1% significance level; ** 5% significance level; * 10% significance level.*

As illustrated in Table no. 5, the only evidence that supports a non-linear relationship between public debt and economic growth is in the short-run for the years 2005 and 2006. The short-run PMG estimate reveals that a 1% increase in public debt that was below the 70% threshold increased income per capita during the two periods that ranged between 1.62% and collapsed to 0.04% though statistically insignificant. Thereafter, the relationship changes where the growth of public debt is negatively associated with the growth of income in the short-run when the 60-70% debt threshold is violated, albeit the results were statistically insignificant. However, the long-run pooled results consistently revealed a negative association between the growth of public debt and income per capita throughout the block periods analysed.

Finally, for the PMG estimation results to be robust, the panel ARDL model assumes that the error terms are white noise or independently and identically distributed. Table no. 6 presents the estimated test results of the cross-sectional dependency regressions estimated in this study. There are a number of tests that test for normality, skewness and kurtosis. However, for panel data, such tests are not robust since, for instance, the standard Jarque-Bera normality test is unable to disentangle the influence of individual and remainder cross-sections from non-Gaussian distributions (Galvao *et al.*, 2013). Rather than using such standard tests, the study employs a new test proposed by Galvao *et al.* (2013) that combines a number of tests to identify non-normality in standard error cross-sections in panel models. The importance of Alejo *et al.* (2015) normality test is that it explores skewness and kurtosis in each cross-section or jointly, thereby extending the standard Jarque-Bera normality test.

Table no. 6 – Skewness, Kurtosis and Normality Tests for Estimated Residuals

Estimated Residuals	Skewness_e	Kurtosis_e	Skewness_u	Kurtosis_u	Joint test Normality_e	Joint test Normality_u
Residuals (1970-2018)	1.40 [0.160]	1.34 [0.180]	0.94 [0.350]	0.89 [0.372]	3.77 [0.152]	1.67 [0.434]
Residuals (1970-2005)	-0.66 [0.511]	0.89 [0.374]	-0.99 [0.324]	0.06 [0.953]	1.22 [0.543]	0.98 [0.613]
Residuals (1970-2006)	0.68 [0.494]	-0.10 [0.918]	-0.32 [0.747]	-1.14 [0.254]	0.48 [0.787]	1.40 [0.495]
Residuals (1970-2007)	1.11 [0.267]	1.87 [0.061]	1.29 [0.197]	-0.63 [0.528]	4.74 [0.093]	2.06 [0.356]
Residuals (1970-2008)	1.03 [0.301]	1.95 [0.051]	1.27 [0.203]	-0.52 [0.604]	4.87 [0.087]	1.89 [0.389]
Residuals (1970-2009)	0.98 [0.329]	1.76 [0.079]	1.91 [0.057]	0.22 [0.825]	4.04 [0.132]	3.68 [0.158]
Residuals (1970-2010)	1.17 [0.241]	1.78 [0.075]	1.94 [0.052]	0.23 [0.816]	4.55 [0.103]	3.83 [0.147]

*Note: for all p-values: *** 1% significance level; ** 5% significance level.*

As presented in Table no. 5, the panel data used in this study exhibit normal distributions within cross-sections as we could not reject the test statistics at the 5% significance level. This means that the computed coefficients in all panel ARDL regression models estimated in this study are efficient estimates and not biased.

6. CONCLUSION AND POLICY IMPLICATIONS

The paper set out to investigate the relationship between public debt and economic growth in ten European countries that are part of the EMU of the European Union using a panel-based ARDL error correction model with cross-section dependence. These countries include Portugal, Greece, Spain, Italy, the United Kingdom, France, Belgium, Finland, Germany and Ireland. The paper focused on understanding first the growth dynamics in these countries by empirically investigating the relationship between the accumulation of public debt and economic growth conditioned on other factors that drive growth; and second, investigating whether indeed public debt stimulates economic growth when it is below the 60-70% debt-to-GDP threshold.

The overall results of the study reveal that much as public debt exhibit the correct negative sign, public debt is not significantly associated with the income per capita both in the short- and long-run. It is only on the short-run that public debt becomes influential only in two of the ten countries studied where the study revealed a positive and significant association between the growth of debt and income per capita in Italy and, conversely, a negative and significant relationship in Greece. In terms of whether there are threshold effects when countries accumulate debt, the study finds statistically insignificant results though being positive in the short-run in some years and negative in others in countries that experienced low debt levels during the study period. evidence of such, particularly when investigating the relationship between public debt and economic growth in countries that experienced low debt levels during the study period.

The study also finds that the growth of population in the short-run is consistently positively associated with the growth of income per capita for pooled and individual countries such as Portugal, Spain and Italy. Similar results are noted between the growth of real effective exchange rate and income per capita in the short run for pooled and individual countries such as Italy and Greece. Other short-run significant results are found between the growth of real interest rates and income per capita in Greece. The growth of trade in the short-run was found to have a negative and significant relationship with income per capita only in Spain. Investment, government consumption and inflation portrayed short-run mixed results: the growth of investment was found to have a significant positive impact on income per capita in Spain and a negative impact in Belgium. The growth of government consumption was found to have a positive impact on income per capita in Spain and Greece, and a negative impact in Portugal. The growth of inflation, on the other hand, was found to have a positive impact on income per capita in Portugal and a negative impact in Spain. Last but not least, the results reveal that the establishment of the EMU in 1998 had a negative and significant impact on income per capita only in Greece.

These results have significant policy implications, especially for the continuation of the EMU in the European Union. Though there are many recommendations to be made from the study results, we emphasize on one as relates to growth dynamics. The argument put forward by public debt economists that the relationship between debt and economic growth in non-linear is evident only in the short-run and the cut-off point is 70% of GDP for the study countries. However, regardless of meeting the debt threshold for advanced economies or not, the growth of public debt has a negative impact on economic growth in the long run, which may be driven by negative market perceptions, uncertainty, or potential crowding-out effects on investment. Thus, we recommend that the concept adopted by the Stability and Growth

Pact that allows countries to accumulate debt to no-more than 60% as well as maintain a budget deficit of not more than 3% should be discouraged at all costs and more towards ensuring either a budget balance or surplus in public finances.

References

Aghion, P., and Kharroubi, E., 2007. Cyclical Macro Policy and Industry Growth: The effect of countercyclical fiscal policy. *Harvard University Working Paper, 837*. https://econpapers.repec.org/paper/redsed008/837.htm.

Baharumshah, A. Z., Soon, S., and Lau, E., 2017. Fiscal Sustainability in an Emerging Market Economy: When does public debt turn bad. *Journal of Policy Modeling, 39*(1), 99-113. http://dx.doi.org/10.1016/j.jpolmod.2016.11.002

Bai, J., and Ng, S., 2004. A Panic Attack on Unit Roots and Cointegration. *Econometrica, 72*(4), 1127-1177.

Baldacci, E., and Kumar, M. S., 2010. Fiscal Deficits, Public Debt and Sovereign Bond Yields. *IMF Working Paper, WP/10/184*, 1-28.

Baum, A., Checherita-Westphal, C., and P., R., 2012. Debt and Growth: New evidence for the Euro Area. *European Central Bank, Working Paper Series, 1450*.

Bosworth, B., and Collins, S., 2003. The Empirics of Growth: An update. *Brookings Papers on Economic Activity, 2*(2), 113-206. http://dx.doi.org/10.1353/eca.2004.0002

Breitung, J., 2000. The Local Power of Some Unit Root Tests for Panel Data. In B. Baltagi (Ed.), *Advances in Econometrics, 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels* (pp. 161-178). Amsterdam: JAI Press. http://dx.doi.org/10.1016/S0731-9053(00)15006-6

Breusch, T. S., and Pagan, A. R., 1980. The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. *The Review of Economic Studies, 47*(1), 239-253. http://dx.doi.org/10.2307/2297111

Burnside, C., Eichenbaum, M., and Rebelo, S., 2001. Prospective Deficits and the Asian Currency Crisis. *Journal of Political Economy, 109*(6), 1155-1197. http://dx.doi.org/10.1086/323271

Caner, M., Grennes, T., and Koehler-Geib, F., 2010. Finding the Tipping Point: When Sovereign Debt Turns Bad *Sovereign Debt and the Financial Crisis* (pp. 63-75): World Bank. http://dx.doi.org/10.1596/9780821384831_ch03

Cesares, E. R., 2015. A Relationship between External Public Debt and Economic Growth. *Estudos Economicos, 30*(2), 219-243.

Chirwa, T. G., and Odhiambo, N. M., 2016. What Drives Long-Run Economic Growth? Empirical evidence from South Africa. *Economia Internazionale/International Economics, 69*(4), 425-452.

Chirwa, T. G., and Odhiambo, N. M., 2017. Sources of Economic Growth in Zambia: An empirical investigation. *Global Business Review, 18*(2), 275-290. http://dx.doi.org/10.1177/0972150916668449

Choi, I., 2001. Unit Root Tests for Panel Data. *Journal of International Money and Finance, 20*(2), 249-272. http://dx.doi.org/10.1016/S0261-5606(00)00048-6

Chudik, A., Mohaddes, K., Pesaran, M. H., and Raissi, M., 2013. Debt, Inflation and Growth: RobustEstimation of Long-Run Effects in Dynamic Panel Data Models. *Federal Reserve Bank ofDallas, Globalization and Monetary Policy Institute Working Paper, 162*.

Chudik, A., and Pesaran, M. H., 2015. Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics, 188*(2), 393–420. http://dx.doi.org/10.1016/j.jeconom.2015.03.007

Clements, B., Bhattacharya, R., and Nguyen, T. Q., 2003. External Debt, Public Investment, and Growth in Low-Income Countries. *IMF Working Paper*(WP/03/249).

Cochrane, J. H., 2010. Understanding Policy in the Great Recession: Some unpleasant fiscal arithmetic. *NBER Working Paper Series, 16087*.

Dotsey, M., 1994. Some Unpleasant Supply Side Arithmetic. *Journal of Monetary Economics, 33*(3), 507-524. http://dx.doi.org/10.1016/0304-3932(94)90041-8

Elmendorf, D., and Mankiw, N. G., 1999. Government Debt. In J. Taylor and M. Woodford (Eds.), *Handbook of Macroeconomics* (Vol. 1C). Amsterdam, North Holland.

Engle, R. F., and Granger, C. W. J., 1987. Co-integration and Error-Correction: Representation, estimation, and testing. *Econometrica, 55*(2), 251-276. http://dx.doi.org/10.2307/1913236

European Union, 2019. AMECO Database on Gross Public Debt. from http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm

Eurostat, 2019. Database on Gross Public Debt. from https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/macro-economic-database-ameco/download-annual-data-set-macro-economic-database-ameco_en

Fischer, S., 1993. The Role of Macroeconomic Factors in Growth. *Journal of Monetary Economics, 32*(3), 485-512. http://dx.doi.org/10.1016/0304-3932(93)90027-D

Fisher, R. A., 1932. *Statistical Methods for Research Workers* (4th ed. ed.). Edinburgh: Oliver & Boyd.

Galvao, A. F., Montes-Rojas, G., Sosa-Escudero, W., and Wang, L., 2013. Tests for skewness and kurtosis in the one-way error component model. *Journal of Multivariate Analysis, 122*(35-52).

Hemming, R., Kell, M., and Schimmelpfennig, A., 2003. *Fiscal Vulnerability and Financial Crises in Emerging Market Economies. IMF Occassional Paper No. 218*. Washington: International Monetary Fund. http://dx.doi.org/10.5089/9781589061965.084

Im, K. S., Pesaran, M. H., and Shin, Y., 2003. Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics, 115*(1), 53-74. http://dx.doi.org/10.1016/S0304-4076(03)00092-7

Kao, C. D., 1999. Spurious Regression and Residual-Based Tests for Cointegration in Panel Data. *Journal of Econometrics, 90*(1), 1-44. http://dx.doi.org/10.1016/S0304-4076(98)00023-2

Kumar, M. S., and Woo, J., 2010. Public Debt and Growth. *IMF Working Paper*(WP/10/174), 1-46.

Levin, A., Lin, C. F., and Chu, C., 2002. Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. *Journal of Econometrics, 108*(1), 1-24. http://dx.doi.org/10.1016/S0304-4076(01)00098-7

Maddala, G. S., and Wu, S., 1999. A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and Statistics, 61*, 631-652. http://dx.doi.org/10.1111/1468-0084.0610s1631

OECD, 2016. GDP up by 26.3% in 2015. https://www.oecd.org/std/na/Irish-GDP-up-in-2015-OECD.pdf.

Pattillo, C., Poirson, H., and Ricci, L., 2002. External Debt and Growth. *Revista de Economia Institucional*, *2*(3), 1-30.

Pattillo, C., Poirson, H., and Ricci, L., 2004. What are the channels through which external debt affects growth? *IMF Working Paper, 04/15*.

Pattillo, C., Poirson, H., and Ricci, L., 2011. External debt and growth. *Review of Economics andInstitutions, 2*, 1-30. http://dx.doi.org/10.5202/rei.v2i3.45

Pedroni, P., 1999. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. *Oxford Bulletin of Economics and Statistics, 61*, 653-670. http://dx.doi.org/10.1111/1468-0084.61.s1.14

Pedroni, P., 2004. Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis. *Econometric Theory, 20*(03), 597-625. http://dx.doi.org/10.1017/S0266466604203073

Pesaran, M. H., 2007. A Simple Panel Unit Root Test in the Presence of Cross-Section Dependence. *Journal of Applied Econometrics, 22*(2), 265-312.

Pesaran, M. H., 2015. Testing Weak Cross-Sectional Dependence in Large Panels. *Econometric Reviews, 34*(6-10), 1089–1117.

Pesaran, M. H., Shin, Y., and Smith, R. P., 1999. Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association, 94*(446), 621-634. http://dx.doi.org/10.1080/01621459.1999.10474156

Reinhart, C. M., and Rogoff, K. S., 2009. The Aftermath of Financial Crises. *NBER Working Paper Series*(14656). http://dx.doi.org/10.3386/w14656
Reinhart, C. M., and Rogoff, K. S., 2010. Growth in a Time of Debt. *NBER Working Paper Series*(15639). http://dx.doi.org/10.3386/w15639
Schclarek, S., 2004. *Debt and Economic Growth in Developing and Industrial Countries*.
World Bank, 2019. World Development Indicators 2017. from www.worldbank.org

Notes

[1] The study employs STATA 16 for all panel unit root tests, cointegration tests, and regression analysis.

Copyright