

4 A COMPARATIVE EMPIRICAL ANALYSIS BETWEEN CORE AND PERIPHERY EU ECONOMIES IN THE POST-EMU PERIOD: RE-EXAMINING THE EMU SOVEREIGN DEBT CRISIS

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Abstract

This study empirically explores whether there is an asymmetry between the competitiveness of core and periphery European Union (EU) economies in the post economic and monetary union (EMU) period, including the EMU sovereign debt crisis. For this purpose, this study comparatively analyzed the influence of the interest rates on long term government bond yields and total credit to the general government on sovereign debt in core and periphery EU economies in separate panels employing the panel autoregressive distributive lag (ARDL) method for the period 2000:1–2020:4. In addition, robustness checks were carried out using panel econometric methods such as fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS), and common correlated effects mean group (CCEMG). The analysis results revealed a long term cointegration nexus between the variables in both groups of countries. The findings also showed that interest rates on long term government bond yields and total credit to the general government positively influence sovereign debt in both groups of economies in the long run, yet the positive effect of total credit to the general government is stronger. Furthermore, the comparative analysis demonstrated that the long run positive coefficients of interest rates on long term government bond yields and total credit to the general government of the periphery EU economies are higher than those of the core EU economies. Ultimately, empirical results supported the existence of an asymmetric structure between core and periphery EU economies, contradicting the convergence approach during the post-EMU period. The findings of this study recommend that governments in the eurozone restrict their long-term credit usage and that less competitive countries should create their own liquid financial resources. As a result, this study proposes various policy solutions to eliminate competitiveness disparities in EU integration.

Keywords: The EMU sovereign debt crisis, core EU economies, periphery EU economies, competitiveness differences

JEL Classification: F45, N14, N24

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1. Introduction

After the outbreak of the global financial crisis, the EMU sovereign debt crisis began in Greece in 2009 but soon spread to Portugal, Italy, Ireland, and Spain (Roman and Bilan, 2012). Numerous studies have looked into what led to the controversial EMU sovereign debt crisis. Although previous studies emphasize many reasons, this study uncovers the factors that a considerable number of studies attach significance to as follows: (i) the adoption of the euro as a common currency in structurally different countries (core and periphery EU economies). This has resulted in periphery EU economies losing their ability to take advantage of exchange rates as a balancing factor (Lane, 2012; Overbeek, 2012; Wignall, 2012; Wegener et al, 2019; Afonso and Jalles, 2019). (ii) EU economic integration creates a climate of confidence that encourages borrowing. According to this factor, low real interest rates (underpricing of risk) weakened the risk perception of periphery EU economies with inadequate financial discipline and low competitiveness and motivated them to over-borrow (Katsimi and Moutos, 2010; Obstfeld, 2013; Moro, 2014; Gibson et al, 2014; Frankel, 2015; Frieden and Walter, 2017; Basse et al, 2018; Afonso and Jalles, 2019; Afonso et al, 2020).

Prior to the crisis, a large portion of the credits went toward the boosting non-tradable housing markets of the periphery EU economies and related construction sectors. A substantial amount of financial resources allocated to the aforementioned non-tradable sectors created inhibiting effects on meeting payment obligations because they restricted trade-related resources and future growth capacities (Obstfeld, 2013; Gruppe and Lange, 2014). (iii) Financial and macroeconomic inequalities between core and periphery EU economies (Katsimi and Moutos, 2010; Gros, 2012; Brancaccio, 2012; Lane, 2012; Moro, 2014; Frieden and Walter, 2017). This factor refers to macroeconomic imbalances; for instance, prior to the EMU sovereign debt crisis, core EU economies had a current account surplus, whereas periphery EU economies had a current account deficit (Brancaccio, 2012; Hall, 2017). Thanks to their organized manufacturing, most of the coordinated economies of core EU economies have specialized in producing high-value goods and services. On the other hand, periphery EU economies lack the institutional capacity for skill development and the necessary innovation for export-led growth (Hall and Soskice, 2001; Iversen et al, 2016; Frieden and Walter, 2017). Moreover, it has been underlined by De Ville and Vermeiren (2016) and Hall (2012) that the macroeconomic systems of core EU economies are more resilient than those of the periphery EU economies.

Periphery EU economies were subjected to massive private capital flow reversals during the EMU sovereign debt crisis (Merler and Pisani-Ferry, 2012). The repo bond markets in Ireland, Portugal, and Spain became less liquid, and investors' willingness to purchase Greek, Portuguese, and Spanish government bonds declined substantially (Katsimi and Moutos, 2010). Associated with institutional fragility, a real liquidity crisis destabilized the banking system in periphery EU nations (Collignon, 2012). The International Monetary Fund (IMF) and the European Central Bank (ECB) were able to alleviate the influence of the crisis by providing bailout packages to periphery EU economies that were unable to pay their obligations throughout the crisis (Hall, 2017). However, fiscal support and bailout packages have resulted in a higher sovereign debt (Ureche-Rangau and Burietz, 2013; Hall, 2017; Afonso et al, 2018). Additionally, we should underline that a high ratio of sovereign debt makes periphery EU nations susceptible to external adverse shocks.

Considering the influence of the crisis and inflation expectations in its aftermath, the ECB focused on non-conventional monetary policy practices such as quantitative easing (QE) (Kojien et al, 2017). Some studies have questioned the effectiveness of the QE policy. Lyonnet and Werner (2012), for instance, underlined that the asset expansion spurred by QE did not help recover from the crisis; consequently, the study concluded that the ECB's QE policy was unlikely to be effective as a monetary instrument. Although QE lost its significance in the EU prior to the COVID-19 pandemic, the expansion of the money supply and the provision of additional funding for public

expenditures were used to avert economic contraction following the pandemic's impact on the EU (Barbier-Guachard et al, 2023). COVID-19 undoubtedly affected EU economies negatively; however, periphery EU economies—with their low competitiveness and weak institutional and structural dynamics—had a significant decline in tourism revenue and faced more severe economic challenges during the COVID-19 period. Along with the expanding monetary base due to COVID-19, events such as energy crises due to the Russia-Ukraine war, the oil supply restrictions imposed by OPEC plus countries, and the escalation of geopolitical risks, exacerbated inflation risks in EU economic integration. Consequently, the ECB began raising real interest rates after a long period by enforcing a strict monetary policy to curb inflation. Nonetheless, it stopped raising interest rates toward the end of 2023 due to the slowdown in economic activity. All the aforementioned factors contributed to economic problems in EU integration. However, EU nations with low levels of competitiveness have more severe economic problems.

This study deals with a theoretical framework that sheds light on the EMU sovereign debt crisis in order to get at the heart of the issue. As defined by a fixed exchange rate system or a single currency in the optimum area, the optimum currency area (OCA) indicates that a single currency represents a single central bank and, consequently, a flexible supply of interregional means of payment (Mundell, 1961). The OCA defines the three primary conditions for a resilient monetary union as follows (Mundell, 1961; McKinnon, 1963; Mundell and Swoboda, 1969): (i) Members should restrain any potential shifts in competitiveness that fuel discrimination among participating nations. (ii) They ought to construct flexible labor and financial markets to absorb macroeconomic disparities and labor inactivity among participating nations. (iii) A central budgetary system that facilitates financial transfers between member states must be established. Concentrating on a new framework for comprehending institutional convergence and divergence among industrialized nations, the varieties of capitalism (VoC) demonstrates that the long-term economic developments underlying the EMU sovereign debt crisis lie in the institutional asymmetries of miscellaneous varieties of capitalism converging in a single currency union (Hall, 2017). Another approach analyzing the differences in institutional, political, and economic issues among countries, comparative political economy (CPE), highlights three noteworthy net observations that provide vital knowledge for understanding the dynamism and dysfunctionality of capital development among EU nations as follows: (a) institutional structures vary throughout EU member countries. (b) Core EU economies are more competitive than periphery EU economies. (c) Core EU economies outperform periphery EU economies in price competition (Olzhas, 2020).

In addition to the aforementioned theoretical framework, fundamentalists, and monetarists address the EMU sovereign debt crisis as well. Fundamentalists, for instance, attribute the EMU sovereign debt crisis to a lack of rules and discipline, a robust and competitive macroeconomic structure, and strict government fiscal principles (Weidmann, 2011). According to fundamentalists, taking stringent measures and sustaining stability and confidence in financial markets is essential (Issing, 2009). However, the liquidity gap was the primary concern of monetarists during the EMU sovereign debt crisis. According to monetarists, a tiny spark that begins as a liquidity deficit soon spreads to banks, drives down asset values, and eventually explodes into a systematic global crisis. They contend that a last funder can stop a financial crisis before it turns into an epidemic. Monetarists advocate the continuation of monetary unions and convergence with new institutions, whereas fundamentalists insist that monetary unions cannot be applied to economies with different structures (Collignon, 2012). Monetarists have highlighted the need for rescue money to resolve financial crises. On the other hand, rescue funds may foster distrust and unaffordable expenses in nations with low competitiveness (Roman and Bilan, 2012).

The VoC approach, which postulates an institutional asymmetry between the countries that are united under a single roof in the European Union, shares a common point with the CPE approach's net observations on the differences in competitiveness between the core and periphery EU economies. This common point refers to the competitiveness inequalities between

the core and periphery EU economies. Also, fundamentalists have highlighted the low competitiveness and lack of fiscal discipline of periphery EU economies in the EMU sovereign debt crisis, implying the differences in competitiveness between member countries (Hall, 2017; Olzhas, 2020). We should also consider the first and second conditions of the OCA for the elimination of competitiveness disparities and macroeconomic inequalities in the EMU (Mundell, 1961; McKinnon, 1963; Mundell and Swoboda, 1969). As a result, competitiveness inequalities between core and periphery EU countries may be a common feature of the aforementioned approaches to addressing the EMU sovereign debt crisis, other than the monetarist approach. This common feature is a bridge between this study and the theoretical framework. Consequently, this study empirically investigates the existence of competitiveness differences between the core and periphery EU economies in the long term.

In accordance with the aforementioned significant factors that postulate the primary reasons for the EMU sovereign debt crisis in the post-EMU period, the theoretical framework provides crucial information about the competitiveness inequalities between the core and periphery EU economies. The main purpose of this study is to empirically investigate the existence of asymmetry between the competitiveness of core and periphery EU economies in the long term. Rather than concentrating on the effects of short-term shocks, it investigates the existence of empirical findings that contradict the convergence approach in the eurozone for the post-EMU period. As a novel study, the summary of the unique contributions of this study to the literature is expressed as follows. (i) By robustly estimating the sovereign debt equations of core and periphery EU economies separately, the empirical analysis compares the competitiveness inequalities between core and periphery EU economies through sovereign debt estimates. (ii) This study employs advanced panel analysis techniques to conduct an empirically comprehensive and comparative analysis across 11 EU nations, using different panels for core and periphery EU economies from 2000:1 to 2022:4, via a new set of variables. Finally, (iii) the study offers policy recommendations for the sustainability of the European economy in light of empirical findings. Solving the competitiveness problems of periphery EU economies and stopping further erosion of trust is of great importance in this respect. The remainder of the study proceeds as follows. Section 2 reviews previous studies. Section 3 describes the model specifications and data. Section 4 presents the results of the empirical analysis and discussion. Section 5 concludes.

2. Literature Review

Reinhart and Rogoff (2010) highlighted that banking crises often trigger sovereign debt crises and accelerate banking crises through contagion. The 2008 global financial crisis caused many countries to confront financial challenges. Lane (2012) posited that the financial crisis caused a reassessment of asset prices and growth expectations. From this perspective, the US-based global financial crisis may be the trigger, rather than the cause, of the EMU sovereign debt crisis (Wegener et al, 2019). However, this issue remains a controversial topic in the literature. Ureche-Rangau and Burietz (2013) found empirical evidence for a statistically significant relationship between the financial crisis embodied by capital injections and government guarantees and the EMU sovereign debt crisis. Wegener et al. (2019) revealed clear evidence of the rapidly divergent behavior of periphery economies' EMU government bond yields compared to Germany during the financial and EMU sovereign debt crises (see also, Lund, 1999; Basse et al, 2012; Frömmel and Kruse, 2015). The authors tested whether the collapsed housing market bubble triggered divergent sovereign bond yields during the financial and EMU sovereign debt crises. The findings showed that this was the case during the 2008 global financial crisis but not during the EMU sovereign debt crisis. The analysis results revealed that austere financial issues in the periphery EU economies were related to the housing sector rather than imported from the USA.

Analyzing the contagion effects during the EMU sovereign debt crisis, Gomez-Puig and Sosvilla-Rivero (2013) found that causal relationships between sovereign debt yields in periphery EU economies exhibited a notable increase during the crisis. Katsimi and Moutas (2010) uncovered an empirical relationship between sovereign debt and current account deficits in Greece. The authors underlined that an increasing proportion of Greece's sovereign debt is held by non-residents, rendering the country susceptible to fluctuations in foreign investment. Peggas (2018) investigated a cointegration nexus between economic growth and investment, private and government consumption, trade openness, population growth, and sovereign debt variables for the Greek economy. The analysis results indicated that while the effect of sovereign debt on GDP growth was insignificant in the pre-2000 period, boosting sovereign debt after 2000 slowed economic growth. Exploring the nexus between sovereign debt and economic growth in a sample of EU member countries, Misztal (2010) revealed that a (1%) rise in sovereign debt has a negative influence on economic growth at a rate of (0.3), whereas a (1%) increase in economic growth has an impact on sovereign debt at a rate of (-0.4). Checherita-Westphal and Rother (2012) investigated the influence of sovereign debt on GDP per capita growth in twelve euro countries. The empirical results revealed that sovereign debt has a nonlinear negative effect on GDP per capita growth. The study identified the channels that were found to have a nonlinear influence on the per capita GDP ratio of sovereign debt as private savings, public investment, and total factor productivity. Examining the influence of current accounts and private sector debt on sovereign debt in core and periphery EU economies, Lazar and Andreica (2013) found that current accounts and private sector debt influenced sovereign debt in both country groups, yet they played a more significant role in increasing sovereign debt in periphery EU economies.

In their study, Gruppe and Lange (2014) presented empirical evidence that German and Spanish sovereign bond yields are cointegrated. In addition, they revealed empirical findings for the existence of a structural break in early 2009. The authors interpreted their empirical findings as an indication that financial markets were starting to see a higher sovereign credit risk in Spain. Ludwig (2014) found that the sovereign bond yields of Greece, Ireland, Italy, and Spain exhibited a convergence towards German interest rates, yet subsequently diverged, as evidenced by time series data from 1995 to 2012. Additionally, the study emphasized that bonds should not be considered risk-free in cases of long-term divergence. Wegener et al. (2016) employed the neural network technique (NN) with and without error correction terms to determine the convergence of sovereign bond yields for Germany and France and compared the performance of the estimation between both models. The analysis results demonstrated that a hybrid model, which combined with cointegration analysis and NN forecasting models, converged the sovereign bond yield series in Germany and France more strongly than the NN forecasting model. Exploring the alteration in the sovereign yield spread in the EMU sovereign debt process with panel data analysis, Kinatader and Wagner (2017) revealed that three unobserved common risk factors added to the model helped explain the valuation of bonds of periphery EU economies, particularly during the sovereign debt crisis.

Afonso et al. (2018) employed threshold vector autoregression (VAR) analysis to examine the associations between changes in debt ratio, economic activity, and financial stress in different financial regimes such as the USA, the UK, Germany, and Italy. The findings of the study detected that outputs exhibited a predominantly positive response to increases in debt ratios under different financial stress regimes. In addition, analysis results determined the negative impacts of financial stress shock, such as worsening growth and financial situation. Afonso and Jalles (2019) investigated the determinants of sovereign bond yield spreads using panel data analysis in ten EU countries. The analysis identified the primary determinants of sovereign bond yields as follows: (i) spread (liquidity measure), (ii) VIX (international risk measure), (iii) financial developments (debt ratios and budget balance ratios), (iv) rating developments (credit risk), (v) real effective exchange rate, and (vi) economic growth.

Examining the influence of macroeconomic, fiscal, and monetary developments and well-defined events on sovereign bond yield spreads in ten EMU countries, Afonso et al. (2020) found that the ECB's deposit facility, prime refinancing operations, marginal lending facility rate auctions, and critical interest rate announcements had a negative influence on the bond sovereign yield spreads of the sample countries. O'Sullivan and Papavassiliou (2020) conducted an empirical investigation into liquidity time series along the yield curve utilizing high-frequency data. The study presented empirical evidence of significant partnerships in the proxies of diffusion and depth liquidity in core and periphery EU economies that were weaker during the EMU sovereign debt crisis. Nevertheless, the empirical findings of the study revealed that the periphery EU economies exhibited a greater degree of partnership in the liquidity proxies than the core EU economies during the EMU sovereign debt crisis. Investigating the Eurobond issue in the euro area by using a two-country monetary union DSGE model, Badarau et al. (2021) revealed that the spending multiplier is highest for Eurobonds and lowest for limited Eurobonds, assuming a country decides to increase its public spending and cares little about debt stability. The findings of the study also showed that limited Eurobonds can yield higher total output and greater benefits for overall household well-being, contingent on country size. Concentrating on differentials between interest rates on sovereign bonds (r) and economic growth [g] in 22 OECD states for the period 1970-2018, Heimberger (2023) revealed that $[r-g]$ is the key determinant of sovereign debt dynamics. The study also indicated that the EMU sovereign debt crisis is associated with less favorable $[r-g]$, yet only in periphery EU countries.

3. Empirical Analysis

3.1. Model Specification and Data

The empirical analysis was performed using contemporary panel data techniques. The analysis resulted in 552 observations for core EU economies and 460 observations for periphery EU economies, using quarterly data for the period 2000:1–2022:4 (the post-EMU period). The core EU countries consist of Austria, Belgium, Denmark, the Netherlands, Germany, and France, while the periphery EU economies are Greece, Ireland, Italy, Portugal, and Spain. Analyses were carried out comparatively, utilizing separate panels for core and periphery EU economies. The data were retrieved from Eurostat and the FRED digital database. The baseline linear panel regression model for both groups of countries was formulated as follows:

$$SOVDE_{i,t} = \alpha_0 + \beta_1 IR_{i,t} + \beta_2 TCGG_{i,t} + \varepsilon_{i,t} \quad (1)$$

In Equation (1), the government debt-to-GDP ratio is defined as SOVDE, IR is the interest rates on long-term government bonds based on the index value (2000*=100), and, as a proportion of GDP, TCGG is the total credit to the general government. The selected independent variables are crucial to capture sovereign dynamics and draw significant inferences on sovereign debt in the sample EU economies. Consequently, this study employs robust and appropriate econometric methods to capture the behavior of variables based on panel data from core and periphery EU economies to analyze the influence of IR and TCGG on SOVDE for the post-EMU period. Moreover, it extends the analysis by comparing short and long term estimations obtained for core and periphery EU economies.

Descriptive Statistics

The distribution of the variables examined as a group is summarized in Table 1. Mean SOVDE and TCGG values in periphery EU economies are higher than in core EU economies (see, $b > a$, $f > e$). Approximately, the SOVDE of the periphery EU economies is significantly higher (about 40%) than that of the core EU economies, and this asymmetry is greater than the difference

between the independent variables of the two groups of countries. Similarly, TCGG is, on average, about 25% higher in periphery EU economies than in core EU economies. On the other hand, there is no significant difference in the IR between the two groups of countries. However, we highlight that the IR is higher in the core EU economies than in the periphery EU economies, albeit by a small amount (see, $c > d$). As a result, we conclude that the descriptive statistics provide significant preliminary information on the asymmetry between two groups of countries.

Table 1. Descriptive Statistics for Core and Periphery EU Countries as Groups

Descriptive Statistics	SOVDE	IR	TCGG
Core EU countries			
Mean	60.16 ^(a)	41.31 ^(c)	75.04 ^(e)
Std. Dev.	20.99	34.22	24.94
Max	105.80	127.85	135.60
Min	18.10	-12.35	24.90
Observations	552	552	552
Periphery EU countries			
Mean	99.84 ^(b)	38.22 ^(d)	102.98 ^(f)
Std. Dev.	45.38	32.93	43.65
Max	222.50	274.00	224.10
Min	23.40	-2.57	24
Observations	460	460	460

Notes: (a) and (b) show the mean of SOVDE, (c) and (d) the mean of IR, and (e) and (f) the mean of TCGG in core and periphery EU economies.

Table 2. Pairwise Correlations

Variables	SOVDE	IR	TCGG	SOVDE	IR	TCGG
	Core EU Countries			Periphery EU Countries		
SOVDE	1			1		
IR	0.076*	1		0.226***	1	
TCGG	0.914***	-0.03	1	0.968***	0.024	1

Notes: (*) and (***) denote significance at the %10 and %1 level, respectively.

Prior to a comprehensive econometric analysis, Pearson pairwise correlations may provide significant preliminary knowledge about the nexus between variables. Pairwise correlations are calculated and documented in Table 2. When we check Table 2, we detect positive and statistically significant correlations between SOVDE and the independent variables, such as IR and TCGG. We also underline that the positive correlation coefficients are stronger in periphery EU economies. These results motivate us to carry out comprehensive econometric analyses. In addition, the Pearson correlation coefficients between the independent variables provide enough evidence that there is no multicollinearity concern in the models. As a result, the bivariate

correlation coefficients, as well as the descriptive statistics, provide preliminary significant information to draw attention to the asymmetry between core and periphery EU economies.

Cross-sectional Dependence Tests

In order to apply appropriate unit root and cointegration tests in panel data, we must check the presence of cross-sectional dependence in the series (Mallick et al, 2016; Magweva and Sibanda, 2020). To this end, Breusch-Pagan LM, Pesaran scaled LM, Bias-corrected scaled LM, and Pesaran CD tests were applied to all series. The results of four tests were reported in Table 3. Based on the results of the cross-sectional dependence tests, we conclude that all series in two groups of countries are cross-sectionally dependent at the 1% level of error.

Table 3. Cross-sectional Dependence of Variables

Variables	Breusch-Pagan LM	Pesaran Scaled LM	Bias-corrected scaled LM	Pesaran CD
Core EU Countries				
SOVDE	394.68***	69.32***	69.28***	11.63***
IR	1345.49***	242.91***	242.88***	36.68***
TCGG	464.08***	81.99***	81.95***	19.58***
Periphery EU Countries				
SOVDE	628.76***	138.36***	138.33***	24.51***
IR	564.20***	123.92***	123.89***	23.12***
TCGG	606.43***	133.36***	133.34***	23.95***

Notes: (***) denotes significance at the %1 level.

Unit Root Tests

Before the main estimations, unit root tests must be carried out to check whether the variables are stationary. Stationarity tests, Im-Pesaran-Shin (IPS), and the cross-sectional augmented Im-Pesaran-Shin (CIPS unit root) tests, which take into account cross-sectional dependence, were carried out. Table 4 shows the results of the stationarity tests. Based on the results in Table 4, we conclude that the variables are integrated at the I(1) level at the 1% error level, and no variables are integrated in a second or higher order. This result shows that the stationarity condition of the panel ARDL approach is satisfied.

Table 4. The Results of Unit Root Tests

Variables	Order	Constant	Constant and Trend	Constant	Constant and Trend
		IPS		CIPS	
Core EU Countries					
SOVDE	Level	-0.4623	-0.7161	-16.741	-2.8683**
	First Difference	-12.7017***	-11.9345***	-8.1293***	-8.1567***

Variables	Order	Constant	Constant and Trend	Constant	Constant and Trend
		IPS		CIPS	
IR	Level	-0.3770	4.2935	-2.5176**	-3.5798**
	First Difference	-14.1263***	-14.1947***	-6.2757***	-6.2526***
TCGG	Level	-0.3078	1.3669	-19.133	-18.037
	First Difference	-12.3912***	-11.7650***	-4.6244***	-4.8796***
Periphery EU Countries					
SOVDE	Level	1.2894	1.3416	-19.116	-16.599
	First Difference	-5.8015***	-4.7684***	-5.9704***	-6.3589***
IR	Level	-1.4501	0.0477	-19.730	-23.420
	First Difference	-6.3893***	-5.2536***	-7.4764***	-7.5083***
TCGG	Level	0.5060	1.0173	-12.639	-0.2032
	First Difference	-5.605***	-4.5702***	-5.6949***	-7.1519***

Notes: (**) and (***) indicate significance at 5% and 1% levels, respectively.

Panel Cointegration Test

After the stationarity tests, panel cointegration tests were carried out to analyze the cointegration relationship between variables in the long run. In order to test cointegration, Pedroni (1999, 2004) and Westerlund (2007) panel cointegration tests were employed. Table 5 rolls out the results of the panel cointegration tests. Based on the results exhibited in Table 5, the null hypothesis was rejected for the two groups of countries. As a result, we conclude that there is a long-run cointegration nexus between the variables in both groups of countries. The results of the cointegration tests provide a solid basis for further econometric analyses.

Table 5. Results of Panel Cointegration Tests

	Core EU Countries		Periphery EU Countries	
Pedroni (1999, 2004) cointegration test				
Statistics	t-Statistic		t-Statistic	
panel v-statistic	1.9931**		6.5051***	
panel rho-statistic	-13.1405***		-5.5812***	
panel PP-statistic	-11.2664***		-4.8853***	
group ADF-statistic	-11.1160***		-4.5620***	
group rho-statistic	-4.6767***		-2.0555***	
group PP-statistic	-4.4776***		-1.7735**	
group ADF-statistic	-1.6349**		-0.6570	
Westerlund (2007) cointegration test				
Statistics	Value	P-value	Value	P-value
$Group_t$	-2.701	0.308	-2.525	0.503

$Group_a$	-18.996**	0.037	-20.750**	0.015
$Panel_t$	-10.523***	0.000	-8.889***	0.000
$Panel_a$	-38.672***	0.000	-31.826***	0.000

Notes: (**) and (***) indicate significance at 5% and 1% levels, respectively.

3.2. Results and Discussion

Loayza and Ranciere (2006) posited that static panel approaches such as pooled OLS fixed and random effects do not distinguish between short and long term relationships. The generalized method of moments (GMM) difference estimator introduced by Arellano and Bond (1991) and the GMM system estimator introduced by Arellano and Bover (1995) require a large number of samples. In addition, the GMM focuses more on short-term dynamics. However, the autoregressive distributed lag (ARDL) approach, which is a dynamic model that incorporates short and long-term information, can produce effective results even with a small number of samples. Moreover, the ARDL approach can be used for variables that are integrated in order, such as I(0) and I(1) (Ramos-Herrera and Prats, 2020). When the analysis period T is larger than the total cross-section volume N (T>N), the panel ARDL approach is appropriate and thus chosen for this study (see also, Asteriou, 2021). Taking advantage of its powerful features, this study employs the panel ARDL approach of Pesaran et al. (1999) as a main method to analyze the long-run and short-run relationships between variables. The results of the panel ARDL model are documented in Table 6.

Table 6. The Results of Panel ARDL Model

Main Model	Core EU Countries		Periphery EU Countries	
	ARDL (1, 1, 1)		ARDL (1, 1, 1)	
Dependent Variable: SOVDE				
Variables	Coef.	Std. Err.	Coef.	Std. Err.
Long Run				
IR	0.174***	[0.0261]	0.231***	[0.0111]
TCGG	0.713***	[0.0427]	0.886***	[0.0100]
Main Model	Core EU Countries		Periphery EU Countries	
Short Run				
ECC(-1)	-0.231**	[0.1156]	-0.202***	[0.0744]
Δ IR	0.1290***	[0.0392]	0.111	[0.0787]
Δ TCGG	0.5870***	[0.1079]	0.494***	[0.1094]
Constant	-1.394 [†]	[0.8249]	-1.296	[0.0074]
Obs.	552		460	
Num. of Grp.	6		5	

Notes: (*), (**), (***) and denote significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are in [brackets]. ECC is the error correction coefficient. (Δ) represents the first difference in the relevant variable. Akaike information criterion (AIC) was used in both models.

3.3. Robustness Check

Robustness checks were carried out for cointegrated regressions such as fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS), and finally the common correlated effects mean group (CCEMG) methods. The FMOLS model developed by Pedroni (2001), based on a non-parametric approach, takes into account the problems of autocorrelation, heterogeneity, simultaneous bias, and endogeneity of the regressors. Similarly, the DOLS model developed by Kao and Chiang (2001), which is similar to the FMOLS in terms of the problems it addresses, is based on a dynamic yet parametric approach that also covers the lags of the independent variables. The CCEMG model developed by Pesaran (2006) considers not only the autocorrelation and endogeneity problems but also the cross-sectional dependence problem. The consistency of the long-term coefficients in the ARDL model, which plays a critical role in determining the existence of an asymmetry between the core and periphery EU economies and demonstrates the competitiveness inequalities between the two groups of countries, was checked through a robustness analysis utilizing models that consider the problems of endogeneity and cross-sectional dependence.

The results of the models are documented in Table 7. In the FMOLS and DOLS models, the difference between core and periphery EU economies is evident in the IR and TCGG variables. Only in the CCEMG model are the coefficients of the IR variable very close in the two groups of economies. Although the coefficients of the IR variable are very close in both groups of countries, there is a notable difference in the TCGG variable between the two groups of countries in the CCEMG model. This result implies that the CCEMG method also provides empirical results that support the existence of the asymmetry between core and periphery EU economies, in addition to FMOLS and DOLS methods. As a result, the empirical results of three different models demonstrate that the coefficients of IR and TCGG in both country groups are not significantly different from the main model in the long run. As a result, we can conclude that the robustness control significantly supports the long term results of the ARDL model.

The results of the analysis were also discussed with the relevant literature. Previous studies, such as Ludwig (2014), Gruppe and Lange (2014), and Wegener et al. (2019), showed that the sovereign bond yields of periphery EU economies diverged from German sovereign bond yields during the EMU sovereign debt crisis. In addition, O'Sullivan and Papavassiliou (2020) detected similar results in the yield curves between core and periphery EU economies. The divergent behavior of macroeconomies within the same ecosystem during the crisis period can provide significant knowledge about the structural inequalities between them. In this context, the findings of this study align with Ludwig (2014), Gruppe and Lange (2014), Wegener et al. (2019), and O'Sullivan and Papavassiliou (2020). The empirical results of this study are also consistent with those rolled out by Lazar and Andreica (2013), who indicate that the current account and private sector debt have a stronger influence on sovereign debt, particularly in periphery EU economies. The findings of Lazar and Andreica (2013) are in line with those of this study, implying that the periphery EU economies exhibit weaker structural dynamics. Finally, Heimberger (2023) revealed that the differential between government bond interest rates and economic growth has a more pronounced influence on government debt dynamics in periphery EU economies. As a result, the results of Heimberger (2023) are in line with this study, implying a weaker macroeconomic structure of the periphery EU economies.

Table 7. The Results of FMOLS, DOLS and CCEMG Models

Models	Core EU Countries		Periphery EU Countries	
Dependent Variable: SOVDE				
MODEL (1): FMOLS	Coef.	Std. Err.	Coef.	Std. Err.
IR	0.052***	[0.0121]	0.208***	[0.0122]
TCGG	0.816***	[0.0030]	0.973***	[0.0098]
Adj. R ²	0.96		0.98	
MODEL (2): DOLS	Coef.	Std. Err.	Coef.	Std. Err.
IR	0.048***	[0.0133]	0.211***	[0.0119]
TCGG	0.794***	[0.0335]	0.973***	[0.0089]
Adj. R ²	0.98		0.99	
MODEL (3): CCEMG	Coef.	Std. Err.	Coef.	Std. Err.
IR	0.160***	[0.0363]	0.149***	[0.0467]
TCGG	0.758***	[0.0811]	0.867***	[0.0500]
Constant	-1.681	[4.8055]	-8.414*	[5.0485]
Wald X ²	106.80***		310.63***	
Obs.	552		460	
Num. of Grp.	6		5	

Notes: (*) and (***) denote significance at 10% and 1% levels, respectively. Robust standard errors are in [brackets].

4. Conclusion

The EU economies have surely shown impressive economic integration in the millennium. EMU, for example, may be regarded as an important sign of expanded economic integration inside the Eurozone. EU economies have had the opportunity to benefit from economic integration through free trade, foreign direct investments, integrated financial markets, and institutions that provide low-cost credits. However, the EMU sovereign debt crisis has caused significant concerns about maintaining the welfare environment. Thus, numerous academic studies have investigated the causes of the EMU sovereign debt crisis. After examining these studies meticulously, critical factors highlighted in these studies were discovered. These factors implicitly implied the asymmetry between EU economies in the post-EMU period. In addition, this study also analyzed the theoretical structure that provides a crucial framework for the EMU sovereign debt crisis. Similarly, apart from the monetarist approach, the theoretical framework attributed the primary cause of the problem to the disparities in competitiveness between EU economies. In this concept, this study formulated its investigation with the help of both the relevant literature and the theoretical framework. Accordingly, this study explored the existence of an asymmetry between the competitiveness of the core and periphery EU economies in the post-EMU period.

In order to empirically analyze the asymmetry in the competitiveness between core and periphery EU economies, this study estimated government debt separately for the period 2000:1–2022:4 with variables that are crucial in terms of competitiveness and sovereign debt dynamics in the

post-EMU period for both groups of countries. The analysis results demonstrated that IR and TCGG positively affect SOVDE, and the positive influence of TCGG is stronger than that of IR. The empirical findings discover two significant variables that boost sovereign debt in both groups of countries, yet we highlight the strong influence of TCGG. These results are consistent with the real situation of sovereign debt growth in the Eurozone, especially when considering the credits used by governments in EU economies. When the estimation results are compared between the two groups of countries, it is seen that the coefficients of the periphery EU economies are larger than those of the core EU in the long run, with the exception of the IR variable in the CCEMG model. The IR coefficient is similar in the CCEMG model across the two groups of countries in the long run. The empirical findings of the study indicated that a unit increase in IR and TCGG results in higher sovereign debts in periphery EU economies in the long run. Ultimately, the empirical results support the existence of an asymmetric structure between core and periphery EU economies, contradicting the convergence approach during the post-EMU period. In light of empirical evidence, this study argues for policy solutions that absorb competitiveness disparities between core and periphery EU economies. Contrary to the monetarist approach, which emphasizes the significance of providing funds as a last resort to close the liquidity gap, this study suggests that governments in the eurozone should limit their use of credit in the long term and that less competitive countries should create their own liquid financial resources. In the long run, this strategy is essential to reversing the sovereign debt growth dynamics of EU economies with low competitiveness. Thus, this study accepts the logical heterogeneity of EU economic policy, which solves the competitiveness and structural problems of EU countries with low competitiveness. In addition, we recommend that corporate companies producing highly qualified goods and services in core EU countries should increase their investments in countries with low competitiveness in the eurozone. Finally, we would like to draw attention to the significance of all these policy proposals being discussed by the EU's leading economists.

A new Brexit-like development may endanger the sustainability of the EU. With its recent robust economic performance after leaving the union with Brexit, the Irish case may become a target for another EU country. In this context, the resolution of the economic challenges faced by countries with low levels of competitiveness in the EU's economic integration is now a very critical issue for the long-run sustainability of the EU. Therefore, a consensus on the causes of the EMU sovereign debt crisis is of great importance. However, the fact that the causes of the EMU sovereign debt crisis are still controversial is an important limitation of this study. Instead of focusing on the effects of short-term shocks, this study depends on a long term basis and attributes the root of the problem to the long-term competitiveness differences between EU members. Nevertheless, there are also different perspectives. For example, it is posited that the financial crisis originating from the USA triggered the EMU sovereign debt crisis, while some studies draw attention to the construction sector expansion that has reached advanced levels in periphery EU countries. The issue of economic growth and competition against robust emerging economies is also on the agenda. Another issue that is given importance is that fiscal policy remains at the national level, in contrast to the integration performance of the monetary policy, that is, the integration problems and the lack of full harmony between the main policymakers. Some have attributed the problem to the EU's expansion, which they consider to have been both mismanaged and unnecessary. In conclusion, this study suggests that, firstly, future studies should analyze in detail the disparities in competitiveness between EU members in the eurozone. Secondly, there is a need for further discussion in EU policy-making on policy measures to reduce competitiveness inequalities between EU members. Finally, there can be an in-depth discussion on how to encourage corporate companies to produce quality goods and services in EU countries with high competitiveness to boost their investments in EU countries with low competitiveness.

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