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Government debt accumulation and non-performing loans: An ARDL bounds testing approach

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Abstract

Following the financial and debt crises in the euro area and the global COVID pandemic, governments supported their economies by increasing borrowing and accumulating debt with ambiguous long-run effects on non-performing loans (NPLs). We empirically investigate the determinants of NPLs using quarterly (2003Q1-2020Q2) aggregate data for Greece and applying the autoregressive distributed lag (ARDL) bounds testing approach. We offer new policy-making relevant evidence by showing that government debt has a significant and positive long-term impact on NPLs irrespective of possible short-term dynamics that appear to provide a temporary relief. Fiscal balance, on the contrary, exerts a negative long-term effect justifying the quest for surpluses post-COVID.

Keywords: Non-performing loans; Government debt; Fiscal balance; ARDL Bounds testing; Greece
JEL Classification Codes: C22, G21, H62, H63

1. Introduction

The COVID pandemic hit the global economy after a long period of financial instability following the financial and debt crises, especially in Europe. Governments intervened to protect employment and production continuity by providing generous support to firms and households. Central bank monetary policy became loose lowering the cost of borrowing and leading to increased government deficits and debt. Since NPLs were already high in many European countries, the short- and long-run effects of such measures became of utmost interest. How will NPLs be affected by the sharp increases in debt? Do the short-run effects provide a respite as expected? Do the effects persist in the long-run?

As it has been well documented in the related empirical literature, NPLs are determined by two groups of factors: country-related and bank-related. In particular, macroeconomic conditions, such as GDP growth (Anastasiou et al., 2016; Jimenez and Saurina, 2006; Karadima and

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Louri, 2021), unemployment and public debt (Foglia, 2022; Konstantakis et al., 2016; Louzis et al., 2012), lending rates (Espinoza and Prasad, 2010), inflation/deflation (Ghosh, 2015; Vithessonthi, 2016) and exchange rates (Beck et al., 2015) have been found to be major determinants of NPLs. Factors related to the structure of the banking sector, such as the degree of competition and the level of concentration have also been estimated in cross-country studies to affect risk taking and NPLs (Anginer et al, 2014; Kick and Prieto, 2015; Karadima and Louri, 2020). Finally, bank-related characteristics representing the quality of management, such as cost efficiency (Podpiera and Weill, 2008; Vo et al., 2021), bank performance (Anastasiou et al., 2019; Makri et al., 2014) and bank capitalization (Ghosh, 2015; Koju et al., 2018) have also been documented to play a role.

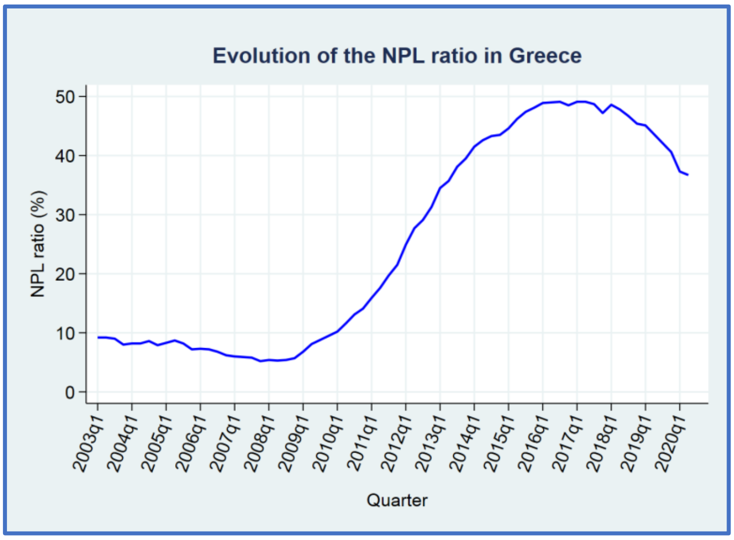
In this paper we attempt to empirically investigate the intricate role of fiscal expansion and buildup of debt using data from the Greek banking sector, which suffers from the highest rate of NPLs in Europe and, consequently, is the most vulnerable in terms of risk. There have so far been conducted some notable empirical studies for the Greek banking sector, such as those of Louzis et al. (2012) who investigated the impact of public debt on NPLs following a GMM panel data methodology, and Konstantakis et al. (2016) who examined the interdependency between public debt and NPLs using a VECM/VAR approach. We extend the existing literature for Greece by applying for the first time the autoregressive distributed lag (ARDL) bounds testing approach proposed by Pesaran et al. (2001), in order to investigate the effects of both debt and fiscal balance on NPLs in Greece and distinguish their short- and long-term effects. The Pesaran et al. (2001) approach facilitates the examination of a long-run relationship between variables that are purely I(0), purely I(1) or a mixture of both, thus removing the strict restrictions of traditional cointegration tests regarding the integration order of the variables involved in a regression model.

2. Data and variables

2.1. Data

We employ a dataset containing aggregated quarterly data for the period 2003Q1-2020Q2 obtained from the Bank of Greece, the Organisation for Economic Co-operation and Development (OECD), the Bank of International Settlements (BIS) and Eurostat. The evolution of the NPL ratio in Greece is shown in Figure 1.

*Figure 1***.** Evolution of the NPL ratio in Greece.



Source: Bank of Greece.

2.2. Variables

The growth rate of the NPL ratio (*NPL*) is the dependent variable in all our regressions and approximates credit risk.

The growth rate of the public (government) debt as percent of GDP (*PublicDebt*) is used as a proxy for a country's solvency risk, while the fiscal balance (government budget balance) as percent of GDP (*FiscalBalance*) quantifies the government's ability to meet its financing needs. The motivation behind the use of the above variables was to empirically investigate the intricate, and of most importance for us, role of fiscal expansion and buildup of debt on NPLs.

We also control for the following macroeconomic and bank-specific variables that have been well documented in the NPL-related empirical literature as some of the most important NPL determinants.

The real GDP growth rate (*GDP*) shows the fluctuations in economic activity. The inverse of the employment expectations indicator (EEI), compiled by Eurostat, is used to take into account unemployment uncertainty (*Unemployment*). The quarterly growth rate of the Consumer Price Index (CPI) measures inflation (*Inflation*).

The growth rate of bank credit (provided to non-financial corporations) as percent of GDP (*BankCredit*) is used as a proxy for financial development. To take into account possible long-term changes of the credit-to-GDP ratio, for example due to financial deepening (Drehmann et al., 2010), we also use the growth rate of the credit-to-GDP gap (*CreditGap*) as an alternative measure of credit growth. The ratio of net loans to total assets (*Loans_to_Assets*) indicates the specialization of banks in providing loans. The growth rate of the 3-month interbank rate (*InterbankRate*) approximates the stance of monetary policy. Finally, the growth rate of the interest rate spread (*InterestRateSpread*), which is the spread between loan and deposit rates, quantifies the efficiency of financial intermediation.

We allocate the above variables into four groups (see Table 1) in order to investigate the existence of a long-run relationship between the members of each group.

Table 1. Groups of variables.

Group 1	**Group 2**	**Group 3**	**Group 4**
NPL	*NPL*	*NPL*	*NPL*
GDP	*GDP*	*GDP*	*GDP*
PublicDebt	*PublicDebt*	*FiscalBalance*	*FiscalBalance*
Unemployment	*Unemployment*	*CreditGap*	*Inflation*
BankCredit	*Loans_ to_ Assets*	*Inflation*	*InterbankRate*
			InterestRateSpread

3. Econometric methodology

3.1. Selection of econometric methodology

In this study, we empirically investigate the long-run equilibrium relationship between the dependent variable (*NPL*) and each of the sets of independent variables belonging to the groups presented in Table 1. Our Augmented Dickey-Fuller (ADF) unit-root tests showed that our dataset contained both I(1) and I(0) variables, so it was impossible to use traditional cointegration techniques which concentrate on cases where all the underlying variables are I(1), although the original concept of cointegration, as defined in Engle and Granger (1987), may occasionally be extended to allow for both I(1) and I(0) variables in a cointegration equation (Johansen, 1995, p. 34, 74; Lutkepohl, 2004, p. 89). For this reason, we decided to use a bounds testing approach, within the autoregressive distributed lag (ARDL) framework proposed by Pesaran et al. (2001)

which can be applied irrespective of whether the underlying variables are I(1), I(0) or a mixture of both. In this context, we consider the following unrestricted error correction (EC) model.

$$\Delta y_t = \beta_0 + \sum_{i=1}^{p-1} \beta_{y,i}\, \Delta y_{t-i} + \sum_{k=1}^{K} \sum_{i=0}^{q_k-1} \beta_{k,i}\, \Delta x_{k,t-i} + \gamma_y y_{t-1} + \sum_{k=1}^{K} \gamma_k\, x_{k,t-1} + u_t \qquad (1)$$

where *y* is the dependent variable, x_κ (κ=1,2,..,K) are the independent variables, Δ is the difference operator, *p* and q_k (*k*=1,2,...,*K*) denote number of lags, *t* represents time (quarters) and u_t is the error term.

The proposed tests by Pesaran et al. (2001) are based on the standard F- and t-statistics. The F-statistic is used to test the null hypothesis (H_0) that the values of the coefficients γ_y and γ_k (k=1,2,…,K) are jointly zero (i.e., $\gamma_y=\gamma_1=\gamma_2=\ldots=\gamma_K=0$), suggesting the absence of a long-run relationship, against the alternative hypothesis (H_1) that at least one of these coefficients differs from zero. As the F-statistic has a non-standard distribution, Pesaran et al. (2001) provide two sets of critical values for the F-statistic, one that assumes that all variables are I(0) and another one that assumes that all variables are I(1). The critical values for the I(0) and the I(1) variables are considered as the lower bound and the upper bound critical values, respectively. If the F-statistic falls below the lower bound, the H_0 hypothesis cannot be rejected. If the F-statistic falls between the two bounds, the bounds F-test is inconclusive. Finally, if the F-statistic exceeds the upper bound, the H_0 hypothesis is rejected.

However, the rejection of the null hypothesis (H_0) solely cannot guarantee the existence of a long-run relationship, since the alternative hypothesis H_1 permits two cases, referred by Pesaran et al. (2001) as "degenerate level relationships", which imply no long-run relationship.

(a) $\gamma_y=0$, but at least one of $\gamma_1, \gamma_2, \ldots, \gamma_K$ is different from zero.

(b) $\gamma_y\neq 0$, but $\gamma_1=\gamma_2=\ldots=\gamma_K=0$.

To rule out the degenerate case (a), we use the t-statistic to test the null hypothesis of a zero coefficient of the lagged dependent variable (H_0:$\gamma_y=0$ against H_1:$\gamma_y<0$). As the t-statistic has a non-standard distribution, Pesaran et al. (2001) provide two sets of critical values for the t-statistic, one that assumes that all variables are I(0) and another that assumes that all variables are I(1). The bounds t-test is performed in a similar way with that of the bounds F-test.

Following Kripfganz and Schneider (2020), the ruling out of the degenerate case (b) is checked by conducting conventional Wald tests in order to test the null hypothesis (H_0) that the normalized long-run coefficients of the independent variables (i.e. $\theta_1=-\gamma_1/\gamma_y$, $\theta_2=-\gamma_2/\gamma_y,\ldots,\theta_K=-\gamma_K/\gamma_y$) are jointly zero.

3.2. Implementation of the selected econometric methodology

Our single-step estimation procedure was performed using the ardl.ado program, developed by Kripfganz and Schneider (2018). The regression results are presented in Table 2. The optimal number of lags per model and for each variable among all possible combinations of up to a maximum of 6 lags was selected using the Bayesian information criterion (BIC). The ardl.ado program uses the critical values that have been computed by Kripfganz and Schneider (2020). These values fit well to our small-size sample, since the critical values provided by Pesaran et al. (2001) have been generated for larger samples.

Based on the results of all three tests, i.e. the bounds F-test, the bounds t-test and the Wald test (see Tables A2 and A3 in the Appendix), we can definitely conclude that there exists a long-run relationship between our variables across all Models 1-4.

A set of post-estimation checks in order to assess the validity of our regression results were also conducted (see Table A3 in the Appendix).

Table 2. NPL regression models.

VARIABLES	Model 1	Model 2	Model 3	Model 4
Adjustment to equilibrium				
NPL(-1)	-0.688***	-0.657***	-0.512***	-0.535***
	(0.105)	(0.107)	(0.080)	(0.078)
Long-run relationship				
GDP (-1)	-1.965***	-1.809***	-3.355***	-3.347***
	(0.601)	(0.642)	(0.620)	(0.575)
PublicDebt (-1)	0.916***	0.905**		
	(0.333)	(0.361)		
Unemployment (-1)	0.178**	0.181**		
	(0.078)	(0.084)		
FiscalBalance (-1)			-0.338**	-0.308**
			(0.163)	(0.152)
Inflation (-1)			0.528	0.122
			(1.670)	(1.561)
BankCredit (-1)	0.042			
	(0.268)			
CreditGap (-1)			0.012	
			(0.010)	
Loans_to_Assets (-1)		0.063		
		(0.124)		
InterbankRate (-1)				-0.027*
				(0.014)
InterestRateSpread (-1)				0.242*
				(0.129)
Short-run relationship				
Δ*GDP*	-0.261	-0.011	-0.325*	-0.268
	(0.239)	(0.212)	(0.170)	(0.166)
Δ*PublicDebt*	0.062	0.097		
	(0.130)	(0.133)		
Δ*PublicDebt* (-1)	-0.338***	-0.313**		
	(0.119)	(0.122)		
Δ*Unemployment*	0.140	0.139		
	(0.087)	(0.090)		
Δ*Unemployment* (-1)	0.314***	0.292***		
	(0.087)	(0.090)		
Δ*FiscalBalance*			0.212**	0.196**
			(0.094)	(0.091)
Δ*Inflation*			-1.591**	-1.414**
			(0.647)	(0.626)
Δ*Inflation* (-1)			-0.577	-0.141
			(0.987)	(0.999)
Δ*Inflation* (-2)			-0.840	-0.051
			(0.879)	(0.928)
Δ*Inflation* (-3)			-3.532***	-3.153***
			(0.814)	(0.793)
Δ*Inflation* (-4)			-1.661**	-1.345*
			(0.715)	(0.708)
Δ*BankCredit*	-0.611*			
	(0.310)			
Δ*CreditGap*			0.006	
			(0.005)	

VARIABLES	Model 1	Model 2	Model 3	Model 4
ΔLoans_to_Assets		0.041		
		(0.082)		
Δ*InterbankRate*				-0.015*
				(0.007)
Δ*InterestRateSpread*				0.129*
				(0.067)
Constant	9.683	6.568	-0.754	-1.628
	(6.551)	(8.185)	(2.359)	(2.321)
Observations	64	64	64	64
R-squared	0.761	0.740	0.781	0.798
Adj. R-squared	0.692	0.672	0.712	0.729

Notes: **Dependent variable: Δ*NPL***. The symbols *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels respectively. Standard errors are reported in parentheses. Δ is the first difference operator, while (-n) represents the n-th lag (n=1,2,3,4). Models 1-4 correspond to the groups of variables 1-4 (see Table 1).

4. Empirical results

The results of the econometric estimation of our regression models are presented in Table 2.

4.1. Adjustment to equilibrium

The speed of adjustment, provided by the opposite of the statistically significant and negative coefficient of the first lag of the dependent variable, denotes how much of the adjustment to equilibrium takes place in each period. For example, the coefficient of adjustment in Model 1 is equal to -(-0.688)=0.688, which denotes that 68.8% of the adjustment takes place each quarter.

4.2. Long-run effects

The real GDP growth (*GDP*) exerts a statistically significant and negative impact on NPLs across all Models 1-4. Economic growth usually translates into higher income, which improves the financial capacity of borrowers.

The coefficient of the public debt growth rate (*PublicDebt*) is positive and statistically significant (Models 1-2). The sharp and continuing increase of the Greek public debt after the first quarter of 2009 fueled fears about sovereign solvency and about the need to introduce austerity measures aiming at improving debt sustainability. Such fears make people and enterprises insecure and willing to suspend their loan repayments. They also create financing difficulties for banks, which cannot roll over existing loans to enterprises. Debt servicing comes to a standstill and NPLs increase.

The uncertainty about future unemployment (*Unemployment*) has a positive and statistically significant impact on NPLs (Models 1-2). It is the fear about future unemployment that makes debtors likely to delay their loan payments or even stop them completely.

The coefficient of fiscal balance (*FiscalBalance*) is negative and statistically significant (Models 3-4). A fiscal surplus may give the opportunity to the government to increase public spending and investment, stimulating economic activity and leading to a subsequent reduction of NPLs. In contrast, a fiscal deficit may force the government to take austerity measures that would have an adverse impact on households and firms' income, thus increasing NPLs.

The coefficient of inflation (*Inflation*) is positive but not statistically significant (Models 3-4) as are the coefficients of the three bank-specific variables. An excessive growth rate of bank credit (*BankCredit*) is often coupled with lower lending standards and collateral requirements, a practice that turns up as loan losses during economic downturns (Model 1). Bank credit in Greece exceeded 100% of GDP in 2008Q3, reaching a peak of 119% in 2012Q2. A positive sign was also obtained for the growth rate of credit gap (*CreditGap*) in Model 3. Finally, the coefficient of the loans to assets ratio (*Loans_to_Assets*) in Model 2 was positive indicating that banks with high loans to assets ratios incur higher levels of NPLs due to selecting riskier projects as they increase loans. Still, all three estimated coefficients corresponding to bank-related characteristics were not statistically significant.

Finally, the last two variables taking into account the variability of interest rates were found to exert statistically significant long-term effects on NPL growth. The coefficient of the interbank rate (*InterbankRate*) is negative (Model 4), suggesting that an increase in interbank rates may lead banks with surplus money to invest in the interbank money market rather than provide risky loans. The coefficient of the interest rate spread (*InterestRateSpread*) is positive (Model 4), denoting that higher spreads between deposit and loan rates increase the cost to borrowers and, thus, lead to higher growth of NPLs.

4.3. Short-run effects

The coefficient of the variable Δ*GDP* is statistically significant only in Model 3. The coefficient of the variable Δ*PublicDebt(-1)*, representing the one-period delayed effect of an increase in public debt, is statistically significant and negative in Models 1 and 2. An increase in public debt, directed towards public spending, can promote lending activity and lead to a temporary decrease of NPL ratios through the denominator effect. A statistically significant and positive one-period delayed effect on NPLs is noticed in the case of unemployment uncertainty (Δ*Unemployment (-1)*) in Models 1 and 2, while fiscal balance appears to affect NPLs contemporaneously as the coefficient of Δ*FiscalBalance* is positive and statistically significant across both Models 3 and 4. Some noteworthy effects of inflation on NPLs, either being contemporaneous or coming from three and four quarters back, are indicated by the negative and statistically significant coefficients of the variables Δ*Inflation*, Δ*Inflation*(-3) and Δ*Inflation*(-4), respectively.

Regarding the bank-related determinants, the negative coefficient of bank credit (Δ*BankCredit*) in Model 1 implies a short-run reaction of the NPL ratio which can be attributed to the denominator effect. The short-term effect of the interbank rate (Δ*InterbankRate*) was found to be statistically significant and negative (Model 4) as in the long-term estimations. Likewise, the coefficient of the interest rate spread (Δ*InterestRateSpread*) is statistically significant and positive (Model 4) as in the long-term estimations. Finally, the coefficients of the variables Δ*CreditGap* and Δ*Loans_to_Assets* are statistically insignificant.

5. Conclusions

In this study, we empirically investigated the determinants of NPLs using quarterly (2003Q1-2020Q2) aggregate data for Greece and applying the autoregressive distributed lag (ARDL) bounds testing approach. We found that NPLs are determined mostly by factors related to macroeconomic conditions (GDP growth, public debt, fiscal balance and unemployment uncertainty) rather than by bank-related factors. Only the interbank interest rate and the spreads between deposit and loan rates as set by banks were found to affect NPLs significantly.

Of particular interest is the case of government debt, which was found to exert a significant and positive long-term impact on NPLs irrespective of some short-term dynamics that appear to provide a temporary relief. The fiscal balance was also found to exert a negative long-term effect, justifying the quest for surpluses post-crisis and for restoring fiscal sustainability. As debt accumulation is a policy followed by most countries in order to stabilize economies hit by the COVID crisis, its long-term effects on the financial system and, more specifically, on risk and NPLs should be taken into account, in particular by countries like Greece, which have already amassed a large fiscal burden.

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Appendix

Table A1. Summary statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max
NPL	70	2.400	6.794	-12.690	18.957
GDP	70	-0.372	2.345	-14.148	3.258
PublicDebt	70	0.897	3.519	-19.582	9.827
Unemployment	70	-99.449	10.385	-116.200	-75.100
FiscalBalance	70	-6.629	6.313	-30.700	5.700
Inflation	70	0.373	1.393	-2.070	3.550
BankCredit	70	0.633	2.266	-5.379	4.762
CreditGap	70	3.299	75.698	-300.000	525.00
Loans to Assets	70	65.584	5.044	53.487	74.209
InterbankRate	70	4.820	54.536	-114.130	327.692
InterestRateSpread	70	-0.056	6.000	-13.232	16.024

Table A2. Bounds F- and t-tests results.

			Critical values (at 5%)	
Model No.	**F-statistic**	**t-statistic**	**I(0)**	**I(1)**
1	11.576		2.986	4.358
		-6.570	-2.838	-3.979
2	10.122		2.994	4.350
		-6.156	-2.843	-3.986
3	8.284		3.019	4.326
		-5.412	-2.861	-4.006
4	11.622		2.977	4.366
		-6.369	-2.832	-3.972

Table A3. Other post-estimation tests results.

Test	**Null hypothesis**	**Model No.**	**p-value**	**t-value**	**Critical value (at 5%)**
Wald test	Long-run coefficients of independent variables are jointly zero	1	0.0000		
		2	0.0000		
		3	0.0000		
		4	0.0000		
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity	Constant variance	1	0.3935		
		2	0.3607		
		3	0.9939		
		4	0.5267		
Breusch-Godfrey LM test for autocorrelation	No serial correlation	1	0.1902		
		2	0.2918		
		3	0.9165		
		4	0.8693		
Durbin's alternative test for autocorrelation	No serial correlation	1	0.2502		
		2	0.3521		
		3	0.9284		
		4	0.8890		
Skewness and kurtosis joint test for normality (*)	Normality	1	0.0672		
		2	0.0635		
		3	0.3775		
		4	0.1972		
Shapiro-Wilk W test for normal data	Normality	1	0.1080		
		2	0.0766		
		3	0.3075		
		4	0.2339		
Ramsey RESET (Regression Specification-Error Test) for omitted variables	Model has no omitted variables	1	0.5278		
		2	0.3421		
		3	0.7344		
		4	0.5831		

Test	Null hypothesis	Model No.	p-value	t-value	Critical value (at 5%)
Cumulative sum (CUSUM) test for parameter stability	No structural break	1		0.9048	0.9479
		2		0.8857	0.9479
		3		0.4155	0.9479
		4		0.6131	0.9479

Note: * D'Agostino, Belanger and D'Agostino Jr. (1990) test, with the adjustment made by Royston (1991).