International Journal of Corporate Finance and Accounting
Volume 9 • Issue 1

Financial and Macroeconomic Drivers of Bank Profitability:

Evidence From Greek Systemic Banks During 2009-2019

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ABSTRACT

This paper aims at investigating the factors that affected the profitability of Greek systemic banks during the period 2009-2019. The authors initially review the findings of relevant international literature. Then, details of the methodology followed are provided and the variables that constitute the model are explained. Based on those, they investigate econometrically the factors that influenced banks' return on assets. The econometric analysis establishes that the ability of Greek systemic banks to generate profits through the use of their assets, during the period 2009-2019, was shaped under the influence of the debt crisis, which turned into a financial crisis, as well as specific financial and macroeconomic factors.

KEYWORDS

Debt Crisis, Financial Analysis, Financial Ratios, Greek Systemic Banks, Profitability, ROA

INTRODUCTION

The 2009-2019 decade has featured prominent changes in the economic landscape of Greece. Among others, the banking sector has undergone structural transformation both through the channel of EU-wide regulatory changes, as well as Greece-specific factors. We primarily cater about the latter set of factors in this paper, those pertaining to Greece. The performance of Greek banks could have not been left unaffected by a series of drastic developments in an economy which aimed to simultaneously tackle fiscal and structural problems, at a time when financing was scarce and the business environment fragile.

In parallel with the crisis unfolding in Greece, systemic banks were asked to continue their operation in an even more competitive EU banking market. Technological advances, new forms of finance, deregulation and increased interlinks shaped the morphology of the Greek banking sector, requiring banks to be open to new opportunities, but also ready to tackle any arising challenges that came along. At the same time, they had to support the resurgence of the Greek economy, distinguish profitable opportunities in a macroeconomic situation with asymmetric information and moral hazard, and continue credit provision to their clients. Besides, the issue of high non-performing loans featured prominently both in the academic and the policy debate.

DOI: 10.4018/IJCFA.312568 *Corresponding Author

As the backbone connecting and fueling economic activity across various sectors of the economy, banks ought to be aware of their dependencies, as well as their links to other economic sectors. As the same time, as firms that not only maximise their own profits, but also constitute the input for other sectors to carry out investment, it is equally important that banks have a clear understanding of the driving factors of their financial performance.

International literature has explored the driving factors of bank profitability during the great recession. In Greece, similar studies are carried out either for previous time periods or in a broader frame, comprising various aspects of bank balance sheets. Yet, the study of Greek bank profitability during the 2009-2019 period remains relatively less studies from an economic perspective. This is the gap that the present paper endeavours to fill through an econometric analysis of key factors often cited in the theoretical and international relevant literature.

The rest of the paper is structured as follows. We first provide a literature review. Then, we present the methodological framework, which is followed by an analysis of the research results. The last two sections discuss the policy implications of findings and conclude.

LITERATURE REVIEW

According to Katsimi and Moutos (2010), the situation that led to the Greek crisis mainly featured bureaucracy, vested interests and relations between private interests and the public sector, which contributed to the mismanagement of public resources, tax evasion and the deterioration of the quality of public services. At the macroeconomic level, governments proved to have been unable to reduce the fiscal deficit. On the side of the Greek statistical authorities, there may have been not only misrepresentation of data, but also significant errors on the side of European partners. The latter revealed the weakness or reluctance in their reactions to the visible signs of Greek failure, such as the chronically large current account deficits. In this regard, Kotios and Roukanas (2013) analysed the Greek financial crisis in light of the functional responsibilities and inadequacies of eurozone governance. Some of the dimensions of the management of the Greek crisis are the weaknesses of the European decision-making mechanism and European leadership, the economic nationalism displayed by some member states, the risks of contagion of the crisis to the Eurozone and the overreactions of markets and credit rating agencies.

Causes of the Greek Fiscal Crisis

Kutter (2014) points out that the high level of public debt in Greece rendered the implementation of austerity measures necessary, while the contagion dynamics of the Greek crisis justify the implementation of similar measures in other European countries. However, the Greek crisis has revealed the systemic flaws of EMU, highlighting the need for deeper economic integration. Provopoulos (2014), claims that the causes of the Greek crisis were the large external and fiscal imbalances. The growing deficit was the result of reduced competitiveness and the expansion of the public sector. Unlike what happened in other countries, the initial crisis in Greece led to a banking crisis. The country made significant progress in addressing the imbalances and the Bank of Greece managed to restructure the banking system. The resulting conditions have improved the outlook for the Greek economy, as assessed by financial markets. Finally, Gourinchas, Philippon and Vayanos (2017) concluded that the depth of the crisis related to the size of the macroeconomic imbalances, while the sudden interruption of capital flows in the economy also played an important role.

The Greek crisis highlighted the failure of the asymmetric institutional framework of EMU, which was due to its exclusive reliance on internal devaluation, economic fragmentation and lack of counter-cyclical policies, and which led to external imbalances. The Greek problem has pushed the Eurozone in the direction of developing strong policies and institutions and avoiding an existential challenge. Yet, it is argued that the EMU is stronger today, but not necessarily adequately equipped to deal with the next major crisis (Pagoulatos, 2020).

The Impact of Implemented Austerity Policies

According to Tsoulfidis, Alexiou and Tsaliki (2015) stressed that the recessionary environment created by sluggish profitability, discouraging investment, declining output and rising unemployment, combined with rising levels of debt, was exacerbated by the austerity policies imposed by the Troika. These contributed to one of the worst economic crises since World War II. Along the same lines, Lapavitsas (2019), the Greek crisis evolved into an economic and social disruption of historic proportions, with the main cause being the country's reduced competitiveness vis-à-vis the other members of the Eurozone. The austerity policies imposed on Greece by its lenders to ensure the stability of the Eurozone had a devastating impact on the economy and society.

Argitis and Nikolaidis (2014), prove that the austerity and fiscal consolidation did not improve the fiscal performance of the Greek public sector. The implementation of fiscal and wage austerity measures in an economy lacking structural competitiveness caused prolonged recession and deteriorated unemployment. Examining the characteristics of crises in four European countries, Galenianos (2015) concluded that the crisis was largely the result of fiscal inefficiency in Greece and less so in Portugal. This justifies the approaches on austerity policy as the appropriate way out of the crisis. On the other hand, public debt levels in Ireland and Spain were much lower. The common feature across all four countries was their high current account deficits. It therefore stipulates that the origin of the crisis should be traced more on external and less on fiscal imbalances. Furthermore, it also supports that the recovery in these countries will come through the regaining of their competitiveness as a result of a reduction in external deficits.

Matsaganis and Leventi (2013) examined the social impact of the crisis, recession, and austerity measures in Greece in the period 2009-2012. They showed that relative poverty increased, and income losses were higher for high-income groups in absolute terms. However, in relative terms, lower income groups were affected the most. The state response to the increased social protection needs, resulting from job and income losses, is considered insufficient, while tackling tax evasion would be crucial to reduce deficits. Leventi and Matsaganis (2016) show that inequality increased further in 2013, due to the even greater recession and unemployment. It then slightly decreased in 2014 with the temporary stabilisation of the economy. Relative poverty followed roughly the same path. The population groups most affected were the unemployed, the self-employed, the young, the middle-aged and families paying rent or mortgage instalments.

During the crisis, Greece experienced serious and rapid changes in labour relations and the system of determining wages in the private and public sectors. Despite the general perception, the adjustment of public sector wages was limited and slow. In contrast, the private sector has recorded a remarkable adjustment. There, the characteristics of workers and work have changed and a pay structure that better rewards marketable skills has emerged. This structural change in the labour sector may contribute to the recovery prospects of the Greek economy (Christopoulou & Monastiriotis, 2016).

The austerity program in Greece has had serious consequences on the Greek banking market, which can be seen in the dramatic increase in non-performing loans, the reduction in the number of banks operating in the country due to mergers and acquisitions, the reduction in the number of bank branches, the dismissal of employees, and the withdrawal of foreign banks. Greece ended up with the most centralised banking system in the Eurozone. However, certain metrics were formed that seem to work in favour of bank productivity, such as deposit or loan ratios per branch and per employee (Karafolas, 2019).

The Greek Banking Sector During the Crisis

The banking sector in Greece has been severely affected by the crisis. Considering that the NPE ratio peaked in 2016 at 45%, banks became unable to raise capital. This undermined their intermediation role. Due to the uncertainty of the macroeconomic environment and the country's prospects in the euro area, deposits fell by €117 billion, or 49%, between September 2009 and December 2015. During long recessions, it is expected that higher levels of capital adequacy are required as a buffer against unforeseen risks, which in the case of Greek banks was another obstacle to financing the

real economy. These factors, combined with high provisions against loans of low creditworthiness, triggered the banks' continuous losses until 2015. Increased business risk and uncertainty about the future financial situation of households limited the demand for credit. In addition, restrictions on capital movements further hampered economic activity (Stournaras, 2018, Katsaboxakis, 2021).

The quality of Greek banks' balance sheets deteriorated, negatively affecting the supply of credit to the economy, with an impact on economic activity. Exploring the period 2001-2018, Louri and Migiakis (2019) come to some important findings on this. Bank recapitalizations and liquidity provision by the CB were a temporary solution. Market financing of the economy could only partially substitute bank financing. Therefore, as the Greek economy recovers, Greek banks need to resolve the NPLs problem on the one hand and provide the necessary liquidity to the economy on the other hand, looking forward to an efficient allocation of capital.

Various researchers have examined the volatility of bank's financial indicators during the Greek crisis. Regarding the factors that influenced the profitability of Greek banks during the crisis, Schiniotakis (2012) showed that a high ROA ratio is associated with well-capitalised banks with sufficient liquidity. It is also observed that cooperative banks were initially less affected by the crisis than commercial banks. The research by Sompolos and Mavri (2018) reveals that the operating efficiency of Greek banks reached its peak in 2008 and until 2013 it had a downward trend. The financial crisis led to a 30% to 40% decline in their profitability during the same period.

The exit from the crisis, which affected incomes and employment in Greece, required three adjustment programmes, a major debt restructuring and three bank recapitalisations. The duration and depth of the crisis could be explained by political insufficiencies, delays in implementing the necessary reforms and inadequacies in the EMU infrastructure. However, the implemented economic adjustment programme has largely eliminated macroeconomic imbalances and reformed the economy in various sectors, improving its competitiveness. The banking system has been restructured and the economy is recovering. High levels of public debt, non-performing loans and unemployment remain. Reforms to accelerate the recovery, and export-oriented growth models, should therefore be implemented. In this direction, political solidarity at the European level and risk-sharing are needed to achieve EMU integration (Stournaras, 2019).

Factors Affecting Banking Sector Profitability

At the macroeconomic level, Kosmidou (2008) showed that the two variables that have a statistically significant effect on return on assets are the change in gross domestic product (GDP) and inflation, which have a positive and negative effect on performance respectively. Athanassoglou, Brissimis and Delis (2008) studied the banking and macroeconomic factors that affect the profitability of Greek banks over the 1985-2001 period. They concluded that capital is important in explaining profitability and credit risk exposure has a negative effect on profits. Increased labour productivity has a positive impact, while operating expenses have a negative impact. The effect of industry concentration on bank profitability is found to be insignificant. Inflation also clearly affects the performance of the financial sector. The business cycle has a positive effect, but only in its upper phase. Bucevska and Hadzi Misheva (2017) show that the degree of industry concentration, the size of the credit institution and macroeconomic variables such as inflation and economic growth do not have a statistically significant impact on profitability.

Besides macroeconomic factors, various studies highlight the importance of financial factors. In their study, Kosmidou and Zopounidis (2008) evaluated the efficiency of Greek commercial and cooperative banks for the period 2003-2004. The results of the study showed that commercial banks improve their financial ratios, increasing their competitiveness and maximizing their profits through increasing their accounts and attracting more customers. For cooperative banks, on the other hand, the conclusions are not uniform because some show significant profits, while others show deteriorating financial ratios. Studying the profitability of Greek banks over the period 2002-2005, Gaganis, Liadaki, Doumpos and Zopounidis (2009) found that the use of loan loss provisions as an independent variable improves the explanation of profitability. The logarithmic variables of staff number, income per capita,

gross fixed capital formation and the loan-to-deposit and loan-to-total assets ratios have a significant impact on efficiency. Analysing the determinants of Greek banks' profitability during the crisis, Schiniotakis (2012) also confirmed that well capitalized banks with high liquidity are characterized by high return on total assets. This implied that capitalization was a variable that impacted profitability regardless of the time period during which the study took place. Moreover, Menicucci and Paolucci (2016) studied variables affecting the profitability of the 35 largest European banks over the period 2009-2013. The regression results showed that size and capital adequacy are important factors that have a positive impact on the profitability of financial institutions, while higher loan loss provisions result in lower levels of profitability. In addition, according to the findings, a high deposit to loan ratio leads to higher profitability, although in some cases, the impact on profitability is statistically insignificant. Bongini, Cucinelli, Di Battista and Nieri (2019) identified the main factors leading to profitability crises (significant, sudden drop in profits) and those that allow banks to regain lost ground. Their findings showed that the profitability crisis is driven by deteriorating loan portfolio quality, in particular excessive risk taking not offset by adequate provisions for credit risk. On the other hand, recovery occurs when institutions adopt a conservative lending policy, reducing the supply of loans and effectively addressing the issue of NPLs.

Through a review of the existing literature, it appears that there are two broad groups of variables that affect bank profitability (Katsaboxakis et al., 2022). The first group includes factors related to the industry itself and the second group includes those related to the macroeconomic environment in which the banking sector operates (Alexiou & Voyazas, 2009, Basdekis et al., 2020). Pasiouras and Kosmidou's (2007) survey of Greek and foreign banks in the European Union during the period 1995-2001, points also in the same direction. Both macroeconomic and financial variables are important, but their relationship with and impact on profits is not always the same for foreign and Greek banks. More specifically, the examination of either domestic or foreign banks showed that equity is positively related to the return on assets ratio. In fact, for domestic banks, equity is the most important factor in profitability. The cost-to-income ratio is negatively related to profitability and seems to be the most important determinant, as far as foreign banking institutions are concerned. The relationship between size and profitability is negative for Greek and other European banks. The change in GDP and inflation have significant effects on return on assets, but in different directions for domestic and foreign financial institutions. Finally, the degree of market concentration has a different impact on the ROA ratio for Greek and European banks. Cheng and Mevis (2019) collected data from the financial statements of 310 Euro Area banks for the period 2005-2016, covering the global financial crisis and the European debt crisis. According to their research, the profitability of euro area credit institutions suffered a double whammy. Large banks, with diversified portfolios, were affected by the collapse of Lehman Brothers, as their investments in securities suffered losses. Traditional banks, specialising in retail loans, were hit by the debt crisis and the subsequent economic downturn, due to the rising costs associated with the impairment of the loan portfolio. The first shock had a negative impact on bank profitability for a short period of time, while the second continues to affect the profits of European banks.

The literature on the subject looking beyond Greece also establishes similar findings for banks in other countries (Eriotis et al., 2007, Katsaboxakis et al., 2015). According to a study by Staikouras and Wood (2004) on external and internal factors affecting the profitability of European banks, it was shown to be influenced by management decisions and by changes in the external macroeconomic environment. The results are contrary to what past studies have shown, in which a positive relationship was established between profitability and the degree of concentration and/or market share variables. Kanas, Vasiliou and Eriotis (2012), the profitability of banks in the US over the 1988-2011 period is non-parametrically affected by factors such as the business cycle, inflation expectations, short-term interest rates, credit risk and loan portfolio structure. Berger and Bouwman (2013), examined how capital, and by extension capital adequacy, affects the performance of a US bank in normal times, in times of banking crises and in times of market crises. According to the results, capital helps small financial institutions to survive and medium and large ones to enhance their efficiency, especially

during banking crises. Van Dooren (2017) investigates the determinants of the differences in bank profits across EU countries over the period 1998-2013. Specifically for Greece, he reports that the debt crisis caused significant losses to domestic financial institutions, which experienced negative return on assets for the period considered Using a sample of banks from 47 countries, covering the period 2005-2013, Claessens, Coleman and Donelly (2018) investigated the effects of interest rates on banks' net interest margin and profitability. They found that low interest rates have a significantly larger impact on NIM, and hence profitability, compared to high interest rates, although the impact of interest rates on profitability was found to be less strong.

METHODOLOGY

In this paper, a multiple linear regression analysis is used to estimate a model that has the "*ROA*" as the dependent variable Y and includes five independent variables. Of these, three are banking indicators ("*CAR*", "*Δ%Deposits*", "*PCL*"), one is a macroeconomic variable ("*LnDebt*") and one is dummy variable ("*PSI*"). Based on the results of the regression analysis, the statistical significance of the estimated coefficients of the variables and the existence of a linear relationship between the dependent variable and the explanatory variables are tested. Furthermore, the degree of correlation between the variables is examined and a test of multicollinearity is carried out.

Table 1 contains a summary description of the dependent and independent variables used in the model.

Table 1. Variables of the linear regression model

Variable		Description
Υ	*ROA*	Return on assets ratio
X_1	*CAR*	(Total) capital adequacy ratio
X_2	*Δ%Deposits*	Annual percentage change in deposits
X_3	*PCL*	Provision for credit losses ratio
X_4	*LnDebt*	Natural logarithm of public debt
X_5	*PSI*	Pseudo-variable for the year that banks were affected by the haircut of Greek government bonds

Therefore, the estimated regression equation is formulated as follows:

$$\hat{Y} = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5$$

or

$$\widehat{ROA} = b_0 + b_{CAR} \times CAR + b_{\text{"}\%\text{Deposits}} \times \text{"}\%\text{Deposits} + b_{\text{PCL}} \times \text{PCL} + b_{\text{LnDebt}} \times \text{LnDebt} + b_{\text{PSI}} \times \text{PSI}$$

where: b_i are the estimated values of β_i coefficients.

The choice of "*CAR*" and "*PCL*" variables is consistent with the literature, in which their effect on bank profitability is significant. Considering that Greek banks went through a period when lack of confidence led to deposit losses, which started to return when economic sentiment reversed, the

variable "*Δ%Deposits*" was included in the model. Banks hold a significant proportion of public debt. With the implementation of the private sector-led debt write-down programme, the initial fiscal crisis in Greece turned into a banking crisis, affecting the profitability of financial institutions. Therefore, through the model, the effect of the variable "*LnDebt*" and the dummy variable "*PCL*" on the profitability of banks' assets is examined.

The variables constituting banking indicators have been calculated on the basis of data extracted from the annual financial reports of the four Greek systemic banks for the years 2009-2019 (seeAnnex). Data for the macro variable were retrieved from Thomson – Reuters database and processed accordingly. TheAnnex tables summarize the data used to perform the analysis.

DATA ANALYSIS AND RESULTS

The Linear Regression Equation

The sample consists of 44 observations. It can be seen from Table 4 (in Annex 1) that the estimated regression equation is as follows:

$$\hat{\mathrm{Y}} = 0,207289 \times \mathrm{X}_1 + 0,051853 \times \mathrm{X}_2 - 0,561679 \times \mathrm{X}_3 - 0,003596 \times \mathrm{X}_4 - 0,054572 \times \mathrm{X}_5$$

or

$$\widehat{ROA} = 0,207289 \times CAR + 0,051853 \times \Delta\%Deposits - 0,561679 \times PCL - 0,003596 \times LnDebt - 0,054572 \times PSI$$

Testing for Statistical Significance of the Regression Equation

The coefficient of multiple determination R^2 indicates that 89.2% of the volatility of the asset return ratio is due to the effect of the independent variables of the model. All other factors account for 10.8% of the volatility of the asset return ratio. The adjusted coefficient of multiple determination (adjusted R^2) equals 85.5%, i.e., 3.7 percentage points lower than the simple determination factor. It takes into account the loss of degrees of freedom, which is due to the addition of variables into the model. Considering the R^2 and R_a^2 values, it could be asserted that the ability of a Greek systemic bank to generate profits in a given accounting year between 2009 and 2019 – based on all its available financial resources – depended approximately 87.3% upon:

- the capital adequacy of the bank
- the annual percentage change of client deposits
- the provision for credit losses
- the domestic public sector debt
- the consideration on whether that specific year a "haircut" of Greek government bonds occurred.

In order to test for statistical significance of the linear regression equation, we examine the statistical significance of the R^2 coefficient. We thus test whether the coefficient of multiple determination measures, i.e., the percentage of variability of the dependent variable, which comes from the effects of independent variables and which can therefore be explained by the regression equation, is different from zero (Halikias, 2008). Below, the test is performed at the 1% significance level. We formulate the null and the alternative hypotheses as follows:

H_0: The linear regression equation does not explain the changes of the dependent variable at all. Thus, $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$.
H_1: The linear regression equation explains part of the variability of the dependent variable. Hence, at least one of the β_1, β_2, β_3, β_4, β_5 coefficients is different from zero.

From Table 4 we infer:

$$F_{5,39} = 64.234 \, and \, P\left(F_{5,39} > 64.234\right) = 1.706 \times 10^{-17} < 0.01$$

The area or probability of the $F_{5,39}$ distribution for values equal or above 64.234 is less than the significance level (1%). The null hypothesis is rejected, meaning that at least one partial regression coefficient is non-zero. Therefore, the model is generally statistically significant, at a significance level of 1%. Thus, it is confirmed that the regression equation partially explains the variation in the dependent variable. The percentage of "*ROA*" dispersion explained by the explanatory variables of the model is greater than zero.

Testing for Statistical Significance of Regression Coefficients

Based on the results of the regression, we can test for the statistical significance of its parameters. We chose to do so at the significance level $\alpha = 1\%$. We test for the sign of the partial regression coefficients. We thus get:

- **β0 coefficient**

The constant term was found to be statistically non-significant. Hence, it was removed from the model.

- **β1 coefficient**

To test for the statistical significance, we formulate the null and the alternative hypotheses as follows:

H_0: $\beta_1 = 0$, provided that all the independent variables are included in the model.
H_1: β_1 1 0, provided that the above condition applies.

As per the results table, we note that $P(|t_{39}| > 4.027) = 2.522 \times 10^{-4}$ for the β_1 coefficient, i.e., the two-dimensional probability corresponding to the value $|t_{39}| = 4.027$ is less than the significance level $\alpha = 0.01$ (p-value < 0.01). Thus, the H_0 hypothesis is rejected and the coefficient of the X_1 variable "*Capital adequacy of the bank*" is statistically significant, other than zero. The coefficient of the X_1 variable is 0.207289, implying a positive impact on the return on assets. Increasing the "*CAR*" index by 1% will increase the "*ROA*" by about 0.00207 points or by about 0.207 percentage points, provided that all other variables of the model remain constant. The positive sign of the factor is deemed reasonable, expected and in accordance with the international literature (Pasiouras & Kosmidou, 2007; Kosmidou, 2008; Schiniotakis, 2012; Menicucci & Paolucci, 2016). Based on the coefficient value, it can be concluded that a change of the "*CAR*" index greatly affects the dependent variable.

- **β2 coefficient**

To test for the statistical significance, we formulate the null and the alternative hypotheses as follows:

H_0: $\beta_2 = 0$, provided that all the independent variables are included in the model.
H_1: β_2 1 0, provided that the above condition applies.

As per the results table, we note that $P(|t_{39}| > 4.044) = 2.4\times10^{-4}$ for the β_2 coefficient, i.e., the two-dimensional probability corresponding to the value $|t_{39}| = 4{,}044$ is less than the significance level $\alpha = 0.01$ (p-value < 0.01). Thus, the H_0 hypothesis is rejected and the coefficient of the X_2 variable "*Annual percentage change of client deposits*" is statistically significant, other than zero. The coefficient of the X_2 variable is 0.051853, implying a positive impact on the return on assets. This is deemed to be expected. Increasing the X_2 variable by 1% will increase the "*ROA*" by about 0.00052 points or by about 0.052 percentage points, provided that all other variables of the model remain constant. The value of the coefficient reveals that a change of the X_2 explanatory variable has a relatively small effect on the dependent "*ROA*" variable.

- **β_3 coefficient**

To test for the statistical significance, we formulate the null and the alternative hypotheses as follows:

H_0: $\beta_3 = 0$, provided that all the independent variables are included in the model.
H_1: β_3 1 0, provided that the above condition applies.

As per the results table, we note that $P(|t_{39}| > 5.549) = 2.189 \times 10^{-6}$ for the β_3 coefficient, i.e., the two-dimensional probability corresponding to the value $|t_{39}| = 5.549$ is less than the significance level $\alpha = 0.01$ (p-value < 0.01). Thus, the H_0 hypothesis is rejected and the coefficient of the X_3 variable "*Provision for credit losses ratio*" is statistically significant, other than zero. The coefficient of the X_3 variable is -0.561679, implying a negative impact on the return on assets, ceteris paribus. In other words, increasing the "*PCL*" ratio by 1% will result in a fall of the "*ROA*" by about 0.00562 points or by about 0.562 percentage points, ceteris paribus. According to the international literature (Menicucci & Paolucci, 2016; Bucevska & Hadzi Misheva, 2017), the positive sign of the factor is deemed reasonable and expected. In our model, the value of the coefficient reveals that a change of the X_3 explanatory variable greatly affects the dependent "*ROA*" variable.

- **β4 coefficient**

To test for the statistical significance, we formulate the null and the alternative hypotheses as follows:

H_0: $\beta_4 = 0$, provided that all the independent variables are included in the model.
H_1: β_4 1 0, provided that the above condition applies.

As per the results table, we note that $P(|t_{39}| > 2.367) = 0{,}023$ for the β_4 coefficient, i.e., the two-dimensional probability corresponding to the value $|t_{39}| = 2.367$ is greater than the significance level $\alpha = 0.01$ (p-value > 0.01), meaning that the H_0 hypothesis cannot be rejected. However, the two-dimensional probability is less than the significance level $\alpha = 0.05$ (p-value < 0.05). Thus, at the specific significance level ($\alpha = 0.05$), the H_0 hypothesis is rejected and the coefficient of the X_4 variable "*LnDebt*" is statistically significant, other than zero. The coefficient of the X_4 variable is -0.003596. This is deemed to be reasonable and expected. An increase in the logarithm of the Greek public debt by one unit will result in a fall of the "*ROA*" by about 0.003596 points or by about 0.36 percentage points, ceteris paribus. A change of "*LnDebt*" greatly affects the dependent variable.

As per relevant literature, banks are argued to be significantly exposed to sovereign debt (Kosmidou, Kousenidis & Negakis, 2015). In Greece, the initial debt crisis led to a widespread financial system crisis (Pagoulatos & Quaglia, 2013; Provopoulos, 2014), causing huge losses to banks, which experienced negative return on assets (Van Dooren, 2017). In particular, institutions specializing in retail banking were hit hard by the subsequent economic downturn, affecting their profitability even in the post-crisis period (Cheng & Mevis, 2019)

- **β5 coefficient**

To test for the statistical significance, we formulate the null and the alternative hypotheses as follows:

H_0: $\beta_5 = 0$, provided that all the independent variables are included in the model.
H_1: β_5 [1] 0, provided that the above condition applies.

As per the results table, we note that $P(|t_{39}| > 5.568) = 2.062 \times 10^{-6}$ for the β_5 coefficient, i.e., the two-dimensional probability corresponding to the value $|t_{39}| = 5.568$ is less than the significance level $\alpha = 0.01$ (p-value < 0.01). Thus, the H_0 hypothesis is rejected and the coefficient of the X_5 variable "*PSI*" is statistically significant, other than zero. The coefficient of the X_5 variable is -0.054572. The possible values for the pseudo-variable are 1 (if we refer to the year 2011) and 0 (for all other years). If it takes the value 0, the independent variable has no effect on the dependent one. Taking the value 1, it will negatively affect the "*ROA*" index and will reduce it by 0.054572 points or by 5.457 percentage points, ceteris paribus. The negative effect in this case is deemed as expected. As the research of Vousinas (2015) has shown, the "haircut" of bonds incurred a negative impact on Greek banks. In our model, the degree of influence of the pseudo-variable on the dependent variable is found to be very high.

- **Conclusions on the Linear Relation**

The above analysis confirms the existence of a linear relationship between the dependent variable ("*ROA*") and the explanatory variables of the model, at the 1% significance level for the variables "*CAR*", "*Δ%Deposits*", "*PCL*", "*PSI*" and at the 5% significance level for the variable "*LnDebt*".

Correlation Analysis

The following table examines the correlation between of the model variables (Table 2):

Examining the data in the table, we observe a strong positive correlation between the dependent variable Y ("*ROA*") and the independent variables X_1 "*Capital adequacy of the bank*" (71.1%) and X_2 "*Annual percentage change of client deposits*" (52.5%). The dependent variable is negatively, less

Table 2. Correlation matrix

	Y=ROA	*X1=CAR*	*X2=Δ%Deposits*	*X3=PCL*	*X4=LnDebt*
Y=ROA	1				
X1=CAR	0,711014967	1			
X2=Δ%Deposits	0,524846678	0,17672628	1		
X3=PCL	-0,411494942	-0,064306834	-0,136955567	1	
X4=LnDebt	-0,43133419	-0,653935323	0,106254368	-0,140220508	1

strongly, correlated with the independent variables X_3 "*Provision for credit losses ratio*" (-41.1%) and X_4 "*Logarithm of public debt*" (-43.1%).

Regarding the correlation between the independent variables of the model, it is worth mentioning the high negative value of the coefficient (-65.4%) for the variables "*CAR*" and "*LnDebt*". Although as a result it is considered reasonable, due to the high coefficient, a test of multilinearity is subsequently performed. A mild positive correlation appears to exist between the explanatory variables X_1 and X_2 (17.7%), while the correlation between X_1 and X_3 is very limited (-6.4%). The negative correlation between the variables "*D%Deposits*" and "*PCL*" is also mild (-13.7%). The coefficient for variable X_2 relative to X_4 (10.6%) indicates a limited positive correlation between them. The sign could be explained by the fact that a high public debt pushes governments to take measures such as tax increases, which leads to a decrease in private consumption and a tendency to save more. Finally, the negative correlation between the "*PCL*" and "*LnDebt*" variables is relatively weak (-14%).

Testing for Multicollinearity

To test for multicollinearity using the VIF coefficient, we need to calculate the multiple determination coefficient for each independent variable of the model, in relation to the other interpretive variables. In this regard, the regression analysis is repeated, setting X_1 as dependent variable and examining its linear relationship with the other interpretive variables of the model. The same exercise is performed again, using X_2 and then X_3 and X_4 as dependent variable. The multiplication coefficients R_j^2 are derived from the results of the analyses.

$$\mathrm{VIF_j} = \frac{1}{1 - \mathrm{R_j^2}}$$

The variance coefficients of expansion (VIF) for the four independent variables were calculated according to the equation above and their values are presented in Table 3 below. At first stage, the X5 pseudo-variable was not included in the analysis. Then, the process was repeated with its addition.

Examining the section on the left in Table 3 we see that the value of the VIF coefficient is less than 2 or marginally greater than 2, for all four variables, which indicates that the multicollinearity is limited. By repeating the procedure after adding the pseudo-variable (right section of Table 3), the coefficient values increase. It remains at low levels (1.1 and 1.55 respectively) for X_3 ("*PCL*") and X_2 ("*Δ%Deposits*") variables, while it is above 2 (2.26 and 2.85 respectively) for X_1 ("*CAR*") and X_4 ("*LnDebt*") variables respectively. A coefficient above 2 indicates a low degree of multilinearity, but is far from the value of 5, at which the problem is particularly severe. We therefore conclude that no correction is required.

Table 3. Variance coefficients of expansion of independent variables

X_j	Without pseudo-variables		With pseudo-variables	
	R_j^2	VIF_j	R_j^2	VIF_j
X_1	0.505288	2.021377	0.55778	2.261317
X_2	0.120419	1.136905	0.354736	1.549754
X_3	0.065601	1.070207	0.090943	1.100041
X_4	0.502481	2.009974	0.648801	2.847391

CONCLUSION

The conditions under which Greek financial institutions operated in the course of the crisis decade (2009-2019) are characterized by peculiarities, which, as expected, affected their performance. The fragile environment also affected the profitability and efficiency of Greek banks. Shedding light on the factors that drove their performance was thus essential. This helps to establish links between factors that generally – as per international banking economics literature – affect bank profitability, as well as to highlight Greek economy specificities that might have constituted important drivers of bank profitability. The results of our analysis need to be carefully considered by banking sector regulators and bank management in their effort to reduce regulatory barriers, ensure the stable and smooth functioning of credit markets and maximise profitability of banks through banking operation decisions (loan provision, capital adequacy, asset quality, cost of risk inherent in loans and advances to customers, etc.). In line with recent developments in the field of banking regulation in the EU by the European Banking Authority and the European Central Bank, we show that capital adequacy and liquidity, as well as the quality of loan portfolios, are crucial in reducing credit losses. This is important for bank management, as well as regulators.

To identify and investigate these driving factors, the previous section examined econometrically the factors that affected the return on assets of the Greek systemic banks during the 2009-2019 period. The necessary data for the calculation of the ratios were obtained from the annual financial reports of Piraeus Bank, Eurobank, Alpha Bank and the National Bank of Greece. Data from electronic databases were also used and processed. Then, having created a sample of 44 observations (4 banks × 11 uses), we developed a model with the "*ROA*" index as dependent variable. As independent variables, we used the total capital adequacy ratio, the annual percentage change in bank deposits by customers, the provision for credit losses ratio and the natural logarithm of Greek public debt. Also, a pseudo-variable was introduced in the model, capturing the effect of the "haircut" of Greek government bonds.

The results of the regression analysis showed that the model is generally statistically significant at the 1% significance level. It turned out that 89.2% (based on the coefficient of multiple determination R^2) of the "*ROA*" variability is explained by the regression function, i.e., due to the effect of the interpretive variables examined[1]. The coefficients of the independent variables are also statistically significant, at a significance level of 1%[2].

The existence of a linear relationship between the dependent and the independent variables was confirmed by our econometric analysis. Examining the partial regression coefficients and their signs, we summarise the key findings of our econometric analysis as follows:

- The implementation of the Greek public debt restructuring program, with the participation of the private sector, had a negative impact on the "*ROA*" index. We find that this is, in fact, the factor with the greatest impact on the dependent variable.
- The coefficient of the variable referring to the provision for credit losses reveals that the latter also put negative pressure on the return on assets of banks.
- The annual percentual change of the liabilities of financial institutions towards their customers had a positive, albeit small, impact on the "*ROA*".
- The effect of banks' capital adequacy on profitability is found to be positive and significant.
- The macro-variable we used in the model (public debt) had a negative impact on the return on assets ratio.

The findings of the regression analysis are largely in line with the international literature, which predominantly highlights the negative impact of the crisis and the implementation of the PSI program on Greek banks (Vousinas, 2015). The restructuring that Greek privately held bonds underwent in 2012 had a devastating effect on banks' balance sheets. This could be either through the channel of bonds directly held by the four systemic banks, or indirectly, through the overall negative economic repercussions of the PSI programme for bank deposits, economic activity of bank clients or the increase of spreads after

the PSI programme implementation. The exact identification of the channel through which the shock was transmitted constitutes a topic for further research, extending the findings of the current paper.

In line with the literature, our findings also confirm the significant effect of the provision for credit losses (Menicucci & Paolucci, 2016; Bucevska & Hadzi Misheva, 2017) and the public debt (Pagoulatos & Quaglia, 2013; Provopoulos, 2014; Kosmidou, Kousenidis & Negakis, 2015; Van Dooren, 2017; Cheng & Mevis, 2019) on the "*ROA*" index. We further show that asset returns are positively associated with well-capitalized banks with access to liquidity (in line with Pasiouras & Kosmidou, 2007; Kosmidou, 2008; Schiniotakis, 2012; Menicucci & Paolucci, 2016).

We test for correlation between variables and multicollinearity. The correlation matrix revealed a significant positive correlation between the independent variables "*CAR"* and "*LnDebt"* (65.4%). The multicollinearity test showed low VIF coefficient for every variable of the model, appreciably lower than the prohibitive levels (value 5).

In conclusion, in this study we show that the ability of Greek systemic banks to generate profits during the period 2009-2019, through the use of instruments at their possession, was influenced by specific internal financial and macroeconomic factors. As evidenced econometrically, their profitability was shaped under the influence of the debt crisis, which soon turned into a financial crisis, through the PSI implementation. In light of, and strategically preparing for, potential future financial shocks, our research shows that resilience in bank asset returns requires bank management to focus on maintaining high levels of capital adequacy and liquidity and improving loan portfolio in order to reduce credit losses provisions.

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APPENDIX 1

Table 4 shows the results of the linear regression analysis.

Table 4. Results of regression

Regression Statistics								
Multiple R	0.944308177							
R Square	0.891717933							
Adjusted R Square	0.854971054							
Standard Error	0.012388319							
Observations	44							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	5	0.04929017	0.009858034	64.23408859	1.70646E-17			
Residual	39	0.005985347	0.00015347					
Total	44	0.055275518						
	Coefficients	*Standard Error*	*t-Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99%*	*Upper 99%*
Intercept*	0	--	--	--	--	--	--	--
X_1=CAR	0.207289431	0.051469027	4.027459688	0.000252248	0.103183499	0.311395364	0.067915775	0.346663088
X_2=Δ%Deposits	0.051852754	0.012821781	4.044114589	0.00023996	0.025918253	0.077787254	0.017132483	0.086573025
X_3=PCL	-0.561678727	0.101218794	-5.549154521	2.1886E-06	-0.76641306	-0.356944394	-0.835770433	-0.287587021
X_4=LnDebt	-0.003595896	0.001519387	-2.366675237	0.023009208	-0.006669146	-0.000522645	-0.007710264	0.000518472
Dummy X_5=PSI	-0.054571906	0.009801396	-5.56776869	2.06235E-06	-0.0743971	-0.034746711	-0.081113235	-0.028030576

* The constant term was not statistically significant.

APPENDIX 2

Model variables

Table 5. Dependent variable "*ROA*" (Y)

Year	*Piraeus*	*Eurobank*	*Alpha*	*NBG*
2009	0.294%	0.003%	0.637%	0.257%
2010	-0.007%	-0.087%	-0.086%	-0.385%
2011	-13.458%	-6.205%	-6.460%	-13.239%
2012	-1.510%	-2.003%	-2.079%	-3.544%
2013	3.369%	-1.532%	4.688%	0.762%
2014	-2.424%	-2.002%	-0.086%	-0.460%
2015	-2.844%	-1.596%	-1.557%	-5.710%
2016	0.013%	0.016%	0.416%	0.012%
2017	0.004%	0.020%	0.076%	0.014%
2018	0.082%	0.065%	0.114%	0.012%
2019	0.044%	0.059%	0.096%	0.010%

Source: Annual financial reports of banks and authors' calculations

Table 6. Independent variable "*CAR*" (X_1)

Year	*Piraeus*	*Eurobank*	*Alpha*	*NBG*
2009	11.75%	12.40%	13.20%	16.40%
2010	11.19%	12.30%	13.50%	18.54%
2011	-5.66%	13.41%	9.40%	-1.14%
2012	11.00%	13.53%	9.10%	12.00%
2013	15.43%	12.92%	16.40%	15.80%
2014	13.94%	17.17%	14.90%	21.80%
2015	18.10%	18.29%	17.10%	21.30%
2016	17.55%	19.16%	17.30%	16.30%
2017	16.28%	18.90%	18.70%	16.90%
2018	14.68%	16.07%	17.80%	16.70%
2019	15.84%	19.41%	18.30%	17.40%

Source: Annual financial reports of banks and authors' calculations

Independent variable "*Δ%Deposits*" (X_2)

Table 7. Customer deposits (in thousands of EUR)

Year	*Piraeus*	*Eurobank*	*Alpha*	*NBG*
2007	19,030	38,939	23,335	49,260
2008	24,110	44,467	33,816	56,291
2009	25,730	45,807	35,258	58,081
2010	24,052	40,522	31,234	52,471
2011	18,334	26,864	23,749	44,025
2012	31,108	23,366	23,191	40,908
2013	48,498	33,952	37,505	45,290
2014	50,240	31,985	37,817	44,130
2015	36,971	22,802	27,734	36,868
2016	39,765	23,678	29,010	37,326
2017	41,301	25,015	30,255	38,849
2018	44,919	29,135	33,492	42,249
2019	47,572	32,693	35,541	42,661

Source: Annual financial reports of banks and authors' calculations

The X_2 independent variable refers to the annual percentual change of the average amount of deposits across the four systemic banks. We calculate the values as follows:

$$\Delta\%Deposits = \frac{Average\,current\,use\,deposits - Average\,previous\,use\,deposits}{Average\,previous\,use\,deposits}$$

whereby, the average amount of deposits for each year is derived from the average of liabilities to customers, taking into account the deposit levels at the beginning and end of the year. So, for the period 2009-2019, we obtained the values below for each financial institution:

Table 8. financial institution values

Year	*Piraeus*	*Eurobank*	*Alpha*	*NBG*
2009	15.53%	8.23%	20.86%	8.36%
2010	-0.12%	-4.37%	-3.74%	-3.34%
2011	-14.86%	-21.94%	-17.31%	-12.71%
2012	16.65%	-25.46%	-14.63%	-11.98%
2013	61.01%	14.11%	29.30%	1.49%
2014	24.03%	15.04%	24.10%	3.74%
2015	-11.67%	-16.91%	-12.97%	-9.42%
2016	-12.01%	-15.16%	-13.44%	-8.40%
2017	5.64%	4.76%	4.44%	2.67%
2018	6.36%	11.21%	7.56%	6.46%
2019	7.27%	14.18%	8.29%	4.70%

Source: Annual financial reports of banks and authors' calculations

Independent variable "*PCL*" (X_3)

This is a banking institution's provision to loan ratio, which reflects the cost of risk inherent in loans and advances to customers. A high ratio indicates reduced asset quality, in particular in the loan portfolio, and increased risk costs. Having drawn the necessary data from the annual financial

Table 9. 2009-2019

Year	*Piraeus*	*Eurobank*	*Alpha*	*NBG*
2009	0.81%	1.95%	1.31%	1.08%
2010	1.11%	2.34%	1.77%	1.74%
2011	5.84%	2.73%	2.33%	4.16%
2012	5.09%	3.90%	3.98%	4.16%
2013	3.97%	4.48%	3.87%	1.48%
2014	6.45%	5.24%	3.01%	4.42%
2015	6.27%	7.36%	6.34%	8.52%
2016	1.96%	2.58%	2.89%	1.90%
2017	4.23%	2.28%	2.06%	2.32%
2018	1.34%	2.01%	3.84%	0.88%
2019	2.36%	1.79%	2.12%	1.34%

Source: Annual financial reports of banks and authors' calculations

statements of the four Greek banks and performing the necessary calculations for the ratio, the following table is formed for the period 2009-2019:

Independent variable "*LnDebt*" (X_4)

The values below are expressed in billion US dollars, and refer to the general government gross dept of Greece, from 2009 to 2019. Government debt, also known as national debt or public debt is the total financial obligations incurred by the government of a nation:

Table 10. total financial obligations

Year	*Debt*	*Year*	*Debt*
2009	419,921	**2015**	345,863
2010	438,237	**2016**	348,687
2011	495,879	**2017**	358,658
2012	391,973	**2018**	395,306
2013	425,653	**2019**	370,656
2014	424,627		

Source: Thomson – Reuters Database

Then, for each year, we calculated the natural logarithm of the corresponding value:

Table 11. natural logarithm of the corresponding value

Year	*Debt*	*Year*	*Debt*
2009	6.040067	**2015**	5.846043
2010	6.08276	**2016**	5.854175
2011	6.206332	**2017**	5.882369
2012	5.971193	**2018**	5.97966
2013	6.053624	**2019**	5.915274
2014	6.051211		

Source: Thomson – Reuters Database

Independent variable "*PSI*" (X_5)

The "*PSI*" pseudo-variable aims to detect whether the implementation of the PSI program affected the efficiency of bank assets. Although the "haircut" of Greek government bonds took place in March 2012, capital losses are reflected in the financial statements of banks since 2011. Therefore, the pseudo-variable takes the value 1 for this year and the value 0 for the rest.

Panagiotis Barkas is an academic economist and policy analyst, whose work and research focus on the design and implementation of economic policy and reforms, at both national and international level. In parallel, an EU Policy Officer at ESMA, a Research Fellow at the Greek and European Economy Observatory of the Hellenic Foundation for European & Foreign Policy (ELIAMEP) and a Visiting Fellow at the Hellenic Observatory of the London School of Economics and Political Science (LSE), his research interests comprise international trade, finance and industrial organisation, with a focus on competitiveness, investment, regulation and competition policy. Dr. Barkas has contributed to research projects and publications in the areas of trade and international economics, economic policy of reforms, finance, sectoral competitiveness and the political economy of innovation financing. He has conducted research at the London School of Economics, the Max Planck Institute for the Study of Societies in Cologne, Germany, the University of Athens and the Foundation for Economic and Industrial Research, while also held two teaching assistantships in financial markets and corporate finance at the University of Athens. Beyond academia, his professional experience extends into EU/international organisations and institutions in France, Switzerland and Greece, while he has actively participated in policy missions of international organisations in Albania, Greece, Kosovo, Kuwait and Tunisia. Panagiotis is a Policy Officer at the Investor Protection and Intermediaries Unit of the European Securities and Markets Authority (ESMA) in Paris. Prior to joining ESMA, he was one of the twelve globally selected participants of the 2020 cohort of the Young Professionals Programme of the World Trade Organization (WTO). He joined the Trade in Services and Investment Division in 2020, supporting the policy and research work of the WTO Secretariat on domestic regulation, services trade policies in the travel, tourism, transport, e-commerce, financial sector, etc. He also worked as an Economic Affairs Officer for the WTO Academic Outreach and Chairs Programme. Prior to that, Panagiotis worked as Economist and Consultant at the Organisation for Economic Co-operation and Development (OECD). Between 2014 and 2016, he supported the work of the OECD South East Europe Division in designing policy frameworks for innovation and social innovation in Albania, Croatia and Kosovo. Panagiotis then moved to the OECD Competition Division of the Directorate for Financial and Enterprise Affairs, where he worked as OECD official staff on competition policy issues in Greece (2016) and Tunisia (2018-2019). Panagiotis also worked in the OECD Directorate for Science, Technology and Innovation, as well as the OECD Economics Department, in conducting research on innovation policy in Kuwait, as well as investment and product market regulation in Greece. Panagiotis Barkas holds a Doctor of Philosophy (PhD) degree in Economics from the National and Kapodistrian University of Athens. He also holds a Master of Philosophy (MPhil) degree in Finance and Economics from the University of Cambridge (St. John's College), while he has graduated with a first class honours degree as class valedictorian from the Faculty of Economics of the National and Kapodistrian University of Athens. He fluently speaks six languages, and is the recipient of more than fifteen scholarships, grants, and awards.

ENDNOTES

1 The explainability falls at 85.5%, when considering the adjusted coefficient of multiple determination R_a^2.
2 With the exception of the coefficient of the variable "*LnDebt*", which is statistically significant at the 5% significance level.