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ON THE DETERMINANTS OF NPLs: LESSONS FROM GREECE

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Abstract

We investigate the relationship between non-performing loans (NPLs) and their fundamentals, mainly bank and macroeconomic variables. This is done based on aggregate portfolio loans in the Greek economy. Greece constitutes an interesting case to study the factors determining NPLs, given the pervasive recessionary conditions that have characterized it since the outbreak of its sovereign debt crisis in 2010. We suggest a new econometric framework to study the above relationship which extends the SUR (seemingly unrelated regressions) framework to allow for a common break in its slope coefficient of unknown date. We show that the deterioration in the macroeconomic conditions (captured by very high rates of unemployment) and political uncertainty constitute key factors explaining the sharp rise of NPLs of the Greek banking sector after the first quarter of 2012. With the exception of bank profitability, we find that bank specific variables associated with bank capitalization and liquidity risk seem to determine NPLs only under normal economic conditions.

Keywords: NPLs, break point, bank-specific variables, macroeconomic conditions.

JEL Classification: C22, G01, G21

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1 Introduction

Since the onset of the financial crisis academics and practitioners have shown renewed interest in the credit quality of loan portfolios. Average bank asset quality has deteriorated, sharply, due to the global financial crisis that began at the end of 2008. The rapid increase in non-performing loans (hereafter, NPLs) has increased banks' vulnerability to further shocks and, at the same time, has limited their lending operations with major consequences for economic activity. The deterioration of the ratio of NPLs to total bank loans can be attributed to macroeconomic and bank-specific factors (see, e.g., Berger and De Young (1997) and Louzis et al. (2012)). Empirical evidence suggests that NPLs exhibit anti-cyclical behavior. A deterioration in macroeconomic conditions, with a fall in GDP and rising unemployment rate, has negative effects on NPLs, as it reduces the ability of borrowers to service their debt. Among the bank-specific factors that have been found in the literature to affect NPLs are size, cost efficiency and management performance, credit conditions, market power and banks' risk profile.

Based on aggregate data from the Greek banking system, in this study we focus on the factors that affect NPLs during recessions. Answering this question has important implications for banking policies trying to mitigate the effects of recession on NPLs. The Greek economy constitutes an interesting case to study the factors determining NPLs, given the pervasive recessionary conditions that have characterized the economy since 2008. In 2009, the economy went into recession leading to a fall in GDP of around 3% in 2009 and an increase in the NPL ratio by 3.5 percentage points. In 2010, financial markets started to lose faith in Greece's ability to service its public debt and, after some months of negotiations between the country and EU leaders, Greece received its first bailout from the European union and the IMF to ensure debt servicing and prevent a default. Greece committed to adopt a sharp fiscal consolidation which led to further recessionary pressures and rapidly raised NPLs. The undervaluation of the assets in the banking sector along with a loss of deposits and a high ratio of NPLs to total bank loans caused liquidity problems for the Greek banks . Along with the losses taken by the Greek banks from the haircut on private debt, the need for substantial recapitalization of Greek banks was inevitable. The increase in NPLs also opened a vicious cycle between them and unemployment further worsening the macroeconomic environment.

The data used in our analysis consists of three different categories of loan portfolios: mortgages, business and consumer loans. The relationship between NPLs in these three categories of loans and lagged values of their determinants (bank-specific or macroeconomic variables) was estimated based on the seemingly unrelated regressions (SUR) framework. Using the SUR estimation method we allow for cross-correlation across the error terms of the equations of the system of NPLs and possible sources of heterogeneity in the slope coefficients of the estimated regressions. Also, estimation and inference can be drawn based on the time-dimension of our data, which is reasonable and much larger than its cross-sectional one. One innovation of our econometric analysis is that the SUR framework is extended to allow for a common break in the relationship between NPLs and their determinants. The existence of such a break may capture the influence of exogenous events (i.e., deterioration of the economic conditions, sovereign debt crisis, political events etc) on the relationship between NPLs and their determinants, and whether the break applies to the bank-specific or the macroeconomic conditions.

The results of the paper lead to a number of interesting conclusions. They show that the intensification of the recession and the political uncertainty in the first quarter of year 2012, i.e., 2012:Q1 were responsible for the sharp rise in NPLS in the Greek banking system. These conditions structurally changed the relationship between NPLs and their determinants after that period. In particular, we find that unemployment and inflation determine the NPLs of the Greek banking system, over the whole sample, but their effects become stronger after 2012:Q1. From the bank-specific variables examined, we find that only changes in the return on assets can explain the path of NPL after 2012:Q1. Bank specific variables, like changes in equity and the loans-to-deposits, are found to determine, significantly, the NPLs of the Greek banking system only during the period before year 2012. Summing up, our results support the view that the abrupt shift in NPLs can be mainly attributed to macroeconomic deterioration and political uncertainty.

The paper is organised as follows. Section 2 presents the model that we will employ to estimate the relationship between NPLs and their determinants, and it discuss hypotheses of interest that can be tested regarding the bank-specific variables employed in our analysis. Section 3 describes the data and econometric analysis. Section 4 concludes.

2 The model

Our empirical analysis is based on the following reduced form model for non-performing loans (denoted as NPL_{it}):

$$\begin{aligned}
&\Delta NPL_{it} \\
= \;&(c_i + b_1\Delta ROA_{t-1} + b_2\%EQTY_{t-1} + b_3\Delta LTD_{t-1} + \gamma_1\Delta UNPL_{t-1} + \gamma_2 INFL_{t-1}) * DUM_{t-1} \\
&+(c_i^* + b_1^*\Delta ROA_{t-1} + b_2^*\%EQTY_{t-1} + b_3^*\Delta LTD_{t-1} + \gamma_1^*\Delta UNPL_{t-1} + \gamma_2^* INFL_{t-1}) * DUM_{t-1}^* \\
&+\rho\Delta NPL_{It-1} + u_{it}, \qquad (1)
\end{aligned}$$

where Δ denotes first-difference, % denotes percentage change of a variable, $i = 1, 2$ and 3 denote the three aggregate categories of loans (i.e., business, mortgages and consumer, respectively), $t = 1, 2, ..., T$ denotes the time series observations of our sample, and DUM_{t-1} is a dummy variable which takes the value of 1 when $t - 1 \leq T_0$, when a structural change in model (1) occurs, and unity otherwise. DUM_{t-1}^* is the complementary variable to DUM_{t-1}, which takes the value of 1 when $t - 1 > T_0$, and zero otherwise. The definitions of the bank-specific and macroeconomic variables included in the RHS of (1) are as follows.

Bank-specific:

(i) ΔROA_t is the first-difference of ROA, defined as earnings before interest and taxes divided by total assets. ROA is a measure of bank profitability. We use this variable as a proxy for quality of management to investigate the bad management hypothesis. In particular, a less profitable bank is more likely to exhibit poor performance in credit scoring, appraisal of pledged collaterals and monitoring borrowers which in turn leads to higher NPL_{it} ratios. Therefore, we expect a negative effect of profitability on NPLs; see, for example, Berger and DeYoung (1997), Podpiera and Weil (2008) and Louzis et al.(2008).

(ii) $\%EQTY$ is the percentage change (%) in equity (denoted EQTY). This variable can capture the effects of bank capitalization on NPLs. According to the moral hazard hypothesis, low capitalization of banks increases NPLs, as bank managers tend to increase the riskiness of the bank's loan portfolio when the bank is weakly capitalized and, as a result, NPLs will increase; see, for example, Berger and DeYoung (1997) and Salas and Saurina (2002). We thus expect a negative relationship between $\%EQTY_{it-1}$ and ΔNPL_{it}. Apart from the empirical literature, the moral hazard problem in the banking sector has received increasing attention in recent theoretical DSGE models; see, for example, Gertler, Kiyotaki and Queralto (2012) and Borio (2014). Note that we do not employ the ratio of Equity-to-Assets (ETA) in our analysis to capture the effects of capitalization on NPLs, due to the sharp devaluations of bank assets that occurred during our sample.

(iii) ΔLTD is the first-difference of the loan-to-deposit ratio, which is considered as a proxy for liquidity risk. One would expect that an increase in ΔLTD will increase NPLs, as it increases the banks' probabilities of default ; see for example, Louzis et al. (2014), Makri et al. (2014) and Anastasiou et al. (2016).

Macroeconomic:

(i) $\Delta UNPL_{t-1}$ is the change in the unemployment rate. This variable captures the business and macroeconomic conditions in the economy, at any point of time. Instead of this variable, we could have used the real GDP growth rate. As in Monokroussos and Thomakos (2016), we find that choosing one of these two macro variables is sufficient to capture the macroeconomic conditions in the economy. Changes in unemployment may be thought as a better indicator of how deep and persistent the recession in an economy is. As expected a priori, an increase in $\Delta UNPL_{t-1}$ leads to an increase in NPLs, for all categories of loans. The positive effect of the unemployment has also been documented in Quagliarello (2007), Louzis et al (2012) Anastasiou et al. (2016) and Monokroussos et al. (2016).

(ii) $INFL_{t-1}$ is the quarter inflation rate. The effect of inflation on NPLs should be positive, since an increase in inflation leads to a fall in the real income of borrowers. This is in line with prior evidence; see, among others, Beck et al. (2013) and Klein (2013).

In addition to the above variables, note that in the RHS of the model we have also included variable ΔNPL_{it-1} to capture the own dynamic (trend) effects of NPLs on ΔNPL_{it}, over time.

Model (1) can be employed to test a number of hypotheses about NPLs. It can test for a regime change in the relationship between NPLs and their determinants associated with a structural change in the financial, banking, and economic conditions of the economy, after break point T_0. These changes could be associated with exogenous events, which can be identified by the data through model (1).[1] Given the existence of such a change, the model can reveal if the effects of bank-specific or macroeconomic variables on NPLs are asymmetric across the different regimes identified by the data. Although one may argue that bank-specific variables, like ΔROA_{t-1} and changes in equity or credit, constitute valid explanatory variables of NPLs, these effects may considerably change across the different economic conditions after break point T_0. Similar arguments can be applied to the macroeconomic variables of the model.

In our analysis, T_0 will be treated as an unknown quantity and it will be estimated, endogenously, from the data. This can shed light on the particular conditions of the economy (or the banking sector) that triggered a structural change in the relationship between NPLs and their determinants. To identify T_0, we rely on a search procedure (see, e.g., Andrews (1993)) solving the following optimization problem:

$$T_0 = \arg \underset{T_0 \in Q}{sup} \log L(\theta | T_0),.$$

where Q is the set of possible structural break points of the sample such that $Q \subseteq \{1, 2, .., T\}$, and $L(\theta | T_0)$ is the likelihood function of model (1) conditional on T_0, where θ denotes the vector of parameters. In short, the above procedure will select the break point T_0 which maximizes the log-likelihood function of the model, over all possible break points in the sample.

Before proceeding to estimation of the model, a number of final remarks are necessary in order to justify its econometric specification. First, both dependent and independent variables of the model are expressed in first differences (or percentage rates) to become stationary series. This is done in order that estimation procedure and inference can rely on standard asymptotic results, holding over the time (T)-dimension of our data. Second, a number of bank-specific or macroeconomic variables, like the size of banks and loan interest rates, are not present in analysis. These variables were found to be insignificant for our sample, either when allowing for a common break in the model or not. Third, the lag specification of the model is chosen based on the Akaike information criterion. The inclusion of lagged values of the regressors in the model also helps to avoid inference and estimations problems that could arise from the contemporaneous correlation between the explanatory variables and the error terms of the model.

[1] See Dendramis et al. (2015) for a recent survey on the effects of a structural break on economic relationships.

3 Empirical analysis

In this Section, we estimate model (1) and discuss the results. In our analysis, we also compare the estimates of the model to those of a version of it which does not allow for a structural break. The estimation of both these models is carried out using maximum likelihood (which is asymptotically equivalent to three stage least squares based on the SUR framework of the model, for $i = 1, 2$ and 3 equations (categories of loans). This estimation method allows for the disturbance terms u_{it} to be cross-sectionally correlated, across i, as is assumed in SUR equations. To formally test if there is a structural break in the model, we will carry out a likelihood ratio test (denoted as *LR-stat*), with the null hypothesis:

$$H_0\text{: } c_i = c_i^*,\ b_1 = b_1^*,\ b_2 = b_2^*,\ b_3 = b_3^*,\ \gamma_1 = \gamma_1^*,\ \gamma_2 = \gamma_2^*$$

against its alternative

$$H_a : c_i \neq c_i^*, \text{ or } b_1 \neq b_1^*, \text{ or } b_2 \neq b_2^*, \text{ or } b_3 \neq b_3^*, \text{ or } \gamma_1 \neq \gamma_1^*, \text{ or } \gamma_2 \neq \gamma_2^*$$

Testing the above null hypothesis is a crucial step to examining if there is a break in model (1) and, hence, whether the model constitutes a consistent specification with the data. The test statistic *LR-stat* is defined as $LR\text{-}stat = 2\left(\log L\left(\theta|T_0\right) - \log L\left(\theta_0\right)\right)$, where $L(\theta_0)$ is the likelihood function of the model under the null hypothesis H_0 (i.e., without a break; θ_0 is the vector of parameters of this version of the model, without a break).[2] Since T_0 (and, hence, the slope coefficients of the model) is not identified under the null hypothesis, the significance levels (probability values) of *LR-stat* will be obtained based on the bootstrap statistical technique. The steps of this procedure are described below.

First, we estimate model (1) without a structural break and obtain estimates of its vector of slope coefficients θ_0 and its residuals, denoted as $\hat{u}_{it}$. Based on these estimates and the values of our explanatory variables, next we generate bootstrap values of ΔNPL_{it} by replacement from the residuals $\hat{u}_{it}$. We generate B bootstrap samples of size $3 \times T$. For each bootstrap sample, we estimate the model with and without a break at T_0 and calculate statistic *LR-stat*, defined above. The above procedure is repeated $B = 1000$ times. Based on these repetitions, we then compute the 5% (or 1%) quantile value of the empirical distribution of *LR-stat*, which constitutes its 5% (or 1%) critical value. The null hypothesis is rejected for values of *LR-stat* bigger than the above 5% (or 1%) level.

[2]Note that, since the intercepts of the model c_i are not found to differ across i, in the implementation of test statistic *LR-stat* we assume that under the null hypothesis $c = c^*$, for all i.

3.1 The data

Our data set consists of quarterly observations of the macroeconomic and bank-specific variables of the model covering the period from 2005:Q1 to 2015:Q4, implying $T = 44$ observations. They are obtained from the Bank of Greece. Regarding the data on NPLs, these consist of three different type of loans: business, mortgage and consumer and they also include restructured loans. Lolou et al. (2016) provide a more detailed analysis of the new loan restructuring framework. The inclusion of restructured loans is important. It measures more accurately the size of NPLs. Thus, the NPL ratio excluding the restructured loans in 2015 Q4 was 35.6% whereas the NPL ratio including the restructured loans was 43.5%. The sample period of the study captures different phases of the business cycle in the Greek economy. It refers to the pre-sovereign debt crisis period, i.e., 2005-2010 and to its aftermath, i.e., 2010-2015. Thus, it can provide useful insights into the determinants of the NPLs before and after the crisis.

Figures 1, 2, 3 and 4 present graphs of the dependent and explanatory variables of model (1). In particular, Figures 1 and 2 present graphs of the three different NPL series, NPL_{it}, and their first differences ΔNPL_{it}, used in the estimation of the model, respectively. Figure 3 presents the bank specific variables ΔROA_t, $\%EQTY_t$ and ΔLTD_t, while Figure 4 the macroeconomic variables $UNPL_t$ and $INFL_t$, in levels. In Table 1, we present correlation coefficients across the above variables, as defined in the model, i.e., the independent variables are lagged one period. A number of comments can be drawn from an inspection of the above figures and table. First, the ratio of the non-performing to total loans rose sharply to reach its highest level in 2015:Q4 from its low in 2005:Q1. From 2010 to 2015, there was a 45% increase in the NPLs on consumer loans. The NPLs ratio of business and mortgage loans increased by 33% and 31.8%, respectively. Figure 2 shows that the biggest quarter on quarter increase in NPLs for consumer and mortgage loans occurred from 2011:Q4 to 2012:Q1. For NPLs on business loans, the highest increase in this ratio was from 2012:Q4 to 2013:Q1.

[Insert Figure 1 and Figure 2 about here.]

An inspection of the unemployment rate in Figure 4, indicates that its dramatic increase over the period can be attributed to the need to eliminate the unsustainable fiscal and current account imbalances in the Greek economy that appeared in year 2009. The elimination of fiscal and current account deficits came at the expense of growth and unemployment. Greece lost more than a quarter of its GDP. Figure 4 indicates that the unemployment rate has been increasing since 2008, with a sharp increase occuring immediately after the implementation of the first fiscal stabilization program in 2010. Unemployment stabilized in 2013 and began to fall in 2014, when the real economy exhibited a slightly positive growth rate. Note that the high levels of unemployment after 2013 were associated with deflation of the economy.

[Insert Figure 3 about here.]

Turning to the bank-specific variables (see Figure 3), we observe that the sharpest drop in profitability in the banking sector occurred in the second quarter of 2012. This was the outcome of the heavy losses incurred by the implementationof the PSI (Private Sector Involvement) program of debt restructuring. According to the Annual Report of Bank of Greece (2012), in the period between January and September of 2012, Greek banking groups listed on the Athens stock exchange recorded after tax losses of 5.1 billion euros, which, on one hand, reflect additional write-downs on their Greek government bonds as a result of the PSI, and, on the other hand, impairment charges on loans to the private sector. The change in the loan to deposit ratio (LTD) is highly volatile during our sample period. The sharp increase in LTD ratio occurred in the second quarter of 2012 can be attributed to the massive bank deposits withdrawal, which in turn can be due to the political uncertainty (double elections) and the fears of exit of Greece from the Eurozone (known as GREXIT). From 2012:Q3 to 2014:Q4, there was a drop in the LTD ratio, which can be attributed to reduced new lending. At the last quarter of 2014, the LTD ratio rose sharply again owing to deposit outflows triggered by the heightened political risk, the failure of the Parliament to elect a new President of the Republic and the need, thus, for elections in January 2015. Note that, due to the fears of GREXIT, the change in the LTD ratio remained positive until the imposition of capital controls at the end of June of year 2015. Finally, looking at the change of the equity growth, Figure 3 indicates that, from 2012:Q1 to 2013:Q3, there was an impairment in the capital base of the Greek banking system mainly due to the restructuring of public debt occurred in March 2012, due to the PSI program, and the continuous deposit outflows due to the high economic and political uncertainty of Greece since the start of the sovereign debt crisis.

[Insert Figure 4 about here]

Finally, the correlation coefficients between the dependent and independent variables of the model indicate that there is a positive and very high correlation among the three different categories of NPLs ratio changes. This is not surprising, given that NPL_{it} or ΔNPL_{it} seem to move very closely, over the whole sample (see Figures 1 and 2). As expected, we find a negative correlation between ΔNPL_{it} and ΔROA_{t-1}, and ΔNPL_{it} and $\%EQYTY_{t-1}$, for all i, but it is not a strong correlation. The only explanatory variable which exhibits the highest degree of correlation with ΔNPL_{it}, for all i, is the change in unemployment rate. As expected, this is positively associated with ΔNPL_{it}. Another interesting finding of the table is that there is a low degree of correlation between the bank-specific and macroeconomic sets of variables used in the estimation of the model. Thus, these two groups of variables can be taken to reflect different sources of information. This also holds within the variables of each of these groups. It may attributed to the fact that the variables of both of these groups are appropriately transformed (e.g., differenced) to remove any common trend driving them.

[Insert Table 1 about here.]

3.2 Estimates

Maximum likelihood (ML) estimates of model (1) and its alternative versions, without a break and/or the macroeconomic variables, are reported in Tables 2 and 3, respectively. Table 2 presents results for the model without a break based on single equation ML estimates, for each category of loans (i.e., business, mortgages and consumer). These estimates can reveal if there is high degree of heterogeneity in the slope coefficients estimates of the model, across i. This table also reports the adjusted coefficient of determination $\bar{R}^2$ and the maximum likelihood value of the model (denoted $loglik$), at its optimal estimates. These can be used for model comparison and to show how well the model fits into the data.

Tables 3A and 3B present ML estimates of the model without and with the break, respectively. This is done based on the SUR framework, assuming homogeneity in the slope coefficients of the model, across the different categories of loans i. This assumption can improve upon the efficiency of the estimates of the model, given the small number of degrees of freedom available, for all i. It can be justified, empirically, by the single equation estimates of the model without a break, reported in Table 2, which indicate that there is not a high degree of heterogeneity in the slope coefficient estimates, across i. Note that, where there is some degree of heterogeneity, the estimates of the slope coefficients of the model tend to be insignificant, at the 5% level. To see if there is evidence of cross-correlation of error terms u_{it}, across i, both Tables 3A and 3B present estimates where u_{it} are assumed to be correlated across i. The correlation matrix across u_{it} is denoted as Σ.

The values of $\bar{R}^2$, reported in Table 2, indicate that the full specification of the model, with the set of macroeconomic variables, fits the data better than the model without the macroeconomic variables . The relationship between ΔNPL_{it} and $\Delta UNPL_{t-1}$ is positive as expected from the theory. This is true for all different sets of estimates reported in Tables 2 and 3A-3B. ΔNPL_{it} is also positively related to $INFL_{t-1}$, but this relationship is less strong, compared to that between ΔNPL_{it} and $\Delta UNPL_{t-1}$. For the SUR based estimates, reported in Table 3A, the slope coefficient of $\Delta UNPL_{t-1}$ becomes significant at 10% level. The positive relationship between ΔNPL_{it} and $INFL_{t-1}$ can be attributed to the fact that an increase in inflation reduces the real income of borrowers. Regarding the relationship between NPLs and the bank-specific variables, the single equation results of Table 2 indicate that, although the sign of the slope coefficients of these variables is consistent with the theory, they are not always significant. Note that the estimates of the slope coefficient of ΔLTD_{t-1} are not found to be significant, for all i, at the 10%, or 5%, level. This is true even for the SUR based estimates of the model, reported in Table 3A. The SUR based estimates of the model clearly indicate that the relationship of ΔROA_{t-1} and $\%EQTY_{t-1}$ with ΔNPL_{it} is negative and significant, as predicted by the bad management and moral hazard hypotheses.

[Insert Table 2 about here.]

Turning to the estimates of the model with a break, the results of Table 3B leads to a number of very interesting conclusions. First, they provide clear cut evidence that there is a structural change (break) in the relationship between ΔNPL_{it} and fundamentals for the Greek economy. The break occurs in the first quarter of year 2012 (i.e., 2012:Q1). Note that, for the specification of the model without the macroeconomic variables, it occurs two quarters later (i.e., at 2012:Q3). This can be obviously attributed to omitting the unemployment rate variable from the model. The values of *loglik* and statistic *LR-stat*, reported in the table, indicate that the full specification model (1), with the bank-specific and macroeconomic variables, as well the break point considered, is more consistent with the data, compared to its version without a break and/or the macroeconomic variables. The p-value of statistic *LR-stat*, reported in the table, clearly rejects the null hypothesis H_0 that there is no structural change in the slope coefficients of the model against its alternative H_a, which assumes that there exists. Similarly, the better fit of the model with the break, compared to the version with no break, can be also confirmed by the values of the coefficient of determination $\bar{R}^2$ of all SUR. These results are not reported in the table for reasons of space.

[Insert Table 3A about here.]

The existence of a structural change in the relationship between NPLs and its determinants , at point 2012:Q1, may be associated to the deepening of the recession, the political uncertainty and instability, and the strong fears for GREXIT in this year, as mentioned before. As the results of Table 3B indicate, the effects of $\Delta UNPL_{t-1}$ on ΔNPL_{it} become stronger and more significant in the subsample after the break point 2012:Q1 than before. The same is true for inflation rate $INFL_{t-1}$. Figure 4 shows that inflation was rising in 2012, despite the severe recession of the Greek economy in this year. This had negative effects on the real income of borrowers and, hence, on NPLs, for all loan categories considered. The positive effect of the unemployment rate on NPLs is consistent with prior empirical evidence (see Louzis et al. (2012) and Monokrousos et al.(2016)).

[Insert Table 3B about here.]

The results of Table 3B also indicate that, apart from the macroeconomic variables, there is also a structural change in the relationship between NPLs and the bank-specific variables of the model, after the break point in 2012:Q3. The change in NPLs, ΔNPL_{it}, becomes negatively and significantly related to ΔROA_{t-1} only after this break point. This is the only bank-specific variable which can explain future NPLs changes after the break point. Its effects on ΔNPL_{it} are consistent with the bad management hypothesis, predicting that a positive change in ROA leads to a decrease in NPLs, and conversely. The change in LTD ratio (ΔLTD_{t-1}) and the percentage change in equity ($\%EQTY_{t-1}$) are found to have no and little (less significant) effect on ΔNPL_{it}, respectively, after 2012:Q1. Comparing the results of Table 3B to those of 3A, one can see that the significant effects of ΔLTD_{t-1} and $\%EQTY_{t-1}$ on ΔNPL_{it} are present only in the period before 2012:Q1, where the economy was not at that time suffering from a severe recession and political uncertainty. The positive relationship between ΔNPL_{it} and ΔLTD_{t-1} found for the period before this point is consistent with the liquidity risk hypothesis, while the negative relationship between ΔNPL_{it} and $\%EQTY_{t-1}$ is consistent with the moral hazard hypothesis.

4 Conclusion

In this paper we investigate whether bank-specific or macroeconomic factors determine NPLs using loan portfolios data from the Greek banking sector. Our econometric analysis is based on a SUR (seeming unrelated regressions) framework which allows for cross-correlation across the error terms of the different categories of loans considered. We have extended this framework to allow for a common structural break in the relationship between NPLs and their determinants. This break can be justified by changes in institutional factors and/or exogenous events, including political uncertainty.

The results of the paper lead to a number of interesting conclusions, with banking or macroeconomic policy implications.. They show that political instability and the severe deterioration of the macroeconomic conditions constitute the key factors explaining abrupt shifts in NPLs in the Greek banking system, over the recent years. Under these conditions, we found that the key factors that can explain movements in NPLs are changes in unemployment and inflation rates. With the exception of the earning to assets variable, which reflects bank management conditions, bank-specific variables like changes in equity and loan-to- deposit ratio do not appear to have a significant effect on NPLs.

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Figures and Tables

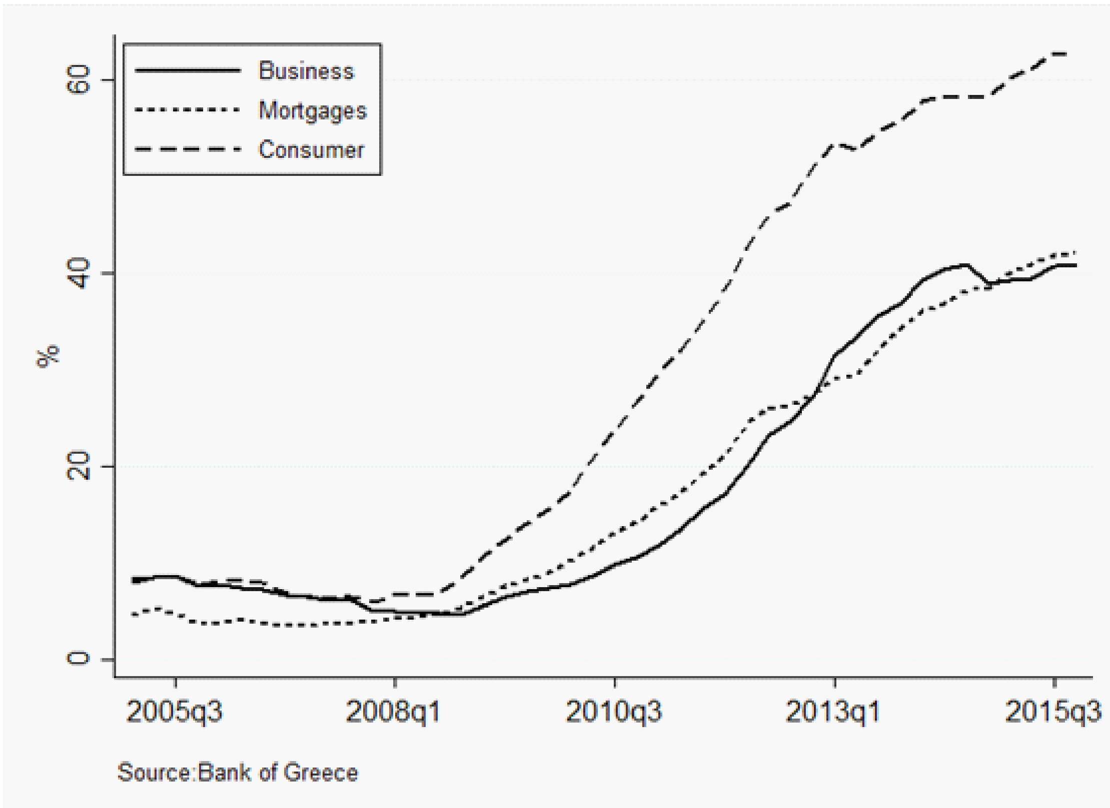

Figure 1: Evolution of NPLs by type of loans

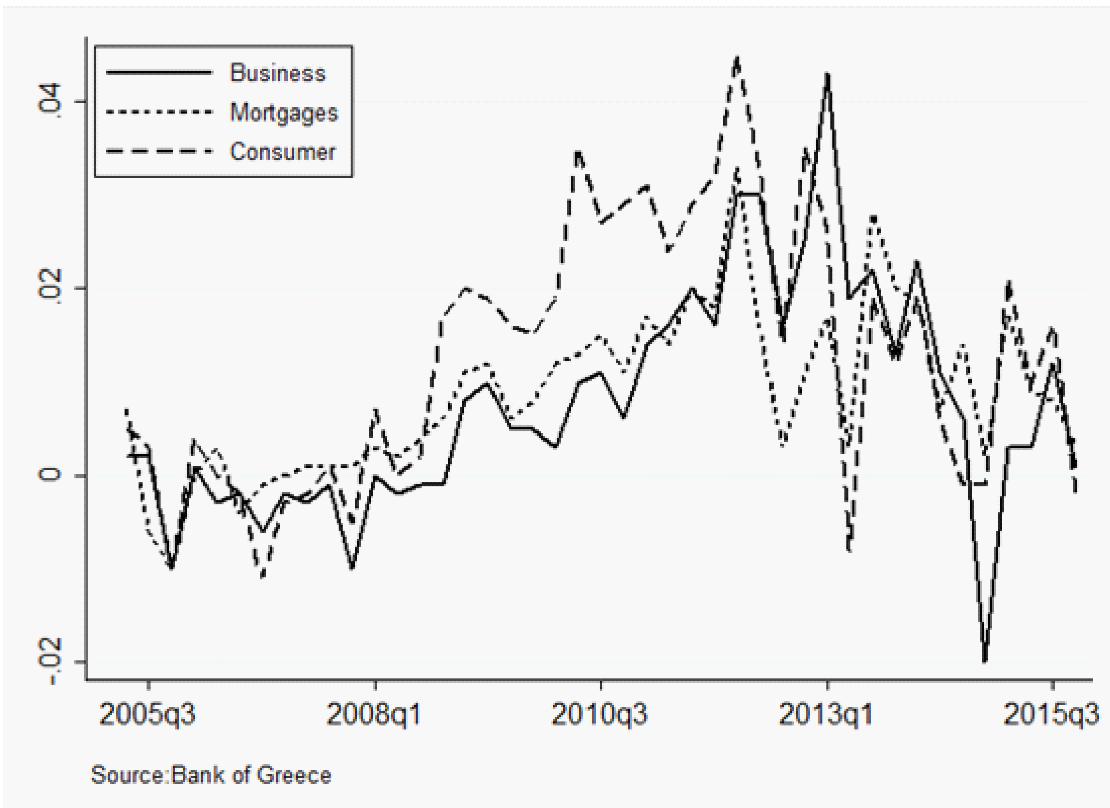

Figure 2: Changes in NPLs by type of loans

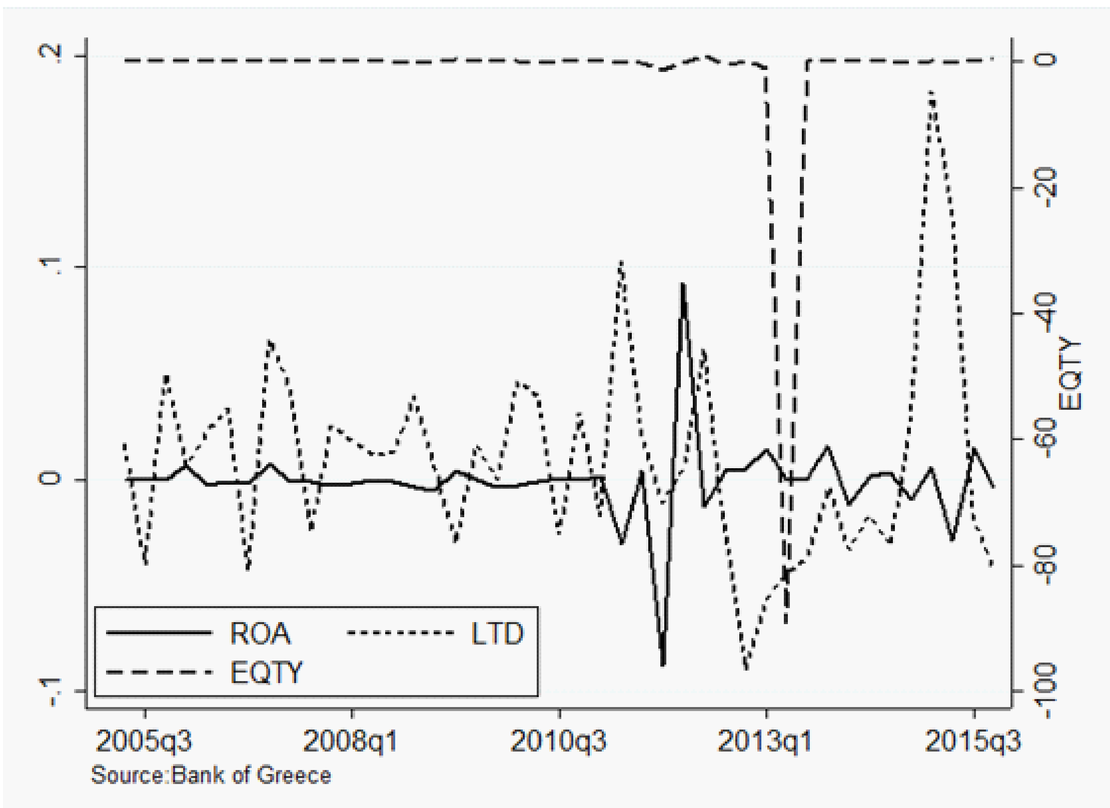

Figure 3: Change in ROA and LTD, and equity growth

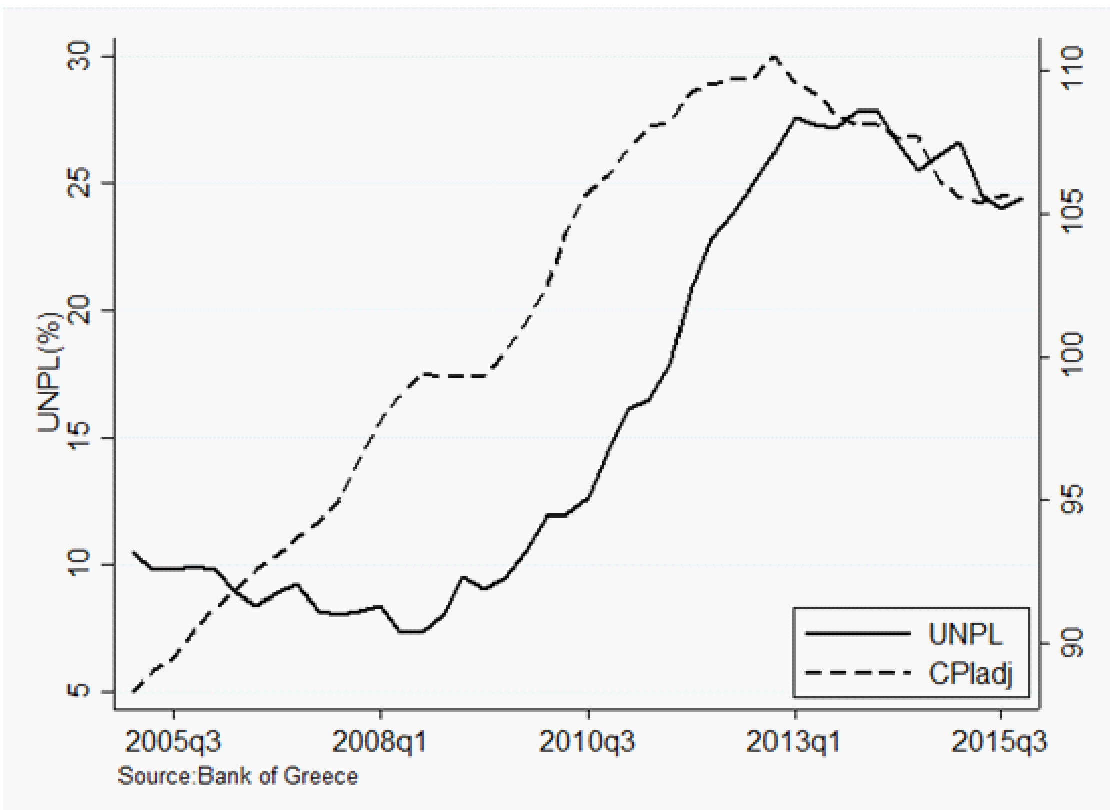

Figure 4: Unemployment rate and CPI seasonally adjusted

Table 1: Correlation Coefficients								
	ΔNPL_{Bt}	ΔNPL_{Mt}	ΔNPL_{ct}	ΔROA_{t-1}	$\%EQTY_{t-1}$	ΔLTD_{t-1}	$\Delta UNPL_{t-1}$	$INFL_{t-1}$
ΔNPL_{Bt}	1							
ΔNPL_{Mt}	0.79	1						
ΔNPL_{Ct}	0.75	0.80	1					
ΔROA_{t-1}	-0.001	-0.21	-0.15	1				
$\%EQTY_{t-1}$	-0.19	-0.35	-0.08	0.09	1			
ΔLTD_{t-1}	-0.15	-0.06	0.08	-0.35	-0.12	1		
$\Delta UNPL_{t-1}$	0.58	0.50	0.64	-0.02	-0.23	-0.008	1	
$INFL_{t-1}$	-0.004	-0.047	0.10	-0.43	0.11	0.36	-0.15	1

Notes: The table presents correlation coefficients among all the variables of the model.

Table 2: Single Equation Estimates of the Model Without a Break									
				All explanatory variables					
	const	ΔROA_{t-1}	$\%EQTY_{t-1}$	ΔLTD_{t-1}	$\Delta UNPL_{t-1}$	$INFL_{t-1}$	ΔNPL_{it-1}	$\bar{R}^2$	*loglik*
Business	-0.0001	-0.0056	-0.0001	0.0206	0.5284	0.2317	0.5891	0.64	150.21
	(-0.007)	(-0.10)	(-1.32)	(0.83)	(4.16)	(2.64)	(5.32)		
Mortgages	0.0019	-0.1091	-0.0003	0.0056	0.3008	0.0662	0.5432	0.63	163.09
	(1.48)	(-2.60)	(-4.38)	(0.32)	(3.16)	(1.02)	(4.97)		
Consumer	0.0031	-0.0785	-0.0002	0.0397	0.5628	0.1396	0.4909	0.57	139.88
	(1.39)	(-1.08)	(-2.14)	(1.28)	(2.89)	(1.25)	(3.55)		
				Only bank-specific variables					
Business	0.0017	-0.0644	-0.0001	0.0231			0.7185	0.44	139.90
	(0.90)	(-0.96)	(-0.84)	(0.74)			(5.70)		
Mortgages	0.0022	-0.1396	-0.0003	-0.0005			0.6669	0.54	157.64
	(1.55)	(-3.15)	(-3.85)	(-0.02)			(6.15)		
Consumer	0.0023	-0.1358	-0.0003	0.0303			0.7408	0.49	135.23
	(0.95)	(-1.82)	(-2.23)	(0.91)			(6.35)		

Notes: The table presents single equation estimates of model (1) without a common break, for all categories of loans i (business, mortgages and consumer). Panel A presents estimates of the model with all explanatory variables, while Panel B excludes the set of macroeconomic variables (namely, $\Delta UNPL_{t-1}$ and ΔNPL_{it-1}). $\bar{R}^2$ is the adjusted coefficient of determination and *loglik* denotes the maximum likelihood value of the model, at the optimal estimates of the model.

Table 3A: System (SUR) Estimates of the Model Without a Break

	A: With all explanatory variables		B: Only with bank-specific variables	
const	0.0012	(1.22)	0.0023	(2.17)
ΔROA_{t-1}	-0.095	(-2.53)	-0.1419	(-3.48)
$\%EQTY_{t-1}$	-0.0003	(-4.44)	-0.0003	(-4.28)
ΔLTD_{t-1}	0.0056	(0.34)	-0.0045	(-0.24)
$\Delta UNPL_{t-1}$	0.3098	(3.82)		
$INFL_{t-1}$	0.0934	(1.61)		
ΔNPL_{it-1}	0.5959	(9.32)	0.6380	(9.83)
	$\Sigma = \begin{array}{cccc} & u_{Bt} & u_{Mt} & u_{Ct} \\ u_{Bt} & 1 & & \\ u_{Mt} & 0.48 & 1 & \\ u_{Ct} & 0.51 & 0.57 & 1 \end{array}$		$\Sigma = \begin{array}{cccc} & u_{Bt} & u_{Mt} & u_{Ct} \\ u_{Bt} & 1 & & \\ u_{Mt} & 0.68 & 1 & \\ u_{Ct} & 0.63 & 0.68 & 1 \end{array}$	
loglik	462.30		456.74	

Notes: The table presents SUR estimates of model (1) without a common break in its slope coefficients. Panel A presents results of the full specification of the model, with all explanatory variables considered, while Panel B excludes the set of macroeconomic variables (namely, $\Delta UNPL_{t-1}$ and ΔNPL_{it-1}). Σ is the correlation matrix across error terms u_{it}, where denotes the three categories of loans (Business, Mortgage and Consumer, denoted as B, M and C, respectively). t-ratios are in parenthesis and *loglik* denotes the maximum value of the likelihood function, at the optimal estimates of the model.

Table 3B: System (SUR) Estimates of the Model with a Break				
	A: All explanatory variables		B: Only with bank-specific variables	
	Before Break Point T_0 =2012:Q1		Before Break Point T_0 =2012:Q3	
const	-0.0006	(-0.72)	0.0022	(2.06)
ΔROA_{t-1}	0.0058	(0.20)	-0.0699	(-1.68)
$\%EQTY_{t-1}$	-0.0083	(-3.76)	-0.0116	(-3.72)
ΔLTD_{t-1}	0.0476	(2.54)	0.0384	(1.40)
$\Delta UNPL_{t-1}$	0.3489	(4.55)		
$INFL_{t-1}$	0.1084	(2.06)		
	After Break Point T_0 =2012:Q1		After Break Point T_0 =2012:Q3	
const	0.0073	(6.37)	0.0028	(1.61)
ΔROA_{t-1}	-0.2029	(-2.22)	-0.1061	(-0.85)
$\%EQTY_{t-1}$	-0.0001	(-1.62)	-0.0003	(-4.38)
ΔLTD_{t-1}	0.0121	(0.87)	-0.0097	(-0.46)
$\Delta UNPL_{t-1}$	0.8031	(7.59)		
$INFL_{t-1}$	0.5572	(7.56)		
ΔNPL_{it-1}	0.5169	(7.12)	0.6000	(9.38)
loglik	480.97		462.56	
LR-stat	37.33 (p-value=0.01(1%))			

Notes: The table presents SUR estimates of model (1), with a common break in its slope coefficients. Panel A presents results of the full specification of the model, with all explanatory variables considered, while Panel B excludes the set of macroeconomic variables (namely, $\Delta UNPL_{t-1}$ and $INFL_{t-1}$). Σ is the correlation matrix across error terms u_{it}, where denotes the three categories of loans (Business, Mortgage and Consumer, denoted as B, M and C, respectively). t-ratios are in parenthesis and *loglik* denotes the maximum value of the likelihood function, at the optimal estimates of the model. *LR-stat* is the likelihood ratio statistic testing null hypothesis H_0: $c_i = c_i^*$, $b_1 = b_1^*$, $b_2 = b_2^*$, $b_3 = b_3^*$, $\gamma_1 = \gamma_1^*$, $\gamma_2 = \gamma_2^*$ against its alternative $H_a : c_i \neq c_i^*$, or $b_1 \neq b_1^*$, or $b_2 \neq b_2^*$, or $b_3 \neq b_3^*$, or $\gamma_1 \neq \gamma_1^*$, or $\gamma_2 \neq \gamma_2^*$, where c_i and c_i^* are assumed to be the same across i. Critical and p-values of this statistic are calculated based on the bootstrapping procedure described in the paper.

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