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MACROECONOMIC AND BANK-SPECIFIC DETERMINANTS OF NON-PERFORMING LOANS IN GREECE: A COMPARATIVE STUDY OF MORTGAGE, BUSINESS AND CONSUMER LOAN PORTFOLIOS

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ABSTRACT

This paper uses dynamic panel data methods to examine the determinants of non-performing loans (NPLs) in the Greek banking sector, separately for each type of loan (consumer, business and mortgage loans). The study is motivated by the hypothesis that both macroeconomic and bank-specific variables have an effect on loan quality and that these effects vary between different categories of loans. The results show that NPLs in the Greek banking system can be explained mainly by macrofundamentals (GDP, unemployment, interest rates) and management quality. Differences in the quantitative impact of macroeconomic factors among types of loans are evident with non-performing mortgages being the least responsive towards changes in the macroeconomic conditions.

Keywords: Non-perfoming loans; Greek banking system; Macroeconomic determinants; Bank specific determinants; Dynamic panel data

JEL classifications codes: G21; C23

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1. Introduction

Exploring the determinant factors of ex post credit risk is an issue of substantial importance for regulatory authorities concerned about financial stability and banks' management. The ex post credit risk takes the form of non-performing loans (NPLs). Despite the fact that banks have developed sophisticated techniques for quantifying ex ante credit risk by focusing on the borrower's idiosyncratic features, the ex post credit risk as reflected in the number of NPLs seems to be primarily driven by macroeconomic developments as the business cycle literature has shown. Another strand of the literature has focused on the effect of bank-specific characteristics such as the quality of management, policy choices, size and market power on problem loans.

This paper aims to provide a synthesis of these two approaches on the issue of NPLs' determinant factors. In this direction, the explanatory power of both macroeconomic and bank-specific variables will be investigated. Another issue, which according to our knowledge has been neglected so far, is a comparative study of NPLs on different types of loans and their corresponding determinants. It may be conjectured that macroeconomic and bank-specific variables have a differential impact on NPLs depending on the type of loan. This could be attributed to institutional settings creating different incentive structures for each type of loan with regards to the costs of bankruptcy. Moreover, differences in the sensitivity of various types of NPLs to macroeconomic developments may be linked to differential effects of the business cycle on agents' cash flows and collateralized assets' values. In this study, NPLs on consumer, business and mortgage loans are examined separately and their corresponding determinants are compared.

The paper focuses on the Greek financial sector which has been affected by the recent macroeconomic developments in the Greek economy. It utilizes a panel data set comprising the 9 largest Greek banks (which account for approximately 90% of Greece's banking sector) and spans the period 2003Q1 to 2009Q3. The time period 2003-9 includes both a period of growth (which began in the mid-1990s) as well as the downturn. following the financial crisis and the ensuing manifestation of Greece's own structural weaknesses.

The rest of the paper is structured as follows. Section 2 briefly presents the evolution of the Greek banking system and links it with empirical observations regarding non-performing loans. Section 3 overviews the theoretical and empirical literature on the determinants of non-performing loans and formulates a number of hypotheses relating bank-specific variables to the number of non-performing loans. Section 4 presents preliminary econometric results while Section 5 investigates the use of a dynamic panel data approach and provides a discussion of empirical results. Finally, Section 6 concludes.

2. Greek banking system and non-performing loans evolution

2.1 Development of the Greek banking sector

Until the end of the 1980s the Greek banking system was highly regulated. Regulations pertained both to the quantity (and direction) of credit supply (e.g. requirements for financing specific sector and in particular the public sector) and the interest rates charged.[1] Voridis (1993) has examined the supply of credit for fixed capital investment in the context of the a financial repressed regime[2] which characterized the Greek banking sector throughout the period and found significant distortions as regards the operation of the credit market[3].

The early 1990s saw the gradual lifting of regulative restrictions on credit markets. The ensuing transformation of the financial system should be attributed to the aspiration of Greek policy makers to harmonize the institutional environment of Greece with that of the European Union (following Greece's accession to the EC in 1981). During the 1990s

[1] According to the Economic Survey of Greece, published by the OECD (1986), the regulations on the Greek financial sector featured "extensive controls of volume, direction, and price of credit flows" while "direct government intervention" was also mentioned (OECD 1986, p. 52).
[2] Defined as a financial system where the scope of regulation is pervasive.
[3] Specifically, in his estimation of the determinants of investment, ,he finds a positive sign for all the significant lags of the 'user cost of capital' (which approximates the real cost of capital). Subsequently, a number of arguments from the literature on financial repression are invoked to justify this sign which contradicts the predictions of standard neoclassical theory.

liberalization proceeded more decisively as the prospect of joining the EMU became a primary goal for Greece. [4,5]

Overall, the 1990s constituted a landmark for the development of the Greek financial system. From the late-1980s to the early 2000s, a total of sixteen commercial banks were incorporated (Kamberoglou *et al* 2004). A wave of mergers and acquisitions was observed during that period, caused by financial institutions'need to capture market share, exploit economies of scale and become more efficient[6]. Technological improvement was reflected in increased investment in IT. Technological progress accordingly led to the introduction of innovative products (Panopoulou 2005)[7]. Furthermore, a surge in branch expansion took place as the Greek credit market was underdeveloped compared to the average of the EU and banks sought to expand and gain market share (Eichengreen and Gibson 2001, p. 563). Competition intensified as the relatively small banks exhibited high growth rates and gained market share[8].

The decade starting in 2000 saw a continuation of this trend and accordingly credit expansion proceeded apace, following Greece's accession to the euro area in 2001 and the impetus for growth provided by the Olympic Games in 2004. There were also significant changes in the direction of further improving the institutional settings in the financial sector (such as the setting up of a national credit bureau in the form of an interbank company, the imperative to comply with the standards set forth by Basel II (2007) and the new bankruptcy law enacted in 2007). The outbreak of the financial crisis in 2007 and the deterioration of public finance in Greece, which became evident in 2009, put the banking sector in a stressed situation.

The transformation of the economic environment within which the banks in Greece operated dictated a change of attitude with regards to risk management and as a

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[4] Gibson and Tsakalotos argue that the general trend towards less government since the late 1970s was another contributing factor conducive to financial liberalization (Gibson and Tsakalotos 1992, p. 11).
[5] Specifically, the Second Banking Directive enacted by the EU in 1992 was critical in directing efforts towards harmonization of national regulations.
[6] For a more detailed account of the mergers wave in the Greek financial system during the 1990s, see Eichengreen and Gibson (2001, p. 584-7)
[7] Christopoulos and Tsionas (2001) found that technical inefficiency dropped drastically during the post-liberalization period.
[8] The downward trend of the Herfindahl-Hirschman index during the 1990s testifies to this empirical observation.

consequence is expected to have affected decisively the factors determining non-performing loans (NPLs).

2.2 Non-performing loans in Greece: institutional settings and evolution

Before the liberalization of the financial sector, the regulatory restrictions determined to a large extent, the risk attitude of the banking institutions. According to Tsakalotos (1991, quoted in Gibson and Tsakalotos 1992, p. 61) credits granted by Greek banks were frequently made on the basis of "personal contacts and social pressure" leading, as a consequence, to inefficiency with regards to risk management and subsequently to problems with non-performing loans.

By contrast, the changing economic environment within which the banks operated, led banks in Greece to adopt a different mode of operation with regards to the ways they handled risk. In order to achieve satisfactory levels of profitability and survive in the face of more intense competition, the banks were forced to improve their risk management efficiency and to adopt sophisticated related technology.

Taking into account the transformation of the banking sector, as analyzed above, it is logical to infer that the determinants of NPLs should have changed over time. In the place of determinants related to public policy directions, market forces are expected to have taken over as the major drivers of NPLs. Thus, it makes sense to restrict our investigation to the post-liberalization time period.

This study focuses on the period from 2003 until today and uses a panel data set of the 9 largest banks in Greece which, in total, account for almost 80% of the market share. During this period, the Greek banking system can safely be characterized as a relatively mature financial sector where market forces govern its functioning. In addition this period encompasses a part of the booming period (which started since the mid-1990s) and the current financial crisis, originating from the US subprime mortgages market. Thus, in the time period examined various phases of the business cycle are represented.

The evolution of the aggregate NPLs ratio for all types of loans is depicted in Figure 1. A common feature for all three types of loans is that the NPL ratio exhibited a downward trend from 2003 onwards which was reversed abruptly after the outbreak of the financial crisis (the trend reversal is evident in the last two quarters of 2008). It can also be observed that the problem loans ratio in the business sector was noticeably lower (relative to their average value) compared to the consumer and mortgage loans.

[Insert Figure 1 about here]

In addition to the concerns raised by the current financial crisis for a further NPL ratio deterioration, the steep credit expansion which occurred during this decade (see Figure 2) also poses the question whether the quality of loans granted during this period was accurately evaluated by the banking system. Generally, the high rates of credit growth during the 2000s can be attributed to rightward shifts both in the demand and the supply curves. On the one hand, the deregulation of the financial system which took place in the 1990s and the ensuing competition between banks for market share, fuelled credit growth. On the demand side, the increase in debt ceilings, brought about by bank competition, induced households to attempt to smooth their consumption through borrowing[9]. In addition, the high rates of growth that prevailed in Greece since the mid-1990s[10], motivated firms to undertake investments, leading to increased debt obligations for the business sector as well.

[Insert Figure 2 about here]

The fact that the Greek financial sector has crystallized in its current form for little more than a decade implies that there are many unresolved issues with regards to the determinants of NPLs. More generally, there is a dearth of studies focusing on credit risk in the Greek economy. In the single related study, Kalfaoglou (2006) presents a stress-testing exercise conducted as a collaboration of the Bank of Greece and the IMF, aiming to quantify the resilience of Greek banks to internal and external shocks related to credit and market risk. The credit risk impact turned out to be the most significant risk component (as would be expected).

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[9] In a theoretical contribution, Antzoulatos (1994) argues (using a stochastic optimization framework) that increases in the debt ceiling may lead to increases in optimal consumption. Debt ceiling is assumed to be exogenous in his model, so that one can interpret it as a choice variable for bank policy. Antzoulatos links this theoretical result with the observed decrease in savings, presumably related to improved consumer access to credit (caused by financial deregulation), across a diverse set of countries. Furthermore, the proposed model implies that improved access to credit primarily affects middle-income groups.

[10] For a periodization of the growth phases for the Greek economy, see Bosworth and Kollintzas (2001).

The present study aims to fill this gap by investigating the macroeconomic and bank-specific determinants of problem loans, per type of loan (business, consumer and mortgage loans) for the Greek banking system, taking into account the empirical information provided by the current financial crisis.

3. Determinant factors of NPLs

3.1 Macroeconomic factors

The relation between the macroeconomic environment and loan quality has been investigated in the literature linking the phase of the business cycle with banking stability. In this line of research the hypothesis is formulated that the expansion phase of the economy is characterized by a relatively low number of NPLs, as both consumers and firms face a sufficient stream of income and revenues to service their debts. However as the booming period continues, credit is extended to lower-quality debtors and subsequently, when the recession phase sets in, NPLs increase[11].

Empirical studies tend to confirm the aforementioned link between the phase of the cycle and credit defaults. Quagliarello (2007) find that the business cycle affects the NPL ratio for a large panel of Italian banks over the period 1985 to 2002. Furthermore, Cifter *et al* (2009), using neural network based wavelet decomposition, find a lagged impact of industrial production on the number of non-performing loans in the Turkish financial system over the period January 2001 to November 2007. Finally, Salas and Saurina (2002) estimate a significant negative contemporaneous effect of GDP growth on the NPL ratio and infer a quick transmission of macroeconomic developments to the ability of economic agents to service their loans.

It seems plausible to include other macroeconomic variables, aside from GDP growth, such as unemployment and interest rates as these may provide additional information regarding the impact of macroeconomic conditions on household and firms.

[11] The inability of lower-quality debtors (either households or firms) to service their loans during a recession is also caused by the decrease in asset values which serve as collateral and the subsequent contraction of credit as banks become more risk-averse (See e.g. Fisher 1933, Minsky 1986, Kiyotaki and Moore 1997, Geanakoplos 2009).

More specifically, an increase in the unemployment rate should influence negatively the cash flow streams of households and increase the debt burden. With regards to firms, increases in unemployment may signal a decrease production as a consequence of a drop in effective demand. This may lead to a decrease in revenues and a fragile debt condition.

The interest rate affects the difficulty in servicing debt, in the case of floating rate loans. This implies that the effect of the interest rate should be positive, and as a result the increasing debt burden caused from rising interest rate payments should lead to a higher number of NPLs.

The choice of GDP, unemployment and interest rate as the primary determinants of NPLs may also be justified from the theoretical literature of life-cycle consumption models. Lawrence (1995) examines such a model and introduces explicitly the probability of default. The model implies that borrowers with low incomes have higher rates of default. This is explained by their increased risk of facing unemployment and being unable to pay. Additionally, in equilibrium, banks charge higher interest rates to riskier clients. Rinaldi and Sanchis-Arellano (2006) extend Lawrence's model by including the possibility that agents can also borrow in order to invest in real or financial assets. After solving the optimization problem of an agent, they derive the probability of default which depends on current income, the unemployment rate (which is linked to uncertainty regarding future income) and the lending rate[12].

3.2 Bank specific factors

The determinants of NPLs should not be sought exclusively in macroeconomic factors which are viewed as exogenous forces influencing the banking industry. On the contrary, the distinctive features of the banking sector and the policy choices of each particular bank with respect to their efforts for maximum efficiency and improvements in their risk management are expected to exert a decisive influence on the evolution of NPLs. A strand in the literature has examined the connection between bank-specific factors and NPLs.

[12] The probability of default, in this model, also depends on the amount of loan taken, the volume of investment and the time preference rate.

In their seminal paper, Berger and DeYoung (1997) investigate the existence of causality among loan quality, cost efficiency and bank capital using a sample of U.S. commercial banks for the period 1985-1994. They codify and test four hypotheses concerning the flow of causality between these variables:

1) *'Bad luck'* hypothesis: exogenous increases in nonperforming loans cause decreases in measured cost efficiency. The underlying argument is that a high number of problem loans leads to extra operating costs associated with dealing with them.

2) *'Bad management'* hypothesis: low cost efficiency is positively associated with increases in future nonperforming loans.[13] The proposed justification links 'bad' management with poor skills in credit scoring, appraisal of pledged collaterals and monitoring borrowers.

3) *'Skimping'* hypothesis: high measured efficiency causes increasing numbers of nonperforming loans. According to this view, there exists a trade-off between allocating resources for underwriting and monitoring loans and measured cost efficiency. In other words, banks which devote less effort to ensure higher loan quality will seem to be more cost-efficient; however, there will be a burgeoning number of NPLs in the long run.

4) '*Moral hazard*' hypothesis: low capitalization of banks leads to an increase in nonperforming loans. The link is supposed to be found in the moral hazard incentives on the part of banks' managers who increase the riskiness of their loan portfolio when their banks are thinly capitalized.14

Berger and DeYoung find support both for the 'bad management' hypothesis and the 'bad luck' hypothesis implying bidirectional causation between cost efficiency and NPLs (negative association). In addition, they find evidence for the moral hazard hypothesis.

[13] i.e. this hypothesis concerns the same variables as the 'bad luck' hypothesis but implies the opposite temporal ordering (cost inefficiency causes NPLs rather than the opposite).
[14] See Berger and DeYoung (1997, pp. 852-854) for a more detailed formulation of these hypotheses.

Podpiera and Weill (2008) examine empirically the relation between cost efficiency and non-performing loans in the context of the Czech banking industry for the period 1994 to 2005. They conclude that there is strong evidence in favor of the bad management hypothesis and propose that regulatory authorities in emerging economies should focus on managerial performance in order to enhance the stability of the financial system (by reducing nonperforming loans).

Salas and Saurina (2002) combine macroeconomic and microeconomic variables as explanatory regressors to explain NPLs in a study which is concerned with Spanish Commercial and Savings Banks (for the period 1985-1997). They estimate a statistically insignificant effect of lagged efficiency on problem loans (probably as a consequence of the counteraction of the 'bad management' and 'skimping' effects) and a negative influence of lagged solvency ratio to NPLs which is consistent with the moral hazard hypothesis. In addition, they find a *'size'* effect i.e. large banks seem to have fewer NPLs. Thus the following hypothesis may also be formulated:

5) 'Size effect' hypothesis: The size of the bank is negatively related to nonperforming loans.15

The link between lagged measures of performance and problem loans is ambiguous in its direction. One hypothesis is that worse performance may be a proxy of lower quality of skills with respect to lending activities (similar to the 'bad management' hypothesis). This implies a negative relationship between past earnings and problem loans. The inverse direction of effect is also possible as in the model of Rajan (1994). The argument is that a bank may attempt to convince the market about the profitability of its lending by adopting liberal credit policies and thus inflating current earnings at the expense of future problem loans. A bank may also use loan loss provisions in order to boost its current earnings.[16] As a consequence, past earnings may be positively linked to future NPLs.

[15] Salas and Saurina explain this by noting that size allows for more diversification opportunities (Salas and Saurina 2002, p. 219).
[16] Ahmed *et al* (1999), however, do not find evidence of earnings management via loan loss provisions for a sample of U.S. banks over 1986-1995.

6) ‘*Bad management II*’ hypothesis: worse performance is positively associated with increases in future nonperforming loans. This may be justified in a way analogous to the ‘bad management’ hypothesis by regarding past performance as a proxy for the quality of management.

Furthermore, we could conjecture credit growth as a cause of future NPLs, in accordance with the business cycle literature:

7) ‘*Procyclical credit policy*’ hypothesis: Banks adopt a liberal credit policy (defined by Rajan (1994) as a ‘negative NPV extension of credit’) during the boom of the cycle, and a tight policy in the contraction phase (defined in an inverse manner).

Table 1 presents the bank specific variables used in the econometric analysis and their mapping to specific hypotheses.

[Insert Table 1 about here]

Finally, it is noteworthy that (according to our knowledge) there is no comparative study for the determinants of NPLs between different types of loans. It is to be expected that the weight of the various determinants (both macroeconomic and bank-specific) will vary across different types of loans. For example, macroeconomic developments such as the rate of unemployment may have different quantitative implications for the future number of business and consumer NPLs as the strategic behaviour and incentives of economic agents differ across economic units. This could be attributed to differences in the strictness of bankruptcy laws regarding firm defaults and household defaults[17,18].

4. Preliminary econometric analysis

As a starting point, we investigate the existence of a cointegrating relation between NPLs and macroeconomic variables. Subsequently, we estimate a fixed effects model of the first differences intended to capture short-run movements in the NPL ratio.

[17] For an international comparison of bankruptcy laws see Kolecek (2008).

[18] The regulatory framework e.g. the obligation of the banks to write off NPLs quickly or not is another factor that affects the observed value of NPLs.

The data set consists of a balanced panel of nine (9) Greek commercial banks spanning the period from 2003 q1 to 2009 q3 on a quarterly basis. The analysis is conducted in a disaggregated manner by classifying the banks' total loan portfolio into three main categories i.e. mortgages, business and consumer loans. Each category of problem loans is examined separately so as to detect possible similarities or differences in the behavior (i.e. the determinants) of each type of portfolio. The dependent variable is the NPL ratio which is defined as the ratio of the NPLs to the value of total loans.

Our analysis is built on the *baseline* model where the relation between NPLs and a set of fundamental macroeconomic indicators, specifically, the real GDP growth rate, the unemployment rate and the real lending rates (corresponding to each type of loan) is investigated. Subsequently, the baseline model is further extended by the inclusion of additional microeconomic variables (see section 5).

However, as empirical evidence suggests that the NPL ratio may follow a unit root process hinting at a possible cointegrating relation with macroeconomic variables (see e.g. Rinaldi and Sanchis-Arellano (2006)), we perform a preliminary panel unit root and cointegration analysis. The panel unit root results for the NPLs and the real lending rates are presented in Table 2.

[Insert Table 2 about here]

The null hypothesis of the presence of a unit root cannot be rejected for all three categories of NPLs and across both tests. The presence of unit root can also not be rejected for the lending rates with the exception of the Im, Pesaran and Shin (1997 (IPS) test for the business rates. These results confirm the empirical findings of Rinaldi and Sanchis-Arellano (2006) who report non-stationarity of NPLs for household loans and real lending rates in a European cross country study. Table 3 summarizes the unit root results for GDP and the unemployment rate.

[Insert Table 3 about here]

The hypothesis of a unit root process is not rejected for both macroeconomic variables, as expected. The natural extension of the analysis is to test for a sustainable long-run equilibrium relationship between NPLs and the macroeconomic indicators as shown in Rinaldi and Sanchis-Arellano (2006). Nonetheless, our data sample covers a period, where the downward trend in the NPLs is abruptly interrupted by an upward shift approximately in the first half of 2008 (see Graphs 1,2 and 3) due to the ongoing crisis. This may signal an interruption of the common stochastic trend between NPLs and the macroeconomic factors. In other areas of financial research, such as stock markets, it has been shown that established long-run relations in a pre-crisis period are (temporarily) interrupted during the crisis (e.g. see Jochum et.al (1999) and Yang et.al (2006)). In order to detect possible shifts in the long-run behavior of the variables, we proceed as follows. First, we test for cointegration utilizing the full data sample. For each type of NPL, a pre-crisis period is defined by observing in the data, the date when the jump in the NPLs occurred. The new data set is used in order to perform panel cointegration test. The Pedroni panel cointegration test (Pedroni, 1999) for the full sample is shown in Table 4.

[Insert Table 4 about here]

For all panel cointegration tests and for each type of loans, the null hypothesis of no cointegration is not rejected implying the absence of a cointegrating relation between the NPLs and the macroeconomic variables when the full data sample is used. Table 5 presents the Pedroni panel cointegration results for the pre-crisis sample.

[Insert Table 5 about here]

The rejection of the null hypothesis for four out of seven statistics for almost all types of NPLs generates evidence in favor of a long-run equilibrium in the pre-crisis period. In addition, as the Panel and Group t-statistics are the most powerful amongst its counterparts for $N<T$ and for relative small T (Pedroni, 2004), non-rejection of the cointegration hypothesis is a reasonable conclusion. These empirical findings are indicative of a long-run equilibrium between NPLs and macroeconomic factors which was interrupted by the unfolding crisis. However, we would like to utilize the whole data sample in order to enhance the consistency of our estimates. As a result, we choose a model in first differences rather than a specification involving a cointegration relation.

The baseline model for the three categories of loan portfolios is initially estimated using the Fixed Effects (FE) method. The regression results are presented in Table 6.

[Insert Table 6 about here]

From Table 6 we see that the signs of all coefficients are as expected. The real growth is negatively related to changes in the NPL ratio, while the unemployment rate and the real lending rates have a positive impact on the dependent variable. Nonetheless, for the NPLs of mortgage loans, the first lag of the growth rate is the only statistical by significant variable. For the other two categories of loans, a statistical by significant relation is established with the second lag in the growth rate and the first lag of unemployment and real lending rates for business and consumer loans, respectively. Across all three categories of loans, the GDP growth seems to govern the relationship between the NPLs and the macroeconomic factors. Another interesting conclusion is that the NPLs of consumer loans are the most sensitive[19] towards a change in both growth rate and lending rates, while the NPLs of business loans are the most sensitive towards a change in the unemployment rate. The NPLs of mortgage loans is the least sensitive to changes of macroeconomic factors. These results are indicative of the differences in the driving forces behind NPLs for various types of portfolio loans. However, as it is expected that some degree of persistence may exist in the evolution of NPLs, the analysis is subsequently extended to a dynamic setting. In addition, the dynamic specification is suitable for testing the hypotheses formulated in Section 3 regarding the micro-determinants of NPLs.

5. Dynamic panel data analysis

5.1 Dynamic panel data estimators

Following the recent literature in panel data studies (e.g. see Salas and Saurina (2002), Athanasoglou et al. (2009) and Merkl and Stolz (2009) on banking related studies, Calderon and Chong (2001), Cheng and Kwan (2000), Beck and Levine (2004), Santos-Paulino and Thirlwall (2004) and Carstensen and Toubal (2004) on macroeconomic studies), a dynamic approach is adopted in order to account for the time persistence in the NPLs structure.

[19] The sensitivity is measured by the long-run coefficients which are computed as the sum of the individual parameters (see section 6).

The main feature of a dynamic panel data specification is the inclusion of a lagged dependent variable in the set of regressors i.e.:

$$y_{it} = \alpha y_{it-1} + \beta(L)X_{it} + \eta_i + \varepsilon_{it}\,,\ |\alpha| < 1,\ i = 1,...,N\,,\ t = 1,...,T \qquad (1)$$

where the subscripts i and t denote the cross sectional and time dimension of the panel sample respectively, y_{it} is the first difference of the NPLs, $\beta(L)$ is the $1 \times k$ lag polynomial vector, X_{it} is the $k \times 1$ vector of explanatory variables other than y_{it-1}, η_i are the unobserved individual (bank specific) effects and ε_{it} are the error terms.

As the lagged dependent variable, y_{it-1} is inherently correlated with the bank-specific effects, η_i, OLS estimation methods will produce biased and inconsistent parameters estimates. Equation (1) is consistently estimated utilizing the Generalized Method of Moments (GMM) as proposed by Arellano and Bond (1991) and generalized by Arellano and Bover (1995) and Blundell and Bond (1998). The GMM estimation of Arellano and Bond (1991) is based on the first difference transformation of equation (1) and the subsequent elimination of bank-specific effects:

$$\Delta y_{it} = \alpha \Delta y_{it-1} + \beta(L)\Delta X_{it} + \Delta\varepsilon_{it} \qquad (2)$$

where Δ is the first difference operator. In equation (2), the lagged dependent variable, Δy_{it-1} is, by construction, correlated with the error term, $,\Delta\varepsilon_{it}$ imposing a bias in the estimation of the model. Nonetheless, y_{it-2}, which is expected to be correlated with Δy_{it-1} and not correlated with $\Delta\varepsilon_{it}$ for $t = 3,...,T$, can be used as an instrument in the estimation of (2), given that ε_{it} are not serially correlated. This suggests that lags of order two, and more, of the dependent variable satisfy the following moment conditions:

$$E[y_{it-s}\Delta\varepsilon_{it}] = 0 \text{ for } t = 3,...,T \text{ and } s \geq 2 \qquad (3)$$

A second source of bias stems from the possible endogeneity of the explanatory variables and the resultant correlation with the error term. In the case of *strictly exogenous* variables, all past and future values of the explanatory variable are uncorrelated with the error term, implying the following moment conditions:

$$E\left[X_{it-s}\Delta\varepsilon_{it}\right]=0 \;\; t=3,\ldots,T \text{ and for all } s. \tag{4}$$

The assumption of strict exogeneity is restrictive and invalid in the presence of reverse causality i.e. when $E\left[X_{is}\varepsilon_{it}\right]\neq 0$ for $t<s$. For a set of *weakly exogenous* or *predetermined* explanatory variables, only current and lagged values of X_{it} are valid instruments and the following moment conditions can be used:

$$E\left[X_{it-s}\Delta\varepsilon_{it}\right]=0 \;\; t=3,\ldots,T \text{ and for } s\geq 2. \tag{5}$$

The orthogonality restrictions described in (3) – (5) form the underpinnings of the one-step GMM estimation which produces, under the assumption of independent and homoscedastic residuals (both cross-sectionally and over time), consistent parameter estimates. Arellano and Bond (1991) propose another variant of the GMM estimator, namely the two-step estimator, which utilizes the estimated residuals in order to construct a consistent variance covariance matrix of the moment conditions. Although the two-step estimator is asymptotically more efficient than the one-step estimator and relaxes the assumption of homoscedasticity, the efficiency gains are not that important even in the case of heteroscedastic errors (e.g. see Arellano and Bond (1991), Blundel and Bond (1998) and Blundell et al. (2000)). This result is further supported by the empirical findings of Judson and Owen (1999), who performed Monte Carlo experiments for a variety of cross sectional and time series dimensions and showed that the one-step estimator outperforms the two-step estimator. Moreover, the two-step estimator imposes a downward (upward) bias in standard errors (t-statistics) due to its dependence to estimated values (as it uses the estimated residuals from the one-step estimator) (Windmeijer, 2005), which may lead to unreliable asymptotic statistical inference (Bond, 2002, Bond and Windmeijeir, 2002). This issue should be taken into account, especially in the case of data samples with relatively small cross section dimension (see Arellano and Bond, 1991 and Blundell and Bond, 1998).

As noted above, the validity of the instruments used in the moment conditions as well as the assumption of serial independence of the residuals is crucial for the consistency of the GMM estimates. In line with the dynamic panel data literature, we test the overall validity of the instruments using the Sargan specification test proposed by

Arellano and Bond (1991), Arellano and Bover (1995) and Blundel and Bond (1998). The Sargan test for over-identifying restrictions is based on the sample analog of the moment conditions used in the estimation process so as to determine the suitability of the instruments. Under the null hypothesis of valid moment conditions, the Sargan test statistic is asymptotically distributed as chi-square. Furthermore, the fundamental assumption that the errors, ε_{it}, are serially uncorrelated can be assessed by testing for the hypothesis that the differenced errors, $\Delta\varepsilon_{it}$ are not second order autocorrelated. Rejection of the null hypothesis of no second order autocorrelation of the differenced errors implies serial correlation for the level of the error term and thus inconsistency of the GMM estimates.

5.2 Econometric specification

Equation (1) takes the following form in the baseline model:

$$\Delta NPL_{it}^{h} = a\Delta NPL_{it-1}^{h} + \sum\nolimits_{j=1}^{2} \beta_{1j}^{h} \Delta GDP_{t-j}$$

$$+ \sum\nolimits_{j=1}^{2} \beta_{2j}^{h} \Delta UN_{t-j} + \sum\nolimits_{i=1}^{2} \beta_{3j}^{h} \Delta RLR_{it-j}^{h} + \eta_{i}^{h} + \varepsilon_{it}^{h} \qquad (6)$$

with $|a| < 1$, $i = 1,...,9$ and $t = 1,...,27$.

In equation (6) the superscript h denotes the type of loan (i.e. mortgages, business and consumer loans), ΔNPL_{it}^{h} is the first difference of the non-performing loans ratio, ΔGDP_t is the real GDP growth rate, ΔUN_t is the change in the unemployment rate and ΔRLR_{it}^{h} is the first differences of the the real lending rates. For each type of loan, the baseline model, i.e. equation (6), is estimated in its dynamic form.

Then, each of the microeconomic indicators of Table 1 is added to the baseline model in order to examine its additive explanatory power. Moreover, from an econometric point, the limited number of cross-sectional units in the sample (there are nine (9) banks) poses additional limitations on the number of instruments that can be used in the estimation and subsequently the number of exogenous variables that can be added to equation (6). Specifically, when the number of instruments is greater than or equal to the number of cross-sectional units, then both the standard errors and the Sargan test are downwards biased and as a consequence the asymptotic inference may be misleading. To cope with this problem, we implement a "restricted" GMM procedure (see Judson and Owen, (1999)[20], i.e. we use only a limited number of lagged regressors as instruments and, secondly, as already mentioned, we add just one bank-specific variable at a time reducing the need of extra instruments. The number of instruments is cautiously determined so that their total number does not exceed the number of cross-sectional units in the sample. The baseline model in (6) is extended to account for the extra microeconomic variable:

$$\Delta NPL_{it}^{h} = a\Delta NPL_{it-1}^{h} + \sum_{j=1}^{2}\beta_{1j}^{h}\Delta GDP_{t-j}$$

$$+\sum_{j=1}^{2}\beta_{2j}^{h}\Delta UN_{t-j} + \sum_{i=1}^{2}\beta_{3j}^{h}\Delta RLR_{it-j}^{h} + \sum_{i=1}^{4}\beta_{4j}^{h}X_{it-j}^{h} + \eta_{i}^{h} + \varepsilon_{it}^{h} \tag{7}$$

where X_{it}^{h} denotes a bank-specific variable from those presented in Table 6. The set of these bank-specific variables was chosen in order to enable the testing of the hypotheses formulated in Section 3[21].

In both equations (6) and (7), the macroeconomic variables are considered as strictly exogenous while the bank-specific regressors are treated as weakly exogenous in the sense that NPLs can reversely cause the microeconomic factors used in (7). Thus, the macroeconomic variables are instrumented following condition (4) and microeconomic variables following condition (5) where only current and lagged values of the regressors are valid instruments.

In addition to the individual lags' estimations, we also calculated the long-run coefficient for each of the regressions, which is defined as:

$$\beta_{m}^{LR} = \sum_{j=1}^{n}\beta_{mj} \Big/ (1-a) \tag{8}$$

[20] Judson and Owen (1999) show that the use of the restricted procedure does not materially worsen the performance of the GMM estimation.

[21] The "Bad luck" hypothesis could not be tested using the dynamic panel data framework represented by Eq. 7. We test the hypothesis that NPLs do not Granger-cause inefficiency and found mixed results. The p-values were found as follows: Business NPLs (0.124), Consumer NPLs (0.010) and mortgage NPLs (0.404).

where $m = 1,...,4$. Its variance is calculated from the following formula:

$$Var\left(\beta_m^{LR}\right) = \frac{\left(\sum_{j=1}^{n}\beta_{mj}\right)^2}{(1-a)^2}\left[\frac{Var\left(\sum_{j=1}^{n}\beta_{mj}\right)}{\left(\sum_{j=1}^{n}\beta_{mj}\right)^2} - 2\frac{Cov\left(\left(\sum_{j=1}^{n}\beta_{mj}\right),(1-a)\right)}{\left(\sum_{j=1}^{n}\beta_{mj}\right)(1-a)} + \frac{Var(a)}{(1-a)^2}\right] \quad (9)$$

where $Var\left(\sum_{j=1}^{n}\beta_{mj}\right) = \sum_{j=1}^{n}Var\left(\beta_{mj}\right) + 2\sum_{j\neq l}Cov\left(\beta_{mj},\beta_{ml}\right)$.

5.3 Estimation results

One-step GMM estimation[22] results for all categories of NPLs are presented in Tables 7, 8 and 9. Each table contains both the baseline specification estimates and those obtained when an extra bank-specific variable is included as an explanatory variable. For each model, the Sargan test of overidentifying restrictions and the m_2 test of second order serial correlation are reported.

[Insert Table 7 about here]

[Insert Table 8 about here]

[Insert Table 9 about here]

It may be observed that most estimated coefficients have signs which are compatible with economic intuition and the theoretical arguments surveyed in Section 3. The coefficient of the lagged dependent variable is negative and statistically significant for business and consumer loans. The implication is that the NPL ratio is likely to decrease when it has increased in the previous quarter, due to the write-offs[23]. On the other hand, this coefficient is statistically insignificant for mortgages. Specifically, for this category of loans, macrofundamentals and bank-specific variables seem to be the main drivers of the NPL ratio.

The NPL ratio is negatively affected by a slowdown in economic growth for all types of loans. The effect of the GDP growth rate is found to be stronger for business

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[22] The Blundell-Bond system GMM estimator (Blundell and Bond 1998) has also been proposed in the literature. However using the Sargan - difference test we rejected its underlying assumptions.

[23] Sorge and Virolainen (2006) report a negative coefficient for the lagged dependent variable in their estimated equation of loan loss provisions for the Finnish banking system. The economic interpretation for the negative coefficient in both cases is similar.

loans. In that case, all lags are significant at a 1% significance level. This result points to a strong dependence of the business sector's ability to repay its loans on the phase of the cycle. Specfically, an increase of one percentage point of GDP eads to a decrease of 0.28 in the the NPL ratio during the first quarter and a further decrease of 0.43 during the second quarter. Thus, the hypothesis that a recession phase has an adverse impact on NPLs is confirmed. This effect is exacerbated by the small average size of Greek firms which results in them being most vulnerable to adverse macroeconomic shocks. The NPL ratio for consumer loans is also a negative function of the GDP growth rate. The GDP growth rate affects the NPL ratio of consumer loans with a lag of two quarters. Finally, in the case of mortgage loans, the coefficient of the lagged GDP growth rate is also statistically significant, however its quantitative impact is attenuated compared to the other two types of loans.

Lagged unemployment affects, in particular, business loans, with one lag. Thus, it seems that firms cut their labor cost before they face credit repayment problems. Additionally, unemployment with one-period lag is a leading indicator of NPLs in the consumer loan portfolio. It may be inferred that a rise in unemployment affects households' ability to service their debts with a three-month time delay. Mortgages are again the least sensitive type of loans. This could be explained by the fact that mortgage loans are mostly extended to public servants and high-skilled workers of the private sector and consequently unemployment does not have any noticeable effect on the corresponding NPL ratio (Mitrakos *et al,* 2005).

The coefficients on the lagged real lending rates are positive as expected. The one-quarter lagged coefficient is statistically significant in the case of consumer and business loans. Despite the fact that, in the case of mortgage loans, the statistical significance of each individual lag is low, this could be attributed to the high level of covariance between the individual coefficients (as the estimation of the long-run coefficients shows – see below). It should be noticed that the great majority of both consumer and business loans are floating rate loans, compared to mortgages, where there is a significant portion of fixed rate loans. This is compatible with the aforementioned finding that the one quarter lag for both consumer and business loans is statistical significant, implying a direct effect of interest rates on the NPL ratio, in contrast to mortgages, where only the long-run coefficient turns out to be statistically significant. Consumer loans are not easily refinanced as banks tend to resort to tight credit granting policies with regards to consumer loans during recessions. In contrast, firms facing difficulties in servicing their debt possess greater bargaining power to renegotiate interest payments on their loans.

For each type of loans, the coefficients for the macroeconomic variables are rather stable across alternative models (which include bank-specific explanatory variables), thus providing a robustness check of our estimated results.

In order to assess in a more transparent manner the differential impact of macroeconomic and bank specific variables one should look at the long-run coefficients (see Tables 10 and 11 respectively). For all macroeconomic variables, the estimated long-run coefficients estimates are statistically significant with the expected sign. Focusing on specific macrofundamentals, the real GDP growth have the strongest long-run effect on the NPL ratio of business loans, as does unemployment. On the other hand, lending rates impact noticeably, in the long- run, on the NPL ratio of the consumer loans' portfolio.

[Insert Table 10 about here]

[Insert Table 11 about here]

The most striking implication of the estimated long-run coefficients is the relative insensitivity of mortgage NPLs, to macroeconomic conditions, compared to consumer and business NPLs. One possible explanation is that a borrower faces greater incentives to avoid defaulting on a mortgage loan due to the pledged collateral. In addition, home ownership is highly valued in Greece, a feature that may be considered as a social specificity.

The estimated coefficients for the bank-specific explanatory variables imply the existence of certain regularities as regards the relation between banks' features and the quality of loans. The empirical evidence for the hypotheses presented in Table 1 is summarized in Table 12. Performance indicators (such as ROE and ROA) are found to be significant and negatively related to the NPLs for mortgages and consumer loans while they are not significant for business loans. In the case of mortgages and consumer loans, this provides evidence in favor of the 'bad management II' hypothesis. The fact that empirical evidence in favor of the ‘bad management II’ hypothesis is restriced to mortgages and consumer loans, but is absent for business loans, may signify that the effect of management quality is mainly reflected on the efficiency of cross grating procedures to households which are primarily based on the development of quantitative modeling techniques while the quality of case-by-case assignment procedures which characterize the granting of business loans does not differ substantially among banks.

[Insert Table 12 about here]

Banks’ risk attitude, as reflected in the solvency and loans-to-deposit ratio, does not seem to have explanatory power over NPLs for all types of loans. Thus, the ‘moral hazard’ hypothesis does not find any support in the Greek banking system. A possible explanation is that the small size of the market for bank managers in Greece creates dis-incentives for reckless risk-taking and short-termism for reputation reasons. In addition, due to the small number of banks, the regulatory authorities tend to have an accurate on-site overview of the riskiness of each individual bank’s loan portfolio and thus they can intervene accordingly to ensure financial stability. As a result, the potential of bank managers to generate causing high levels of NPLs because of moral hazard incentives is minimized.

On the other hand, inefficiency index has a positive and statistically significant thus lending support to the ‘bad management’ hypothesis. Moreover, its impact is quantitatively similar for NPLs of all types. Empirical support for the ‘bad management’ hypothesis is also consistent with the aforementioned finding that lagged performance is negatively related to the problem loans through the ‘bad management II’ hypothesis. Thus, both performance indicators and the inefficiency index may serve as proxies for the quality of management and both have explanatory power over the NPL ratio.

Past credit growth does not go a long way to explain NPLs implying that short sightedness on the part of managers was not present in the present sample and that aggressive lending does not necessarily coincide with reckless risk taking. Consequently, the procyclical credit growth hypothesis is rejected for the Greek banking system. Finally, market power indicators have a significant impact only for business loans’ NPLs (specifically the market share). It can be deduced that diversification opportunities are more ample in the business loan portfolio.

6. Concluding remarks and discussion

In this study we used dynamic panel data methods to examine the determinants of non-performing loans (NPLs) in the Greek financial sector. It was found that macroeconomic variables, specifically the real GDP growth rate, the unemployment rate and the lending rates have a strong effect on the level of NPLs. Furthermore, bank-specific variables such as performance and efficiency indicators were found to possess additional explanatory power when added to the baseline model, thus lending support to the 'bad management' hypothesis linking these indicators to the quality of management. Empirical results also indicate significant differences with regards to the quantitative effects of the various NPLs' determinants depending on the category of loans.

Our findings have several implications in terms of regulation and policy. Specifically, there is evidence that performance and inefficiency measures may serve as leading indicators of future problem loans. This suggests that the regulatory authorities could use these measures to detect banks with potential NPLs increases. Moreover, regulators should place greater emphasis on risk management systems and procedures followed by banks in order to avert future financial instability.

In addition, the econometric relations established in the paper can be used for forecasting and stress testing purposes by both regulators and banks. In a macro-stress testing exercise, alternative scenarios for the evolution of the macrovariables can be used in order to assess if NPLs are likely to exceed a threshold indicative of financial instability and to evaluate the adequacy of loan-loss provisions in the banking system. On the other hand, similar exercises could be performed on a bank-specific level in order to assess future problems that may ensue in particular banks characterized by relatively low performance and efficiency. Given that the analysis has been conducted on a disaggregated basis, stress testing exercises may focus on different types of loan portfolios, enhancing the reliability of the results.

The study could be extended in various ways. In the first place, a “vintage” loan analysis could be used to pinpoint any differences in the quality of loans granted during the cycle. Such a type of analysis would be directly linked to the hypothesis which posits a change in the risk attitude of banks between the phases of the cycle. Additionally, further investigation of the crisis effects would be worthy of study. It may be conjectured that the financial crisis represents a structural break affecting the interrelations between non-performing loans and their determinant factors, but additional data is required to test hypothesis.

REFERENCES

Ahmed, A. S., Takeda, C. and Thomas, S., 1999. Bank Loan Loss Provisions: A Reexamination of Capital Management, Earnings Management and Signaling Effects. *Journal of Accounting and Economics* 28, 1-25.

Antzoulatos, A. A., 1994, Credit Rationing and Rational Behavior. *Journal of Money, Credit and Banking* 26 (2), 182-202.

Arellano, M. and Bond S., 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies* 58, 277–297.

Arellano, M. and Bover, O., 1995. Another Look at the Instrumental Variable Estimation of Error-Component Models. *Journal of Econometrics* 68, 29 – 51.

Athanasoglou, P. P., Brissimis, S. N. and Delis M. D., 2008. Bank-Specific, Industry-Specific and Macroeconomic Determinants of Bank Profitability. *Journal of International Financial Markets, Institutions and Money* 18 (2), 121 – 136.

Beck, T. and Levin R., 2004. Stock Markets, Banks, and Growth: Panel Evidence. *Journal of Banking and Finance* 28 (3), 423 – 442.

Berger, A. N. and DeYoung R., 1997. Problem Loans and Cost Efficiency in Commercial Banks. *Journal of Banking and Finance* 21, 849-870

Blundell, R., Bond, S., 1998. Initial Conditions and Moment Conditions in Dynamic Panel Data Models. *Journal of Econometrics* 87, 115–143.

Blundell, R., Bond, S. and Windmeijer F., 2000. Estimation in Dynamic Panel Data Models: Improving on The Performance of the Standard GMM Estimator. in B. Baltagi (ed). Advances in Econometrics, Volume 15: Non-stationary Panels, Panel Cointegration and Dynamic Panels, JAI Elsevier Science.

Bond, S., 2002. Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice, *Portuguese Economic Review* 1 (2).

Bond, S., Windmeijer F., 2002. Finite Sample Inference for GMM Estimators in linear Panel Data Models: A Comparison of Alternative Tests. mimeo, Institute for fiscal studies, London.

Bosworth, B., Kollintzas, T., 2001. Economic Growth in Greece: Past Performance and Future Prospects in Bryant R. C., Garganas N. C. and Tavlas G. S. (Eds.), *Greece's Economic Performance and Prospects*, Bank of Greece and the Brookings Institution

Calderon, C., Chong, A., 2001. External Sector and Income Inequality in Interdependent Economies Using a Dynamic Panel Data Approach. *Economics Letters* 71, 225 – 231.

Carstensen, K., Toubal, F., 2004. Foreign Direct Investment in Central and Eastern European countries: a Dynamic Panel Analysis. *Journal of Comparative Economics* 32, 3 – 22.

Cheng, L.K., Kwan, Y.K., 2000. What are the Determinants of the Location of Foreign Direct Investment? The Chinese experience. *Journal of International Economics* 51, 379 – 400.

Christopoulos, D. K., Tsionas, E., 2001. Banking Economic Efficiency in the Deregulation Period: Results from Heteroscedastic Stochastic Frontier Models. *The Manchester School* 69 (6), 656-676.

Cifter, A., Yilmazer, S., Cifter E., 2009. Analysis of Sectoral Credit Default Cycle Dependency with Wavelet Networks: Evidence from Turkey. *Economic Modelling* 26, 1382-1388

Eichengreen B. and Gibson H. D., 2001. Greek Banking at the Dawn of the New Millenium in Bryant R. C., Garganas N. C. and Tavlas G. S. (Eds.), *Greece's Economic Performance and Prospects*, Bank of Greece and the Brookings Institution

Fisher, I., 1933. The Debt Deflation Theory of Great Depressions. *Econometrica* 1, 337-57.

Geanakoplos, J. 2009. The Leverage Cycle. *Cowles Foundation Discussion Paper* No. 1715.

Gibson, H., Tsakalotos, E., 1992. *Economic Integration and Financial Liberalization: Prospects for Southern Europe*. St. Antony/MacMillan Press.

Im, K., Pesaran H., Shin Y., 1997. Testing for Unit Roots in Heterogeneous Panels. Discussion Paper, University of Cambridge.

Jochum, C., Kirchgassner, G. and Platek, M., 1999. A Long-Run Relationship Between Eastern Stock Markets? Cointegration and The 1997 – 1998 Crisis In Emerging Markets. Weltwirtschaftliches Archiv 135, 455–479.

Judson, R. A. and Owen, L. A., 1999. Estimating Dynamic Panel Data Models: A Guide for Macroeconomists. *Economics Letters* 65, 9 – 15.

Kalfaoglou, F. 2006. Stress Testing of the Greek Banking System. Bank of Greece: Economic Bulletin 27.

Kamberoglou, N., Liapis, E., Simigiannis, G. and Tzamourani, P., 2004. Cost Efficiency in Greek Banking. Working Paper Bank of Greece 9.

Kiyotaki, N., Moore, J., 1997. Credit Cycles. *Journal of Political Economy* 105 (2) 211-248.

Kolecek, L. 2008. Bankruptcy Laws and Debt Renegotiation. *Journal of Financial Stability* 4, 40-61.

Lawrence, E. C., 1995. Consumer Default and the Life Cycle Model. *Journal of Money Credit and Banking*. 27, 939-954.

Merkl, C., Stolz S., 2009. Banks Regulatory Buffers, Liquidity Networks and Monetary Policy Transmission. *Applied Economics* 41, 2013 – 2024.

Minsky, H. 1986. *Stabilizing an Unstable Economy*, McGraw-Hill.

Mitrakos, T., Simigiannis, G. and Tzamourani P. 2005. Indebtedness of Greek Households: Evidence from a Survey. *Economic Bulletin*, Bank of Greece.

Organization for Economic Cooperation and Development (OECD), Economic Surveys: Greece Paris, 1986

Panopoulou, M., 2005. Technological Change and Corporate Strategy in the Greek Banking Industry, Athens: KEPE

Pedroni, P., 1999. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. *Oxford Bulletin of Economics and Statistics* 61, 653 – 70.

Pedroni, P., 2004. Panel Cointegration, Asymptotic and Finite Sample Properties of Pooled Time Series Tests with Application to PPP Hypothesis. *Econometric Theory* 20, 597 – 625.

Podpiera, J., Weill L., 2008. Bad Luck or Bad Management? Emerging Banking Market Experience. *Journal of Financial Stability* 4, 135-148.

Quagliarello M. 2007. Banks' Riskiness Over the Business Cycle: a Panel Analysis on Italian Intermediaries. *Applied Financial Economics* 17, 119-138.

Rajan R., 1994. Why Bank Credit Policies Fluctuate: A Theory and Some Evidence. *The Quarterly Journal of Economics* 109, 399-441

Rinaldi L. and Sanchis-Arellano A., 2006. Household Debt Sustainability: What explains Household Non-performing Loans? An Empirical Analysis. *ECB Working Paper*

Salas, V. and Saurina, J., 2002. Credit Risk in Two Institutional Regimes: Spanish Commercial and Savings Banks. *Journal of Financial Services Research* 22 (3), 203-224.

Santos-Paulino, A. and Thirlwall A.P. 2004. The Impact of Trade Liberalization on Exports, Imports and Balance of Payments of Developing Countries. *The Economic Journal* 114.

Sorge, M. and Virolainen K., 2006. A Comparative Analysis of Macro Stress-Testing Methodologies with Application to Finland. *Journal of Financial Stability* 2, 113-151.

Voridis, H., 1993. Ceilings on Interest Rates and Investment: The Example of Greece. *Review of Economics and Statistics* 75 (2), 276-283.

Wahlen, J. M., 1994. The Nature of Information in Commercial Bank Loan Loss Disclosure. *The Accounting Review* 69 (3), 455-478.

Windmeijer, F., 2005. A Finite Sample Correction for the Variance of Linear Efficient Two-Step GMM Estimators. *Journal of Econometrics* 126 (1), 25 – 51.

Yang, J., Hsiao C., Q. Li and Z. Wang 2006. The Emerging Market Crisis and Stock Market Linkages: Further Evidence. *Journal of Applied Econometrics* 21, 727 – 744.

Appendix

Table 1. Definition of bank specific variables

Variable	*Definition*	*Hypothesis tested*
Return on Assets	$ROA_{it} = \frac{\text{Profits}_{\text{it}}}{\text{Total Assets}_{\text{it}}}$	"Bad management II" (-)
Return on Equity	$ROE_{it} = \frac{\text{Profits}_{\text{it}}}{\text{Total Equity}_{\text{it}}}$	"Bad management II" (-)
Solvency Ratio	$SOLR_{it} = \frac{\text{Owned Capital}_{\text{it}}}{\text{Total Assets}_{\text{it}}}$	"Moral hazard" (-)
Loans to Deposit Ratio	$LtD_{it} = \frac{\text{Loans}_{\text{it}}}{\text{Deposit}_{\text{it}}}$	"Moral hazard" (+)
Inefficiency	$INEF_{it} = \frac{\text{Operating Expenses}_{\text{it}}}{\text{Operating Income}_{\text{it}}}$	"Bad Management" (+) "Skimping" (-)
Credit growth	$GLOANS_{it}^{h} = \frac{Loans_{it}^{t} - Loans_{it-1}^{h}}{Loans_{it-1}^{h}}$	"Procyclical credit policy" (+)
Market power	$MPOW_{it}^{h} = \frac{\text{Loans}_{it}^{h}}{\sum_{\text{i=1}}^{9} \text{Loans}_{it}^{h}}$	"Size" (-)
Size	$SIZE_{it} = \frac{\text{Total Assets}_{\text{it}}}{\sum_{\text{i=1}}^{9} \text{Total Assets}_{\text{it}}}$	"Size" (-)

Note: All ratios are expressed in percentage points. The expected coefficient signs are shown in parenthesis.

Table 2. Panel unit root tests

	Mortgages		Business		Consumer	
	LLC	*IPS*	*LLC*	*IPS*	*LLC*	*IPS*
NPL	[0.948]	[0.964]	[0.973]	[0.946]	[0.911]	[0.967]
Δ*NPL*	[0.000]	[0.000]	[0.008]	[0.000]	[0.003]	[0.000]
RLR	[0.677]	[0.179]	[0.153]	[0.016]	[0.516]	[0.433]
Δ*RLR*	[0.000]	[0.000]	[0.001]	[0.001]	[0.001]	[0.000]

Notes: *NPL* and *RLR* denote the non-performing loans ratio and real lending rates respectively, while the operator Δ is the first difference operator. *LLC* stands for the Levin, Lin and Chu (2002) test where the null hypothesis that each individual time series is a unit root is tested against the alternative that all of them are stationary. *IPS* stands for the Im, Pesaran and Shin (1997) test where the assumption of homogeneity is relaxed under the alternative hypothesis that some of the individual time series are stationary. The p-values of the corresponding t-statistics are shown in brackets.

Table 3. Unit root tests

	ADF	*PP*
GDP	[0.984]	[0.994]
Δ*GDP*	[0.013]	[0.012]
UN	[0.583]	[0.463]
Δ*UN*	[0.002]	[0.001]

Notes: *GDP* and *UN* denote the gross domestic product and the unemployment rate respectively while the operator Δ is the first difference operator. ADF stands for the Augmented Dickey Fuller and *PP* stands for the Phillips Perron test. For both tests the null hypothesis of unit root is tested against the alternative of stationarity. The p-values of the corresponding t-statistics are shown in brackets.

Table 4. Pedroni panel cointegration test for the full sample

	Mortgages	Business	Consumer
Panel *v-statistic*	[0.497]	[0.906]	[0.671]
Panel *ρ-statistic*	[0.869]	[0.974]	[0.797]
Panel *t-statistic (PP)*	[0.174]	[0.902]	[0.127]
Panel *t-statistic (ADF)*	[0.769]	[0.810]	[0.743]
Group *ρ-statistic*	[0.955]	[0.998]	[0.967]
Group *t-statistic (PP)*	[0.147]	[0.975]	[0.154]
Group *t-statistic (ADF)*	[0.685]	[0.949]	[0.874]

Notes: The Pedroni test is an Enlge-Granger type test where the residuals are tested for the presence of unit root. The null hypothesis is that of no cointegration and the decision is based on seven statistics. The main difference between the panel and group statistics is that the latter allows for potential heterogeneity in the individual units through its less restrictive alternative hypothesis. The p-values for the corresponding statistics are shown in brackets.

Table 5. Pedroni panel cointegration test for the pre-crisis period

	Mortgages (Period: 2003 q1 – 2008 q2)	Business (Period: 2003 q1 – 2008 q4)	Consumer (Period: 2003 q1 – 2008 q3)
Panel *v-statistic*	[0.830]	[0.507]	[0.856]
Panel *ρ-statistic*	[0.297]	[0.892]	[0.409]
Panel *t-statistic (PP)*	[0.001]	[0.000]	[0.004]
Panel *t-statistic (ADF)*	[0.000]	[0.000]	[0.000]
Group *ρ-statistic*	[0.772]	[0.951]	[0.836]
Group *t-statistic (PP)*	[0.000]	[0.000]	[0.010]
Group *t-statistic (ADF)*	[0.000]	[0.000]	[0.138]

Notes: The Pedroni test is an Enlge-Granger type test where the residuals are tested for the presence of unit root. The null hypothesis is that of no cointegration and the decision is based on seven statistics. The main difference between the panel and group statistics is that the latter allows for potential heterogeneity in the individual units through its less restrictive alternative hypothesis. The p-values for the corresponding statistics are shown in brackets.

Table 6. Fixed Effects (FE) regressions

	Mortgages	Business	Consumer
constant	0.570*** (5.252)	0.392*** (3.164)	0.788*** (4.312)
ΔGDP_{t-1}	-0.336*** (-3.682)	-0.153 (-1.475)	-0.205 (-1.408)
ΔGDP_{t-2}	-0.077 (-0.871)	-0.305*** (-3.051)	-0.511*** (-3.946)
ΔUN_{t-1}	0.099 (1.245)	0.181** (1.917)	0.108 (1.132)
ΔUN_{t-2}	0.047 (0.572)	0.095 (0.980)	0.002 (0.023)
ΔRLR^{h}_{it-1}	0.128 (1.377)	0.122 (1.124)	0.345*** (2.985)
ΔRLR^{h}_{it-2}	0.078 (0.799)	0.044 (0.377)	0.004 (0.032)
Wald test (p-value)	[0.000]	[0.000]	[0.000]
Adjusted R-square	0.185	0.427	0.464

Notes: ΔGDP is real growth rate, ΔUN is the deseasonalized unemployment rate and ΔRLR is the differenced real lending rate. *,** and *** indicate significance at a 10%, 5% and 1% significance level. The t-statistics are depicted in parenthesis under the parameter estimations.

Table 7. GMM estimation results for mortgages

	Baseline		Model 1		Model 2		Model 3
Constant	0.031** (2.342)	*constant*	0.038** (2.452)	*Constant*	0.033** (2.485)	*constant*	0.032** (2.387)
ΔNPL^h_{it-1}	-0.003 (-0.068)	ΔNPL^h_{it-1}	0.006 (0.113)	ΔNPL^h_{it-1}	0.000 (0.006)	ΔNPL^h_{it-1}	-0.019 (-0.392)
ΔGDP_{t-1}	-0.238** (-2.48)	ΔGDP_{t-1}	-0.170 (-1.527)	ΔGDP_{t-1}	-0.198* (-1.748)	ΔGDP_{t-1}	-0.219** (-2.060)
ΔGDP_{t-2}	-0.041 (-0.670)	ΔGDP_{t-2}	-0.008 (-0.113)	ΔGDP_{t-2}	-0.030 (-0.452)	ΔGDP_{t-2}	-0.027 (-0.346)
ΔUN_{t-1}	0.135* (1.723)	ΔUN_{t-1}	0.126 (1.416)	ΔUN_{t-1}	0.135 (1.618)	ΔUN_{t-1}	0.124 (1.545)
ΔUN_{t-2}	-0.000 (-0.006)	ΔUN_{t-2}	-0.059 (-0.852)	ΔUN_{t-2}	-0.036 (-0.522)	ΔUN_{t-2}	0.011 (0.175)
ΔRLR^h_{it-1}	0.096 (1.582)	ΔRLR^h_{it-1}	0.067 (1.05)	ΔRLR^h_{it-1}	0.086 (1.412)	ΔRLR^h_{it-1}	0.069 (1.08)
ΔRLR^h_{it-2}	0.070 (0.918)	ΔRLR^h_{it-2}	0.086 (1.263)	ΔRLR^h_{it-2}	0.092 (1.201)	ΔRLR^h_{it-2}	0.050 (0.596)
		ROA_{it-1}	0.077 (0.990)	ROE_{it-1}	0.005 (1.282)	$SOLR_{it-1}$	-0.109** (-2.04)
		ROA_{it-2}	-0.253*** (-3.973)	ROE_{it-2}	-0.009** (-2.103)	$SOLR_{it-2}$	-0.025 (-0.397)
		ROA_{it-3}	-0.054 (-1.343)	ROE_{it-3}	-0.000 (-0.024)	$SOLR_{it-3}$	0.071 (1.60)
		ROA_{it-4}	-0.150* (-1.881)	ROE_{it-4}	-0.008** (-2.281)	$SOLR_{it-4}$	-0.029 (-0.557)
Sargan test	119.0 [0.820]		131.6 [0.871]		135.8 [0.807]		128.4 [0.909]
m_2	-1.795 [0.073]		-1.844 [0.065]		-1.881 [0.060]		-2.122 [0.034]

Notes: ***,** and * denote significance at 1%, 5% and 10% respectively. t-statistics are reported in parenthesis. The p-values for the Sargan and the m_2 test are reported in brackets.

Table 7. (continued) GMM estimation results for mortgages

	Model 4		Model 5		Model 6		Model 7		Model 8
constant	0.045* (1.885)	*constant*	0.036** (2.301)	*constant*	0.030** (2.101)	*constant*	0.031** (2.281)	*constant*	0.031** (2.210)
ΔNPL^{h}_{it-1}	-0.031 (-0.709)	ΔNPL^{h}_{it-1}	-0.011 (-0.220)	ΔNPL^{h}_{it-1}	-0.000 (-0.015)	ΔNPL^{h}_{it-1}	-0.013 (-0.277)	ΔNPL^{h}_{it-1}	-0.008 (-0.187)
ΔGDP_{t-1}	-0.236** (-2.493)	ΔGDP_{t-1}	-0.193* (-1.760)	ΔGDP_{t-1}	-0.234** (-2.382)	ΔGDP_{t-1}	-0.230** (-2.412)	ΔGDP_{t-1}	-0.229** (-2.422)
ΔGDP_{t-2}	-0.019 (-0.321)	ΔGDP_{t-2}	-0.014 (-0.199)	ΔGDP_{t-2}	-0.033 (-0.587)	ΔGDP_{t-2}	-0.054 (-0.874)	ΔGDP_{t-2}	-0.047 (-0.740)
ΔUN_{t-1}	0.128* (1.789)	ΔUN_{t-1}	0.127 (1.457)	ΔUN_{t-1}	0.119 (1.569)	ΔUN_{t-1}	0.131* (1.753)	ΔUN_{t-1}	0.130* (1.731)
ΔUN_{t-2}	0.008 (0.184)	ΔUN_{t-2}	-0.031 (-0.444)	ΔUN_{t-2}	-0.002 (-0.033)	ΔUN_{t-2}	0.004 (0.0737)	ΔUN_{t-2}	0.003 (0.057)
ΔRLR^{h}_{it-1}	0.130** (2.491)	ΔRLR^{h}_{it-1}	0.074 (1.178)	ΔRLR^{h}_{it-1}	0.092 (1.285)	ΔRLR^{h}_{it-1}	0.106 (1.507)	ΔRLR^{h}_{it-1}	0.109* (1.701)
ΔRLR^{h}_{it-2}	0.043 (0.553)	ΔRLR^{h}_{it-2}	0.086 (1.276)	ΔRLR^{h}_{it-2}	0.084 (1.078)	ΔRLR^{h}_{it-2}	0.074 (0.988)	ΔRLR^{h}_{it-2}	0.079 (0.969)
LtD_{it-1}	-0.016 (-1.232)	$INEF_{it-1}$	0.000 (0.036)	$GLOANS^{h}_{it-1}$	-0.003 (-0.616)	$SIZE_{it}$	0.005 (0.056)	$MPOW^{h}_{it}$	0.018 (0.148)
LtD_{it-2}	0.028 (1.365)	$INEF_{it-2}$	0.002 (0.436)	$GLOANS^{h}_{it-2}$	-0.000 (-0.035)				
LtD_{it-3}	-0.002 (-0.183)	$INEF_{it-3}$	0.001 (1.064)	$GLOANS^{h}_{it-3}$	-0.009 (-1.332)				
LtD_{it-4}	-0.017** (-2.338)	$INEF_{it-4}$	0.005** (2.211)	$GLOANS^{h}_{it-4}$	-0.001 (-0.199)				
Sargan test	131.8 [0.868]		134.5 [0.829]		131.1 [0.878]		132.0 [0.900]		130.1 [0.920]
m_2	-2.039 [0.041]		-2.006 [0.045]		-1.849 [0.064]		-1.976 [0.048]		-1.986 [0.047]

Notes: ***,** and * denote significance at 1%, 5% and 10% respectively. t-statistics are reported in parenthesis. The p-values for the Sargan and the m_2 test are reported in brackets.

Table 8. GMM estimation results for business loans

	Baseline		Model 1		Model 2		Model 3
constant	-0.037** (-1.983)	*constant*	-0.038** (-1.973)	*constant*	-0.042** (-2.033)	*constant*	-0.038* (-1.768)
ΔNPL^h_{it-1}	-0.102** (-2.081)	ΔNPL^h_{it-1}	-0.087* (-1.824)	ΔNPL^h_{it-1}	-0.091** (-2.074)	ΔNPL^h_{it-1}	-0.084 (-1.604)
ΔGDP_{t-1}	-0.280*** (-4.562)	ΔGDP_{t-1}	-0.245*** (-4.743)	ΔGDP_{t-1}	-0.256*** (-4.332)	ΔGDP_{t-1}	-0.254*** (-5.543)
ΔGDP_{t-2}	-0.436*** (-2.685)	ΔGDP_{t-2}	-0.418*** (-2.502)	ΔGDP_{t-2}	-0.428*** (-2.513)	ΔGDP_{t-2}	-0.446*** (-2.373)
ΔUN_{t-1}	0.156** (2.036)	ΔUN_{t-1}	0.122* (1.698)	ΔUN_{t-1}	0.121* (1.645)	ΔUN_{t-1}	0.137* (1.784)
ΔUN_{t-2}	0.107 1.084	ΔUN_{t-2}	0.067 (0.683)	ΔUN_{t-2}	0.075 (0.791)	ΔUN_{t-2}	0.093 (1.313)
ΔRLR^h_{it-1}	0.175* (1.803)	ΔRLR^h_{it-1}	0.137 (1.504)	ΔRLR^h_{it-1}	0.156* (1.734)	ΔRLR^h_{it-1}	0.157* (1.684)
ΔRLR^h_{it-2}	0.043 0.505	ΔRLR^h_{it-2}	0.048 (0.630)	ΔRLR^h_{it-2}	0.045 (0.589)	ΔRLR^h_{it-2}	0.066 (0.887)
		ROA_{it-1}	-0.193*** (-2.501)	ROE_{it-1}	-0.009*** (-3.724)	$SOLR_{it-1}$	-0.012 (-0.156)
		ROA_{it-2}	0.076 (0.813)	ROE_{it-2}	0.006* (1.688)	$SOLR_{it-2}$	-0.119 (-0.902)
		ROA_{it-3}	-0.221* (-1.818)	ROE_{it-3}	-0.011 (-1.483)	$SOLR_{it-3}$	0.214*** (2.741)
		ROA_{it-4}	0.125 (1.245)	ROE_{it-4}	0.007 (1.232)	$SOLR_{it-4}$	-0.033 (-0.680)
Sargan test	181.7 [0.388]		184.2 [0.682]		184.9 [0.669]		182.8 [0.707]
m_2	-0.462 [0.644]		0.225 [0.821]		0.2336 [0.815]		-0.331 [0.741]

Notes: ***,** and * denote significance at 1%, 5% and 10% respectively. t-statistics are reported in parenthesis. The p-values for the Sargan and the m_2 test are reported in brackets.

Table 8. (continued) GMM estimation results for business loans

	Model 4		Model 5		Model 6		Model 7		Model 8
constant	-0.066**	*constant*	-0.036*	*constant*	-0.039*	*constant*	-0.040*	*constant*	-0.040**
	(-1.984)		(-1.873)		(1.785)		(-1.893)		(-2.048)
ΔNPL^h_{it-1}	-0.138***	ΔNPL^h_{it-1}	-0.106*	ΔNPL^h_{it-1}	-0.077	ΔNPL^h_{it-1}	-0.109**	ΔNPL^h_{it-1}	-0.119**
	(-2.603)		(-1.877)		-1.094		(-2.162)		(-2.569)
ΔGDP_{t-1}	-0.328***	ΔGDP_{t-1}	-0.249***	ΔGDP_{t-1}	-0.284***	ΔGDP_{t-1}	-0.282***	ΔGDP_{t-1}	-0.288***
	(-4.643)		(-3.968)		(4.823)		(-4.628)		(-4.633)
ΔGDP_{t-2}	-0.461***	ΔGDP_{t-2}	-0.405***	ΔGDP_{t-2}	-0.423***	ΔGDP_{t-2}	-0.438***	ΔGDP_{t-2}	-0.434***
	(-2.762)		(-2.432)		(2.674)		(-2.714)		(-2.703)
ΔUN_{t-1}	0.145**	ΔUN_{t-1}	0.119*	ΔUN_{t-1}	0.152*	ΔUN_{t-1}	0.157**	ΔUN_{t-1}	0.163**
	(1.984)		(1.668)		(1.864)		(2.151)		(2.133)
ΔUN_{t-2}	0.095	ΔUN_{t-2}	0.083	ΔUN_{t-2}	0.089	ΔUN_{t-2}	0.103	ΔUN_{t-2}	0.107
	(1.074)		(0.809)		(0.998)		(1.067)		(1.098)
ΔRLR^h_{it-1}	0.177***	ΔRLR^h_{it-1}	0.145	ΔRLR^h_{it-1}	0.158*	ΔRLR^h_{it-1}	0.175*	ΔRLR^h_{it-1}	0.142*
	(2.521)		(1.598)		(1.817)		(1.914)		(1.757)
ΔRLR^h_{it-2}	0.031	ΔRLR^h_{it-2}	0.023	ΔRLR^h_{it-2}	0.045	ΔRLR^h_{it-2}	0.043	ΔRLR^h_{it-2}	0.047
	(0.330)		(0.280)		(0.487)		(0.522)		(0.586)
LtD_{it-1}	-0.022**	$INEF_{it-1}$	0.006***	$GLOANS^h_{it-1}$	0.002	$SIZE_{it}$	0.096	$MPOW^h_{it}$	0.112**
	(-1.971)		(2.758)		(0.179)		1.432		(2.451)
LtD_{it-2}	-0.004	$INEF_{it-2}$	-0.0008	$GLOANS^h_{it-2}$	-0.010				
	(-0.208)		(-0.335)		(-0.674)				
LtD_{it-3}	0.029***	$INEF_{it-3}$	0.003	$GLOANS^h_{it-3}$	0.006				
	(2.725)		(0.974)		(0.865)				
LtD_{it-4}	0.009	$INEF_{it-4}$	0.002	$GLOANS^h_{it-4}$	0.004				
	(0.523)		(0.787)		(0.283)				
Sargan test	180.2		185.1		182.7		187.9		186.9
	[0.753]		[0.664]		[0.709]		[0.667]		[0.686]
m_2	-1.021		-0.215		-0.778		-0.562		-0.564
	[0.307]		[0.829]		[0.436]		[0.574]		[0.573]

Notes: ***,** and * denote significance at 1%, 5% and 10% respectively. t-statistics are reported in parenthesis. The p-values for the Sargan and the m_2 test are reported in brackets.

Table 9. GMM estimation results for consumer loans

	Baseline		Model 1		Model 2		Model 3
constant	0.034***	*constant*	0.044***	*constant*	0.033***	*constant*	0.030***
	(3.232)		(3.153)		(2.624)		(2.948)
ΔNPL^h_{it-1}	-0.175***	ΔNPL^h_{it-1}	-0.191***	ΔNPL^h_{it-1}	-0.185***	ΔNPL^h_{it-1}	-0.198***
	(-3.103)		(-3.235)		(-3.209)		(-3.489)
ΔGDP_{t-1}	-0.150	ΔGDP_{t-1}	-0.110*	ΔGDP_{t-1}	-0.132*	ΔGDP_{t-1}	-0.203**
	(-1.433)		(-1.648)		(-1.905)		(-2.224)
ΔGDP_{t-2}	-0.398***	ΔGDP_{t-2}	-0.343***	ΔGDP_{t-2}	-0.365***	ΔGDP_{t-2}	-0.436***
	(-3.204)		(-2.635)		(-2.928)		(-3.835)
ΔUN_{t-1}	0.160**	ΔUN_{t-1}	0.143	ΔUN_{t-1}	0.141	ΔUN_{t-1}	0.176
	(1.893)		(0.909)		(0.956)		(1.216)
ΔUN_{t-2}	0.053	ΔUN_{t-2}	-0.012	ΔUN_{t-2}	-0.005	ΔUN_{t-2}	0.057
	(0.525)		(-0.143)		(-0.066)		(0.580)
ΔRLR^h_{it-1}	0.438***	ΔRLR^h_{it-1}	0.371***	ΔRLR^h_{it-1}	0.416***	ΔRLR^h_{it-1}	0.400***
	(4.438)		(3.733)		(4.314)		(5.114)
ΔRLR^h_{it-2}	0.081	ΔRLR^h_{it-2}	0.043	ΔRLR^h_{it-2}	0.072	ΔRLR^h_{it-2}	0.019
	(1.081)		(0.818)		(1.597)		(0.226)
		ROA_{it-1}	-0.217	ROE_{it-1}	-0.002	$SOLR_{it-1}$	-0.087
			(-1.108)		(-0.439)		(-1.150)
		ROA_{it-2}	-0.150	ROE_{it-2}	-0.011	$SOLR_{it-2}$	-0.058
			(-1.224)		(-1.615)		(-0.949)
		ROA_{it-3}	-0.059	ROE_{it-3}	0.001	$SOLR_{it-3}$	0.157
			(-0.281)		(0.149)		(1.264)
		ROA_{it-4}	-0.226**	ROE_{it-4}	-0.011	$SOLR_{it-4}$	-0.056
			(-1.908)		(-1.448)		(-0.425)
Sargan test	137.1		154.8		151.2		156.5
	[0.363]		[0.355]		[0.435]		[0.321]
m_2	-1.027		-0.844		-0.448		-1.641
	[0.304]		[0.399]		[0.654]		[0.101]

Notes: ***,** and * denote significance at 1%, 5% and 10% respectively. t-statistics are reported in parenthesis. The p-values for the Sargan and the m_2 test are reported in brackets.

Table 9. (continued) GMM estimation results for consumer loans

	Model 4		Model 5		Model 6		Model 7		Model 8
constant	0.014	*constant*	0.037***	*constant*	0.045***	*constant*	0.033*	*constant*	0.033***
	(0.716)		2.784		(3.374)		(2.043)		(3.204)
ΔNPL^{h}_{it-1}	-0.170***	ΔNPL^{h}_{it-1}	-0.187***	ΔNPL^{h}_{it-1}	-0.208***	ΔNPL^{h}_{it-1}	-0.185***	ΔNPL^{h}_{it-1}	-0.191***
	(-3.060)		(-3.265)		(-3.765)		(-3.735)		(-3.779)
ΔGDP_{t-1}	-0.190**	ΔGDP_{t-1}	-0.152**	ΔGDP_{t-1}	-0.162	ΔGDP_{t-1}	-0.186**	ΔGDP_{t-1}	-0.186**
	(-1.963)		(-2.327)		(-1.564)		(-2.414)		(-2.299)
ΔGDP_{t-2}	-0.467***	ΔGDP_{t-2}	-0.393***	ΔGDP_{t-2}	-0.397***	ΔGDP_{t-2}	-0.433***	ΔGDP_{t-2}	-0.432***
	(-3.604)		(-3.179)		(-3.272)		(-3.360)		(-3.708)
ΔUN_{t-1}	0.204	ΔUN_{t-1}	0.152	ΔUN_{t-1}	0.183	ΔUN_{t-1}	0.186	ΔUN_{t-1}	0.191
	(1.459)		(0.957)		(1.309)		(1.401)		1.443
ΔUN_{t-2}	0.053	ΔUN_{t-2}	-0.005	ΔUN_{t-2}	0.053	ΔUN_{t-2}	0.052	ΔUN_{t-2}	0.052
	(0.595)		(-0.062)		(0.529)		(0.563)		0.568
ΔRLR^{h}_{it-1}	0.415***	ΔRLR^{h}_{it-1}	0.376***	ΔRLR^{h}_{it-1}	0.399***	ΔRLR^{h}_{it-1}	0.395***	ΔRLR^{h}_{it-1}	0.405***
	(4.894)		(3.724)		(5.564)		(4.764)		4.757
ΔRLR^{h}_{it-2}	0.005	ΔRLR^{h}_{it-2}	0.019	ΔRLR^{h}_{it-2}	0.075	ΔRLR^{h}_{it-2}	0.042	ΔRLR^{h}_{it-2}	0.034
	(0.117)		(0.406)		(0.644)		(0.556)		0.436
LtD_{it-1}	0.004	$INEF_{it-1}$	0.003	$GLOANS^{h}_{it-1}$	-0.015	$SIZE_{it}$	-0.167	$MPOW^{h}_{it}$	0.016
	(0.269)		0.827		(-1.015)		(-1.312)		0.251
LtD_{it-2}	0.005	$INEF_{it-2}$	0.004	$GLOANS^{h}_{it-2}$	0.005				
	(0.257)		(0.952)		(0.279)				
LtD_{it-3}	-0.025*	$INEF_{it-3}$	0.0007	$GLOANS^{h}_{it-3}$	0.023*				
	(-1.879)		(0.155)		(1.765)				
LtD_{it-4}	0.025	$INEF_{it-4}$	0.006*	$GLOANS^{h}_{it-4}$	0.018				
	(1.492)		(1.844)		(0.961)				
Sargan test	156.4		156.0		152.0		159.1		164.5
	[0.322]		[0.330]		[0.416]		[0.330]		[0.230]
m_2	-1.541		-0.860		-0.778		-1.255		-1.268
	[0.123]		[0.390]		[0.214]		[0.210]		[0.205]

Notes: ***,** and * denote significance at 1%, 5% and 10% respectively. t-statistics are reported in parenthesis. The p-values for the Sargan and the m_2 test are reported in brackets.

Table 10. Long-run coefficients for the macroeconomic variables

	Mortgages	Business	Consumer
ΔGDP	-0.278** (-2.501)	-0.650*** (-3.534)	-0.466*** (-2.850)
ΔUN	0.134*** (3.065)	0.239** (2.208)	0.181* (1.893)
ΔRLR^{h}	0.166** (2.031)	0.199** (1.972)	0.442** (6.331)

Notes: ***,** and * denote significance at 1%, 5% and 10% respectively. t-statistics for the long run regression coefficients are reported in parenthesis.

Table 11. Long run coefficients for the bank specific variables

	Mortgages	Business	Consumer
ROA	-0.383*** (-3.044)	-0.195 (-1.172)	-0.549* (-1.897)
ROE	-0.012** (-2.491)	-0.006 (-0.801)	-0.020*** (-3.759)
SOLR	-0.092 (-0.994)	0.045 (1.418)	-0.037 (-0.375)
LtD	-0.008 (-1.036)	0.011 (1.333)	0.008 (0.904)
INEF	0.009*** (3.061)	0.010** (2.323)	0.012* (1.770)
$GLOANS^{h}$	-0.014 (-0.727)	0.002 (0.194)	0.026 (1.328)

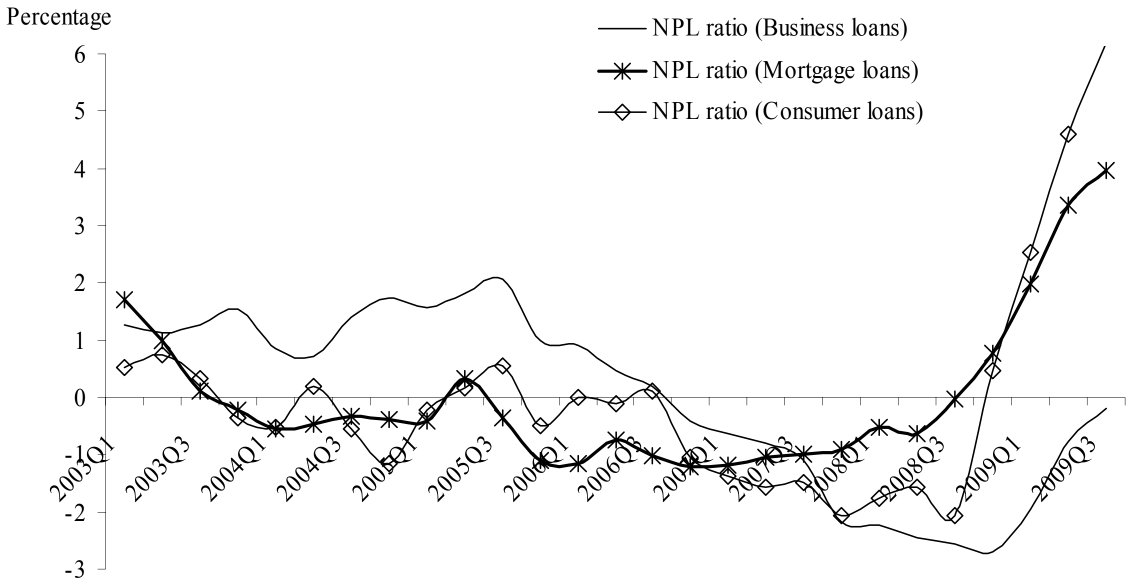
Notes: ***,** and * denote significance at 1%, 5% and 10% respectively. t-statistics for the long run regression coefficients are reported in parenthesis.

Table 12. Empirical evidence for tested hypotheses

Hypothesis Tested	Mortgages	Business	Consumer
Bad luck hypothesis	No	No	Yes
Bad management hypothesis	Yes	Yes	Yes
Skimping hypothesis	No	No	No
Moral hazard hypothesis	No	No	No
Size hypothesis	No	No	No
Bad management hypothesis II	Yes	No	Yes
Procyclical Credit Policy hypothesis	No	No	No

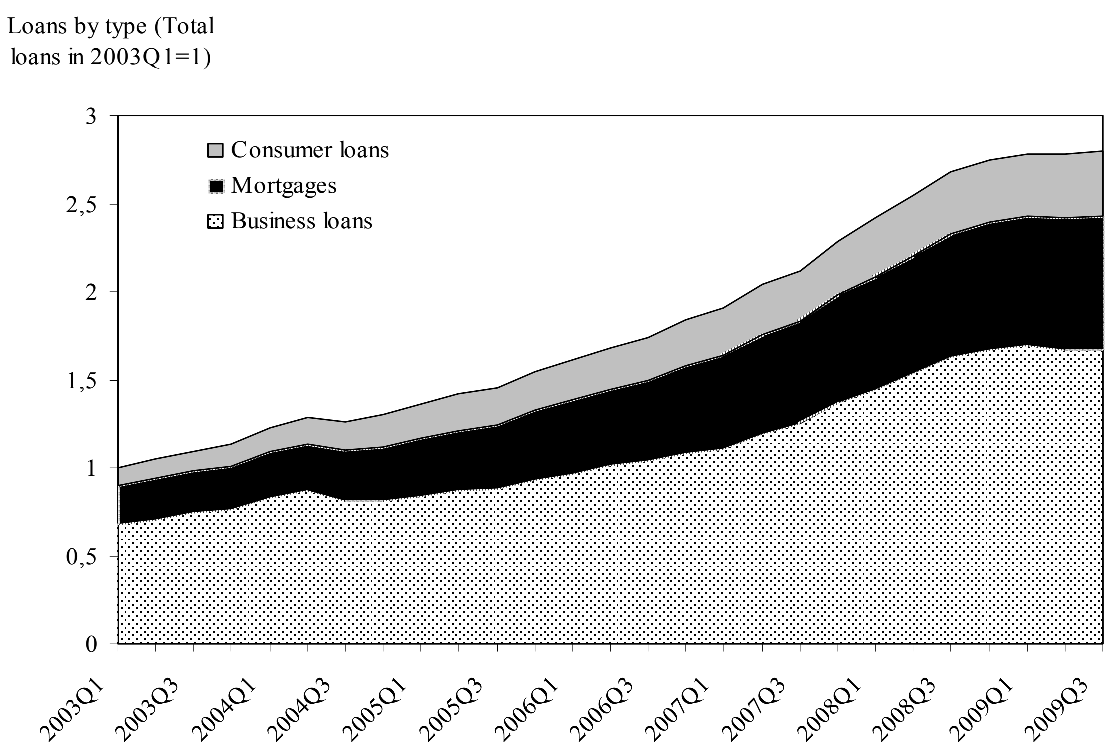
Note: The empirical evidence is based on the sign and the statistical significance of the long run coefficients

Figure 1. Aggregate NPL ratio of loan portfolios (demeaned series)



Source: Bank of Greece

Figure 2. Credit expansion by type of loan



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