Eurobank Global Markets Research
www.eurobank.gr/research
EurobankGlobalMarkets
Research@eurobank.gr

Eurobank

GREECE MACRO MONITOR

February 14, 2014

What explains the rise in non-performing loans (NPLs) in the euro area following the outbreak of the global financial crisis

Greece case study

Dr. Platon Monokroussos
Assistant General Manager
Head of Global Markets Research
pmonokrousos@eurobank.gr

Dimitris Thomakos
Professor, Dept. of Economics
University of Peloponnese
Quantitative Advisor
Global Advisory Division

Preface

The present study utilizes a number of empirical methodologies to explain the evolution of NPLs in a large group of advanced and emerging market economies in the period before and after the global financial crisis, placing particular focus on a number of Eurozone economies (including Greece) that have been severely hit by the euro area debt crisis. The main results from the estimation of our *fixed-effects*, *dynamic* and *VAR (vector autoregressive)* panel models can be summarized as follows: we document a negative (and strongly significant) relationship between NPLs and economic growth; which, in line with other studies in the literature, confirms the *countercyclical* behavior of non-performing loans. Our empirical findings also document the significance of a range of other macro- and bank-related variables in driving NPLs, including, the unemployment rate, loan interest rates, the nominal effective exchange rate, property prices, stock market performance as well as the ratio of loans-to-deposits and private sector credit-to-GDP. Overall, the most important result of our study is the negative relationship between NPLs and economic growth, which remains robust across model specifications. In the case of Greece, our baseline specification of a fixed-effects panel model estimated for the EU countries suggests that, over the period 2008-2013, as much as 90% of the cumulative increase in the NPLs ratio (that can be explained by the particular model) may be attributed to the effects of the economic recession. Furthermore, an out-of-sample forecasting exercise using the latest (July 2013) IMF predictions for the Greek economy points to a likely peak in Greece's NPL ratio in 2015, at levels around 35%.

1. Introduction

Existing data on the intertemporal evolution of non-performing loans (NPLs) shows that the majority of advanced and emerging market economies experienced a significant improvement in bank asset quality over the period 2000-2007, though a notable deterioration occurred following the outbreak of the global financial crisis. Indicatively, for a group of 33 advanced economies for which we have been able to collect relevant data, the average NPLs-to-total loans ratio declined from 4.8% in 2000 to ca 1.6% in 2007, before embarking on an upward path, hitting a post-crisis peak of 5.6% in 2012. On the other hand, a group of as many as 70 emerging market economies recorded a drop in their average NPL ratio to 4.7% in 2008 from 13.3% in 2000, broadly remaining around 7% or higher thereafter.

These aggregate statistics conceal the wide dispersion across countries as regards the evolution of non-performing loan ratios experienced in the years following the outburst of the global crisis. At the one end of the spectrum, a number of countries - primarily large advanced and emerging market economies - experienced a relatively mild increase in their NPL ratio in the post-crisis period. A representative case in this country group is Germany, where, despite the sharp GDP contraction in 2009 (by 5.1% in real terms), the NPL ratio rose by only 0.5ppts (to 3.3% from 2.9%), before returning to a declining path in the following years.

On the other hand, the three Baltic economies, Estonia, Latvia and Lithuania experienced an average real GDP contraction of 15.6% in 2009, while their average NPLs ratio recorded an increase of 340% over that year. In the case of Greece, a country which experienced one of the most severe and prolonged recessions in recent economic history, cumulative real GDP losses in 2008-2013 amounted to around 25.8%, while the non-performing loans-to-total loans ratio increased by ca 24.8ppts, hitting 29.3% in Q2 2013.

Interestingly, for the entire group of countries (103 in total) examined in the present study, we have spotted as many as 97 recessionary episodes over the period 2000-2013, with the corresponding NPL ratios hitting a cyclical peak at the last year of GDP contraction in 61 of these cases. Moreover, NPLs peaked 1 year after the end of economic contraction in 13 recessionary episodes and after 2 to 4 years in 23 cases.[1]

In general, the international literature on the determinants of bank non-performing loans (NPLs) identifies two broad sets of factors that explain their inter-temporal evolution. One set includes macroeconomic factors and focuses on the relationship between the business cycle and the capacity of borrowers to service their loans. The other one includes bank-specific factors related to, among others, loan quality, cost efficiency and capitalization.

The present study utilizes a number of empirical methodologies to explain the evolution of NPLs in a large group of advanced and emerging market economies in the period before and after the global financial crisis, placing particular focus on a number of Eurozone economies (including Greece) that have been severely hit by the euro area debt crisis.

The main results from the estimation of our *fixed-effects*, *dynamic* and *VAR (vector autoregressive)* panel models can be summarized as follows:

We document a negative (and strongly significant) relationship between NPLs and economic growth; which, in line with other studies in the international literature, confirms the *countercyclical* behavior of non-performing loans. Moreover, we find a positive (and strongly significant) relationship between NPLs and the unemployment rate. Our empirical findings also document the significance of a range of other macro and bank-related variables in driving NPLs, including, loan interest rates, the nominal effective exchange rate (especially relevant for non-euro area countries featuring relative high levels of private borrowing in foreign currency), property prices, stock market performance as well as the ratio of loans-to-deposits and private sector credit-to-GDP.

Overall, the most important result of our study is the negative relationship between NPLs and economic growth, which remains robust across model specifications. The plausible rationale behind this finding is as follows: in periods of higher GDP growth, borrowers' income improves and thus, their capacity to service their debts. On the other hand, when economic activity slows down, NPLs increase as unemployment rises, disposable incomes decline and borrowers face difficulties in repaying their debt obligations.

[1] Relevant statics derived from the analysis of annual-frequency data.

In the case of Greece, our baseline specification of a fixed-effects panel model estimated for the EU countries suggests that, over the period 2008-2013, as much as 90% of the cumulative increase in the NPLs ratio (that can be explained by the particular model) may be attributed to the effects of the economic recession. Furthermore, an out-of-sample forecasting exercise using the latest (July 2013) IMF predictions for the Greek economy points to a likely peak in Greece's NPL ratio in 2015, at levels around 35%.

The rest of this document is structured as follows: chapter 2 provides a brief literature review on the macro-and bank-related determinants of NPLs; chapter 3 provides a description of the data and variables utilized in our study; chapter 4 describes our empirical methodology; chapter 5 presents our empirical results and their interpretation; and chapter 6 concludes

2. Literature review – Determinants of NPLs

The international literature on the determinants of bank non-performing loans (NPLs) identifies two broad sets of factors that explain their inter-temporal evolution. One set includes macroeconomic factors and focuses on the relationship between the business cycle and the capacity of borrowers to service their loans. The other one includes bank-specific factors related to, among others, loan quality, cost efficiency and capitalization. A number of related empirical studies document the significance of both sets of factors in explaining NPLs.

2.1 Macroeconomic determinants of NPLs

The empirical literature examining the link between credit risk and the state of the economic cycle is both enormous and diverse and dates back to the papers of King and Plosser (1984), Bernanke and Gertler (1989), and Bernanke, Gertler and Gilchrist (1998).These along with a large number of more recent papers document a negative relationship between macroeconomic conditions and NPLs. A general explanation for this finding is that in periods of higher real GDP growth, borrowers' income improves and thus, their capacity to service their debts. On the other hand, when economic activity slows down, NPLs increase as unemployment rises, disposable incomes decline and borrowers face difficulties in repaying their debt obligations (Salas and Suarina, 2002; Rajan and Dhal 2003; Jimenez and Saurina, 2005; Pesaran et al. 2006; Quagliarello 2007; Beck et al. 2013; and Klein 2013). Other macroeconomic variables that potentially affect the debt servicing capacity of firms and households and, by implication, banks' asset quality include, among others, the exchange rate, inflation, property prices and the lending interest rate.

A number of recent empirical studies have documented a negative relationship between the exchange rate and the level of NPLs (*balance-sheet channel*), especially for countries featuring a floating exchange rate. More specifically, for countries with a relatively high percentage of private-sector borrowing in foreign-currency, a notable depreciation of the national currency can have a negative impact on asset quality, as it usually leads to higher NPLs due to rising difficulties faced by domestic borrowers in servicing their debts and vice versa (see *e.g.* Louzis et al. 2010). However, some other studies have documented a positive relationship between the exchange rate and NPLs, arguably because an exchange rate depreciation improves export competiveness (*competitiveness channel*), leading to higher export revenue in the domestic economy and thus, improving the debt servicing capacity of domestic firms and households (see *e.g.* Klein et al. 2013). Even in the case of an economy featuring a relatively high percentage of private sector borrowing in foreign currency, the competitiveness channel may outweigh the balance-sheet channel, especially in the presence of a great number of hedged borrowers *e.g.* firms generating foreign currency revenue from exports.

As regards the rest of potential macroeconomic determinants noted above, many empirical studies have documented a positive link between lending interest rates and NPLs, particularly in the case of floating rate loans (see, among others, Louzis et al. 2010, Beck et al. 2013; and Klein 2013). On the other hand, the impact of inflation on asset quality may be ambiguous, as higher inflation erodes the real value of outstanding debt, thus making debt servicing easier, but it can also reduce real income (when prices are sticky) and/or instigate an interest rate tightening by the monetary authority (Nkusu, 2011). Finally, several studies have found a negative link between share prices and NPLs, as a pronounced decline in the stock market can lead to more defaults (*wealth effects*) and an erosion of collateral values. Given the difficulty of finding reliable data for property prices for the majority of countries examined in our empirical study we follow Beck, Jakubik & Piloiu (2013) and others and proxy for the effect of collateral values on asset quality by looking at the link between share prices (intervened by a measure of relative market capitalization) and non-performing loans.

2.2 Bank-specific determinants of NPLs

In their influential study, Berger and DeYoung (1997) studied the relationship between NPLs, cost efficiency and capitalization of U.S. commercial banks over the period 1985-94 by testing a number of hypotheses concerning the direction of causality between these variables. In more detail, they fund a negative link (and a two-way causality) between cost efficiency and NPLs as: (i) an exogenous increase in non-performing loans (driven by, say, a notable worsening in the broader macroeconomic conditions) can lead to a deterioration in banks' cost efficiency as a result of increased operating costs to deal with NPLs (*"bad luck"* hypothesis); and (ii) low cost efficiency may signify poor management skills in credit scoring as well as in loan underwriting, monitoring and control, which, in turn, can lead to higher NPLs (*"bad management"* hypothesis). In line with these empirical findings, a number of recent studies found support (of at least one) of the aforementioned hypotheses. An alternative hypothesis (dubbed as *"skimping"*) advanced by Berger and DeYoung (1997), proposes a positive relationship between cost efficiency and NPLs, on the basis that high cost efficiency may reflect limited resources allocated to monitor credit risk, a development that may lead to higher NPLs in the

future than otherwise the case. Finally, Berger and DeYoung (1997) as well as a number of later studies found support of the so-called *"moral hazard"* hypothesis, initially proposed by Keeton and Morris (1987). The latter hypothesis claims that low capitalization of banks leads to higher NPLs as banks' managers have an incentive to carry riskier loan portfolios.

2.3 Feedback for NPLs to the real economy

In a number of empirical studies, the feedback from NPLs to the real economy is usually identified through the credit supply channel. For instance, high NPLs typically imply increased operating costs for their monitoring and management, higher provisioning that hinders capital adequacy and deteriorating bank financing terms. These factors can lead to higher lending interest rates and, more generally, tighter lending conditions (Diawan and Rodrik, 1992).The feedback effects from NPLs to the real economy may also work through non-credit supply channels, as, for instance, debt overhang can discourage companies from investing in new projects since future profits will be shared with the creditors (Myers, 1977).

3. Data and definition of variables

3.1 Data

The relevant dependent variable in our empirical study is the ratio of non-performing loans to total gross loans, taken in first differences. Our full panel data set covers 103 countries and utilizes annual NPLs data spanning the period from 2010 to 2013. Our data combine two data sets from the IMF (Financial Soundness Indicators database) and the World Bank. The Financial Soundness Indicators database from the IMF includes annual NPLs data from a large number of countries over the period 2005-2013, while the World Bank database provides annual NPLs data spanning the period 2000-2012. In the spirit of Beck et al. 2013, we primarily use the relevant database from the IMF and extend it backward using the World Bank data.[2] We also account for possible methodological differences across countries as regards the definition of NPLs, using the World Bank data only when there was no significant difference in levels during the overlapping periods.[3] Our explanatory variables include a range of macro and bank-related indicators which, in line with a number of earlier empirical studies, are thought to affect bank asset quality. These include, real GDP growth, private sector credit to GDP, the loans-to-deposits ratio, consumer price inflation, the nominal effective exchange rate (NEER), share prices, bank lending rates, and stock market capitalization Table 1.1 (Annex) provides a brief description of the macro- & bank-related indicators (and the corresponding acronyms) utilized in our study as well as the respective sources and sample periods. Table 1.2 (Annex) shows the full-sample of countries examined in our study.

3.2 A note of caution for the definition of NPLs across countries

Beck, Jakubik and Piloiu 2013, provide a brief summary of the methodological approaches currently existing in defining non-performing loans. The following paragraph provides a relevant excerpt of that study: *"Since the definitions of NPLs vary across countries, comparisons of the levels of NPLs across countries and regions should be interpreted with caution. According to the most commonly used ("reference") definition, a default occurs when the bank considers that an obligor is unlikely to repay its credit obligations to the banking group in full, without recourse by the bank to actions such as realising security (if held); or the obligor is past due for more than 90 days on any material credit obligation to the banking group (Basel Committee on Banking Supervision, ibid., paragraph 452). Based on this definition, NPLs should include all loans which are 90 days overdue. However, some countries report in their statistics all loans which are 31 days overdue, in some cases 61 days overdue and some countries do not comply with the international standards at all. Based on the proposal of the Institute of International Finance (IIF) aimed at helping to improve cross-country comparisons, five categories of loans are commonly used for reporting purpose: "standard", "watch", "substandard", "doubtful" and "loss loans". Their precise definition varies, however, significantly among countries. In some cases, NPLs correspond to the last three categories, in other only to doubtful and loss loans, in some cases only to loss loans Apart from the number of days overdue, there are other differences among definitions. In some cases, NPL's classification criteria do not cover only one dimension (number of days overdue), but also other elements (e.g. Romania where loan classification takes into account also the financial performance of the debtor and whether or not a judicial procedure has been started). Another important feature of the NPLs definition is for example whether they are reported in gross terms (international standard) or net of provisions. Moreover, classification methods for multiple loans to the same client vary by country. In*

[2] For some countries in our sample, there are no available NPLs data for the full sample period 2000 to 2013.
[3] Beck, Jakubik and Piloiu, 2013 found no structural breaks in their NPLs series, by including a dummy variable that takes the value of one from 2005 onwards and zero otherwise and showing that the said dummy was no statistically significant in their regressions. We performed the same exercise in our data series and derived a similar result (relevant data is available upon request).

several countries if a loan is classified as impaired, all other loans to the same customer are classified in that same category. Another important aspect is the role of collateral and guarantees in the classification process. Several jurisdictions do not take collateral and guarantees into account for classification purposes.[4]"

3.3 What a first descriptive look at the data says about the relationship between NPLs and the macro- & bank-related indicators examined in our study

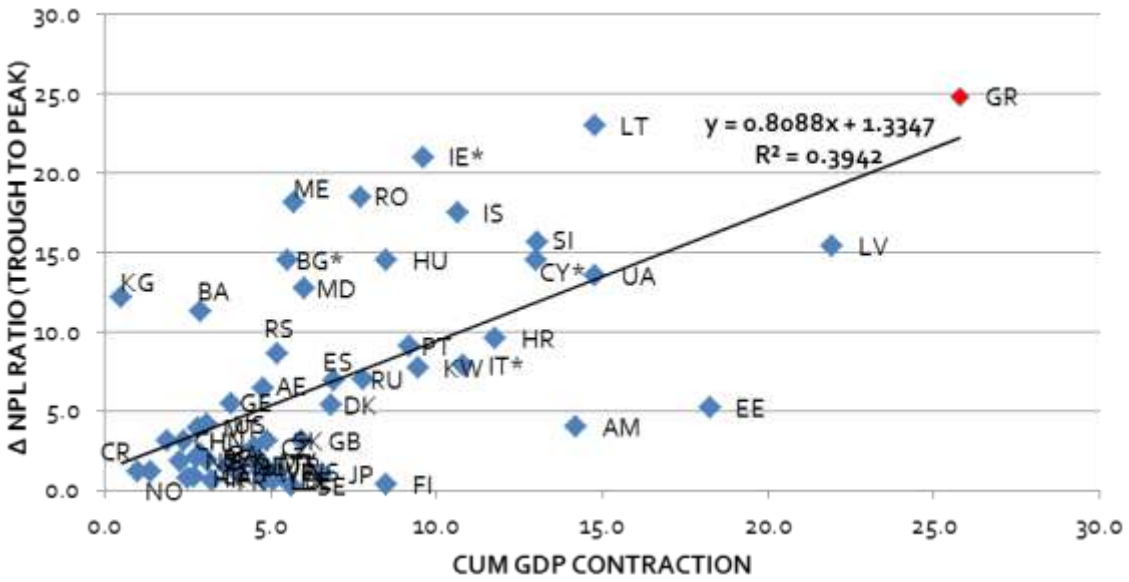
A first look at our NPLs data reveals that for both groups of advanced and *emerging market* economies including in our sample, bank asset quality improved, on average, over the period 2000-2007, but a notable deterioration occurred following the outbreak of the global financial crisis in 2007/2008. As Graph 2 demonstrates (Annex section) the average NPL ratio of the group of 33 advanced economies declined from 4.8% in 2000 to ca 1.6% in 2007, before embarking on an upward path, hitting a post-crisis peak of 5.6% in 2012 (and averaging around 5.1% in H1 2013). For the group of 70 emerging and developing economies covered in our study, the average NPL ratio dropped to 4.7% in 2008 from 13.3% in 2000, broadly remaining around 7% or higher thereafter. In 2009, the average real GDP growth in the 33 advanced economies included in our in data sample contracted by 3.9%, while the ensuing change (increase) in the average NPL ratio was ca 75%. The respective average real GDP decline of the group 70 emerging and developing economies was -0.4%, while the respective rise in the average NPL ratio was around 54%. These aggregate statistics conceal the wide dispersion across countries as regards the evolution of non-performing loan ratios experienced in the years following the outburst of the global crisis. At the one side of the spectrum, a number of countries - primarily large advanced and emerging market economies - experienced a relatively mild increase in their NPL ratio in the post-crisis period. A notable example in this group of countries is Germany, where, despite the sharp GDP contraction in 2009 (by 5.1% in real terms), the NPL ratio rose by only 0.5ppts that year (to 3.3%, from 2.9%), before returning to a declining path thereafter. On the other hand, the three Baltic economies, Estonia, Latvia and Lithuania experienced an average real GDP contraction of 15.6% in 2009, while the average NPLs ratio recorded an increase of 340% over that year. As regards the theoretical relationship between real economic activity and non-performing loans, Graph 3.1 (Annex) confirms the countercyclical nature of NPLs, depicting a negative correlation between real GDP growth and the change in the NPLs ratio for the entire set of economies examined in our study over the period 2000-2013. Moreover, the full data sample includes as many as 97 recessionary episodes over the latter period, with the NPL ratio peaking at the last year of negative GDP growth in 61 of these episodes, 1 year after the end of recession in 13 of these episodes and from between 2 and 4 years after the end of recession in 23 cases.

3.4 Relationship between GDP growth and NPL ratio: is Greece an outlier?

This section provides some preliminary analysis on where Greece stands relative to the rest of advanced and emerging market economies examined in our study, as regards the rise in non-performing loans following the outbreak of the global financial crisis (and the country's ensuing sovereign debt crisis in late 2009). We concentrate in the post FY-2007 period as in the pre-crisis years (2000-2007), the pace of decline in Greece's NPL ratio was broadly in line with the international experience (Graph 3.2 – Annex). The scatterplot presented below (Graph 3) compares the change in the NPL ratio (trough to peak) with the respective cumulative GDP contraction experienced by a number of advanced and emerging market economies following the outbreak of the global financial crisis in 2007/2008.

[4] A good example of the variety in applied definitions is the NPL definition applied by the Central Bank of Russia which is not comparable with the international practices. Russia's NPL definition accounts only for due instalments and interest rather than the total amount of the troubled loan. This results in a significant underestimation of the NPLs, which are reported. In order to obtain more realistic figures reflecting the credit quality, we multiplied in our sample officially reported NPLs in Russia roughly by two (based on the long–term ratio of the aggregate NPLs for both definitions).

Graph 3 - Cumulative real GDP contraction vs. change in NPLs ratio from trough to peak (2008-2013)



Source: IMF, WB, Eurobank Global Markets Research

We then derive two figures (Graphs 3a & 3b) with the group of countries defined by k-means clustering using 3 and 4 clusters. This is just a descriptive device to show what is the point (marked as a star in the figures) around which the countries concentrate. Running regressions on the cluster-defined groups does not produce any significant results. However, a closer look at cluster-center values reveals an approximate 1:1 relationship between the change in the NPL ratios and the respective cumulative GDP contraction. For the 3- and 4-cluster the corresponding centers are:

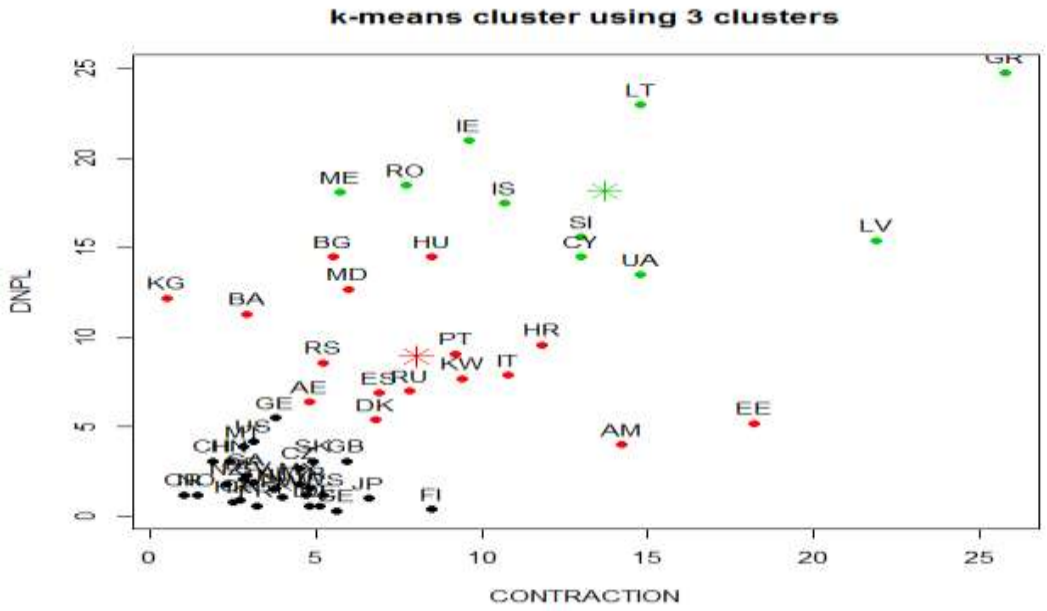
	CONTRACTION	DNPL
1	3.88	1.88
2	8.03	8.94
3	13.70	18.19

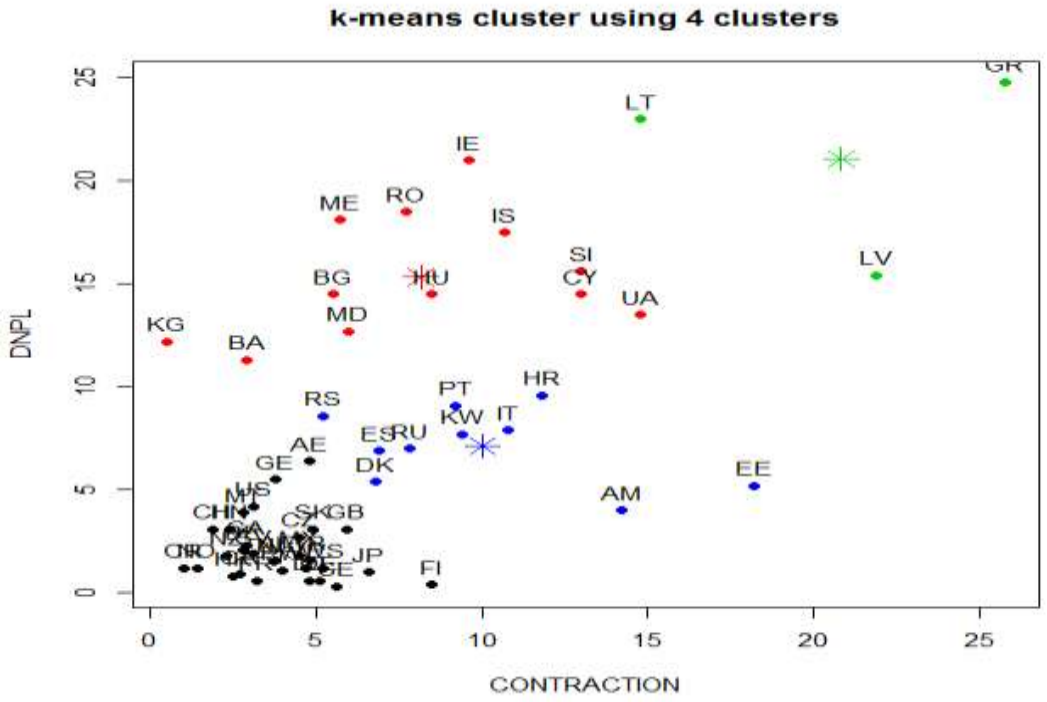
	CONTRACTION	DNPL
1	3.91	2.027
2	8.16	15.32
3	20.83	21.10
4	10.03	7.14

Furthermore, fitting a line to the cluster centers data gives us response coefficients of 1.66 for the 3-cluster case (significant) and 1.00 for the 4-cluster case (insignificant). Therefore, if we were to concentrate on the 3-cluster case we could make an argument that, on average, there is a positive and probably significant relationship between GDP contraction and the change in NPLs. As a final step, we select two country groups from eyeballing the data. The first group is composed of the following countries G1 = {"KG","BA","BG","MD","ME","RO","HU","IE","IS","LT"}, while the second group is G2={"US","GE","AE","ES","DK","RU","PT","KW","IT","HR","UA","SI","CY","LV","GR"}.[5] Next, we estimate two regressions, one for each group. The respective results show that both regressions provide a statistically significant response coefficient of around 0.8, with an R^2 of 66% in the first group and 86% in the second group. The estimates are not only statistically indistinguishable, but they are also the same for the corresponding full-sample regression, which produces an estimated response coefficient value of 0.80, with an R^2 of 38% (results available upon request). Therefore, not only can one claim that the increase in the change in the NPL ratio is primarily due to the contraction of the real economy, but also that the corresponding relationship appears to be 1:1 in the post global crisis period (a formal test accepts this hypothesis).

[5] Annex section provides a list of countries and related acronyms.

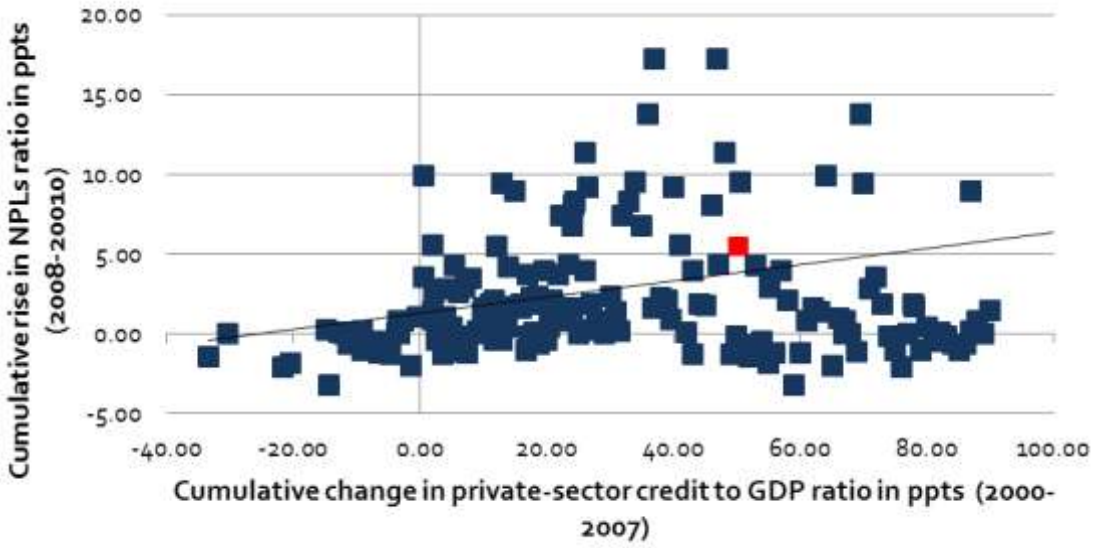
Graphs 3a & 3b





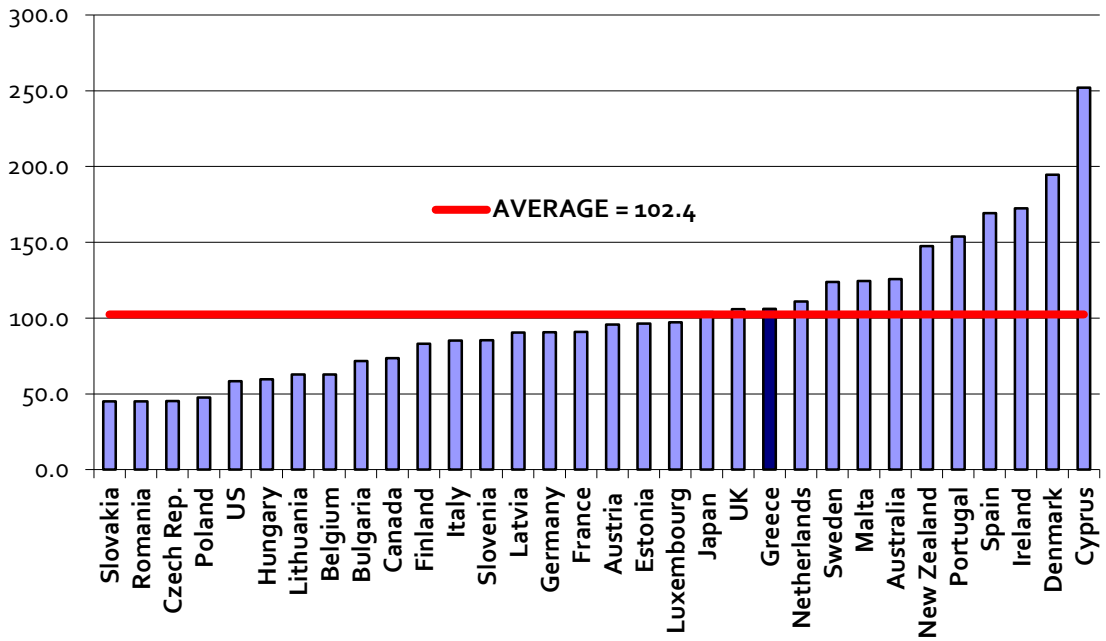
Graph 3c below depicts the cumulative change in the private sector credit to GDP ratio in the pre-crisis period (2000-2007) and the corresponding cumulative rise in the NPL ratios in the 3-year period (2008-2010) that followed the outbreak of the global crisis. The red-colored square depicts Greece. Again, the comparison below shows that Greece was not an outlier, at least for the first 3 years following the outbreak of the global crisis. As a final point to this section, Graphs 4a and 4b below depict the private sector credit to GDP ratio at the end of 2008 (deepening of the global crisis) and the loans to deposits ratio for the euro area member states and a number of other advanced economies. On both leverage-related measures, Greece scores close to the average of the sample of countries presented.

Graphs 3c – Cumulative change in private-sector credit to GDP ratio (2000-2007) vs. cumulative change in the NPLs ratio (2008-2010)



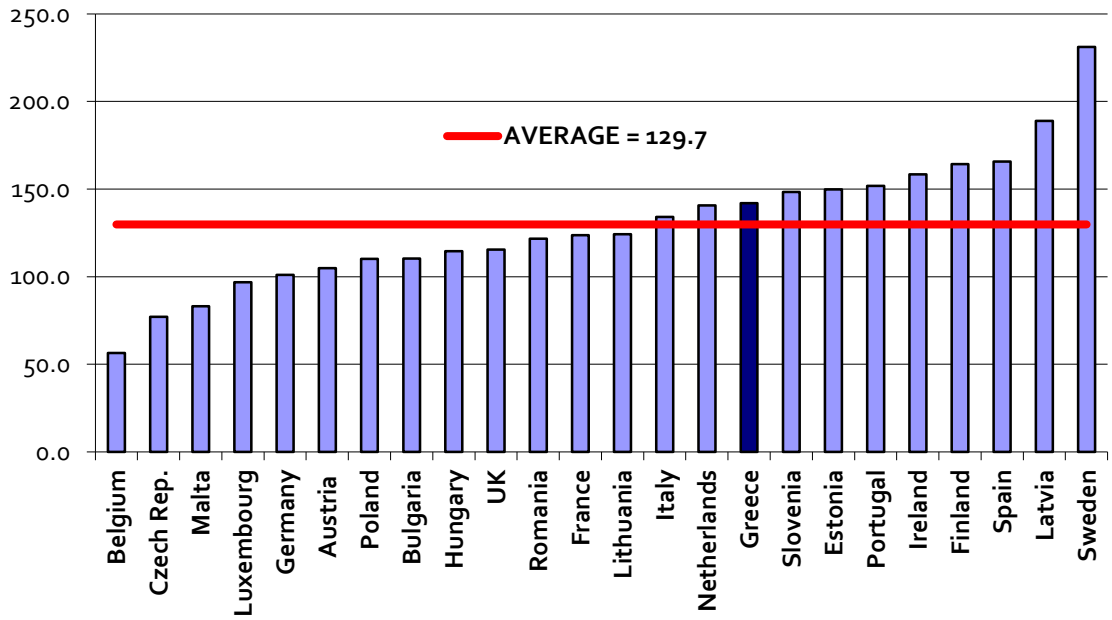
Source: IMF, WB, Eurobank Global Markets Research

Graphs 4a – Private sector credit to GDP (end 2008)



Source: IMF, WB, Eurobank Global Markets Research

Graphs 4b – Private sector loans to deposits ratio (end 2012)



Source: IMF, WB, Eurobank Global Markets Research

4. Empirical methodology

This paper uses a panel estimation method to evaluate the impact of a range of macro- and bank-related indicators on non-performing loans. We first apply a **fixed effects model** to account for the unobservable time-invariant heterogeneity across the countries included in our sample and thus, to address the omitted-variables bias problem. The fixed effects model utilized herein can be summarized as follows:

$y_{it} = \beta(L)X_{it} + \varepsilon_{it}$, with $\varepsilon_{it} = \alpha_i + \eta_{it}$ and $\alpha_i \sim iid(0,\sigma_\alpha^2)$ and $\eta_{it} \sim iid(0,\sigma_\eta^2)$ (1)

where y_{it} is our dependent variable; in our case the NPL ratio;

i and *t* denote the respective time and country dimension of our panel sample, (i = 1,2….,N, with N=103 in our full-data sample and t = 2000, 2001,…,2013);

$\beta(L)$ is the 1xk lag polynomial vector;

X_{it}, denotes the kx1 vector of explanatory variables, which, as we explained in the prior chapter, includes both macro-and bank-specific (potential) drivers of NPLs, e.g. real GDP growth, unemployment rate, inflation, the nominal effective exchange rate (NEER), the bank lending rate, the private-sector credit to GDP ratio and the loans-to-deposits ratio. Note that, in the fixed effects model specified above, X_{it} does not include lags of the dependent variable y_{it}.

η_{it} corresponds to the common stochastic error term, which is assumed to be uncorrelated with the repressors vector X_{it} and, furthermore, to vary unsystematically across countries and time;

α_i is the so-called individual-specific effect and varies across countries but is constant over time.

In the fixed effects model (1), it is assumed that α_i is correlated with X_{it}[6] .

As a second step in our empirical study, we estimate a **dynamic panel model**, which includes the lagged dependent variable in the set of repressors:

$y_{it} = \delta y_{it-1} + \beta(L)X_{it} + \varepsilon_{it}$, with $\varepsilon_{it} = \alpha_i + \eta_{it}$ (2)

[6] Note that by imposing the additional orthogonality assumption that α_i is uncorrelated with X_{it} we get the random effects model, which is not estimated in our study since the said assumption may be far too restrictive.

In model (2), the inclusion of the lagged dependent variable in the set of repressors renders the OLS estimator of the fixed effects model both biased and inconsistent, even if η_{it} are serially uncorrelated. That is because, y_{it} is a function of α_i and, by construction, so is y_{it-1}.

To deal with this problem, Anderson and Hsiao (1981) proposed first differencing of model (2), so as to remove the individual-specific effects, α_i, and then applying an instrumental variables (IV) estimation. This method leads to consistent, but not necessarily efficient estimates.[7]

Arellano and Bond (1991) then proposed a more efficient estimation procedure, which practically suggests that additional instruments can be obtained by utilizing the existing orthogonality conditions between the lagged dependent variable, y_{it-1} and η_{it}.

In more detail, the Arellano and Bond (1991) procedure involves first differencing equation (2) to remove the individual effects, α_i, and then use all the past information of y_{it} as instruments in equation (2.1) below:

$$\Delta y_{it} = \delta \Delta y_{it-1} + \beta(L)\Delta X_{it} + \Delta \eta_{it} \qquad (2.1)$$

where, Δ is the first-difference operator.

The first period where we can use an instrumental variable in model (2.1) is for t = 3. In this case, y_{i1} is a valid instrument, because it is uncorrelated with the error term, $\Delta \eta_{i3}$, but it is correlated with Δy_{i2}. One period ahead, i.e., for t=4, y_{i1} and y_{i2} are valid instruments and, therefore, in period T, the proper set of instruments is $y_{i1}, \ldots, y_{iT-2}$. More generally, the valid set of instruments, y_{it}, for our dependent variable satisfy the following moment conditions: $E[y_{it-s}\Delta\varepsilon_{it}] = 0$ for all $t=3,\ldots,T$ and $s \geq 2$.

Another possible source of bias in estimating equation (2.1) stems from the potential endogeneity of the explanatory variables and the ensuing correlation with the error term. This problem is dealt with as follows:

In the case of strictly exogenous variables, all past and future values of the explanatory variables are uncorrelated with the error term, implying the following moment conditions:

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

In the case of a violation of the strict exogeneity assumption i.e., $E[X_{is}\Delta\varepsilon_{it}] \neq 0$ for $t<s$, only lagged values of X_{it} are valid instruments and the following moment conditions hold:

$E[X_{it-s}\Delta\varepsilon_{it}] = 0$ for all $t=3,\ldots,T$ and for $s \geq 2$.

The above orthogonality conditions form the basis for the Arellano and Bond (1991) *one-step GMM estimation*, which, under the assumption of independent and homoscedastic residuals, yields consistent parameter estimates. Arellano and Bond (1991) also proposed another variant of the GMM estimator i.e., the so-called *two-step estimator*, which utilizes the estimated residuals to construct a consistent variance covariance matrix of the moment conditions.

5. Empirical results and interpretation

5.1 Fixed-effects and dynamic panel estimates

Tables A1 and A2 (Annex) depict the respective empirical results of our dynamic panel estimation of NPL determinants for: (i) the full set of countries (103 in total) examined in our study; and (ii) a more restricted (and, arguably, more homogenous) group of 29 countries, which includes the EU States plus Iceland (29 countries in total). As implied by the estimated fit of regressions, our

[7] This is because, the Anderson and Hsiao (1981) method (i) does not use all available moment conditions; and (ii) does not take into account the differenced structure of the residual differences $\Delta\eta_{it}$.

dynamic panel models can explain the evolution of the non-performing loan ratios in advanced and developing economies reasonably well.[8]

The coefficient of contemporaneous real GDP growth is negative and strongly significant in all model specifications, with the corresponding estimated values mostly ranging between -0.21 and -0.35 in the dynamic panel utilizing the entire set of countries and between -0.43 and -0.55 in the panel estimated for the 28 EU States plus Iceland. These results are in line with the findings of other empirical studies, which document a negative relationship between NPLs and economic growth; e.g. see Glen et al. (2011), Nikusu (2011) and Beck et al. (2013). The coefficients of lagged real GDP growth are also significant in the majority of estimated model specifications, albeit with alternate signs (both positive and negative). Note that, in a broadly similar empirical study Beck, Jakubic and Piliou (2013) find strongly significant and positive coefficient values for the lagged real GDP growth variable.[9] However, in comparison to our study, they generally use different country groups and a different time span i.e., 2000-2010 vs. 2000-2013.

The coefficient of the unemployment rate is also found to be positive and strongly significant, providing additional support to the countercyclical behavior of non-performing loans, i.e., an increase in the unemployment rate leads to a contemporaneous rise in NPLs. It is important to note here the negative (and significant) coefficient estimates for the lagged unemployment rate calculated in model specifications 4&5 of Table A1-Annex. A probable explanation for this finding is in line with a relevant argument provided in Beck, Jakubic and Piliou (2013) i.e., bank asset quality deteriorates with a lag in response to a drop in the unemployment rate, as the latter is generally associated with expansionary economic periods, during which banks generally apply looser credit standards.

The coefficient of our contemporaneous loan interest rate variable is positive and strongly significant in all dynamic panel specifications estimated in our study. Intuitively, this result is pretty straightforward, implying increased difficulties on the part of borrowers to meet their existing debt obligations to banks in periods of rising loan interest rates, especially in the case of floating rate loans. Note also that the coefficients of the lagged loan interest rate are also found to be strongly significant and mostly positive in sign. Note that a positive link between NPLs and bank lending rates is also documented in a number of recent empirical studies, including, among others, Louzis et al. 2010, Beck et al. 2013; and Klein 2013.

The coefficient of the contemporaneous nominal effective exchange rate (NEER) is also found to be strongly significant and positive in most specifications of the estimated dynamic panel model, which includes the full-set of countries. The interpretation of this finding is that in the latter sample, the *balance-sheet channel* is more than outweighed by the *competitiveness channel*. Here, the balance-sheet channel relates to the effect of an appreciation/depreciation of the domestic currency on the borrowers' ability to meet their foreign currency-denominated loan obligations. On the other hand, the competitiveness channel relates to the notion that an exchange rate depreciation (appreciation) leads to higher (lower) export revenue in the domestic economy and thus, improves (deteriorates) the debt-servicing capacity of domestic firms and households.[10]

In line with other empirical studies (see *e.g.* Beck, Jakubik & Piloiu, 2013), our *reduced cross-section* panel estimates (Table A2 – Annex) document a negative link between share prices and NPLs. The economic intuition behind this result is as follows: a pronounced decline in the stock market can lead to more defaults (*wealth effects*), an erosion of collateral values and thus, an increase in non-performing loans. Given the difficulty of finding reliable data for property prices for the majority of countries examined in our empirical study, we follow a number of recent empirical studies and proxy for the effect of collateral values on asset quality by looking at the link between share prices and non-performing loans.

[8] All variables used can enter our estimations either in levels or in first differences, as implied by the pre-testing we conducted for the existence of common and individual unit roots. The dependent variable can enter in levels or first differences without any practical change in our results (the unit root test uniformly suggest that, in the full sample of countries, there are no unit roots present – common or otherwise). We report the regression results for first differences of the dependent variable, so as to more closely connect with the existing literature. However, the panel VAR analysis presented in the following section used the NPL variable in levels.

[9] Beck, Jakubic and Piliou (2013) argue that this finding renders support to the notion that bank asset quality deteriorates with a lag in response to positive GDP growth due to loose credit standards applied during boom periods.

[10] Although we estimate several specifications for our reduced cross-section panel model (EU States plus Iceland), which include NEER and lagged NEER as explanatory variables, we note that the economic relevance of these variables may not be as significant as in the full-country panel case. That is because for most of the time period under examination (2000-2013), 18 euro area countries and 3 other EU countries (Bulgaria, Latvia and Lithuania) have had either fixed or ultra-rigid exchange rate regimes, while the main bulk of their trade was with other euro area countries.

The estimated coefficients of our private sector credit-to-GDP (contemporaneous and lagged) and private sector loans-to-deposits (lagged) variables are mostly positive and significant, implying a positive link between the extent of private-sector leverage and the future rise in non-performing loans in periods of economic slowdown.

Finally note that our dynamic panel GMM estimates assume lack of strong exogeneity of the following variables: real GDP growth, private sector credit-to-GDP and loans-to-deposits ratio, while all other explanatory variables are treated as strongly exogenous.

Although the strong persistence of the change in the NPL ratio[11] generally renders the Arellano and Bond (1991) estimation as the most appropriate method for our research purposes, we have also estimated a fixed-effects panel model for our reduced group of countries (EU28 + Iceland). The estimated coefficients (in terms of size, sign and significance level) of the latter model broadly confirm the results of our dynamic model specifications (results available on request). As a reminder the fixed-effects model has the following form:

$y_{it} = \beta(L)X_{it} + \varepsilon_{it}$, with $\varepsilon_{it} = \alpha_i + \eta_{it}$ and $\alpha_i \sim iid(0,\sigma_\alpha^2)$ and $\eta_{it} \sim iid(0,\sigma_\eta^2)$

where y_{it} is our dependent variable; in our case the NPL ratio;
$\beta(L)$ is the lag polynomial vector;
X_{it}, denotes the vector of explanatory variables, which does *not* include lags of the dependent variable;
η_{it} corresponds to the common stochastic error term; and
α_i is the individual-specific effect**,** which may vary across countries but is constant over time.

5.2 Fixed effects Panel estimates and what they imply for Greece

As an indicative result, we present below the estimated coefficients of a fixed-effect panel model for our reduced group of 29 counties, which has the following form:

$$NPL = c + \beta1 * RGDPG + \beta2 * RGDPG(-1) + \beta3 * PSCGDP + \alpha_i + \eta_{it} \quad (3)$$

Where
NPL denoted the annual change in the NPL ratio;
RGDPG corresponds to annual real GDP growth;
RGDPG(-1) is the lagged (*i.e.*, prior year) annual real GDP growth;
PSCGDP is the annual change in the private sector credit to GDP ratio;
η_{it} corresponds to the common stochastic error term;
α_i is the individual-specific effect**,** which may vary across countries but is constant over time.

Fixed-effects model estimates & significance levels
(***, ** and * indicating significance at the 1%, 5% and 10% levels, respectively)

c	β1	β2	β3	α_i (fixed effect)	R-squared
0.932***	-0.364***	-0.069	0.055***	0.222***	0.41

In the case of Greece, the above coefficient estimates suggest the following:

Of the cumulative rise in the country's NPL ratio over the period 2008-2013 that can be explained by model (3), around 90% can be attributed to the cumulative contraction in real GDP growth and ca 10% to the cumulative change in the private sector credit-to-GDP ratio. Note that over the period 2008-2013, the county's NPL ratio rose by 24.8 ppts (to 29.3% in June 2013); real GDP growth declined by a cumulative 25.8ppts; and the private sector credit to GDP ratio increased by a cumulative 23.5ppts (thought the latter increase was primarily due to the contraction of GDP over the corresponding period). Furthermore, an out-of-sample forecasting exercise using the latest (July 2013) IMF predictions for Greek real GDP growth and credit to GDP over the period 2014-

[11] I.e., highly significant coefficient estimates for the lagged NPLs variable in the majority of estimated model specifications presented in Tables A1 & A2 of Annex.

2015, forecasts a peak in Greece's NPLs ratio (at levels around 35%) in year 2015 i.e., one year after the end of the economic recession.

5.3 Panel VAR estimates

Tables B1 to B6 in the Annex section of this document present the impulse-responses of a first-order, 4-variable panel vector autoregressive model (Panel VAR(1)) estimated, respectively, for the full set of countries examined in our study, the euro area member states and the so-called PIIGS economies (Portugal, Ireland, Italy, Greece and Spain). The variables and their assumed ordering (*Cholesky decomposition applied*) are as follows[12,13]:

[NPLTL, PSCGDP, U, RGDPG]

where,

NPLTL is the non-performing loans to total loans ratio;
PSCGDP is the private sector credit to GDP ratio;
U is the unemployment rate (number of unemployed as % of labor force); and
RGDPG denotes real GDP growth.

Primarily, our Panel VAR(1) model results confirm the existence of a negative and significant relationship between the NPLs ratio and real GDP growth. For instance, our Panel VAR(1) estimates for the euro area member States (Table B3 – Annex) suggest that a +1 standard deviation shock in real GDP can lead to a decline of ca 0.638 in the NPLs ratio in the following period and vice versa. Moreover, the respective estimates for the PIIGS economies (Table B5 – Annex) suggest that a +1 standard deviation shock in real GDP can lead to a decline of ca 0.964 in the NPLs ratio in the following period and vice versa. The translation of the aforementioned standard deviation shocks in percentage points reveals that the Panel VAR(1) impulse response coefficients are broadly comparable with the respective coefficient estimates derived from our dynamic panel model (Tables A1 & A2 – Annex).

6. Concluding remarks

The present study utilized a number of empirical methodologies to explain the evolution of NPLs in a large group of advanced and emerging market economies in the period before and after the global financial crisis, placing particular focus on a number of Eurozone economies (including Greece) that have been severely hit by the euro area debt crisis.

The main results from the estimation of our *fixed-effects*, *dynamic* and *VAR (vector autoregressive)* panel models can be summarized as follows:

We document a negative (and strongly significant) relationship between NPLs and economic growth; which, in line with other studies in the international literature, confirms the *countercyclical* behavior of non-performing loans. Moreover, we find a positive (and strongly significant) relationship between NPLs and the unemployment rate. Our empirical findings also document the significance of a range of other macro and bank-related variables in driving NPLs, including, loan interest rates, the nominal effective exchange rate (especially relevant for non-euro area countries featuring relative high levels of private borrowing in foreign currency), property prices, stock market performance as well as the ratio of loans-to-deposits and private sector credit-to-GDP.

More importantly, the most important result of our study is the negative relationship between NPLs and economic growth, which remains particularly robust across model specifications. The plausible rational behind this finding is as follows: in periods of higher GDP growth, borrowers' income improves and thus, their capacity to service their debts. On the other hand, when economic activity slows down, NPLs increase as unemployment rises, disposable incomes decline and borrowers face difficulties in repaying their debt obligations.

[12] Full model results are available on request.
[13] This ordering in close in spirit to Klein (2013), De Bock and Demyanets (2012), and Marcucci and Qualiariello (2008).

In the case of Greece, our baseline specification of a fixed-effects panel model estimated for the EU countries suggests that, over the period 2008-2013, as much as 90% of the cumulative increase in the NPLs ratio (that can be explained by the particular model) may be attributed to the effects of the economic recession. Furthermore, an out-of-sample forecasting exercise using the latest (July 2013) IMF predictions for the Greek economy points to a likely peak in Greece's NPL ratio in 2015, at levels around 35%.

References

Beck, R., P. Jakubik, and A. Piloiu. 2013. " Non-Performing Loans, What Matters in Addition to the Economic Cycle?" , ECB Working Paper 1515.

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

Bernanke, B., and M.Gertler. 1989. " Agency Costs, Net Worth, and Business Fluctuations" , The American Economic Review, 79(1),14-31.

Bernanke, B., M. Gertler, S. Gilchrist. 1998. "The Financial Accelarator in a Quantitative Business Cycle Framework" , NBER Working Paper No. 6455 .

Diwan, I., and D.Rodick. 1992. "Debt Reduction, Adjustment Lending and Burden Sharing." NBER Working Paper No. 4007 (Cambridge, MA, March).

Jimenez, G., and J. Saurina . 2005. "Credit cycles, credit-risk, and prudential regulation." Banco de Espana, January.

Keeton, W. and C. Morris. 1987. "Why Do Banks' Loan Losses Differ?" Federal Reserve Bank of Kansas City, Economic Review, May, pp. 3-21.

King, R.G., and C.I. Plosser. 1984. "Money, Credit, and Prices in a Real Business Cycle." , American Economic Review, 74, pp. 363-380.

Klein, N. 2013. "Non-Performing Loans in CESEE: Determinants and Impact on Macroeconomic Performance". IMF Working Paper, WP/13/72.

Louzis, D.P., A.T. Vouldis, and V. L.Metaxas. 2010. "Macroeconomic and Bank-specific Determinants of Non-performing Loans in Greece: a Comparative Study of Mortgage, Business and Consumer Loan Portfolios." , Bank of Greece Working Paper118.

Love, I., and L. Zicchino. 2006. "Financial Development and Dynamic Investment Behavior: Evidence from Panel VAR." , The Quarterly Review of Economics and Finance, 46,190-210.

Myers, S. 1977. "The Determinants of Corporate Borrowing." Journal of Financial Economics, No. 5.

Nkusu, M. 2011. "Nonperforming Loans and Macrofinancial Vulnerabilities in Advanced Economies." IMF Working Paper 11/161(Washington: International Monetary Fund).

Pesaran, M.H. , T. Schuerman , B.Treutler, and S.M. Weiner. 2006. "Macroeconomic Dynamics and Credit Risk: A Global Perspective", Journal of Money, Credit and Banking, 38(5) , pp. 1211-1261.

Quagliarello, M. 2007. "Banks' riskiness over the business cycle: a panel analysis on Italian intermediaries," Applied Financial Economics, Taylor and Francis Journals, 17(2), 119-138.

Rajan, R., and S.C. Dahl. 2003. "Non-performing Loans and Terms of Credit of Public Sector Banks in India: An Empirical Assesment." Occasional Papers, 24:3 Reserve Bank of India.

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

Annex

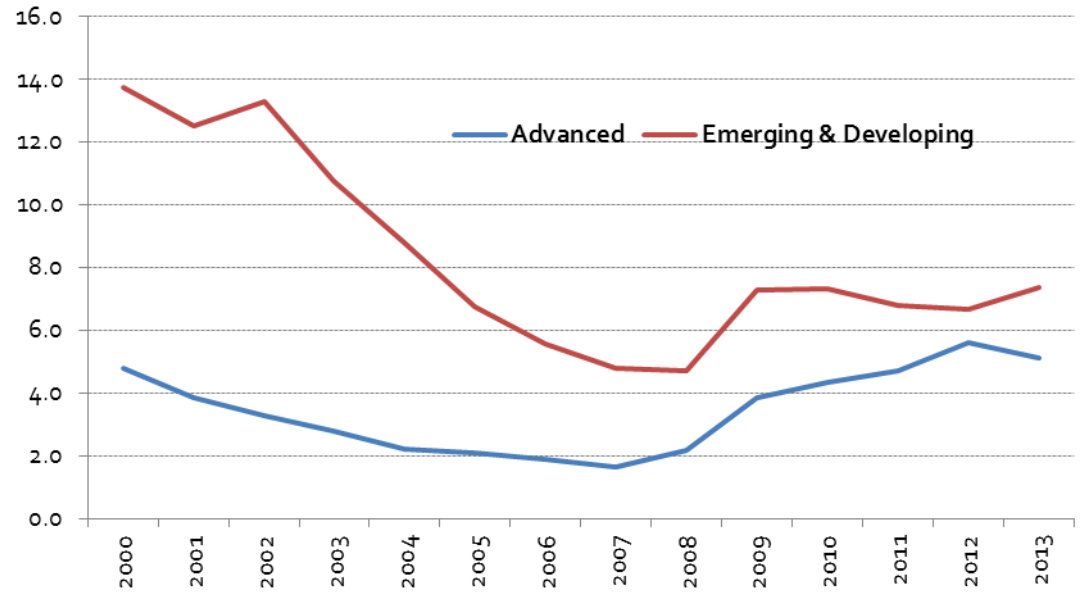
Table 1.1 – Data & sources

Indicator	Acronym	Frequency	time span	Source
Non-performing loans to total loans (%)	**NPLTL**	Annual	2000-2013	IMF, WB
Real GDP growth (%)	**RGDPG**	Annual	2000-2013	IMF
Consumer price inflation (%)	**INF**	Annual	2000-2013	IMF
Unemployment rate (% of labor force)	**U**	Annual	2000-2013	IMF
IBC (International claims, cross-border claims in all currencies & local claims in non-local currencies - in USDbn)	**IBC**	Annual	2007-2013	BIS
Stock Market Capitalization (USD bn)	**SMC**	Annual	2000-2012	WB
Share Price Index (2010=100)	**SPI**	Annual	2000-2013	IMF
Nominal effective exchange rate index (2010 = 100)	**NEER**	Annual	2000-2013	IMF
Bank lending interest rate (%)	**LIR**	Annual	2000-2013	ECB, WB
Private sector credit (% GDP)	**PSCGDP**	Annual	2000-2013	WB, IMF, ECB
Loans to deposits ratio (%)	**LTD**	Annual	2000-2013	WB, IMF, ECB

Table 1.2 – Country sample

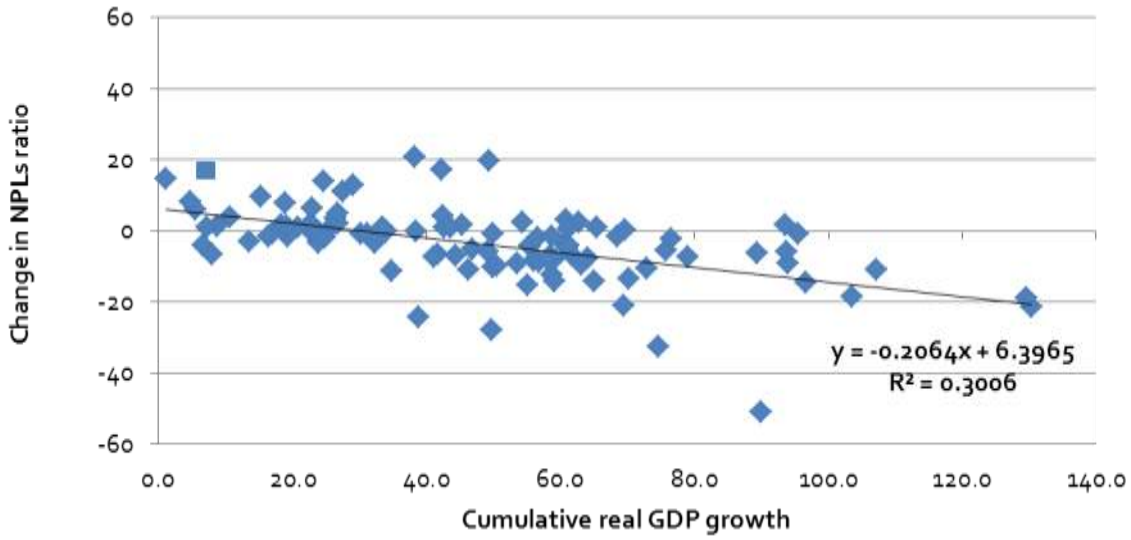
Advanced Economies	Commonwealth of Independent States		Western Hemisphere
Australia	Armenia		Argentina
Austria	Belarus		Bolivia
Belgium	Georgia		Brazil
Canada	Kazakhstan		Chile
Cyprus	Kyrgyz Republic		Colombia
Czech Republic	Moldova		Costa Rica
Denmark	Russia		Dominican Republic
Estonia	Ukraine		Ecuador
Finland			El Salvador
France	**Developing Asia**		Guatemala
Germany	Brunei Darussalam		Honduras
Greece	China		Mexico
Hong Kong SAR	India		Panama
Iceland	Indonesia		Paraguay
Ireland	Malaysia		Peru
Israel	Pakistan		Uruguay
Italy	Philippines		Venezuela
Japan	Sri Lanka		
Korea	Thailand		
Luxembourg			
Malta	**Middle East and North Africa**		
Netherlands	Algeria		
New Zealand	Egypt		
Norway	Jordan		
Portugal	Kuwait		
Singapore	Lebanon		
Slovak Republic	Morocco		
Slovenia	Oman		
Spain	Saudi Arabia		
Sweden	United Arab Emirates		
Switzerland			
United Kingdom	**Sub-Saharan Africa**		
United States	Gabon		
	Ghana		
	Kenya		
Central and Eastern Europe	Lesotho		
Albania	Mauritius		
Bosnia and Herzegovina	Mozambique		
Bulgaria	Namibia		
Hungary	Nigeria		
Latvia	Rwanda		
Lithuania	Senegal		
Macedonia, FYR	Seychelles		
Montenegro	Sierra Leone		
Poland	South Africa		
Romania	Swaziland		
Serbia	Uganda		
Turkey			

Graph 2 - Average NPL ratio (%) in advanced and emerging & developed economies



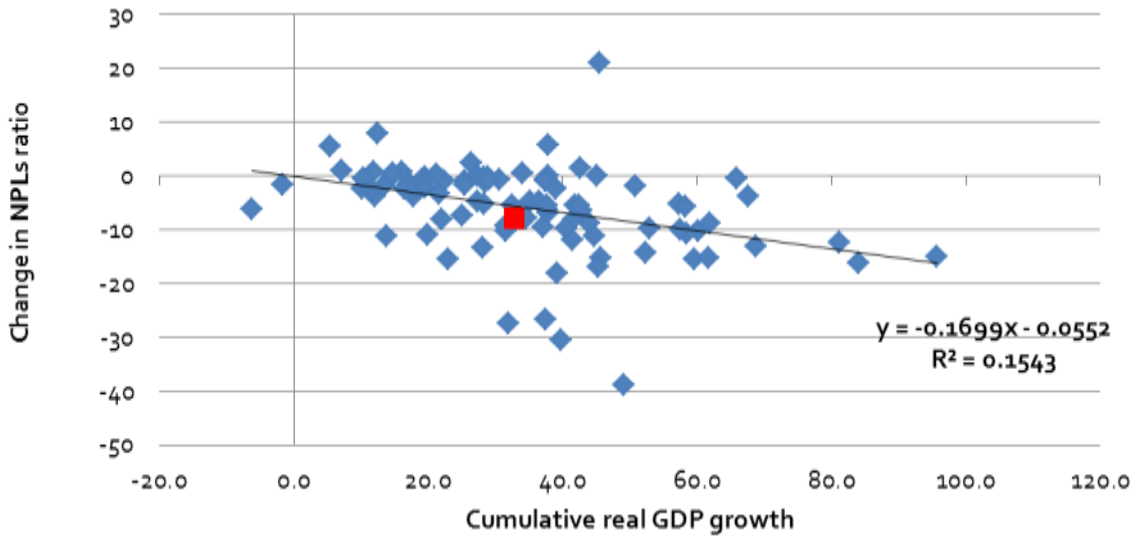
Source: IMF, WB, Eurobank Global Markets Research

Graph 3.1 – Cumulative real GDP growth vs. change in NPLs ratio (2000-2013)



Source: IMF, WB, Eurobank Global Markets Research

Graph 3.2 – Cumulative real GDP growth vs. change in NPLs ratio (2000-2007)
(Red square indicates Greece)



Source: IMF, WB, Eurobank Global Markets Research

Table A1 – Determinants of NPLs based on Arellano and Bond (1991) Dynamic Panel GMM estimation
Full set of countries (103 in total)

	Dependent variable NPL						
	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5	Specification 6	Specification 7
NPL(-1)	0.155***	0.058***	-0.002	0.192***	0.109***	0.216***	0.231***
RGDP	-0.322***	-0.290***	-0.318***		-0.330***	-0.205***	-0.323***
RGDP(-1)	0.045***	0.010**	-0.037***			-0.084***	
Unemployment						0.016***	
Unemployment (-1)				-0.010***	-0.009***		
Loan interest rate			0.294***				0.341***
Loan interest rate(-1)		0.278***	0.279***	0.683***	0.196***		
Inflation							
NEER	-0.026***	0.03***	0.052***			0.016***	0.001
NEER(-1)	-0.030***	-0.066***	-0.060***	0.003	-0.006***		
Share prices * Low stock mkt cap.							
Share prices * High stock mkt cap.							
Loans-to-deposits ratio (-1)							
Private-sector credit to GDP							0.065***
Private-sector credit to GDP (-1)							
Number of obs.	483	263	268	279	284	563	276
Number of groups	59	38	38	38	38	57	38
R^2	30%	38%	41%	13%	41%	7%	46%

Notes: Coefficient estimates from Dynamic panel GMM estimation (Arellano and Bond, 1991) with ***, ** and * indicating significance at the 1%, 5% and 10% levels, respectively. *RGDP* denotes real GDP growth; *NEER* and *Share prices* enter our model in logarithmic differences of the respective indices; and NPLs, *Unemployment rate*, *Loan Interest Rate*, *Loans-to-Deposit ratio* and *Private Sector Credit-to-GDP ratio* enter in first differences. An increase in the nominal effective exchange rate (NEER) denotes an appreciation of the domestic currency vs. the currencies of the respective trading partners and vice versa. The share prices are interacted with a dummy that takes the value of 1 for countries with stock market capitalization above the corresponding sample median and zero otherwise.

Table A1 (continued) – Determinants of NPLs based on Arellano and Bond (1991) Dynamic Panel GMM estimation
Full set of countries (103 in total)

	Dependent variable NPL						
	Specification 8	Specification 9	Specification 10	Specification 11	Specification 12	Specification 13	Specification 14
NPL(-1)	-0.081***	0.183***	0.131***	0.133***	0.201***	0.214***	0.012
RGDP	-0.218***	-0.310***	-0.345***	-0.335***	-0.552***	-0.133***	-0.471***
RGDP(-1)		0.046***	-0.002	-0.021***	-0.010*	0.008	-0.113
Unemployment							
Unemployment (-1)							
Loan interest rate		0.191***	0.474***	0.417***	0.167***	0.123*	0.317**
Loan interest rate(-1)					-0.273***		
Inflation				0.072***			
NEER	0.044***						0.110***
NEER(-1)					-0.024***	-0.040***	
Share prices * Low stock mkt cap.	-0.015***					0.010**	
Share prices * High stock mkt cap.	0.002**					-0.023***	
Loans-to-deposits ratio (-1)							0.034***
Private-sector credit to GDP			0.033***	0.039***			
Private-sector credit to GDP (-1)		0.042***			0.054***	0.014***	
Number of obs.	341	316	328	328	231	225	147
Number of groups	34	43	43	43	38	30	25
R^2	16%	37%	35%	34%	38%	31%	55%

Notes: Coefficient estimates from Dynamic panel GMM estimation (Arellano and Bond, 1991) with ***, ** and * indicating significance at the 1%, 5% and 10% levels, respectively. *RGDP* denotes real GDP growth; *NEER* and *Share prices* enter our model in logarithmic differences of the respective indices; and NPLs, *Unemployment rate*, *Loan Interest Rate*, *Loans-to-Deposit ratio* and *Private Sector Credit-to-GDP ratio* enter in first differences. An increase in the nominal effective exchange rate (NEER) denotes an appreciation of the domestic currency vs. the currencies of the respective trading partners and vice versa. The share prices are interacted with a dummy that takes the value of 1 for countries with stock market capitalization above the corresponding sample median and zero otherwise.

Table A2– Determinants of NPLs based on Arellano and Bond (1991) Dynamic Panel GMM estimation
EU States plus Iceland (29 countries in total)

	Dependent variable NPL					
	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5	Specification 6
NPL(-1)	0.330***	0.177***	0.181***	-0.039*	0.350***	0.251***
RGDP	-0.426***	-0.446***	-0.543***	-0.477***	-0.169***	-0.498***
RGDP(-1)	0.141***	-0.001	-0.063***	-0.193***	0.014**	-0.027
Unemployment						
Unemployment (-1)						
Loan interest rate			1.132***	1.078***		0.957***
Loan interest rate(-1)		0.563***	-0.253***			-0.206***
Inflation						
NEER	-0.011	-0.051***	0.002	0.105***	-0.051***	-0.015
NEER(-1)	-0.011**	-0.001	-0.013***			
Share prices					-0.010***	
Loans-to-deposits ratio (-1)						
Private-sector credit to GDP				0.030***		
Private-sector credit to GDP (-1)						0.016**
Number of obs.	254	180	176	190	199	152
Number of groups	29	27	27	27	22	27
R^2	41%	42%	45%	45%	29%	47%

Notes: Coefficient estimates from Dynamic panel GMM estimation (Arellano and Bond, 1991) with ***, ** and * indicating significance at the 1%, 5% and 10% levels, respectively. *RGDP* denotes real GDP growth; *NEER* and *Share prices* enter our model in logarithmic differences of the respective indices; and NPLs, *Unemployment rate*, *Loan Interest Rate*, *Loans-to-Deposit ratio* and *Private Sector Credit-to-GDP ratio* enter in first differences. An increase in the nominal effective exchange rate (NEER) denotes an appreciation of the domestic currency vs. the currencies of the respective trading partners and vice versa.

Table A2 (continued)– Determinants of NPLs based on Arellano and Bond (1991) Dynamic Panel GMM estimation

EU States plus Iceland (29 countries in total)

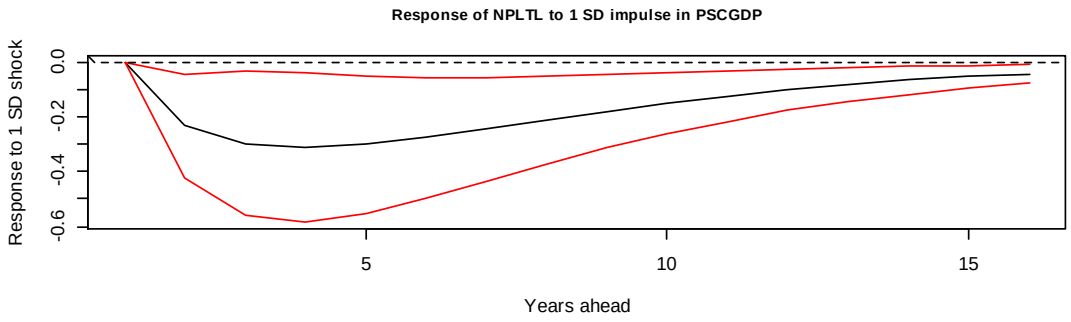
	Dependent variable NPL				
	Specification 7	Specification 8	Specification 9	Specification 10	Specification 11
NPL(-1)	-0.039*	0.435***	-0.040	0.076***	-0.198
RGDP	-0.477***		-0.506***	-0.460***	-0.880***
RGDP(-1)	-0.193***	-0.161***	-0.031	-0.084***	-0.723***
Unemployment					
Unemployment (-1)					
Loan interest rate	1.078***		0.023	0.826***	5.172***
Loan interest rate(-1)			-0.0380***		
Inflation					
NEER	0.105***				
NEER(-1)				0.011**	
Share prices		-0.042***			
Loans-to-deposits ratio (-1)					-0.023
Private-sector credit to GDP	0.030***				
Private-sector credit to GDP (-1)		-0.016***	0.071***	0.024***	
Number of obs.	190	193	152	194	147
Number of groups	27	22	27	27	25
R^2	45%	22%	35%	47%	36%

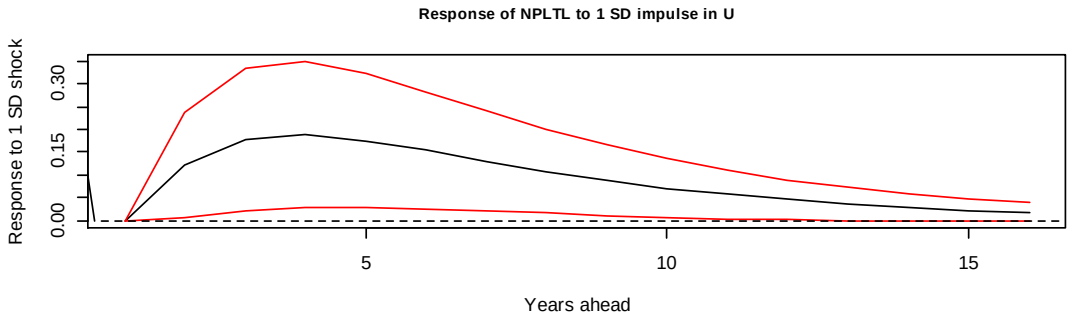
Notes: Coefficient estimates from Dynamic panel GMM estimation (Arellano and Bond, 1991) with ***, ** and * indicating significance at the 1%, 5% and 10% levels, respectively. *RGDP* denotes real GDP growth; *NEER* and *Share prices* enter our model in logarithmic differences of the respective indices; and NPLs, *Unemployment rate*, *Loan Interest Rate*, *Loans-to-Deposit ratio* and *Private Sector Credit-to-GDP ratio* enter in first differences. An increase in the nominal effective exchange rate (NEER) denotes an appreciation of the domestic currency vs. the currencies of the respective trading partners and vice versa.

Table B1 - Results from 4-variable VAR(1) [NPLTL, PSCGDP, U, RGDPG],

PSCGDP and U enter in first differences, full available sample of years and countries

Red lines are +/- 1 s.e. confidence intervals





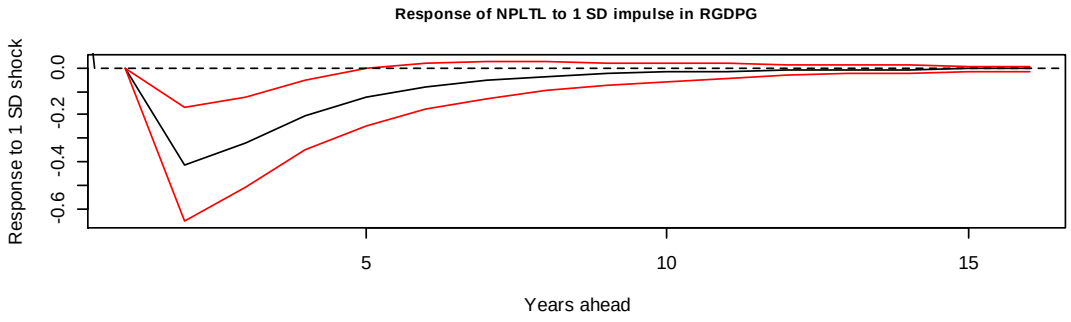
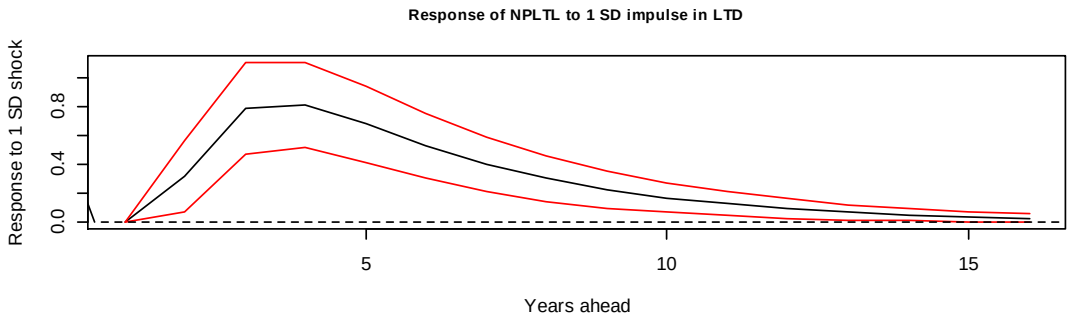
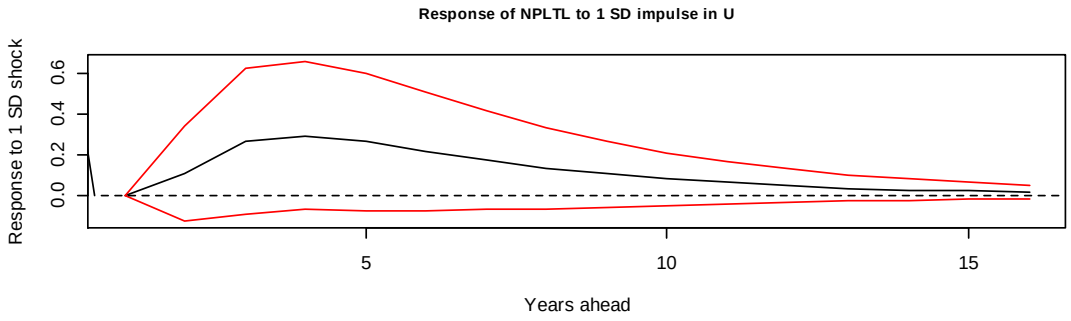


Table B2 - Results from 4-variable VAR(1) [NPLTL, LTD, U, RGDPG],

LTD and U enter in first differences, full available sample of years and countries

Red lines are +/- 1 s.e. confidence intervals





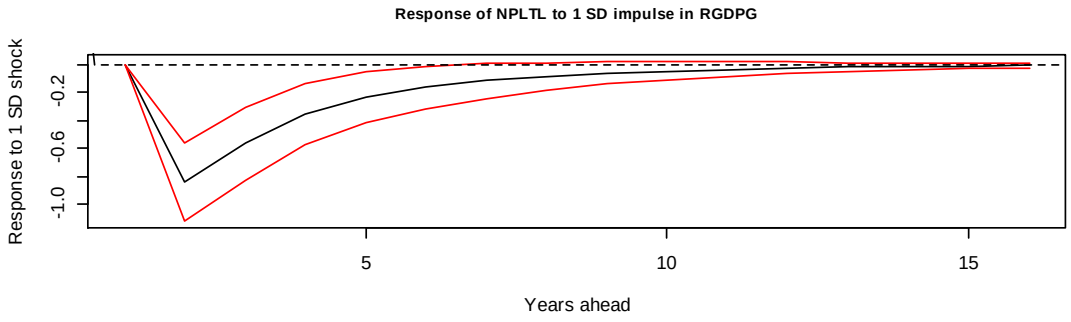
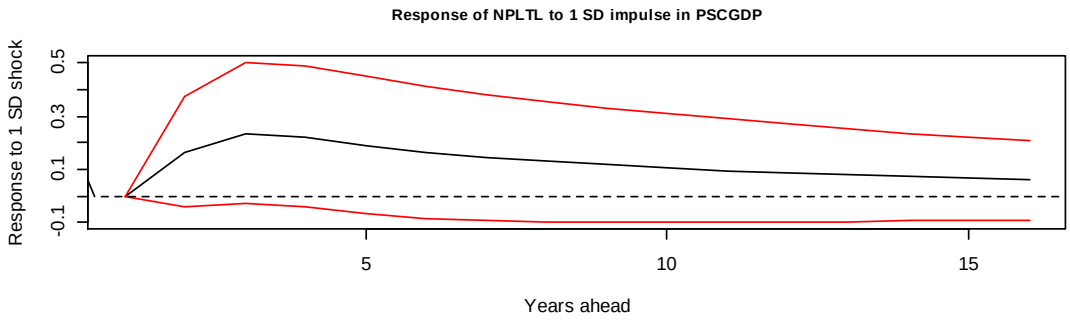
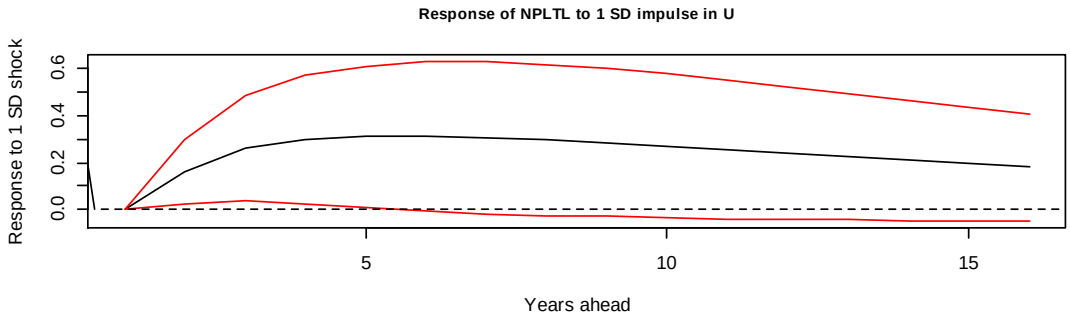


Table B3 - Results from 4-variable VAR(1) [NPLTL, PSCGDP, U, RGDPG],

PSCGDP and U enter in first differences, Eurozone sample of years and countries

Red lines are +/- 1 s.e. confidence intervals





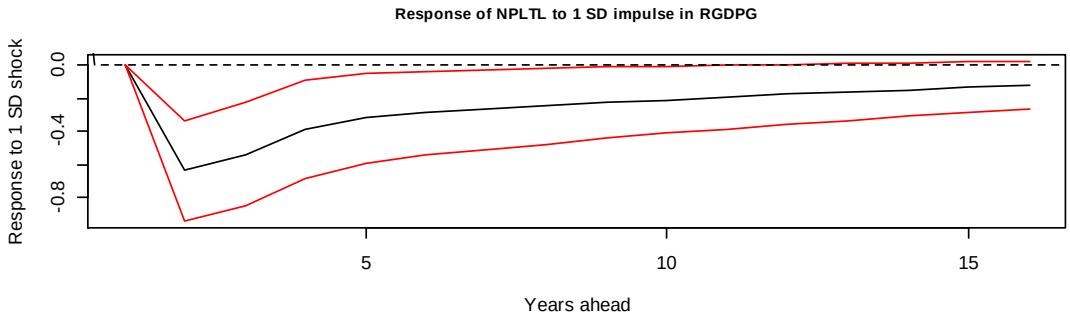
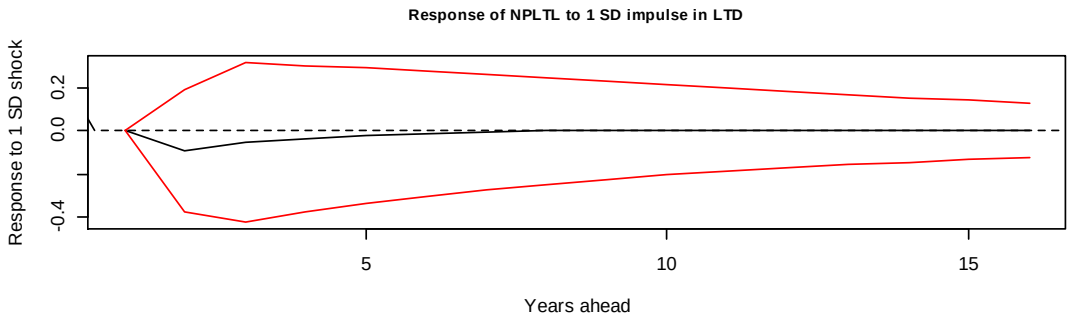
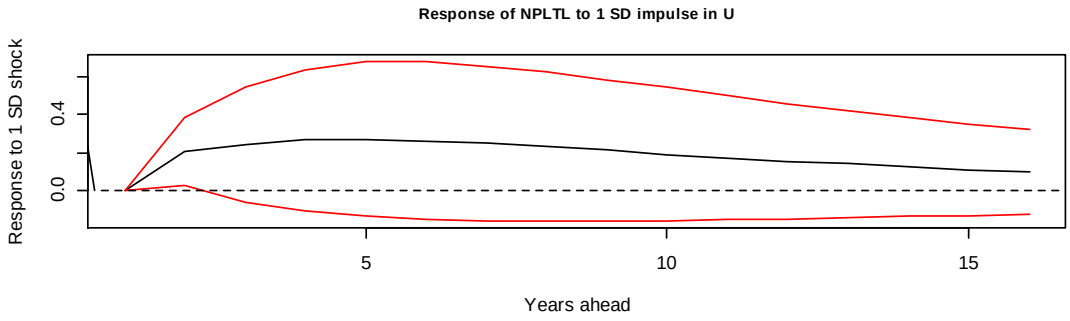


Table B4 - Results from 4-variable VAR(1) [NPLTL, LTD, U, RGDPG],

LTD and U enter in first differences, Eurozone sample of years and countries

Red lines are +/- 1 s.e. confidence intervals





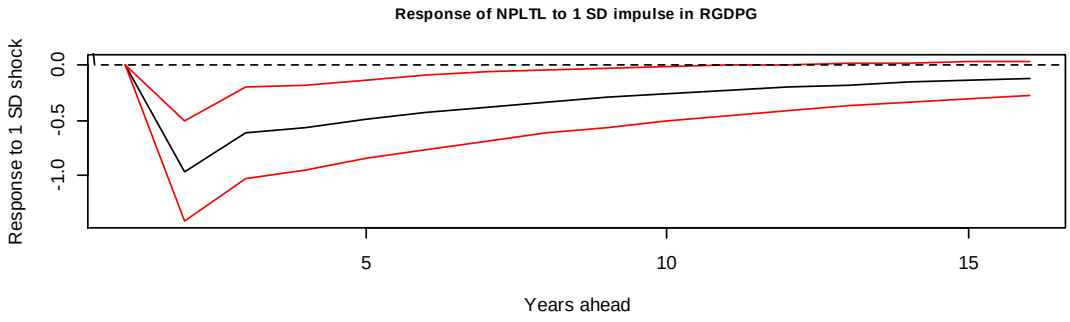
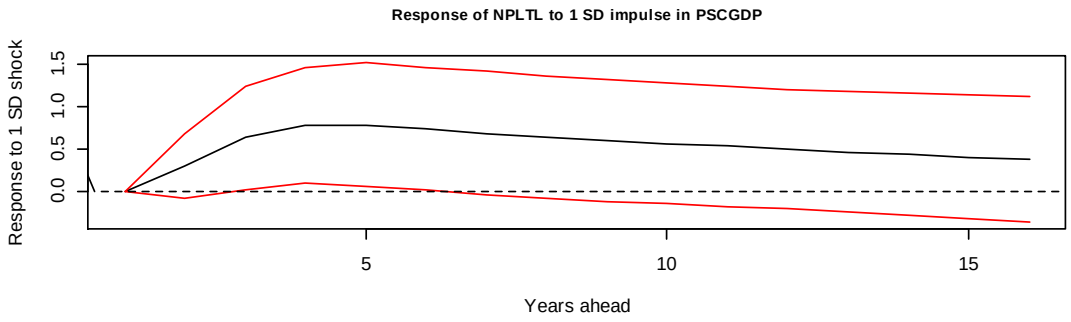
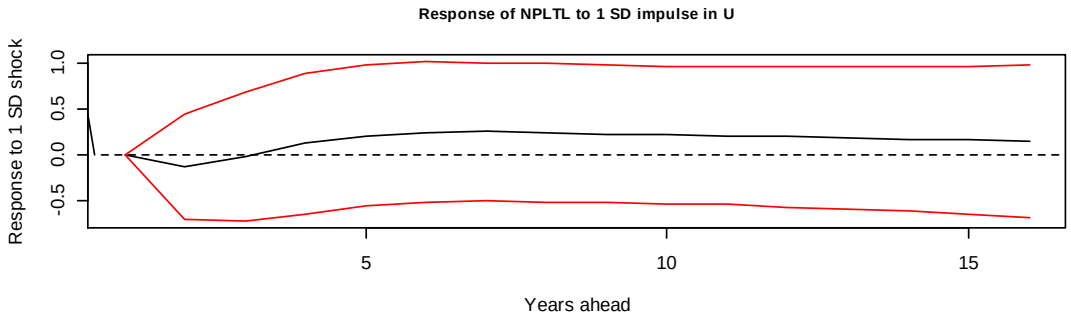


Table B5 - Results from 4-variable VAR(1) [NPLTL, PSCGDP, U, RGDPG],

PSCGDP and U enter in first differences, PIIGS sample of years and countries

Red lines are +/- 1 s.e. confidence intervals





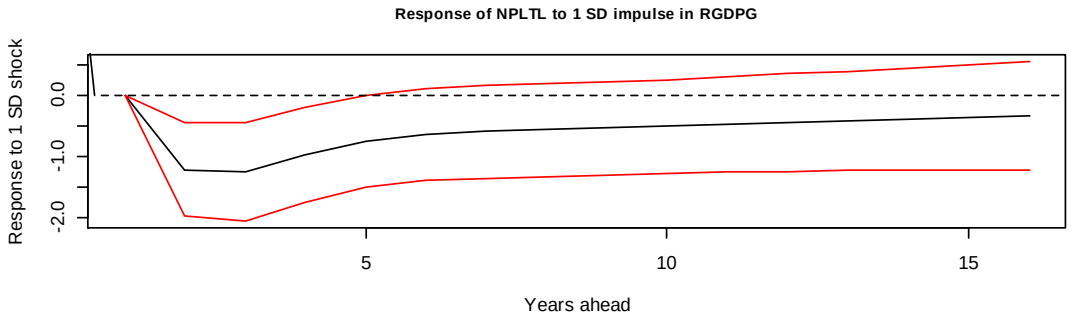
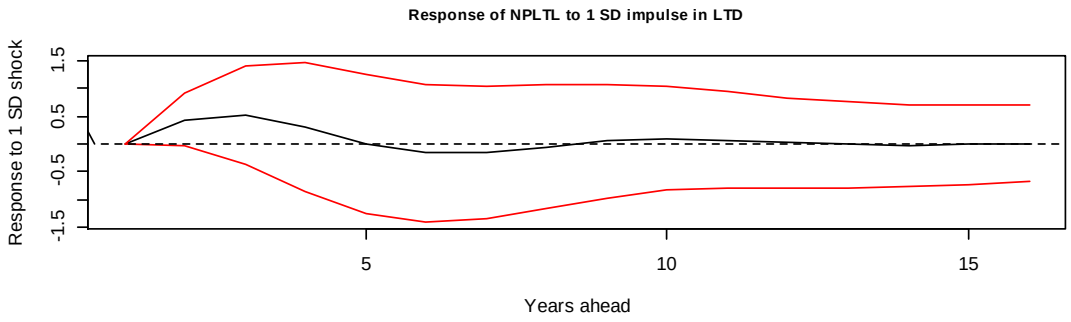
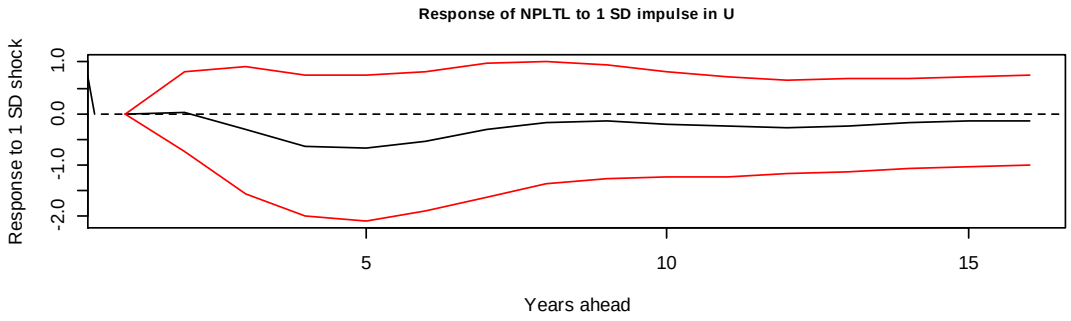


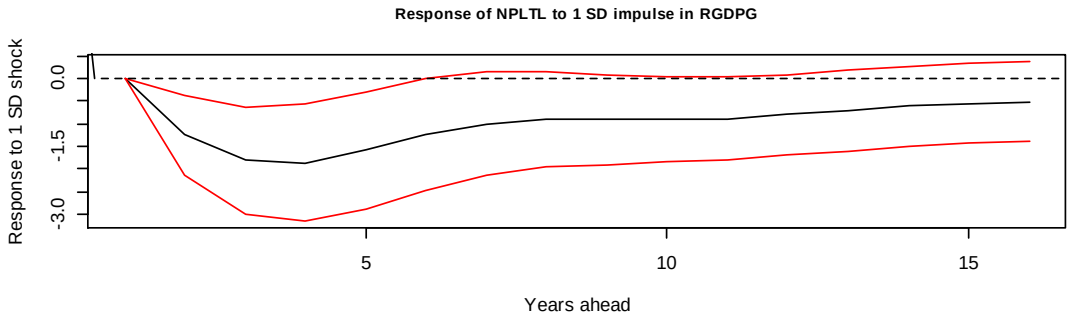
Table B6 - Results from 4-variable VAR(1) [NPLTL, LTD, U, RGDPG],

LTD and U enter in first differences, PIIGS sample of years and countries

Red lines are +/- 1 s.e. confidence intervals







Eurobank Global Markets Research

Global Markets Research Team

Dr. Platon Monokroussos: *Head of Global Markets Research pmonokrousos@eurobank.gr, + 30 210 37 18 903*

Paraskevi Petropoulou: *G10 Markets Analyst ppetropoulou@eurobank.gr, + 30 210 37 18 991*

Galatia Phoka: *Emerging Markets Analyst gphoka@eurobank.gr, + 30 210 37 18 922*

Global Markets Sales

Nikos Laios: *Head of Treasury Sales nlaios@eurobank.gr, + 30 210 37 18 910*

Alexandra Papathanasiou: *Head of Institutional Sales apapathanasiou@eurobank.gr, +30 210 37 18 996*

John Seimenis: *Head of Corporate Sales yseimenis@eurobank.gr, +30 210 37 18 909*

Achilleas Stogioglou: *Head of Private Banking Sales astogioglou@eurobank.gr, +30 210 37 18 904*

George Petrogiannis: *Head of Shipping Sales gpetrogiannis@eurobank.gr, +30 210 37 18 915*

Vassilis Gioulbaxiotis: *Head International Sales vgioulbaxiotis@eurobank.gr, +30 210 3718995*

Eurobank Ergasias S.A, 8 Othonos Str, 105 57 Athens, tel: +30 210 33 37 000, fax: +30 210 33 37 190, email: EurobankGlobalMarketsResearch@eurobank.gr

Eurobank Global Markets Research

More research editions available at htpp://www.eurobank.gr/research

Greece Macro Monitor: Periodic overview of key macro & market developments in Greece
Daily overview of global markets & the SEE region:
Daily overview of key developments in global markets & the SEE region
South East Europe Monthly:
Monthly overview of economic & market developments in the SEE region
Global Markets & SEE themes: Special focus reports on Global Markets & the SEE region

Subscribe electronically at htpp://www.eurobank.gr/research
Follow us on twitter: https://twitter.com/Eurobank Group