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Working Paper

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Dimitrios Anastasiou
Helen Louri
Mike G. Tsionas

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DECEMBER 2016

BANK OF GREECE
Economic Analysis and Research Department – Special Studies Division
21, E. Venizelos Avenue
GR-102 50 Athens
Tel: +30210-320 3610
Fax: +30210-320 2432

www.bankofgreece.gr

Printed in Athens, Greece
at the Bank of Greece Printing Works.

ISSN 1109-6691

NON-PERFORMING LOANS IN THE EURO AREA: ARE CORE-PERIPHERY BANKING MARKETS FRAGMENTED?

Dimitrios Anastasiou
Athens University of Economics and Business

Helen Louri
Athens University of Economics and Business, Bank of Greece and Research Associate LSE EI/HO

Mike G. Tsionas
Athens University of Economics and Business

Abstract

The objective of this study is to examine the causes of non-performing loans (NPLs) in the banking system of the euro area for the period 2003-2013 and distinguish between core and periphery country determinants. The increase in NPLs post crisis has put into question the robustness of many European banks and the stability of the whole sector. It still remains a serious challenge, especially in peripheral countries which are hardest hit by the financial crisis. By employing both Fully Modified OLS and Panel Cointegrated VAR we estimate that NPLs are affected by the same macroeconomic and bank-specific conditions but the responses are stronger in the periphery. Following the FMOLS estimations NPLs in the euro area have performed an upward (much higher in the periphery) shift after 2008 and are mostly related to worsening macroeconomic conditions especially with respect to unemployment, growth and taxes. Fiscal consolidation and interest rate margins are significant for the periphery while credit to GDP is significant only for the core. Quality of management and loans to deposits play an important role, while size is negatively significant only in the periphery. Most of these findings were confirmed by the panel Cointegrated VAR results. A chi-square test comparing the estimated coefficients for the core and periphery NPLs rejects the hypothesis of equality revealing another aspect of banking fragmentation in the euro area. Such findings can be helpful when designing macro-prudential as well as NPL resolution policies, which should be adjusted appropriately to the different responses between core and periphery banks.

Keywords: Non-performing loans; Macroeconomic determinants; Bank-specific determinants; Financial Fragmentation; FMOLS estimation; Panel Cointegrated VAR.

JEL classification: C23, C51, G21, G2

Acknowledgements: The authors would like to thank the Research Center of AUEB for financial assistance. They would also like to thank participants at the ASSET Conference 2016 and the World Finance and Banking Symposium 2016 for useful comments and suggestions.

Correspondence:
Helen Louri
Athens University of Economics and Business,
Bank of Greece and Research Associate LSE EI/HO
76 Patission Street, 10434
Athens, Greece
Email: elouri@aueb.gr

1. Introduction

The recent financial crisis which started in the USA in 2007 was the catalyst that revealed the weaknesses in the international banking system. One such important weakness was the high credit risk undertaken which resulted in increases in non-performing loans (NPLs).[1] Losses due to NPLs reduce banks' profits and when these are not enough (as is often the case, especially post crisis) losses consume banks' capital creating an urgent need for recapitalization and constraining credit provision to the economy. A high rate of non-performing loans may also cause expectations about the stability of the banking system to deteriorate, creating systemic risk which may in turn lead to a run on deposits, significantly reducing the intermediation power of banks. The ensuing banking crisis can impact on the whole economy in diverse ways, such as undermining confidence in the country or suppressing the future growth rate of GDP.

Therefore, it is of urgent importance to understand and identify the factors that affect NPLs and provide some guidance both to the banks so that they improve their credit policies and to the governments and the banks' supervisors so that appropriate preventive measures and stress testing models are adopted. It should be noted that NPLs, along with the liquidity risk, are the most significant types of risk for commercial banks especially after the outburst of the financial crisis. A typical example of an NPL-caused banking crisis is the Asian crisis of 1997. The cost of this crisis to Asia was high not only in fiscal terms but also concerning losses to the real economy.

The problem of the NPLs has expanded in the euro area but countries located in the euro-area periphery and especially those involved in IMF-EU support programmes such as Portugal, Ireland and Greece seem to face the biggest threat. Thus, in 2015 while NPLs in the euro area reached 12% and were less than 2% in Germany, they exceeded 35% in Greece and reached 20% in Italy and Ireland. NPLs present the most significant challenge that euro-area periphery banks have to face. Managing this problem will be a defining factor which will permit (often called zombie) banks to start contributing to the growth of their economies again (ECB 2015).

But are NPLs really different between core and periphery countries? Do NPLs react similarly to the same explanatory variables? Or do banks in periphery countries

[1]According to the ECB, a loan is considered to be non-performing (or impaired) when payments of interest are past due by 90 days or more.

have a different response thus increasing their vulnerability? Are there signs of financial fragmentation (especially visible in money and capital markets after the sovereign debt crisis) meaning that NPLs are to a significant extent determined by the country of origin rather than its underlying fundamentals? Or is it the case that NPLs are higher in the periphery just because macroeconomic conditions have diverged and growth has stagnated?

The contribution of this paper which looks for signs of fragmentation in the determinants of euro-area NPLs in the period 2003-2013 is twofold: First, both FMOLS and Panel Cointegrated VAR as econometric methodologies are used. Second, some new determinants such as income taxes and an interest rate margin, which is an indirect measure of credit risk, are included. The application of a proper (chi square) fragmentation test on the estimated coefficients is also worth noting.

The rest of the paper is organized as follows. In section 2 we offer an extended literature review of the factors that affect NPLs. Section 3 describes the data, the variables and the econometric models employed. In section 4 and 5 we present the empirical econometric methodologies and the empirical results respectively. Finally, section 6 concludes.

2. Literature review

2.1 Initial hypotheses behind NPL creation

One of the earliest studies that tried to understand the reasons behind NPLs is that of Berger and De Young (1997). They applied Granger-causality techniques in order to test four hypotheses regarding the relationship between loan quality, cost efficiency and bank capital taking a sample of US commercial banks for the period 1985-1994. These four hypotheses were referred to as “bad luck”, “bad management”, “skimping”, and “moral hazard”. After the specification of the four hypotheses, they constructed a model and used Granger causality techniques in order to examine which of the above hypotheses were consistent with the data. Based on their results they came to the conclusion that the bad management hypothesis was superior to the others for the whole sample. They also found that another reason for increasing NPLs is the fact that bank capital ratios were generally low, hinting at moral hazard incentives driving inadequately capitalized banks towards taking a high portfolio risk.

Along the same lines as Berger and De Young (1997), Podpiera and Weill (2008) examined the existence of a causal relationship between NPLs and cost efficiency. The authors used a comprehensive dataset, including every Czech bank for the period 1994 to 2005. They expanded on the Granger causality framework used by Berger and De Young (1997) by applying the generalized method of moments (GMM) and using dynamic panel estimators. They found support only for the bad management hypothesis.

2.2 NPLs and macroeconomic conditions

A series of NPL studies focused exclusively on the role of macroeconomic or country-specific determinants and found that they exerted a most significant effect. Espinoza and Prasad (2010) tried to distinguish the determinants of NPLs for the GCC (Gulf Cooperative Council) banking system, using a panel dataset of 80 banks and implementing a GMM model over the period 1995-2008. They found that the NPL ratio rises when economic growth slows and risk aversion decreases as well as when interest rates increase. In particular, NPLs and real (non-oil) GDP growth were found to have a notable inverse relationship. It is important to mention that exchange rates and unemployment were not used as regressors, because of the pegged exchange rate regime and the low and stable unemployment in the GCC countries**.**

Nkusu (2011) followed a similar methodology to that of Espinoza & Prasad (2010). He collected annual data from 1998 to 2009 for a sample of 26 advanced economies and tested an econometric model which explains NPLs by employing only macro-performance variables. He found that an aggravation in the macroeconomic environment, as proxied by sluggish growth, decreasing asset prices or higher unemployment, is interrelated with debt service problems. On the contrary, an improving macroeconomic environment implies a decrease in non-performing loans.

Italian banks for the period 1990-2010 provided the sample on which Bofondi and Ropele (2011) focused for exploring the macro factors affecting impaired business and household loans. Results for household loans before the crisis recorded a positive relationship between NPLs and unemployment and interest rates, and a reverse relationship for GDP growth and real estate prices. Regarding businesses loans, they found a positive effect of unemployment and interest expense ratio to EBITDA, while a negative effect was related to the consumption of durable goods. After the financial

crisis they found that an increase in problem household loans was associated with a rise in unemployment and a decrease in consumption, while for companies high levels of NPLs were mostly associated with a reduction in GDP growth.

The importance of the current account balance was stressed by Kauko (2012) who examined its interrelation with the development of non-performing loans, especially in the recent financial crisis. He also focused on country-specific variables using a sample of 34 developed economies. His main result was that the rapid credit expansion in the period 2000-2005, could be considered as an important risk factor only if combined with the current account deficit (which is a sign of the loss of competitiveness).

Beck et al. (2013) used a more complete panel data set to examine the role of macroeconomic factors on NPLs across 75 countries during the last decade. According to their dynamic panel, the factors which were found to be significant and affect the NPL ratio are share prices (negative sign), real GDP growth rate (negative sign), lending interest rates (positive sign) and nominal exchange rate (positive sign). They found that lower bank asset quality is associated with exchange rate depreciations, while a drop in share prices is related to an increase in NPLs. Moreover, their econometric analysis showed that the real GDP growth was the major driver of the NPL ratio during the last decade. A rise in lending interest rates also implied more NPLs. In addition, they found that reductions in stock prices affected negatively the asset quality of banks, while their direct effect on NPLs was less obvious.

Finally, Çifter (2015) investigated how banking concentration affects NPLs taking a sample of ten Central and Eastern European countries (CEE). He examined this relationship both in the long run and in the short run. However, he did not find concentration to be significant and even its sign was ambiguous. Thus, he concluded that "bank concentration may not affect systemic stability in the CEE countries".

2.3 NPLs and the role of corporate and bank-specific variables

Another strand of the NPL literature examined on top of macroeconomic performance the role of micro-economic factors. Such corporate and banking variables were found to improve the explanatory ability of the estimated models. Ghosh (2006) used both macroeconomic and financial variables and focused especially on the impact of corporate leverage on NPLs. He used data from the manufacturing sector of India and

his main finding was that the lagged value of corporate leverage is a significant determinant of NPLs. More specifically, he found that an increase in one-year lagged corporate leverage (positively associated with firms' financing costs) leads to an increase in NPLs and hence makes the probability of default more likely. He noted that the connection could originate from the fact that leverage is positively associated with firms' financing costs.

The factors that affect the NPLs of the Greek banking system were studied by Louzis et al. (2010) in one of the most cited papers in this literature. They used dynamic panel data including the nine largest Greek banks for the period 2003Q1 to 2009Q3 and applied GMM in order to test for the determinants of NPLs for each kind of loan (mortgage, business and consumer). The effects of the macroeconomic variables were found to be quite stable among alternative models which included also bank-specific factors as explanatory variables. Their results imply that impaired loans are significantly related to various macroeconomic variables, such as the unemployment rate (positive relationship), the GDP growth rate (negative relationship), and the real interest rate (positive relationship). Inferior bank management, represented by the rates of return on assets and equity, is found to have negative effects on NPLs. Moreover, other bank specific factors, such as performance and efficiency indicators, were found to possess extra explanatory power if they are added to the baseline model. Another finding is that non-performing mortgages are less sensitive to the macroeconomic conditions than other types of loans, which is consistent with Espinosa and Prasad (2010). Finally, the market power of each bank was found to exercise a significant effect only in the case of non-performing business loans.

Klein (2013) investigated both the macroeconomic and the financial factors that affect NPLs in Central, Eastern and South Eastern Europe (CESEE) for the period 1998–2011. Although the level of non-performing loans can be ascribed to both bank-specific variables and macroeconomic conditions, banking factors were found to have a relatively low explanatory power. Beyond the typical analysis of the factors affecting NPLs, Klein (2013) goes a step further and examines the feedback effects of NPLs on the above factors. The examination of the feedback effects broadly substantiates the strong macro-financial linkages in the CESEE. While NPLs were found to have a significant response to macroeconomic conditions, his analysis also demonstrated that there exist strong feedback effects from the banking system to the real economy.

A sample of 85 banks from the Greek, Italian and Spanish banking systems for the period 2004-2008 was used by Messai (2013) in her study of NPLs. The reason why she chose these countries is not accidental, since these particular countries had higher NPLs deteriorating impressively in the post-crisis period. NPLs are explained by three macroeconomic variables and three bank-specific variables involving the profitability of assets, the reserves for the loan losses and the change of the loans granted. She found a significant positive relationship of the unemployment rate with the ratio of NPLs and explained that a rise in unemployment restricts both the actual and the imminent purchasing power of households and it is generally found to be interrelated with a decline in output production. Moreover, unemployment affects households' cash flows in a detrimental way and as a result it further intensifies the debt burden. Also, banks' provisions are increasing with NPLs.

For corporations an increase in unemployment means lower output as a result of the reduction in the effective demand. Potentially, this situation may lead to a decrease in revenue and to debt becoming unsustainable. The study by Messai (2013) obtains outcomes akin to the ones which were obtained by Louzis et al. (2010). In addition, she stresses that banks should take into consideration the international competitiveness of the domestic economy as Kauko (2012) has also suggested. An inferior level of competitiveness could impact on the capacity of borrowers from several sectors to amortize their debt. In such circumstances banks should be aware of the real economy's profitability when extending loans. Throughout a financial crisis impaired loans are expected to be of considerable importance. Consequently, supervisors should expand their scope of macroeconomic surveillance in order to encompass macro-prudential variables in order to maintain the stability and soundness of the banking system.

The role of regional economic factors in NPLs was examined by Ghosh (2015). He employed both regional economic determinants and state-level banking variables for exploring the determinants of all commercial banks and all saving institutions NPLs across 50 US states and Washington DC for the period 1984–2013. Regional economic factors play a crucial role in the creation of NPLs as many states with large downturns in house prices had also experienced falls in personal income and in state GDP and relatively large rises in unemployment. Therefore, it becomes highly interesting and illuminating to examine the extent to which NPLs are related to the alterations in the state-level economic conditions. The bank-specific variables used were credit growth,

bank capitalization, loan loss provisions, bank diversification, bank profitability, operating efficiency and size. Moreover, the regional economic determinants employed were the inflation rate, economic activity, the state house price index and the state home ownership ratios. National economic determinants, such as the real interest rate and the state of federal public finances, were also examined. Using both fixed effects and dynamic-GMM estimations he found that the variables that cause an increase in the NPL ratio are the poor credit quality, liquidity risk, bank inefficiency, capitalization needs and banking industry size. Other factors that significantly increase NPLs are the unemployment rates of each state, inflation, and US public debt. On the other hand, a decrease in NPLs is caused by higher real state GDP, an increase in the state housing price index and higher real personal income growth rates.

The issue of the interaction between NPLs and the business cycle was addressed by Ozili (2015). Furthermore, he investigated whether banks anticipate NPLs through making adjustments to their balance sheets. His dataset consists of 82 banks from Europe, US, Africa and Asia with annual bank data for the period 2004-2013. His results demonstrated that banks adjust both the level of loan loss reserves and the rate of loan growth in order to reduce the size of NPLs, while loan diversification is not effective. Adding lagged GDP growth improved the explanatory power of the model and supported the procyclical behavior of NPLs providing further evidence for the existence of macro-financial inter-linkages and cyclical interactions between the state of the economy and NPLs.

In some recent studies of 2016 new themes and new variables related to NPLs are explored. Anastasiou et al. (2016) examine the determinants of NPLs using a sample of European banks in the period 1990-2015. GMM estimators showed that taxes as well as the output gap are two new variables which together with the usual bank- and country-specific characteristics are found to significantly affect NPLs and should be taken into account when formulating macro-prudential policies. Vithessonthi (2016) studied the association between NPLs and bank credit growth for Japan, a country suffering from deflationary pressures in the period 1993-2013. He employed both OLS and two-step GMM to find a positive relationship between NPLs and bank credit growth before the 2007 economic crisis and a negative link afterwards. Another interesting finding is that a rise of credit growth does not induce higher bank profitability. Finally, Zhang et al.

(2016) using a sample of Chinese commercial banks found evidence of moral hazard and cyclical instability that fed into NPLs.

2.4 The role of financial fragmentation

Financial fragmentation or heterogeneities due to country of origin (rather than underlying fundamentals) have been explored in the literature mainly post crisis. There are a few recent studies examining the degree and the effects of fragmentation in different euro-area markets. The macroeconomic effects of fragmented credit supply growth were examined by Bijsterbosch and Falagiarda (2015). They observed a strong rise in cross-country heterogeneity associated with the debt crisis and the weak balance sheets of euro-area periphery banks.

Zaghini (2016) assessed the degree of heterogeneity in euro-area corporate bond markets and the risk premium paid on bonds at origination. He found that although fragmentation showed signs of receding after 2013, it remains high. Similar conclusions were reached by Horny et al. (2016) after decomposing the spreads between German, French, Italian and Spanish corporate bonds post 2010. Ehrmann and Fratzscher (2017) found that while euro-area government bond markets were well integrated before the crisis, they saw a substantial fragmentation after 2010 due to flight to quality. Mayordomo et al. (2015) measured fragmentation in the euro-area interbank market and found that high fragmentation in the periphery was due to counterparty risk, economic sentiment and high levels of debt to GDP.

Following on the one hand the recent literature on fragmentation and on the other the large differences of NPLs in euro-area countries, we believe it would be worthwhile to attempt an econometric estimation of the existence of fragmentation among euro-area banks with respect to their NPLs.

3. Data, variables and econometric models

3.1 Data and variables

The bank data used in this paper refer to the euro zone and are collected from the BankScope Database provided by DataStream Professional on a quarterly basis. The macroeconomic data are collected from sources such as the IMF and OECD. Although

some data is available earlier (from 1995) and later (until 2015), we had to adjust our sample to 2003Q1-2013Q3 because (a) of the nature of FMOLS estimation method and (b) the interest rate margin used was introduced to the ECB's Data Warehouse only in 2003.

Two separate groups of countries are used in order to distinguish for potential differences in the determinants of NPLs between euro-area core and periphery countries. Thus, Austria, Belgium, France, Germany, Finland, Lithuania, Luxemburg, Netherlands and Slovakia are classified as euro-area core, while Greece, Italy, Ireland, Portugal and Spain (GIIPS) are classified as euro-area periphery. The average NPL ratios in our two samples are 4.3% for core and 6.6% for periphery banks, low by recent standards since our data start from 2003 when NPLs were negligible. Still, it is noticeable that periphery banks have on average 50% more NPLs than core banks. The choice of countries and banks was strictly based on data availability for the time period and the variables required. A maximum number of 138 core banks and 88 periphery banks were used for the estimations.

The dependent variable is the ratio of non-performing loans to total loans, expressed in first differences since it was found to be non-stationary in levels (that is, it is unit root). As explanatory variables we employed both macroeconomic and bank-specific characteristics as suggested by the literature. The bank-specific variables used are the ratio of return on assets (ROA) and return on equity (ROE) as proxies for management quality, the ratio of loans to deposits (LTD) and bank size (SIZE). ROA reveals the managerial efficiency of a bank to convert its assets into net profits, while ROE reveals mostly how efficiently a bank has used its equity. Hence, we refer to them in table 1 as "quality of management" indicators and the anticipation is that good quality of management (high levels of ROA-ROE) will be related to low NPLs, that is, a negative sign is expected.

On the other hand, LTD is expected to be positively associated with NPLs, because a higher ratio of loans with respect to deposits means easier loan granting, a risk loving attitude and, therefore, a higher probability of developing NPLs. As bank size we took the logarithm of total assets. The sign of SIZE is ambiguous because a bank with more total assets may be either a risk lover or risk averse. A large sized bank may increase its financial leverage more easily and extend loans to riskier borrowers. It may also feel too big to fail, and thus take on extra risk safe in the knowledge that it has

only upside. Or it may be risk averse and exercise caution just because of its size which may be too big to save.

Concerning the macroeconomic variables, studies have shown a positive and significant relationship between NPLs and unemployment (UNEMP). The reason is that as unemployment increases, more people are unable to meet their debt obligations. Furthermore, the higher unemployment, the more likely that the discouraged worker effect applies with the unemployed moving out of the labour force. This further reduces their ability to service their debts. So, we expect a positive relation between NPLs and unemployment.

GROWTH which is the percentage growth rate of real GDP is anticipated to have a negative effect on NPLs. The output gap (OUTPUT_GAP) also traces the business cycle and was tried as a potential factor that affects NPLs. OUTPUT_GAP is defined as the difference between actual GDP and potential GDP and is obtained by applying a Hodrick-Prescott filter. A negative sign is expected, since if the country is in the expansionary phase of the business cycle, then fewer NPLs are expected.

Following Anastasiou et al. (2016) we also use tax on personal income as percentage of GDP (TAXINC). Higher income tax reduces disposable income and causes NPLs to rise. Euro-area countries in programmes (following the financial and sovereign debt crises) have resorted to tax increases in order to improve their public finances with possible detrimental effects on NPLs.

FISCAL stands for the government budget surplus as percentage of GDP. The relationship between NPLs and the government's fiscal position is ambiguous. On the one hand, a greater budget surplus could signal a restrictive fiscal position raising NPLs. On the other, a higher budget surplus could be associated with lower NPLs due to the reduced country risk, cheaper financing and the development of expectations that the fiscal position is sustainable.

The majority of studies which examine the determinants of NPLs employ different types of interest rates, such as real interest rates, lending rates, margins (i.e. lending rate minus deposit rate). In our study, we use a margin (MIR) derived from the MFI statistics[2]. More specifically, MIR is defined as the difference between interest rates on

[2] "*MFI interest rate statistics cover all interest rates of monetary financial institutions (MFIs) resident in the euro-area".*

consumer loans without guarantee or collateral requirements and consumer loans with collateral requirements or guarantee. This kind of difference (margin) includes information about the valuation of the credit risk of the most risky category of borrowers and can be assumed to represent the maximum risk for all others. As far as we know this is the first study that employs MIR as a potential factor that affects NPLs. An increase in MIR implies higher net costs for borrowers and is expected to be positively associated with NPLs; and also because such borrowers (paying a higher NIM) are by definition more risky. Inflation rate (INFLRAT) is used as proxied by the percentage change of the CPI. The association between NPLs and inflation is equivocal. Finally, one more macroeconomic variable, CREDIT/GDP which stands for credit to the private nonfinancial sector from domestic banks, is included. The sign of CREDIT/GDP could be positive or negative depending on banks' preferences. If more credit in the economy implies more risk loving behaviour, then higher NPLs may follow. But if it leads to more caution lower NPLs are expected.

In tables 1 and 2 we summarise the variables used in our econometric estimation and their expected signs.

*****Insert tables 1 and 2 here*****

3.2 Econometric models

Below we present the three alternative econometric specifications estimated:

$$\text{Model 1: } \left(\frac{NPLs_{it}}{Total\_Loans_{it}}\right) = \beta_0 + \gamma_i M_t + CRISIS\_DUMMY + e_{it}$$

$$\text{Model 2: } \left(\frac{NPLs_{it}}{Total\_Loans_{it}}\right) = \beta_0 + \delta_i B_{it} + CRISIS\_DUMMY + e_{it}$$

$$\text{Model 3: } \left(\frac{NPLs_{it}}{Total\_Loans_{it}}\right) = \beta_0 + \delta_i B_{it} + \gamma_i \mathrm{M}_t + CRISIS\_DUMMY + e_{it} \ ,$$

where B is a vector of bank-specific variables, M a vector of macroeconomic factors, and i and t represent euro-area (periphery and core) banks and time (quarters)

Source: https://www.ecb.europa.eu/stats/money/interest/interest/html/index.en.html

respectively. Moreover, the variable CRISIS_DUMMY is a time dummy which is specified as follows:

$$\text{CRISIS\_DUMMY} = \begin{cases} 0, if\ time \leq 2007Q4 \\ 1, if\ time \geq 2008Q1 \end{cases}$$

The reason why we employ the CRISIS_DUMMY is because we are interested in examining if the 2008 financial crisis in Europe caused a systemic break in the formation of NPLs.

Correlation matrices for the variables of each model can be found in tables 3a, 3b and 3c.

*****Insert tables 3a, 3b and 3c here*****

4. Econometric methodology

As a first step, we examined our variables for unit roots employing the Augmented Dickey-Fuller (ADF) Fisher type test. The null hypothesis is that the panel contains a unit root. Table 4 a details those variables with a unit root.

*****Insert table 4 here*****

In table 5 we can see the results of the Kao panel cointegration test; the null hypothesis is no cointegration. For the whole euro area, the periphery and the core countries we found a clear rejection of the null hypothesis, meaning that there is cointegration.

*****Insert table 5 here*****

In this study, we employed the Fully Modified OLS (FMOLS) method (a non-parametric approach) in order to obtain the long-run coefficients and their signs. Dynamic OLS (DOLS) is an alternative (parametric) approach in which lags and leads are introduced to cope with the problem irrespectively of the order of integration and the existence or absence of cointegration. DOLS was also employed but did not provide significant estimates. Hence, we provide only the FMOLS results.

4.1 Fully modified OLS (FMOLS) methodology

We follow the FMOLS method appropriate for heterogeneous cointegrated panels which, as Pedroni (2000) noted, are associated with the fact that a standard panel OLS estimator is asymptotically biased and its distribution is dependent on nuisance parameters associated with the dynamic underlying processes of variables. To eliminate the problem of bias, Pedroni (2000) developed the group-means FMOLS estimator, by incorporating the Phillips and Hansen (1990) semi-parametric correction into the OLS estimator. The technique also accounts fully for heterogeneity in short-run dynamics as well as for fixed effects. Consider the following cointegrated system for a simple two variable panel of $i = 1,.....N$ members,

$$y_{it} = a_{it} + \beta x_{it} + u_{it} \qquad (1)$$

The FMOLS estimator is:

$$\hat{\beta}_{i,FMOLS} = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \left(x_{it} - \bar{x}_i \right)^2 \right)^{-1} \left(\sum_{t=1}^{T} \left(x_{it} - \bar{x}_i \right) y_{it}^{*} - T\hat{y}_i \right) (2)$$

where $y_{it}^{*} = (x_{it} - \bar{x}_i) - \dfrac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}} \Delta x_{it}$ (3)

$$\hat{\gamma}_{it} = \hat{\Gamma}_{21i} - \hat{\Omega}_{21i}^{0} - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}} \left(\hat{\Gamma}_{22i} - \hat{\Omega}_{22i}^{0} \right) \qquad (4)$$

$\hat{\Omega}$ and $\hat{\Gamma}$ are covariances and sums of autocovariances obtained from the long-run covariance matrix for model (1). After the implementation of the FMOLS method, we employ an alternative econometric methodology as a robustness test for our results. It is a panel cointegrated VAR, the theoretical specification of which is provided in section 4.2.

4.2 Panel Cointegrated Vector Autoregression methodology

Suppose y_t is a $n \times 1$ vector time series which is represented by a cointegrated VAR with r stationary long run relationships:

$$\Delta y_t = \sum_{l=1}^{L} \Gamma_l \Delta y_{t-l} + \Pi y_{t-1} + \Phi d_t + \varepsilon_t, \qquad (1)$$

where the errors $\varepsilon_t \sim iid\ N_n\ (0,\Sigma)$, $\Pi = \alpha\beta'$, α, β are $n \times r$ matrices, Γ_l are $n \times n$ ($l = 1,...,L$), Φ is $n \times d$ and d_t is $m \times 1$ vector containing the constant terms, dummy variables or other deterministic variables. The model can be written more compactly as follows:

$$Y_t = \Gamma X_{2t} + \alpha\beta' X_{1t} + \Phi d_t + \varepsilon_t, \tag{2}$$

where $\Gamma = [\Gamma_1,...,\Gamma_k]$, $Y_t = \Delta x_t$, $X_{1t} = y_{t-1}$, $X_{2t} = [\Delta y_{t-1},...,\Delta y_{t-k}]'$. Alternatively, we have:

$$Y = \Gamma X_2 + \alpha\beta' X_1 + \Phi d + \varepsilon, \tag{3}$$

after collecting all observations. For the error terms, we assume

$$\mathrm{E}\left(\varepsilon_{\mathrm{i,t}}\varepsilon'_{\mathrm{j,s}}\right) = \Sigma_{\mathrm{ij}}, \text{for t = s and zero otherwise} \tag{4}$$

So, there is full cross-sectional correlation but there is no autocorrelation.

We can define $y = (y'_1,..., y'_N)'$ and $b = (b'_1,...,b'_N)'$ and define a matrix x whose diagonal is $(x_1,...,x_N)$. Then, the entire system is $y = xb + e$ and we can write the likelihood function as

$$\begin{aligned} L(b,\Sigma,\beta) &= |\Sigma|^{-T/2} \exp\left\{-\tfrac{1}{2}(y - xb)'V_e^{-1}(y - xb)\right\} \\ &= \Sigma|^{-T/2} \exp\left\{-\tfrac{1}{2}\left[s^2 + (b - \hat{b})'V^{-1}(b - \hat{b})\right]\right\}, \end{aligned} \tag{5}$$

where $s^2 = y'My$, $M = V_e^{-1} - V_e^{-1}xVx'V_e^{-1}$, $\hat{b} = Vx'V_e^{-1}y$, $V = (x'V_e^{-1}x)^{-1}$ with

$$.V_e = \Sigma \otimes I_T$$

With a flat or normal prior on b the conditional (on Σ and β) posterior of b will also be normal.

In terms of the prior, it is well known that the so-called linear normalization $\beta = [I_r \vdots B']'$ does not solve the local and global identification problems of the vector error correction model (VECM). Several papers, including Strachan (2003), Strachan and Inder (2004) and Villani (2005, 2006) propose various approaches and Koop, Leon-Gonzalez and Strachan (2009) extend the general framework outlined in Strachan (2003) and Strachan and Inder (2004) to the panel cointegration model.

Strachan and Inder (2004) propose to set $\beta'\beta = I_r$ which identifies the cointegrating vectors without placing any restrictions on the cointegrating space. In the VECM only the space spanned by the columns of β is identified, such that we only have information on $P = span(\beta)$ which is an element of the Grassmann manifold $G_{n,r}$, i.e. the space of all r-dimensional planes of R^n. A Uniform prior for the cointegration space is therefore given by the Uniform distribution on $G_{n,r}$. Therefore, a proper prior that we can use is the so-called 'semi-orthogonal prior' of the form:

$$p(b,\Sigma,b_\beta) \propto |\Sigma|^{-(Nn+1)/2}, \beta'_i\beta_i = 1. \quad (6)$$

Koop, Leon-Gonzalez and Strachan (2009) discuss also another prior which imposes soft homogeneity (similarity) constraints on the elements of the cointegrating vectors across units:

$$b \sim N(0, h^{-1}\underline{V}) \quad (7)$$

where h is a scalar which controls the degrees of informativeness or precision of the prior. To specify the elements of $\underline{V}$ we proceed as in Koop, Leon-Gonzalez and Strachan (2009).

4.3 Testing for banking markets fragmentation

After estimating our models both with FMOLS and Panel Cointegrated VAR, we tested for possible existence of fragmentation between core and periphery banking markets. In particular, we test the following restrictions:

$$Ho: \beta^{core} = \beta^{periphery}$$

$$Ha: \beta^{core} \neq \beta^{periphery}$$

Rejecting the null hypothesis implies that the responses of the core are not equal to those of the periphery and hence we have an indication of fragmented NPL behaviour in banking markets.

Given estimates b_1 and b_2 with covariance matrices V_1 and V_2 respectively, the statistic that we employed in order to test the fragmentation hypothesis is the following:

$$c^2 = (b_1 - b_2)'(V_1 + V_2)^{-1}(b_1 - b_2),$$

which asymptotically follows a chi-square distribution with degrees of freedom equal to the dimensionality of b_1 and b_2

5. Estimation results

5.1 Estimation results after the FMOLS estimation

In table 6 we report the estimated long-run coefficients and their corresponding t-statistics with the FMOLS methodology. We perform three separate estimations: for all euro-area banks, the core banks and the periphery banks. For each group we run three models (see section 3.2). In model 1 we employ only country-specific variables, in model 2 only bank-specific variables, while model 3 includes both bank-specific and macroeconomic factors as potential variables explaining the behavior of NPLs. The vast majority of the estimated long-run coefficients have signs compatible with the theoretical background of the literature.

*****Insert table 6 here*****

Regarding the whole euro-area, the macroeconomic variables which are found to exert a significant influence on NPLs are the unemployment rate, GDP growth rate, output gap, tax on personal income and credit to GDP. MIR, a variable new to the literature, is found to be positive as expected and significant only in model 1. With respect to the bank-specific variables, only ROA is found to be negative and statistically significant at the 0.01 level consistent with the bad management hypothesis. It is also obvious that the crisis has caused a structural break to NPLs by shifting them upwards.

Pursuant to the determinants of NPLs for core and periphery banks, they were found to be quite different in all three models, which is consistent with the suggested fragmentation of financial markets. The estimated parameters for core countries are relatively smaller than the corresponding coefficients for the periphery, implying that the NPLs of the periphery react more strongly to the determinants examined than the NPLs of the core. So, our results support the existence of fragmentation. In order to make the comparison more interesting, we can juxtapose the coefficients of the unemployment rate and tax on personal income. Their estimated coefficients in the

periphery are much higher than the corresponding coefficients in core countries, implying that an increase in unemployment or in tax will lead to a higher increase of NPLs in the periphery than in the core.

So, the existence of fragmentation between the two financial markets of core and periphery can first be seen from the difference in the sizes of the estimated coefficients, while signs are mostly in the same direction. In a more formal way we also use the Chi-square test presented in section 4.3. Following the test we found a p-value equal to 0.000 rejecting the null hypothesis of equal coefficients between core and periphery NPL determinants, thus providing extra evidence in favor of banking fragmentation.

Another interesting finding that has to be mentioned between core and periphery regarding the macroeconomic variables is that MIR is found to be quite important only for the periphery banking system, and not for the core. On the contrary, CREDIT is found to negatively affect NPLs only for core banks, while it did not affect NPLs of banks in the periphery.

ROA and ROE have the expected negative sign, while only ROA is significant at the 0.01 level. The negative ROA sign supports the bad management hypothesis in the creation of NPLs and is of similar size for both core and periphery. Loans to deposits (LTD) are found to have a positive and significant sign in model 2 for both core and periphery NPLs meaning that as loans to deposits increase more NPLs should be expected. This finding is in support of the moral hazard hypothesis. SIZE is found to be negative and significant for periphery NPLs meaning that larger banks are more cautious and (apparently) have not taken advantage of their too big to fail presence. It seems that smaller banks suffer from higher NPLs, which provides some support to the banking consolidation that has taken place especially in periphery countries in the context of resolution. The resulting fewer and larger banks are expected to be more cautious than their smaller competitors. But this negative effect of size in the periphery may also be partly due to the fact that some banks became bigger post crisis by absorbing the good parts of resolved smaller banks.

Finally, the CRISIS_DUMMY is positive and significant in all models and country groups showing a clear shift in NPLs starting in 2008. It is noticed though that its coefficient in the euro-area periphery is almost three times larger (model 3) than the corresponding coefficient in core countries, implying that the 2008 financial crisis

caused the NPLs of euro-area periphery banks to rise much more than those of the core banks. This finding underlines how much more vulnerable periphery banks have become because of the crisis. One reason behind this difference may be the existence of inflexible and antiquated judicial systems which encourage strategic defaulters.

5.2 Estimation results after the panel Cointegrated VAR estimation

Using the priors stated in the previous section, in our computations we implement the Gibbs sampler using 15,000 passes the first 5,000 of which are discarded to mitigate possible start up effects. Ten chains starting from different initial conditions are used to ensure that the Gibbs sampler has converged to the same results.

*****Insert table 7 here*****

The results from the panel Cointegrated VAR estimations are shown in table 8.

*****Insert table 8 here*****

The estimated coefficients support a similar story with those of the FMOLS estimation. Most coefficients are found to have signs and significance compatible to the theory and our expectations as analyzed in section 3.1. The negative sign of GDP growth and the output gap is confirmed together with the positive effect of unemployment and the interest rate margin. It is worth noticing again the positive effect of taxes on NPLs which provides some extra argument against austerity programs applied in the periphery post crisis. Such effects increase NPLs which in turn will create a negative (second round) effect on the economy.

With respect to the bank-specific variables, their effects are significant in all three areas. The bad management hypothesis is supported by the negative ROA and ROE effects while the moral hazard hypothesis is consistent with the positive sign of the loan-to-deposit ratios. Size has a significant negative role but much larger in the periphery hinting at possible beneficial size effects through the absorption by systemic banks of the good part of resolved, non-systemic banks. Greece is an obvious example in this respect. Moreover, performing the chi-square test presented in section 4.3, a p-value equal to 0.0001 was found which rejects the null hypothesis of equal coefficients and thus provides extra support to the existence of fragmentation between core and periphery banking markets.

5.3 Generalized impulse response functions

In contrast to Impulse Response Functions (IRFs hereafter), with Generalized Impulse Response Functions (GIRFs hereafter) we do not need to detect any structural shocks. We can argue that GIRFs constitute an important means through which we can describe the dynamics of a model and proceed to a detailed presentation of the reaction of the variable of our interest. After the estimation of the Panel Cointegrated VAR we estimated the GIRFs for the whole euro-area sample[3]. They are shown in figures 1-10. The red bands define the 95% confidence interval. GIRFs show how NPLs respond to one-unit shock to each (macroeconomic or bank-specific) variable.

*****Insert figures 1-10 here*****

More specifically, the overall response of NPLs is clearly positive, after an increase in LTD, TAXINC, MIR and UNEMP. Starting from zero, there is an increase until period 2 (i.e. until the second quarter) - apart from UNEMP, whose effects peaks in the first quarter - and thereafter declines before finally dying out.

The response of NPLs to an increase in SIZE, CREDIT/GDP, FISCAL and GROWTH is negative. The response of NPLs occurs only in the first quarter (for all variables' impulses) but these responses are not significant. For these variables, the responses become significant after the second or the third quarter and remain significant until the tenth quarter when the response dies out. It has to be mentioned that CREDIT/GDP has an ambiguous sign and while FMOLS estimated a negative effect, panel cointegrated VAR estimated a positive one. It can be argued from the GIRF plot in Fig 4 that the FMOLS estimation is supported.

After an increase in ROA, NPLs respond negatively only over the very short-term;, they then cross the zero line to become positive in the fifth quarter. The response of NPLs to shocks in the OUTPUT_GAP is not consistent with that presented in the long run relationship, since we have a positive response of NPLs after an increase of OUTPUT_GAP and thus the GIRF does not support the previous results. NPLs in this GIRF reach a maximum about one quarter after the initial OUTPUT_GAP shock and they return to their previous value about seven quarters later.

[3] For space conservation reasons, we do not report the corresponding GIRFs for core and periphery. However, they can be provided upon request.

6. Conclusions

NPLs are an acute problem of euro-area banks and, more specifically, of banks located in the euro-area periphery. Although the already existing literature has examined the factors that affect NPLs from different viewpoints, our analysis is the first to examine if there is a long run effect caused by both macroeconomic and bank-specific determinants using Fully Modified OLS and Panel Cointegrated VAR. A further novelty has to do with the banking market fragmentation question and the separate estimation of euro-area core and periphery NPLs which revealed fragmented banking markets. And a final novelty has to do with the use of two new variables: one measuring the margin between interest rates for collateral backed and non-backed loans as a proxy for the cost of borrowing adjusted for risk; and one measuring the ratio of taxes to GDP. Both were found to affect significantly NPLs with a higher response in the periphery.

Two separate samples of core and periphery euro-area banks (138 core banks and 88 periphery banks) were used for the estimations for the period 2003Q1-2013Q3 (after adjustment). On top of investigating which of the determinants advanced in the relevant literature play a significant role, we wanted to test for differences between the two groups. Financial fragmentation arguments have been discussed recently in the euro area, especially after the outbreak of the sovereign debt crisis. Using FMOLS we found that NPLs in the euro area have followed an upward (much higher for the periphery) shift after 2008 and are mostly due to worsening macroeconomic conditions especially with respect to unemployment, growth and taxes. Fiscal consolidation and interest rate margins are significant for the periphery while credit to GDP is significant only for the core. Quality of management (through ROA and ROE) and moral hazard (through the loan to deposits effect) play an important role, while size is negatively significant and exerting a stronger effect in the periphery.

A chi-square test comparing the estimated coefficients for the core and periphery NPLs rejects the hypothesis of equal coefficients revealing another aspect of banking fragmentation in the euro area. Most of these findings were confirmed by the panel Cointegrated VAR results, which also rejected equality of coefficients between core and periphery and advocated for the existence of fragmentation in banking markets.

Such findings could guide the adoption of appropriate macro-prudential as well as NPL resolution policies much needed in order to invigorate banks and boost growth especially in the much affected and still suffering euro area periphery.

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Tables and Figures

Table 1: Definition and expected sign of Bank-specific variables

Variable	Definition	Hypothesis tested[4]	Expected sign
ROA (Return on Assets)	$ROA_{it} = \frac{\text{Net profits}_{it}}{\text{Total Assets}_{it}}$	"Quality of management"	(-)
ROE (Return on Equity)	$ROE_{it} = \frac{\text{Net profits}_{it}}{\text{Total Equity}_{it}}$	"Quality of management"	(-)
LTD (Loans to Deposits Ratio)	$LTD_{it} = \frac{\text{Total Loans}_{it}}{\text{Total Deposits}_{it}}$	"Moral Hazard"	(+)
SIZE	$SIZE_{it} = \ln(\text{Total Assets})$	"Cautious/Too Big To Fail"	(-)/(+)

[4] In accordance with the paper of Berger and DeYoung (1997) and Louzis et al. (2010)

Table 2: Definition and expected sign of Macroeconomic variables

Variable	Definition	Expected sign
UNEMP	Unemployment rate	(+)
TAXINC	Tax on personal Income	(+)
GROWTH	Economic growth	(-)
FISCAL	Government budget deficit/surplus	(+)/(-)
INFLRAT	Inflation rate	(+)/(-)
OUTPUT_GAP	Output gap	(-)
MIR	Interest rate margin	(+)
CREDIT_GDP	Credit to private non-financial sector as % of GDP	(+)/(-)

Table 3a: Correlation matrix for model 1

	UNEMP	INFLRAT	FISCAL	GROWTH	TAXINC	OUTPUT_ GAP	MIR	CREDIT _GDP
UNEMP	1.000000	-	-	-	-	-	-	-
INFLRAT	-0.179099	1.000000	-	-	-	-	-	-
FISCAL	0.063468	-0.026859	1.000000	-	-	-	-	-
GROWTH	-0.245335	0.155568	0.021068	1.000000	-	-	-	-
TAXINC	-0.362563	-0.178185	0.109601	-0.057156	1.000000	-	-	-
OUTPUT_GAP	-0.239430	0.403103	0.016665	0.152825	-0.035829	1.000000	-	-
MIR	-0.217485	0.200096	-0.161799	-0.126844	-0.380134	0.494501	1.000000	-
CREDIT_GDP	0.563222	-0.050301	0.142957	-0.166510	-0.399328	0.032068	-0.032192	1.00000

Source: DataStream, IMF, own estimations.

Table 3b: Correlation matrix for model 2

	ROA	ROE	LTD	SIZE
ROA	1.000000	-	-	-
ROE	0.419432	1.000000	-	-
LTD	0.114909	-0.007917	1.000000	-
SIZE	-0.048114	-0.033571	-0.036723	1.000000

Source: DataStream, IMF, own estimations.

Table 3c: Correlation matrix for model 3

	UNEMP	INFLRAT	FISCAL	GROWTH	TAXINC	OUTPUT_GAP	MIR	ROA	ROE	LTD	CREDIT_GDP
UNEMP	1.00000										
INFLRAT	-0.12343	1.00000									
FISCAL	-0.09992	-0.06042	1.00000								
GROWTH	-0.24070	0.09904	0.06496	1.00000							
TAXINC	-0.32970	-0.22398	0.21319	-0.05504	1.00000						
OUTPUT_GAP	-0.21778	0.32903	0.02584	0.11870	-0.04794	1.00000					
MIR	-0.21740	0.18766	-0.20357	-0.10419	-0.33005	0.39108	1.00000				
ROA	-0.41772	0.03385	0.04058	0.30302	0.11138	0.09868	-0.03780	1.0000			
ROE	-0.23576	0.01952	0.06409	0.17827	0.09241	0.03138	-0.09603	0.4840	1.00000		
LTD	-0.14543	-0.02626	0.11276	-0.02561	0.30082	0.07836	-0.08690	0.0906	-0.00735	1.00000	
CREDIT_GDP	0.32665	-0.19662	0.22155	-0.07573	-0.13591	0.06807	-0.19137	-0.0666	-0.01661	-0.02685	1.00000

Source: DataStream, IMF, own estimations.

Table 4: Panel unit roots test (at level)

Variables	Fisher Type-ADF (p-values)	ADF - Fisher Chi-square
NPL	1.0000	94.0645
ROE	0.0003	248.714
ROA	0.0053	227.619
UNEMP	0.9999	85.7383
TAXINC	0.9999	114.557
GROWTH	0.0000	831.627
INFLRAT	0.0000	627.336
MIR	0.0103	222.288
SIZE	0.0000	417.666
CREDIT_GDP	1.0000	33.8316
FISCAL	0.0000	313.226
LTD	0.6898	166.227
OUTPUT_GAP	0.0000	986.369

Notes: NPL, ROE, ROA, UNEMP, TAXINC, GROWTH, INFLRAT, DEBT, FISCAL, LTD, OUTPUT_GAP, CREDIT_GDP, MIR, denote the non-performing loans ratio, return on equity, return on assets, unemployment, income tax, growth, inflation rate, government budget deficit or surplus as % of GDP, loans to deposits ratio, output gap, credit to private non-financial sector as % of GDP and interest rate margin respectively. For this test the null hypothesis of unit root is tested against the alternative of stationarity.
Source: DataStream, IMF, OECD, own estimations

Table 5: Panel Cointegration test

Kao panel Cointegration test		
	t-Statistic	**p-Value**
Euro-area countries-Whole Sample	-2.8348	0.0023
Euro-area periphery countries	-1.9225	0.0273
Euro-area core countries	-1.8832	0.0298

Notes: Null Hypothesis: No cointegration

Table 6: FMOLS estimation results, 2003Q1-2013Q3 (after adjustment)

	Euro area			Periphery			Core		
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
$\Delta(UNEMP)_t$	0.283*** (6.814)	-	0.243*** (5.770)	0.301*** (5.489)	-	0.278*** (4.926)	0.262*** (6.528)	-	0.239*** (5.838)
$INFL\_RATE_t$	0.099 (1.293)	-	0.057 (0.728)	0.150 (1.399)	-	0.099 (0.907)	0.033 (0.423)	-	0.015 (0.194)
$FISCAL_t$	0.018* (1.956)	-	0.018* (1.902)	0.032* (2.097)	-	0.033** (2.083)	0.019 (1.620)	-	0.017 (1.406)
$GROWTH_t$	-0.121*** (4.218)	-	-0.086*** (2.701)	-0.100** (2.516)	-	-0.092** (2.183)	-0.101*** (3.399)	-	-0.082** (2.618)
$\Delta(TAXINC)_t$	2.004*** (13.422)	-	1.992*** (12.315)	2.577*** (13.996)	-	2.758*** (13.259)	1.887*** (13.296)	-	1.897*** (12.173)
$OUTPUT\_GAP_t$	-0.016*** (2.614)	-	-0.012* (1.763)	0.003 (0.317)	-	0.012 (1.041)	-0.008 (1.158)	-	-0.005 (0.729)
MIR_t	0.026** (1.963)	-	0.014 (0.483)	0.205*** (3.606)	-	0.201*** (3.409)	-0.051 (1.319)	-	-0.041 (1.043)
$\Delta(CREDIT)_t$	-0.053*** (2.874)	-	-0.041** (2.181)	-0.025 (1.064)	-	-0.018 (0.726)	-0.054*** (2.943)	-	-0.045** (2.372)
ROA_{it}	-	-0.103*** (4.598)	-0.061*** (3.063)	-	-0.092*** (4.000)	-0.008 (0.747)	-	-0.095*** (3.761)	-0.034 (1.474)
ROE_{it}	-	-0.0002 (1.368)	-4.02E-05 (0.228)	-	-0.0002* (1.722)	-0.0001 (0.523)	-	-0.0002 (1.457)	-7.84E-05 (0.414)
$\Delta(LTD)_{it}$	-	-0.016 (0.616)	0.140 (1.438)	-	0.204*** (9.103)	-0.190 (1.486)	-	0.207*** (8.070)	-0.167 (1.771)
$SIZE_{it}$	-	0.004 (1.692)	0.006 (0.761)	-	-0.024 (0.456)	-0.398** (2.135)	-	0.006 (0.117)	-0.046 (0.358)
CRISIS_DUMMY	0.177*** (2.761)	0.330*** (5.291)	0.124* (1.689)	0.342*** (3.415)	0.550*** (6.443)	0.5321*** (4.007)	0.170*** (2.400)	0.373*** (4.633)	0.169 (1.863)
Diagnostics									
Adjusted R-squared	0.139	0.025	0.133	0.175	0.0315	0.169	0.136	0.026	0.124
Number of Observations	2388	4191	2287	1531	2906	1463	2388	4191	2287

Notes: The number of stars (*) denote significance level: *** p-value<0.01, ** p-value<0.05 and * p-value<0.1. In parentheses, we have t-statistics. FMOLS includes 2 (quarter) lags for the euro area as a whole, core and periphery.
Source: DataStream, IMF, OECD, own estimations.

Table 7: Bayes factors for cointegrating relationships

Euro-area Countries						
r →	0	1	2	3	4	5
Model 1	1.00	***17.42***	4.13	1.15	0.12	0.004
Model 2	1.00	***21.34***	7.52	3.24	1.16	0.15
Model 3	1.00	***28.51***	9.13	4.15	2.74	0.022
Periphery Countries						
r →	0	1	2	3	4	5
Model 1	1.00	***32.50***	10.32	4.33	0.23	0.056
Model 2	1.00	***11.43***	7.12	2.15	1.10	0.87
Model 3	1.00	***55.12***	9.32	4.15	3.12	1.25
Core Countries						
r →	0	**1**	2	3	4	5
Model 1	1.00	**44.12**	11.35	2.17	1.15	0.044
Model 2	1.00	**37.21**	7.13	0.14	0.03	0.00
Model 3	1.00	**12.34**	6.15	2.13	0.07	0.02

Notes: r denotes the hypothetical number of cointegrating relationships.
Source: DataStream, IMF, OECD, own estimations.

Table 8: Long-run cointegrating relationships, 2003Q1-2013Q3

	Euro area			Periphery			Core		
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
$\Delta(UNEMP)_t$	0.171***	-	0.162***	0.203***	-	0.180***	0.144***	-	0.144**
	(0.044)		(0.005)	(0.035)		(0.004)	(0.012)		(0.032)
$INFL\_RATE_t$	0.012	-	0.011***	0.023***	-	0.023***	0.017***	-	0.021***
	(0.003)		(0.002)	(0.005)		(0.007)	(0.002)		(0.004)
$FISCAL_t$	-0.015**	-	-0.009***	-0.011*	-	-0.012***	-0.032**	-	-0.007***
	(0.007)		(0.002)	(0.006)		(0.004)	(0.012)		(0.001)
$GROWTH_t$	-0.015***	-	-0.013*	-0.017***	-	-0.021***	-0.022***	-	-0.025***
	(0.005)		(0.007)	(0.004)		(0.002)	(0.007)		(0.005)
$\Delta(TAXINC)_t$	0.014***	-	0.017***	0.021***	-	0.025***	0.021***	-	0.033***
	(0.003)		(0.003)	(0.002)		(0.002)	(0.007)		(0.002)
$OUTPUT\_GAP_t$	-0.015***	-	-0.018***	-0.021	-	-0.023***	-0.022***	-	-0.055***
	(0.002)		(0.003)	(0.030)		(0.001)	(0.007)		(0.012)
MIR_t	0.012	-	0.014***	0.014	-	0.024***	0.045**	-	0.018***
	(0.015)		(0.005)	(0.022)		(0.002)	(0.012)		(0.002)
$\Delta(CREDIT)_t$	0.017	-	0.009***	0.022*	-	0.021***	0.033	-	0.007***
	(0.013)		(0.001)	(0.012)		(0.003)	(0.070)		(0.002)
ROA_{it}	-	-0.013	-0.012***	-	-0.012	-0.017***	-	-0.055**	-0.0255***
		(0.042)	(0.004)		(0.004)	(0.003)		(0.012)	(0.003)
ROE_{it}	-	-0.004	-0.003***	-	-0.015	-0.013***	-	-0.012**	-0.005***
		(0.005)	(0.001)		(0.022)	(0.004)		(0.006)	(0.001)
$(LTD)_{it}$	-	0.122***	0.117***	-	0.117***	0.266***	-	0.203***	0.344**
		(0.005)	(0.003)		(0.004)	(0.011)		(0.023)	(0.017)
$SIZE_{it}$	-	-0.002**	-0.003***	-	-0.004***	-0.013***	-	-0.005**	-0.005***
		(0.001)	(0.001)		(0.001)	(0.004)		(0.002)	(0.001)
CRISIS_DUMMY	0.015	0.012	0.017***	0.032***	0.044***	0.077***	0.062***	0.045***	0.081***
	(0.016)	(0.013)	(0.005)	(0.012)	(0.011)	(0.004)	(0.003)	(0.006)	(0.005)
Bayes Factor	**1.00**	**3.12**	**17.43**	**1.00**	**0.65**	**45.32**	**1.00**	**7.70**	**32.26**

Notes: The results reported are posterior means under the assumption that there is a single cointegrating vector. Posterior standard deviations are reported in parentheses. The panel VAR includes 2 lags for the Euro-area as a whole, core and peripheral countries (that is 2 quarters lags). The number of lags was formally selected using the Bayes factor criterion.
Source: DataStream, IMF, OECD, own estimations

Figure 1: Generalized impulse response function of NPLs: Increase in ROA

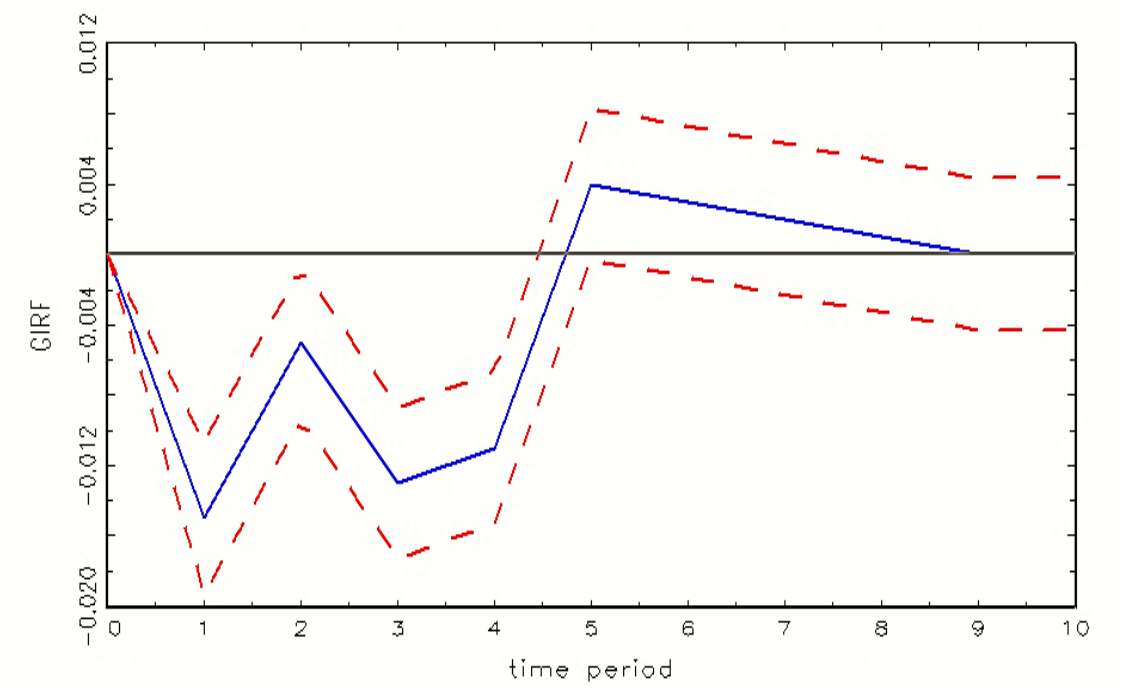


Figure 2: Generalized impulse response function of NPLs: Increase in LTD

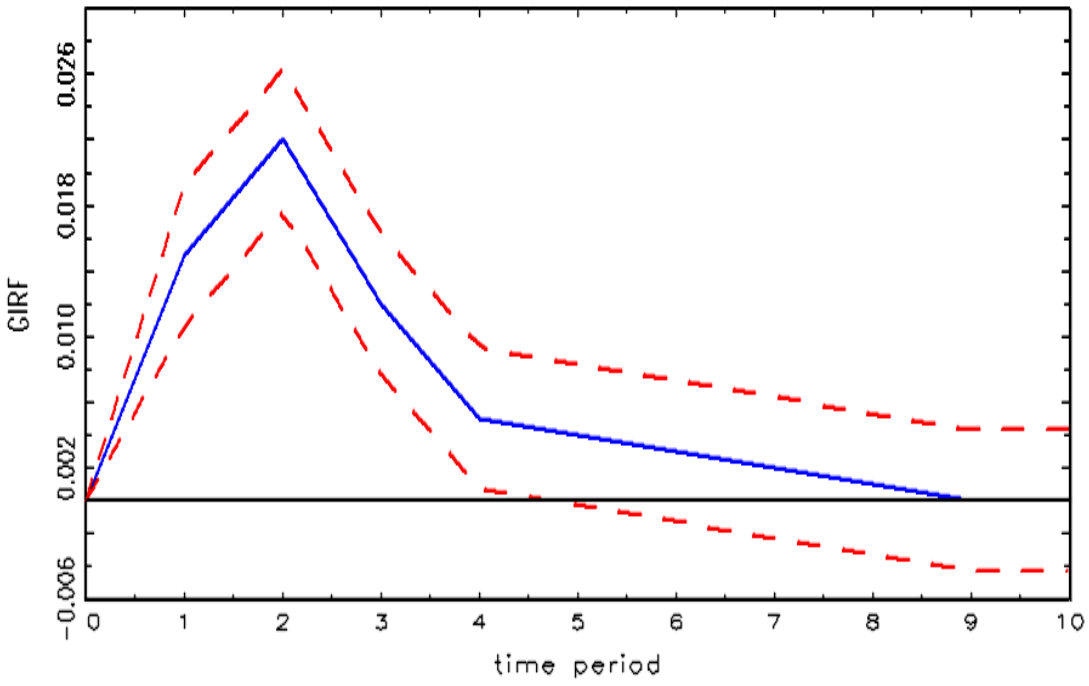


Figure 3: Generalized impulse response function of NPLs: Increase in SIZE

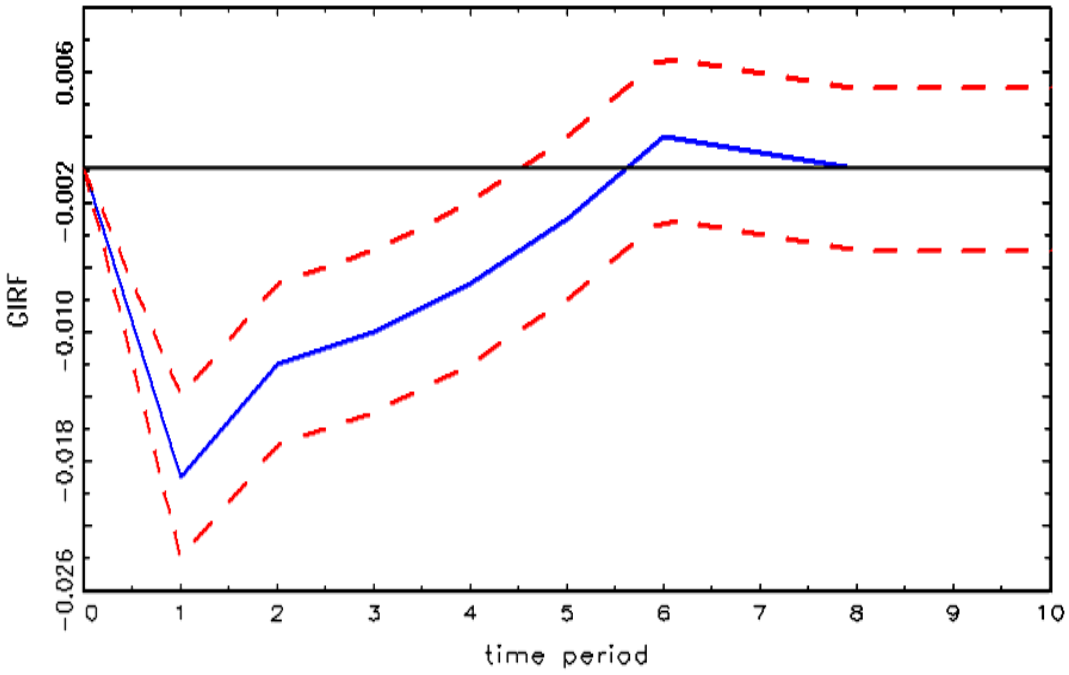


Figure 4: Generalized impulse response function of NPLs: Increase in CREDIT/GDP

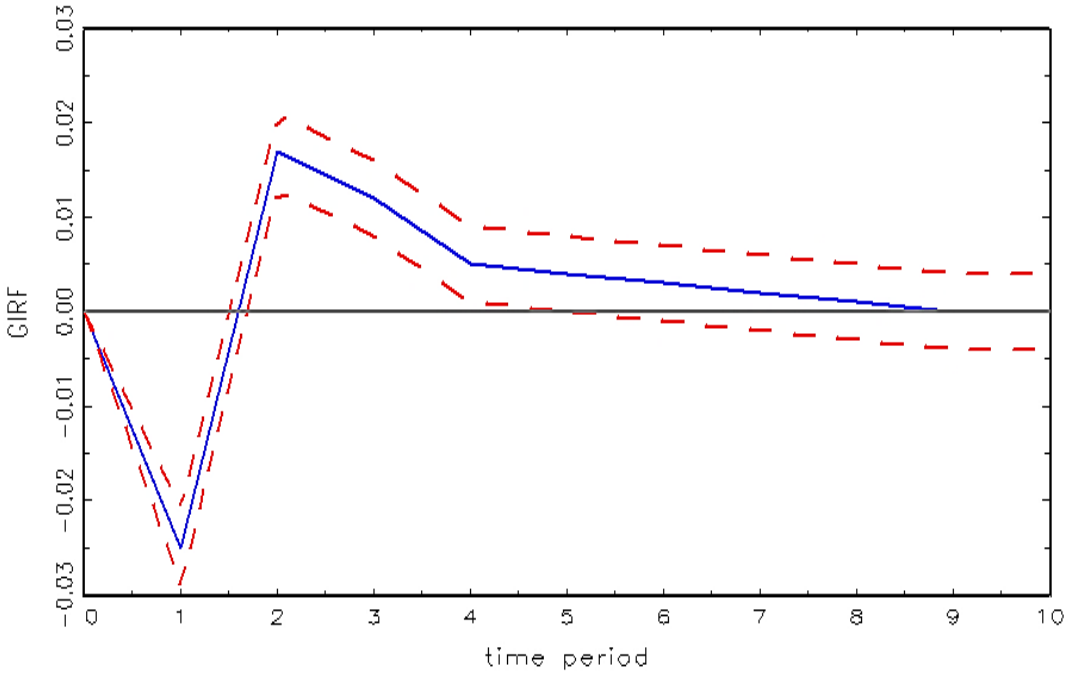


Figure 5: Generalized impulse response function of NPLs: Increase in FISCAL

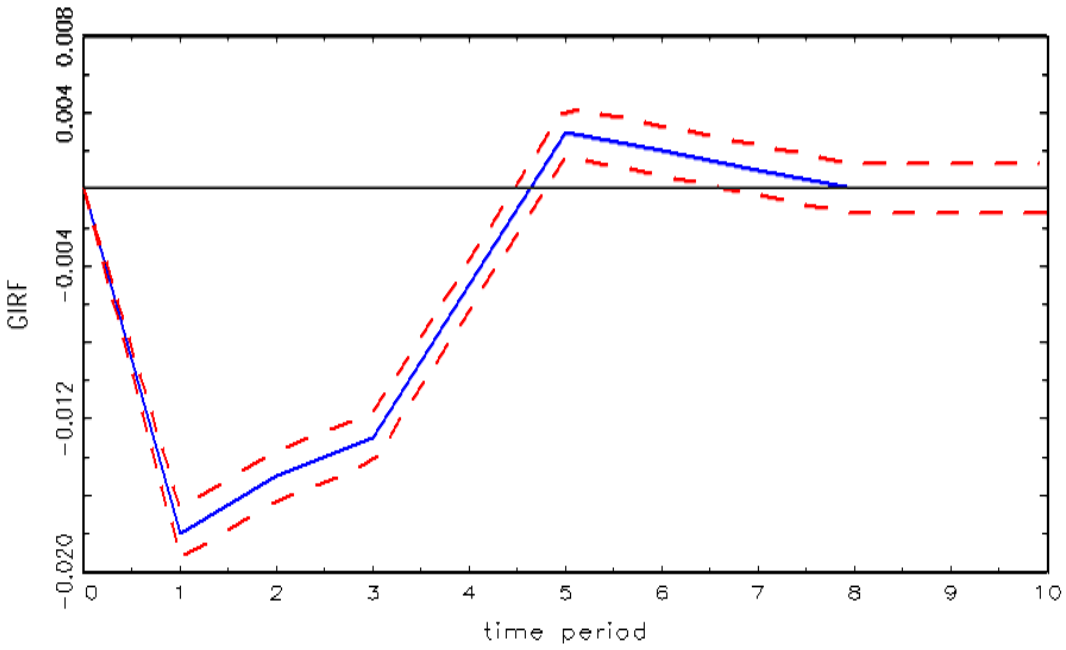


Figure 6: Generalized impulse response function of NPLs: Increase in GROWTH

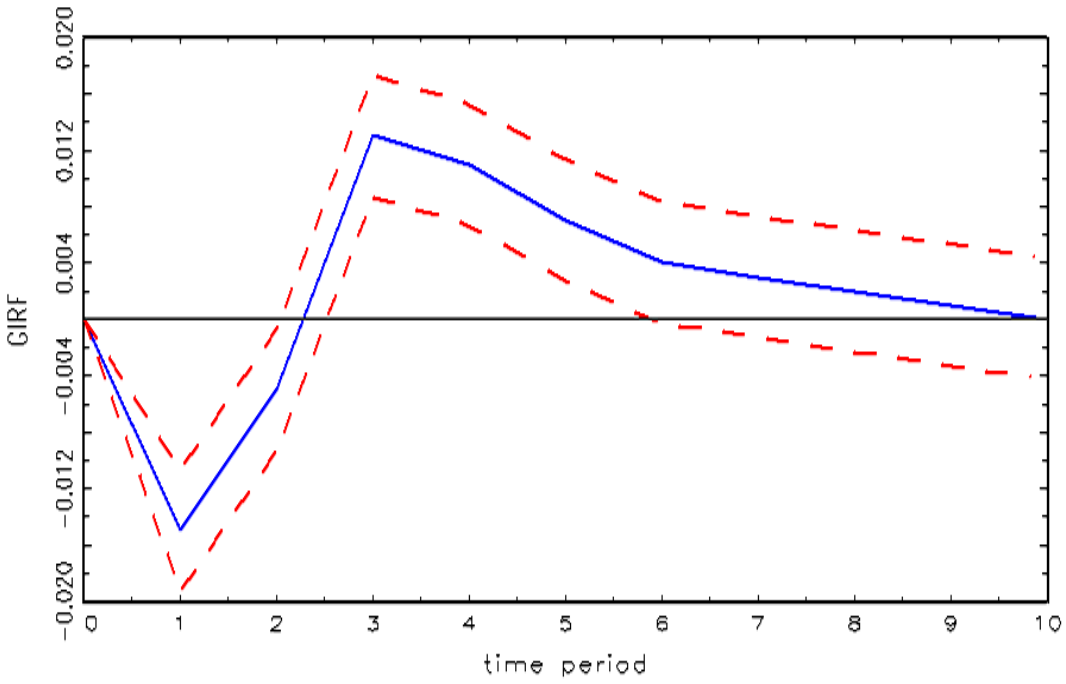


Figure 7: Generalized impulse response function of NPLs: Increase in OUTPUT_GAP

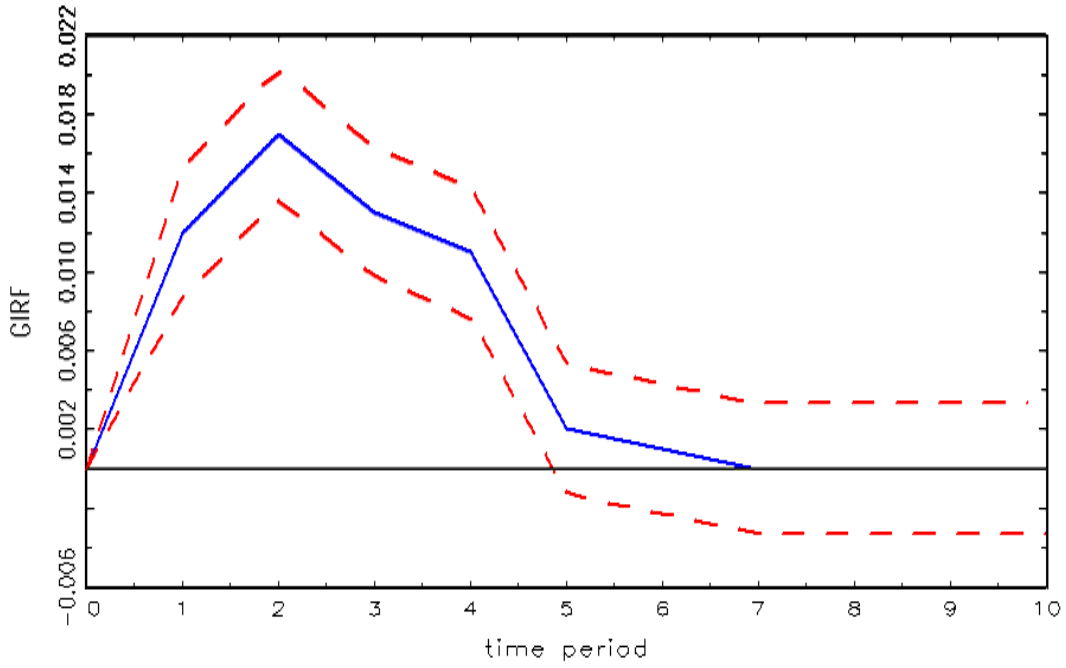


Figure 8: Generalized impulse response function of NPLs: Increase in TAXINC

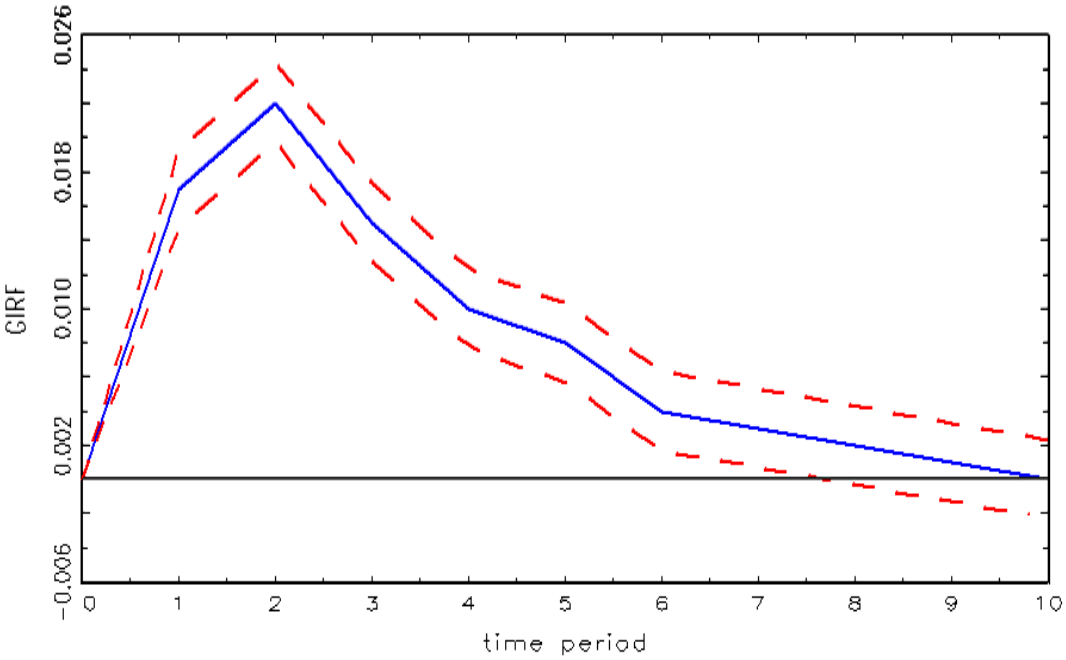


Figure 9: Generalized impulse response function of NPLs: Increase in MIR

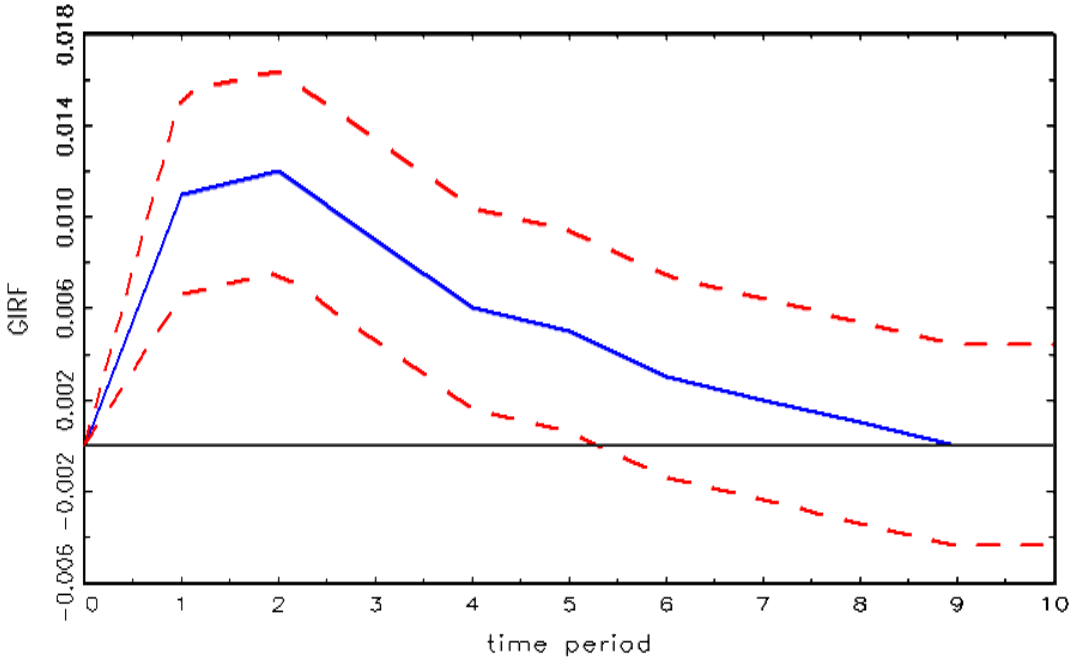
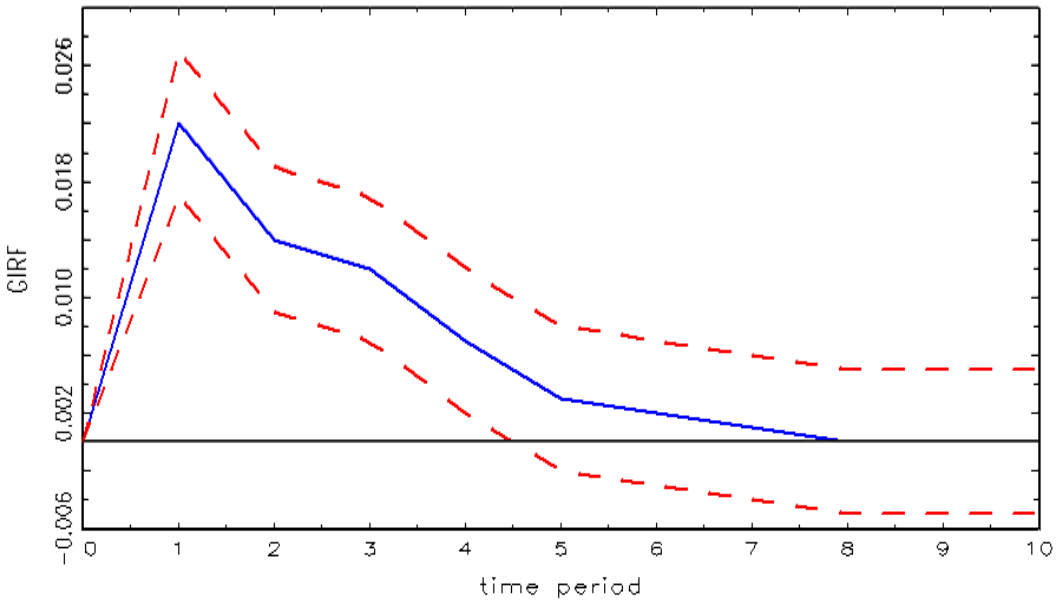


Figure 10: Generalized impulse response function of NPLs: Increase in UNEMPLOYMENT



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