Draft not for citation. Comments Welcome

Saturday, December 23, 2017

Non-Performing Loans in Europe: the Role of Systematic and Idiosyncratic Factors

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Abstract

Why did NPLs increase in some European countries and not in others? Focusing on a sample composed of large banks in the Euro area between 2006 and 2016, we show that greater stocks of NPLs are preceded by a period of higher levels of judicial inefficiency, economic stagnation and higher interest rates. We also estimate the response function that enables us to compare the actual and expected levels of NPLs, given the macro- and microeconomics conditions. We show that banks in Austria, Ireland, Cyprus, and Greece performed worse than a mean European bank would have done (on average, and during the period analyzed) given the same dose (i.e. days to enforce a contract). We find similar evidence using GDP growth and benchmark interest rates as doses.

JEL classification: E32, G21, G23, G28

Keywords: Non-performing loans; Banking, Judicial Efficiency

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The views expressed in this study are not necessarily those of the Italian Banking Association.

"*The elevated NPL stock creates macro-prudential and financial stability issues. NPLs consume scarce financial resources and management attention, thus potentially reducing new loan supply. With increased uncertainty about bank s' asset values, market perception is influenced and the costs of funding and capital are unnecessarily increased for the sector as a whole, which could adversely affect the cost of credit to borrowers. The presence of an elevated NPL stock is a symptom of broader solvency problems in the real economy, especially in the corporate sector, and depressed demand for credit. All these factors adversely affect potential economic growth*." The European Systemic Risk Board (ESRB), European System of Financial Supervision, Resolving non-performing loans in Europe, July 2017 (page 3).

Since the financial crisis of 2007, the credit quality of loan portfolio has declined sharply in most European countries and the stock of Non-Performing Loans (henceforth NPLs) was around €1.0 trillion at end of 2016 (i.e., 5.1% of total loans)[1]. The relevance of the NPLs issue in Europe is made clear by a recent statement from Danièle Nouy, chair of the Supervisory Board of the European Central Bank (ECB): "*The quality of banks' assets continues to be a serious challenge in the banking union as a whole, but the problem is also concentrated in certain countries. Large volumes of non-performing loans, or NPLs, are contributing to low bank profitability and making banks less able to provide new financing to the real economy*"[2]. Conversely, NPLs are not a critical problem in other countries, as it was observed by EBA (2016, page 8): "a *cross-country comparison suggests that the average NPL ratio is up to three times higher in the EU than in other global jurisdictions*". As an example, NPLs in the US were 1.3% of gross loans at the end of 2016[3].

As such, the NPL phenomenon appears to be a critical problem only for Europe or, better, for some of the European countries: specifically, at June 2017, the NPLs ratio was small in some countries, as Luxemburg (1.1%), the U.K. (1.7%), Germany (2.2%), France (3.4%), and very high in other countries, such as Greece (46.5%), Cyprus (42.7%), Portugal (17.5%), Italy

[1] Source of data: ESRB (2017)
[2]Danièle Nouy, Chair of the Supervisory Board of the ECB, Brussels, first ordinary hearing in 2017 of the Chair of the ECB's Supervisory Board at the European Parliament's Economic and Monetary Affairs Committee, 19 June 2017
[3] Source of data: https://data.worldbank.org/indicator/FB.AST.NPER.ZS

(12.0%) and Ireland (13.7%)[4]. In this paper, we argue that this is not surprising, and that it is due to the substantial heterogeneity in European macroeconomic and banking conditions. Looking at the economic and financial conditions in 2016, the annual GDP growth rate ranged from 0% in Greece to 8.4% in Ireland; the interest rates on 10-year benchmark Government bonds ranged from -0.2% in Germany to 4.0% in Greece; and the efficiency of the judicial systems ranged from 280 days in Norway to 1580 days in Greece[5]. Similarly, the level of support provided to the financial system by European Governments after the financial crisis was heterogeneous across countries: the largest proportion of financial support was provided by Ireland (18.1% of used funds and 11.6% of approved funds), U.K. (17.2% of used funds and 15.7% of approved funds), Germany (14.7% of used funds and 13.4% of approved funds), Spain (9.6% of used funds and 11.1% of approved funds) and Denmark (8.2% of used funds and 12.3% of approved funds).

This leads us to a key policy relevant question: why did NPLs increase in some European countries and not in others? What factors are responsible for the NPLs growth? Focusing on a large sample of large Eurozone banks (currently labeled as "significant" under the Single Supervisory Mechanism, SSM) between 2006 and 2016, we show that a higher level of judicial inefficiency is related to a greater level of NPLs in the following year: a reduction of 30 days in the average time period required to enforce a contract corresponds, *ceteris paribus,* to a mean decline in the NPLs ratio by 0.24 percentage points. Similarly, greater NPLs levels are preceded by higher benchmark rates, suggesting that higher interest rates make it difficult for borrowers to repay their debts, and this yields a higher stock of NPLs. A reduction of 100 basis points of the benchmark rates corresponds, *ceteris paribus,* to a mean decline of NPL ratio by 0.51 percentage points. We also estimate the response functions: focusing on the judicial efficiency, we show that

[4] Source of data: Quagliariello(2017)
[5] The efficiency of the judicial system is measured by the days required to enforce contracts provided by the World Bank (http://info.worldbank.org/governance/wgi/index.aspx#home)

banks in Austria, Ireland, Cyprus, and Greece performed worse than a mean European bank would have done (on average, and during the period analyzed), given the same dose (i.e. same number of days to enforce a contract). Conversely, banks in Finland, Germany, France, Estonia, and Netherlands performed better (on average, and during the period analyzed) than a mean European bank would have done (on average, and during the period analyzed), given the same dose (i.e. the same days to enforce a contract). We find similar evidence using GDP growth and benchmark interest rates as doses.

The link between the NPLs level and the real economy has been investigated in various papers by focusing on each of the two possible causality directions. A first group of papers deals with the NPLs consequences on real economy (Accornero, Alessandri, Carpinelli, and Sorrentino, 2017): as summarized by the 2017 ESRB 's statement quoted at the beginning of this paper, higher NPL levels reduce the banks' ability to provide new loans, and also increase the cost of credit to borrowers, two factors that adversely affect potential economic growth. A second group of papers (Us, 2017; Ghosh, 2015; Louzis, Vouldis, and Metaxas, 2012; Bofondi, and Ropele, 2011; Salas and Saurina, 2002) analyzed the causation the other way around (i.e., from real economy to NPLs): the different severity of the economic recession in EU countries (e.g. the European sovereign debt crisis and the subsequent double-dip recession that occurred in some countries), the different level of financial support provided by Governments to financial intermediaries in the early stage of the crisis, and the efficiency of the judicial system played a key role in the NPL accumulation in various European countries.

Our paper is closely related to the second group of papers since it investigates the causation effect from real economy to NPLs. Past papers provide limited evidence of the causation effects focusing either on few macroeconomic factors or few countries or a short time period. As far as we are aware, our paper is the first to provide a comprehensive analysis of the euro area from 2006 to 2016; specifically, it is the first to provide empirical evidence of the effect of judicial system inefficiency on NPLs, which is constantly mentioned as one of the main determinants of NPLs accumulation. As stated by Danièle Nouy (2017)[6] "*I would also like to stress that addressing NPLs requires determined action from all stakeholders, not only supervisors. In addition to our work, legal and institutional measures are required, notably in the areas of insolvency and judicial processes*".

The main contribution of our paper is that it clearly identifies three macroeconomic factors driving the NPL growth (i.e., the inefficiency of the judicial system, the economic growth, and the benchmark rate); it also provides causal evidence of the effect produced by each of these three factors on NPLs levels as well as the fitted values of NPL level due to macroeconomic factors. Specifically, we first estimate the causal link between these macroeconomic determinants and NPLs; then, we estimate a macro-factor response function, i.e. a function showing how NPLs react, *ceteris paribus*, to an increase in each of the macro-economic factors. The estimation of the response function is obtained by interpolating a polynomial function whose coefficients are obtained in a regression estimated using a panel data fixed-effects model and - given the auto-regressive nature of NPLs - by system-GMM whenever a dynamic panel-data model (including lags of the dependent variable) is considered. Therefore, estimating a response function enables us to set out the pattern of NPLs (and provide confidence intervals) over different levels of the considered macro-economic factor.

Our results are particularly relevant and timely for European policy makers and supervisors, especially with regard to the efficiency of judicial systems. Specifically, the ECB

[6]Danièle Nouy, Chair of the Supervisory Board of the ECB, Brussels, first ordinary hearing in 2017 of the Chair of the ECB's Supervisory Board at the European Parliament's Economic and Monetary Affairs Committee, 19 June 2017

(2017) proposed a new calendar provisioning for NPLs[7] to be implemented from 2018 (banks will have to provide full coverage for the unsecured portion of new NPLs after 2 years at the latest and for the secured portion after 7 years at the latest) and stated "*it is immaterial whether the delays in realizing the security were due to reasons beyond the banks control (e.g. length of time it takes to conclude legal proceedings)*" (ECB 2017, page 10). While our paper does not aim to discuss whether the new ECB (2017) calendar provisioning (based on one-fits-all principle) is correct, we believe that our estimated dose-response functions provide policy makers with fitted NPL values that can be interpreted as a benchmark (i.e. NPL level that a "mean" bank in the euro area and during the time period considered would have reach for each value of the macro-economic determinants) to accurately evaluate the real NPL levels of a country. In such a way, our results show that some of the countries with low mean levels of NPLs should have displayed even lower mean level of NPLs, given the high efficiency of their judicial system (e.g. France, Germany and Spain); conversely, countries with greater mean level of NPLs should have had even higher level of NPLs, given the inefficiency of their judicial system (e.g. Italy).

The remainder of the paper proceeds as follows: Section 2 reviews past papers and develop some testable research hypotheses. Section 3 presents an overview of the data and variables. Section 4 provides a preliminary investigation. Section 5 reports the identification strategy and analyses the main results of our multivariate empirical analysis. Section 6 describes various robustness checks. Finally, Section 7 concludes and debates the implications of our findings.

[7] On October 4, 2017, ECB published an addendum for consultation to its "Guidance to banks on non-performing loans" (released in March 2017) in which supervisory expectations for minimum levels of prudential provisioning for new NPLs were set out.

I. Literature & Hypotheses

The roots of the literature on the interaction between the financial system and the real economy can be traced in King and Plosser (1984). A few years later, Bernanke and Gertler (1989) and Bernanke, Gertler, and Gilchrist (1999) developed the concept of 'financial accelerator': in their models, information asymmetries between lenders and borrowers amplify credit market shocks in the economy. If credit markets are imperfect, Kiyotaki and Moore (1997) show how relatively small shocks are able to explain business cycle fluctuations. These models provide the most commonly used theoretical framework to explain the relationship between NPLs and a country's business cycle.

The NPLs phenomenon has been recently investigated focusing both on its drivers (i.e. from macroeconomic and microeconomic variables to NPLs) and its implications (from NPLs to the real economy). Focusing on the NPLs' consequences on real economy, empirical results are based on data at the loan-, bank- and country-levels. Specifically, Accornero, Alessandri, Carpinelli, and Sorrentino, (2017) analyze borrower-level loans between 2008 and 2015 (based on a privately available dataset of Bank of Italy): the paper shows that the Italian banks' lending behavior is not causally affected by the level of NPL ratios (i.e. NPL ratio levels *per se* do not influence bank lending); rather, the authors find that an "exogenous" increase in NPLs may have a negative effect on bank lending, similarly to negative shocks to banks' capital buffers. Bending et al. (2014) analyze bank-level data in 16 European countries (excluding Italy) and show that both NPL ratios and changes in NPLs are negatively linked to corporate and commercial loans growth in the following year. Balgova, Nies, and Plekhanov (2016) use aggregate data on a panel of 100 countries between 1997 and 2014 and findings show that countries that actively reduced their NPLs typically experienced higher growth rates.

A second group of papers analyzed show that NPLs depend both on bank characteristics and on the macroeconomic performance of the economies in which the banks operate. Among macroeconomic factors, NPLs are found to be negatively related to the economic growth, measured by the real GDP growth rate (Us 2017 for Turkish banks; Ghosh 2015 for U.S. banks; Louzis, Vouldis, and Metaxas, 2012 for Greek banks; Bofondi, and Ropele, 2011 for Italy; Salas and Saurina, 2002 for Spanish banks); conversely, NPLs display a positive relationship with the unemployment rate (Ghosh 2015 for the US banks; Klein, 2013 for Central and South Europe; Louzis, Vouldis, and Metaxas, 2012 for Greek banks; Bofondi, and Ropele, 2011 for Italy), inflation (Us 2017, for Turkish banks; Ghosh 2015 for the US banks; Klein, 2013 for Central and South Europe), and lending rates (Louzis, Vouldis, and Metaxas, 2012 for Greek banks; Bofondi, and Ropele, 2011 for Italy). While various policy papers (as Jassaud and Kang, 2015; ECB (2017a,b) suggest that NPLs are related to the inefficiency of judicial systems, there are no papers providing empirical evidence of this occurrence. A large set of microeconomic factors has also been investigated. Various bank-level variables are found to be positively related to NPLs, such as cost inefficiency (Podpiera and Weill, 2008 for Czech banks; Us 2017, for Turkish banks; Louzis, Vouldis, and Metaxas, 2012 for Greek banks), equity levels (Us 2017, for Turkish banks; Ghosh 2015 for the US banks; Klein, 2013 for Central and South Europe;), bank size (Ghosh 2015 for the US banks), and diversification (Ghosh 2015 for the US banks). Overall, these studies produce empirical limited evidence (concentrated in few countries and in specific years) about the role played by macro- and micro-economic factors in generating NPLs.

Based on past studies, we develop various testable hypotheses focusing on the expected link between systemic factors and NPLs. We focus on three major NPLs determinants: the efficiency of the judicial system, the economic growth, and the level of interest rates. Legal uncertainties and a lengthy foreclosure process limit the options for restructuring directly influence the time necessary to recover NPLs in a country: as judicial inefficiency increases, the recovery time increases and so do the NPLs. It is reasonable to expect the efficiency of the judicial system to have a positive impact on the NPLs ratio. Second, we focus on the growth in a country's economy: as the GDP increases, borrowers are more able to repay their debts. Conversely, when economic growth slows down or becomes negative, companies and households reduce their cash flows; in turn, this makes it difficult for them to repay bank loans (Salas and Saurina, 2002). Therefore, we expect GDP growth to have a negative impact on NPLs. Third, a rise in interest rates increases the real value of the borrowers' debt and makes debt servicing more expensive. This increases loan defaults and, hence, NPLs. Thus, we expect higher interest rates to have a positive impact on the NPL ratio.

II. Data and Variables

In this section, we describe the dataset, sources and variables used to examine the effect of macroeconomic and microeconomic factors on the NPLs ratio in Europe. In order to have a good representation of the whole European banking industry, we collected data for the largest 140 banking groups (henceforth banks) between 2006 and 2016, i.e. the 128 banks included in the preliminary list of the European Central Bank Comprehensive Assessment (list released by the ECB in July 2014). Next, we exclude banks not reporting complete balance sheet data and those with a ratio between loans to customers and total assets lower than 10%.

Data (from consolidated banking accounts) was collected from the Bankscope database from 2006 to 2014 and the Orbis bank database for 2015 and 2016. We double-check these numbers by looking at the annual financial statements available on the banks' websites. In order to avoid strong discontinuities in the balance sheet variables for banks involved in significant M&A transactions during the sample period, pre-M&A figures are adjusted to take into account these processes and ensure comparability over time. Furthermore, we double-check the consistency of data from the two datasets.

The variables we used are listed in Table 1. We use NPLs as a dependent variable, measured by the NPLs ratio obtained by dividing total impaired loans by total gross loans to customers[8]. The denominator of this ratio includes: mortgage loans, other retail loans, corporate and commercial loans, other loans and reserves for impaired loans[9]. The numerator represents the impaired loans included in gross loans to customers.[10] In our sample, this ratio (*NPL*) has a mean of 7.9% and a standard deviation of 8.4% (Table 2, panel A).

Looking at NPLs in different countries (Table 2, panel B), the highest NPLs ratios (on average over the period of study) are to be found in Slovenia (24.3%), Greece (19.9%) and Cyprus (21.2%). On the contrary, Estonia (1.8%), Finland (3.4) and the Netherlands (3.8%) recorded the lowest levels of NPLs ratio. The mean levels of NPLs ratio in our sample (at the 2014) are highly consistent with those published in the EBA (2016) report on NPLs in Europe. What is now relevant in our study is to check if there are similar differences in the annual GDP growth among European countries. Looking at the NPLs trend over time (Figure 1, Panel A), we notice that NPLs were relatively low and stable until the outbreak of the Global Financial Crisis (i.e., 2007). After then, the credit quality of loan portfolios deteriorated sharply in Non-Core European countries, but not so much in Core European countries: in 2014, for example, the

[8] For a cross-country comparison, NPLs by category (e.g., mortgage, business and consumer loans) are not available in Bankscope

[9] Since all other items are net figures, reserves for impaired loans are included in the denominator

[10]As highlighted by Klein (2013, page 7), "*Bankscope reports the level of impaired loans, which may be different to the official classification of non-performing loans. Impaired loans is an accounting concept, which reflects cases in which it is probable that the creditor will not be able to collect the full amount specified in the loan agreement, while* '*NPLs is a regulatory concept, which primarily reflects loans* that are more than 90 days past due'. As a consequence we treat impaired loans as NPLs in our study

difference in the NPLs ratio between the two groups of countries was equal to 9% (18% vs. 9%). Looking at the geographical distribution of NPLs ratio (Figure 1, Panel B), East and South European countries recorded a poorer loan portfolio quality with respect to the other European areas up to 2013; from 2014, NPL ratios have generally declined in all areas, except for the South European countries where NPLs increased up to mean ratio of 19%.

As explanatory variables, we focus on three macroeconomic variables: economic growth, interest rates and judicial efficiency. To measure a country's economic growth, we use the real GDP annual growth rate. In our sample, the mean value of this variable (*GDP*) is 0.4%, with a value of 5th percentile equal to -5.5% and a value of 95th percentile equal to 3.9%[11].

Figure 2 (Panel A) shows the GDP growth evolution over time, measured with an index equal to 100 in 2006. Until 2008, the GDP growth was positive and quite similar between Core and Non-Core European Countries. Moreover, the impact of the first recession was also comparable. However, between 2010 and 2013, the evolution of GDP was different. The recovery in Core countries was robust and the impact of the second recession was milder. In Non-Core countries, however, the recovery was anemic with an evident double dip in 2013. Finally, between 2014 and 2016, the GDP growth tuned positive in Non-Core countries and was slightly higher than in Core countries. Regarding the different areas, we notice that Southern countries had the worst macroeconomic performance (i.e., at the end of the period the index was equal to 96.9, with a trough equal to 93 recorded in 2013), whereas Central countries had the best performance (i.e., at the end of the period the index was equal to 114). Northern Countries performed relatively well in the first part of the sample, but their later performance was

[11] Since some banks in the sample operate in different countries, we use the real GDP growth as robustness check with the relative share of loans in each country. As can be seen in Section 6, the results are unchanged

disappointing. Finally, there is clear evidence of the strong recovery recorded in Eastern countries since 2009.

The efficiency of the judicial system is measured by the days required to enforce contracts: this index, provided by the World Bank[12], measures the time necessary to resolve a dispute, from the moment the plaintiff files the lawsuit in court until payment. This includes both the days when actions take place and the waiting periods in between. In our sample, the mean number of days needed to enforce a contract (*JUD*) is 613, with a range between 375 and 1210 days.

Looking at the judicial efficiency trend over time, are there any differences across countries (in a similar way to the ones found for NPLs)? As for the NPLs, there is an evident gap in the mean recovery time between Core and Non-Core countries that remained constant between 2006 and 2016 (Figure 2, Panel B), i.e. the number of days needed to enforce a contract in Non-Core countries is equal, on average, to 813 vis-à-vis 413 days recorded in Core countries. Looking at the various sub-areas, the judicial efficiency was very poor in Eastern countries up to 2008 (1350 days), but substantially improved until 2014 (less than 800 days): this may signal that the NPLs reduction in that geographical area from 2013 may be somehow related to an improved efficiency of the judicial system. This may also suggest that banks in those countries were not able to reduce the stock of NPLs due to judicial inefficiency.

Regarding interest rates, we use the interest rates on 10-year benchmark Government bonds for two reasons: the sovereign debt crisis and the emergence of financial fragmentation within the Eurozone showed that, over the period we analyzed, the most important factor influencing the cost of borrowing for banks was sovereign risk; moreover, this variable is also able to capture the soundness of public finance. In our dataset, the mean value of this variable

[12] http://info.worldbank.org/governance/wgi/index.aspx#home

(*RATE*) is 3.4%, with a value of 5th percentile equal to 0.3% and a value of 95th percentile equal to 6.9%. Are there any differences across countries that are similar to the ones found for the NPLs? Non-Core countries, and in particular South European countries (Panel C of Figure 1), experienced a remarkable increase in the Government bonds interest rates from 2010 (i.e. the beginning of the Greek crisis) to mid-2012 (i.e., till "whatever it takes" ECB speech). From 2014, the benchmark rate gap between Core- and Non-Core European countries (especially in Southern Europe) remained constant (around 180 basis points): this means that, *ceteris paribus*, a company borrowing money in Southern Europe would pay 180 basis point more than a twin company borrowing in a Core-European country. Interestingly, this may signify that the inability of companies to repay a debt in a given country is related to the above mentioned gap.

We also define some microeconomic variables to control for differences among banks: bank profitability, capitalization, risk, loan growth, and size. We measure profitability using return on assets (*ROA*): in our sample, the mean value of this variable is 0.1%, with a value of 5th percentile equal to -1.8% and a value of 95th percentile equal to 1.4%. We proxy bank capitalization by the ratio between the tier 1 capital and the risk-weighted asset (*CAP*). This variable has a mean of 11.1%, with a value of 5th percentile equal to 6.6% and a value of 95th percentile equal to 17.1%. Bank risk is obtained by the risk weighted assets on total assets ratio (*RWA*), which in our sample has a mean of 51.3%. Loan growth (*LOA*) is calculated as the annual variation of total loans over total assets; bank size (*SIZE*) is given by the logarithm of total assets.

Finally, the correlation matrix of our variables are given in Table 3: as expected, NPLs are negatively correlated to GDP growth and bank profitability, while they are positively related to the benchmark interest rate and the number of days required to enforce contracts. Overall, the results showed in Table 3 suggest that the presence of multicollinearity is quite limited as the linear relationship between any pair of variables used in the base model is weak.

III. Identification strategy

To investigate the association between NPL levels and micro- and macroeconomic variables, we use a panel data regression estimating the following equation:

$$Y_{itc} = \alpha + \beta Y_{i,t-1} + \Sigma_j \delta_j MA_{jit-1} + \Sigma_j \theta_j MI_{ji,t-1} + \Sigma_j \lambda_j L_{jc,t-1} + h(s_{it-1}) + A_i + B_t + \varepsilon_{it} \quad (1)$$

where Y is the NPL ratio at time t for bank i; MA are the macroeconomic variables (namely, the annual GDP growth rate, the country judicial inefficiency, and the benchmark rate); MI are the microeconomic variables (specifically, the Tier1 capital on risk weighted, return on asset, loans growth rate, risk-weighted asset on total asset and bank size); L is a set of control variables at country (c) and year (t-1) level (i.e. the private credit by deposit money bank on GDP and industry concentration). We also include bank (A_i) and year (B_t) fixed effects. More importantly, we are interested in estimating $h(s)$: it represents the NPL response function to any specific macro-factor s by taking all the other NPLs determinants as given. we focus on three macro-factors: judicial inefficiency (s_1), GDP rate of growth (s_2), and benchmark rate (s_3). In order to justify an estimation of $h(s)$, we derive eq. (1) from a "continuous treatment" model as set out in the next methodological section. It is worth noticing that variables MA will contain all the macro-factors except the one included as argument of the response function $h(\cdot)$.

NPLs data generating process requires an autoregressive form. As such, we include a one-year lagged NPLs ratio among the independent variables. Although it is still possible to run a fixed-effect regression for a panel autoregressive model (see, Louizis et al., 2012 and Ghosh 2015), we allow for fixed-effect estimation of eq. (1) to be inconsistent when the lagged dependent variable appears in the equation's right-hand-side[13]. In order to tackle the problem, as common practice in the literature, we use a system-GMM estimation of eq. (1) by adding lags in, until reducing to zero any residual autocorrelation equal to, or larger than, the second order (see Arellano and Bover, 1995; Blundell and Bond, 1998). Hence we use the two-step system-GMM estimator with Windmeijer (2005) corrected standard error to conduct our analysis. This choice is consistent with Bofondi and Ropele (2011) who show that changes in the macroeconomic determinants influence the quality of loans with different time lags (e.g. the annual GDP growth enters with a lag of 4 quarters). In our estimation, a one-time-lag is however sufficient to eliminate any second-order residual autocorrelation. For robustness purposes, we also consider one-year lagged macro-factors to attenuate possible reverse causality problems arising from a (potential) contemporaneous impact of NPLs on macroeconomic conditions. Moreover, as system-GMM estimation allows for finding suitable instruments for potentially endogenous variables, we also consider instrumental estimation for the macro-factor used as "dose" into the response function. Finally, our model (based on panel data) includes bank and time fixed-effects to face omitted variable problems. Overall, all these devises should provide deeper robustness to our estimates, thus giving a sounder causal interpretation to the estimated NPLs' response function to each considered macro-factor.

[13] The introduction of a lagged dependent variable among the predictors creates complications in the estimation as the lagged dependent variable is correlated with the disturbance (even under the assumption that $\varepsilon_{i,t}$ is not itself correlated)

III.1 Estimating the response function

The equation (1) may be encompassed within a continuous (or dose-response) treatment model, with s playing the role of the treatment. In order to show this, we consider the baseline random-coefficient treatment model developed by Wooldridge (1997; 2003), and extended by Cerulli (2015) to incorporate a dose-response function within a jointly binary (treated vs. untreated) and continuous treatment setting. According to this model, if the relevant orthogonality conditions implied by the model hold, one can consistently estimate all the parameters of the following conditional expectation:

$$\mathrm{E}(y\,|\,\mathbf{x},w,s)=\mu_0+\mathbf{x}\boldsymbol{\delta}_\mathbf{0}+w\underbrace{[(\mu_1-\mu_0)+\overline{\mathbf{x}}(\boldsymbol{\delta}_1-\boldsymbol{\delta}_\mathbf{0})+\overline{h}]}_{\text{ATE}}+w[\mathbf{x}-\overline{\mathbf{x}}](\boldsymbol{\delta}_1-\boldsymbol{\delta}_\mathbf{0})+w[h(s)-\overline{h}] \quad (2)$$

where **x** are covariates, w the treatment 0/1 dummy, and $h(s)$ the outcome response function to the dose s. If w=1, i.e. when all individuals are treated as in our sample, the previous equation simplifies to:

$$\mathrm{E}(y\,|\,\mathbf{x},w,s)=\mu_1+\boldsymbol{\delta}_1\mathbf{x}+h(s) \quad (3)$$

that is a concise representation of eq. (1), when one assumes **x** to contain the lagged y, the micro and macro variables, and the fixed effects. As in eq. (1), our main objective is to estimate the response function $h(s)$. In order to do this, we give $h(s)$ a q-degree polynomial specification:

$$h(s)=\alpha_1 s+\alpha_2 s^2+\alpha_3 s^3+...+\alpha_q s^q \quad (4)$$

Once plugged-in into eq. (3), we estimate eq. (4) through a consistent procedure, in our case a system-GMM. With this estimation at hand, we obtain the outcome-response function $H(s)$ by averaging over **x**:

$$H(s)=\mathrm{E}_\mathbf{x}\mathrm{E}(y\,|\,\mathbf{x},s)=\mu_1+\boldsymbol{\delta}_1\overline{\mathbf{x}}+\alpha_1 s+\alpha_2 s^2+\alpha_3 s^3+...+\alpha_q s^q \quad (5)$$

The function $H(s)$ is at the heart of our estimation purposes. Indeed, if a consistent and asymptotically normal estimation of $H(s)$ is available, its estimated variance would take on this form:

$$\hat{\sigma}_{\hat{H}(s)} = \left\{ S_1 \hat{\sigma}^2_{\hat{\alpha}_1} + S_2 \hat{\sigma}^2_{\hat{\alpha}_2} + S_3 \hat{\sigma}^2_{\hat{\alpha}_3} + 2 S_1 S_2 \hat{\sigma}_{\hat{\alpha}_1,\hat{\alpha}_2} + 2 S_1 S_3 \hat{\sigma}_{\hat{\alpha}_1,\hat{\alpha}_3} + 2 S_2 S_3 \hat{\sigma}_{\hat{\alpha}_2,\hat{\alpha}_3} + \ldots \right\}^{1/2} \tag{6}$$

where $S_1=s$, $S_2=s^2$, $S_3=s^3$, … . As consequence, the (1-α)% normal-based confidence interval for $\hat{H}(s)$ at each s is given by:

$$\left\{ \hat{H}(s) \pm z_{1-\alpha} \cdot \hat{\sigma}_{\hat{H}(s)} \right\} \tag{7}$$

Once estimated by system-GMM, we can plot the response curve $H(s)$ along with its confidence intervals.

V. Preliminary evidence

In this section, we provide preliminary evidence that the macro-economic variables selected (judicial inefficiency, GDP growth and benchmark rates) are different across European countries and that they are related to NPLs. As shown in Figure 3 (Panel A), we find that Italy and Greece experienced the worst macroeconomic conditions during the period analyzed (i.e. highly inefficient judicial system and low economic growth), Slovakia experienced poor economic growth but not poor judicial performances; Malta, Ireland, Estonia experienced high economic growth (greater that 2%) and high judicial efficiency; core European countries and Spain display significant high economic growth (greater that 1% and smaller that 2%) and high judicial efficiency.

Since judicial efficiency shows a very low correlation with GDP growth, we combine both macroeconomic variables together in a new variable capturing both the high economic growth and the high judicial efficiency of a country. The new variable, labeled as S_4, is obtained as follows: first, we standardize both *GDP* and *JUD* variables between 0 and 1 (zero is the minimum of the variables; one is the maximum of the variable); second, we transform the standardized GDP variable to give both variables (i.e. GDP and JUD) the same directions (i.e. zero is the "highest value" for both judicial efficiency and growth indicators; one is the "lowest value" for both judicial efficiency and growth indicators); third, we add 1 to both variables; fourth, we make the geometric average of the two indicators obtained in the previous step and then transform the mean to make it range between zero and one (i.e. zero indicates the highest judicial efficiency and also the highest economic growth; one indicates the lowest judicial efficiency "and" the lowest economic growth). When plotting the new indicator with the NPL ratios (Figure 3 – Panel B), a strong positive link between NPLs ratios and S_4 is obtained. Most Core-European countries are closely related to each other; interestingly, Italy exhibits high S_4, but the NPL level is less than proportional; conversely, Austria, Ireland, and Cyprus exhibit NPLs ratios that are more than proportional to S_4.

We also run some univariate test to verify the association between our macroeconomic variables and NPLs (table 4). As expected, we find strongly statistically significant evidence that NPLs ratios are higher in countries with low judicial efficiency (*JUD*), lower economic growth (*GDP*), higher interest rates (*RATE*), and low judicial efficiency and low economic growth (S_4) altogether. NPLs are also negatively related to various microeconomic variables, like profitability, efficiency and size; conversely, NPLs are positively linked to capitalization, loan growth, and risk-weighted asset ratio.

VI. Results

Table 5 illustrates the results of our investigation into the relationship between NPLs ratios, micro- and in particular macroeconomic variables. The coefficients of interest are the ones estimated for the judicial efficiency (*JUD*), the economic growth (*GDP*), and the benchmark rates (*RATE*), as in columns (1) and (2). We show that higher levels of judicial inefficiency in one year are related to greater levels of NPLs in the following year: consistently with the results from univariate analysis, this suggests that longer time periods to enforce a contract are related to a higher stock of NPLs in the following year. This result is economically significant: focusing on the GMM-SYS results (column 2, Table 5), a reduction of the 30 days in the average time period to enforce a contract corresponds, *ceteris paribus*, to a mean decline of the NPL ratio by 0.24 percentage points. Similarly, greater NPL levels are preceded by higher benchmark rates suggesting that higher interest rates make it difficult for borrowers to repay their debts and this results in a higher stock of NPLs. A reduction of the 100 basis points of the benchmark rates corresponds, *ceteris paribus*, to a mean decline of the NPL ratio by 0.51 percentage points. Once we combine economic stagnation and judicial inefficiency in a single indicator (S_4), we find strongly significant statistical evidence that a worse economic framework precedes NPLs: in countries with higher S_4 (i.e. in which higher judicial inefficiency and economic stagnation are combined), NPLs are higher in the following year.

Endogeneity problems were also taken into consideration in our study. Consistently with Bofondi and Ropele (2011), we considered one-year lagged macro-factors to attenuate possible reverse causality problems arising from a (potential) contemporaneous impact of NPLs on macroeconomic conditions. This lag is also rational from an economic standpoint: the time necessary to enforce a contract at time *t-1* is found to influence the NPLs ratio at time *t*; it would be hard to support the causality the other way round. Second, we run an instrumental estimation for the macro-factor used as "dose" into the response function. Overall, all these devises provide deeper robustness to our estimates thus giving a sounder causal interpretation to the estimated NPLs' response function to each considered macro-factor.

Looking at the microeconomic determinants, we find that the stock of NPLs is negatively related by banks' ROA (i.e. banks with lower NPLs are also more profitable) and to the loan ratio (i.e. banks more oriented to lending display lower NPLs in comparison to total assets, suggesting a benefit for specializing in lending). Not surprisingly, NPLs are higher for banks with a greater RWA ratio and that operate in countries where the banking system is more important (measured by the private credit by deposit money bank on GDP).

In the next step, following the model set out in section III.1, we estimate the NPLs response function for each of the three macroeconomic variables analyzed and the S_4 variable. Specifically, we report the system-GMM estimation of the response function $H(s)$: this is the pattern of NPLs predictions over different levels of each macro-economic variable. Interestingly, we plot 95% confidence intervals curves for $H(s)$ at any level of the macro-factor, and we report the mean NPLs value of each country during the period 2006-2016. A polynomial function interpolates the response function with coefficients obtained through system-GMM. A second order polynomial curve provides an appropriate fit.

First, we focus on jurisdictional efficiency (Figure 4). We find an increasing trend and, in particular, that the second square term of the dose (days) is positive and highly significant (Figure 4, panel A). Despite the fact that confidence levels substantially rise when the dose is greater than 33% (due to sparseness of data when the number of days increases), we find clear evidence that banks in Austria, Ireland, Cyprus, and Greece performed worse than a mean

European bank would have done (on average, and during the period analyzed), given the same dose (i.e. same number of days to enforce a contract). Conversely, banks in Finland, Germany, France, Estonia, and Netherlands performed better (on average, and during the period analyzed) than a mean European bank would have done (on average, and during the period analyzed), given the same dose (i.e. the same days to enforce a contract). Banks in Italy, Belgium, Malta, Slovenia performed slightly better than a mean European bank given the same dose level, but the actual stock of NPL is not below 5% confidence level. Conversely, banks in Spain performed slightly worse than a mean European bank given the same dose level, but the actual stock of NPL is not above 95% confidence level. Despite a great heterogeneity of observations, the goodness-of-fit for judicial inefficiency is satisfactory (panel B). This panel jointly plots the distribution of NPLs actual values and that of the NPLs predicted by the model. It is evident that they overlap rather well.

Next, we focus on the economic growth and benchmark rates (Figures 5 and 6). We find a negative trend and a slightly positive second square term for the GDP (Figure 4, panel A) and a positive trend and a slightly negative square term for the benchmark rates (Figure 5, panel A). For both macro-factors, banks in Austria, Italy, Ireland, Cyprus, Slovakia, and Greece performed worse than a mean European bank would have done (on average, and during the period analyzed), given the same dose (i.e. the same GDP growth rate and the same interest rate, respectively). Conversely, banks in the remaining countries (expect Spain) performed better than a mean European bank would have done (on average, and during the period analyzed), given the same dose (i.e. the same GDP growth rate and the same interest rate, respectively). According to panel B, figures 4 and 5, the goodness-of-fit of the predictions of the system-GMM model for both GDP growth and benchmark rate is good.

Finally, we consider a fourth model where the dose is a composite index of economic stagnation and juridical inefficiency (S_4). We find a positive pattern and a slightly positive second square term for S_4 (Figure 6, panel A). For both the macro-factors, banks in Austria, Ireland, Cyprus, Slovakia, and Greece performed worse than a mean European bank would have done (on average, and during the period analyzed), given the same dose (i.e. the same GDP growth rate). Conversely, banks in the remaining countries (except for Spain and Italy) performed better (on average, and during the period analyzed) than a mean European bank would have done, given the same dose (i.e. the same days to enforce a contract). Furthermore, the goodness-of-fit of the S_4 model is good (panels B in the figure 6).

VII. Conclusions

NPLs are the most serious problem in the European Union with an overall gross stock of 1 Trillion of Euro at the end of 2016. Our paper addresses a key policy relevant question: why did NPLs increase in some European countries and not in others? What factors are responsible for the NPL growth? Focusing on a sample composed of banks (currently labeled as "significant" under the SSM) in countries in the Euro area between 2006 and 2016, we show that higher levels of judicial inefficiency are related to greater levels of NPLs in the following year: a reduction of 30 days in the average time period required to enforce a contract corresponds, *ceteris paribus,* to a mean decline of the NPL ratio by 0.24 percentage points. Similarly, greater NPL levels are preceded by higher benchmark rates suggesting that higher interest rates make it difficult for companies to repay their debts and this results in a higher stock of NPLs. A reduction of the 100 basis points of the benchmark rates corresponds, *ceteris paribus,* to a mean decline of the NPL ratio by 0.51 percentage points. The evidence is even stronger when we combine economic stagnation and judicial inefficiency in a single indicator (S_4): a worse economic framework precedes NPLs.

We also estimate the response function for each of the three macroeconomic variables analyzed and the S_4 variable. Considering as dose our composite index capturing (at the same time) economic stagnation and juridical inefficiency, we find that banks in Austria, Ireland, Cyprus, Slovakia, and Greece performed worse (on average, and during the period analyzed) than a mean European bank would have done (on average, and during the period analyzed), given the same dose (i.e. the same GDP growth rate). Conversely, banks in the remaining countries (except for Spain and Italy) performed better (on average, and during the period analyzed) than a mean European bank would have done (on average, and during the period analyzed), given the same dose (i.e. the same days to enforce a contract).

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Table 1
Variable Definitions

Table 1 defines the variables used in the paper and the sources of data.

Variable	Acronyms	Definition	Source
Dependent variable			
Non-Performing Loans	NPL	Total Impaired Loans/Gross Loans to Customers (%)	Bankscope
Systematic factors			
GDP growth	GDP	Annual Real GDP growth rate (%)	IMF
Jurisdictional inefficiency	JUR	Time to resolve a dispute (days)	World Bank
Benchmark Rate	RATE	10-year benchmark Government bonds (%)	Datastream
Idiosyncratic factors			
Regulatory Capital	CAP	Tier 1 Regulatory Capital/Risk Weighted Asset (%)	Bankscope
ROA	ROA	Net Income /Total Assets (%)	Bankscope
Loan Ratio	LOA	Annual variation of Total Loans / Total Assets (%)	Bankscope
RWA density	RWA	Risk Weighted Assets / Total Assets	Bankscope
Size	SIZ	Natural log of Total Assets	Bankscope
Control factors			
Banking Industry Size	BIS	Private Credit by Deposit Money bank/GDP (%)	Bankscope
Industry Concentration	CONC	Total Assets of three largest banks / Total Assets of All Commercial Banks (%)	Bankscope

Table 2:
Summary Statistics

Panel A is a summary statistics for all the variables used in the paper. We use both "significant" and "non-significant" European banks (following the ECB's definition of significant) between 2011 and 2014.The Panel B below contains the summary statistics by country of all the regression variables used to examine the effect of systematic and idiosyncratic factors on the NPLs ratio in Europe. In both panels, variables are winsorized at the 1% level. The variables and the sample are defined in Table 2.

Panel A: Descriptive statistics

	N	Mean	Standard Deviation	5^{th} Percentile	50^{th} Percentile	95^{th} Percentile
NPL	881	7.92	8.46	0.83	5.15	26.7
GDP	881	0.43	2.55	-5.48	0.8	3.77
JUD	881	614.73	314.27	390	510	1210
RATE	881	3.56	1.77	0.83	3.76	5.89
ROA	881	0.06	1.35	-1.81	0.27	1.4
CAP	881	11.12	4.25	6.63	10.43	17.13
RWA	881	51.25	20.99	19.99	51.46	84.48
LOA	881	0.21	4.24	-6.63	0.45	6.85
BIS	881	104.74	35.04	59.44	94.04	170.24
CONC	881	70.4	10.72	53.24	71.21	89.45
SIZ	881	11.44	1.37	9.14	11.24	13.93

Panel B: Summary Statistics by Country

Cn	Obs	NPL	GDP	JUR	RATE	ROA	CAP	RWA	LOA	BIS	CONC
Aut	52	10.20	0.96	397	2.90	0.33	10.04	56.04	1.15	93.18	69.93
Bel	36	5.12	0.93	505	3.14	0.10	12.65	27.74	0.61	58.59	72.37
Cyp	14	21.2	-1.27	735	6.42	-0.97	9.44	64.37	1.27	238.08	82.39
Est	7	1.77	3.00	425	2.09	2.08	28.92	58.81	-2.95	70.92	93.55
Fin	27	3.44	0.03	328	2.67	0.60	13.78	46.06	-0.72	86.65	93.45
Fra	90	3.76	0.64	391	2.86	0.46	10.78	48.35	0.38	93.22	60.80
Deu	194	4.37	1.17	400	2.40	-0.02	12.32	36.25	0.50	87.59	75.78
Grc	28	19.86	-1.44	1074	6.92	0.38	10.90	63.06	1.12	101.06	67.75
Irl	30	17.22	0.89	569	5.20	-1.44	12.44	56.76	2.42	132.74	70.52
Ita	134	11.48	-0.77	1202	4.12	0.11	8.65	65.31	-0.12	88.56	59.88
Lva	2	4.14	2.70	469	3.12	1.07	27.17	31.67	-0.71	49.66	49.95
Mlt	13	5.69	2.32	505	3.62	0.89	9.20	51.62	-0.53	111.61	88.03
Nld	45	3.80	0.72	514	2.69	0.07	12.22	34.32	0.03	115.39	84.36
Prt	35	3.78	-0.43	557	5.82	0.18	9.41	63.76	0.18	146.83	84.40
Svk	18	5.51	2.79	582	2.79	1.27	14.09	60.34	3.40	47.03	69.61
Svn	24	24.27	-0.13	1300	3.86	-0.81	11.58	73.91	0.09	73.65	54.96
Esp	132	7.54	0.15	513	4.18	-0.25	10.06	58.36	-1.22	156.02	65.70

Table 3
Correlation Matrix

The Table below shows the correlation among all the regression variables used to examine the effect of systematic and idiosyncratic factors on the NPLs ratio in Europe during the period 2006-2015. The variables and the sample are defined in Table 2. The symbols * and ** indicate significance at 5% and 1% levels, respectively.

	NPL	GDP	JUD	RATE	CAP	ROA	LOA	EFF	RWA	SIZE	BIS	SMS	CONC
NPL	1.00												
GDP	-0.01	1.00											
JUD	0.36	-0.21	1.00										
RATE	0.18	-0.46	0.35	1.00									
CAP	0.18	0.06	0.21	0.06	1.00								
ROA	-0.27	0.22	-0.19	-0.36	0.06	1.00							
LOA	0.04	-0.11	0.35	0.25	0.41	-0.11	1.00						
EFF	0.11	-0.07	0.40	0.19	0.26	-0.05	0.25	1.00					
RWA	0.15	-0.17	0.41	0.31	0.62	-0.12	0.55	0.46	1.00				
SIZ	-0.21	-0.05	-0.19	-0.10	-0.32	-0.02	-0.18	-0.21	-0.34	1.00			
BIS	0.09	-0.27	-0.03	0.40	-0.00	-0.21	0.32	0.07	0.15	-0.07	1.00		
SMS	-0.19	0.17	-0.45	-0.22	-0.17	0.13	-0.26	-0.01	-0.22	0.12	0.09	1.00	
CONC	-0.06	0.09	-0.24	-0.06	0.03	0.02	0.23	-0.38	-0.18	0.11	0.13	-0.37	1.00

Table 4:
Difference in Means

Table 3 illustrates the difference in means between the group of treated banks and the group of untreated banks. The variable construction is shown in Table 1. The treatment period spans from 2013 to 2014, and the pretreatment period is 2011 to 2012. Columns 1, 3, 5, and 7 present the difference in means between treated and untreated banks, and columns 2, 4, 6, and 8 show the *p-values* from a *t-test*. The symbols * and ** indicate significance at 5% and 1% levels, respectively.

	(1) *Lowest third* (0%-33%)	*(2)* *Highest third* (67%-100%)	*(3)* *Difference* (1-2)	*(4)* *p-value* (H_o:1≠2)
JUD	4.0776	13.3869	-9.3094	0.0000
GDP	10.1187	5.6576	4.4611	0.0000
RATE	7.1955	9.6582	-2.4626	0.0002
S_4	6.3135	11.5812	-5.2677	0.0000
CAP	6.2074	8.6256	-2.4182	0.0002
ROA	11.5790	5.5818	5.9973	0.0000
LOA	6.0356	10.0869	-4.0512	0.0000
RWA	4.8849	9.0229	-4.1380	0.0000
SIZ	9.5004	5.0571	4.4433	0.0000

Table 5
Testing the association between NPLs and micro- and macro-factors

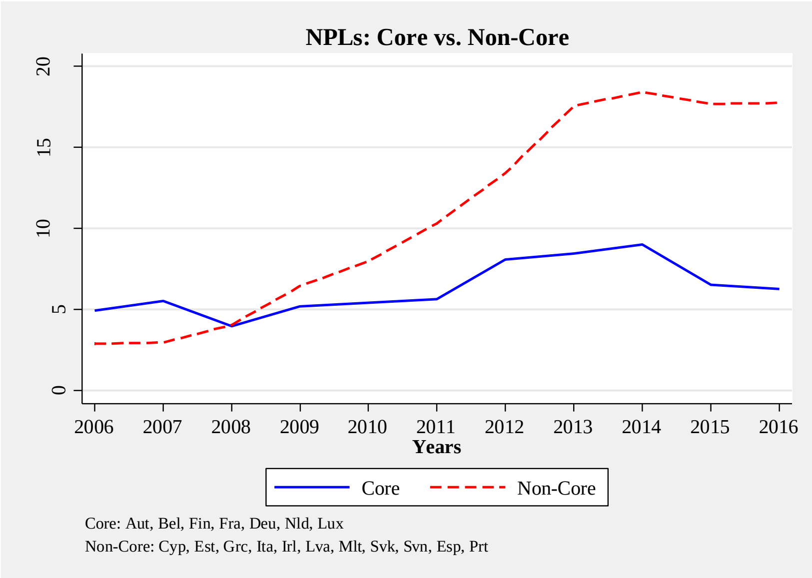
Table 4 reports the results of a two regressions in which the dependent variable refers to NPL ratio. The dependent variable ($Y_{i,t}$) is the NPL ratio at time t for bank i and the independent variables are: i) macro-economic variables (namely, the annual GDP growth rate, the country judicial efficiency, and the benchmark rate); ii) micro-economic variables (specifically, the operating inefficiency, risk-weighted asset on asset, and the asset size);. In our main models, we include bank fixed effects (A_i) and year dummy variables (B_y). Robust standard errors in parentheses are clustered at the bank level. The Sargan/Hansen test of over-identifying restrictions for the GMM estimators: the null hypothesis is that instruments used are not correlated with residuals and so the over-identifying restrictions are valid. Arellano-Bond (AB) test for serial correlation in the first-differenced residuals. The null hypothesis is that errors in the first difference regression do not exhibit second order serial correlation. * and ** indicate significance at the 5% and 1% levels, respectively. All variables are defined in the Table 1.

	(1) FE-OLS	(2) FE-OLS	(3) GMM-SYS	(4) GMM-SYS	(5) FE-OLS	(6) FE-OLS	(7) GMM-SYS	(8) GMM-SYS
NPL_{t-1}	0.8723***	0.8022***	0.9036***	0.8591***	0.8897***	0.7857***	0.9143***	0.8764***
	(21.4535)	(18.3639)	(15.6062)	(13.5235)	(23.8934)	(17.8452)	(17.4881)	(15.7184)
JUD_{t-1}	0.0066***	0.0073***	0.0065*	0.0083**				
	(2.9124)	(2.9976)	(1.8187)	(2.2206)				
GDP_{t-1}	-0.2154***	0.0115	-0.1967***	0.1096				
	(-5.4484)	(0.1199)	(-5.0620)	(1.0893)				
$S4_{t-1}$					0.0175	0.0728***	0.0008	0.0551**
					(1.4244)	(3.7579)	(0.0837)	(2.1866)
$RATE_{t-1}$	0.4904***	0.7031***	0.3887***	0.4974***	0.5023***	0.6117***	0.3791***	0.4558**
	(4.0544)	(3.5305)	(3.1973)	(2.6981)	(4.2573)	(3.5154)	(3.0210)	(2.3085)
ROA_{t-1}	-0.0050***	-0.0039**	-0.0066**	-0.0056**	-0.0053***	-0.0035**	-0.0077***	-0.0048**
	(-2.9345)	(-2.6004)	(-2.3013)	(-2.3477)	(-3.1402)	(-2.6109)	(-2.6170)	(-2.1418)
CAP_{t-1}	-0.0289	-12.0138*	0.0244	-0.1447	-0.0093	-0.0995	0.0498	-0.1142
	(-0.5126)	(-1.7299)	(0.4017)	(-1.5634)	(-0.1507)	(-1.4303)	(0.8520)	(-1.1948)
RWA_{t-1}	-0.0005***	-0.0248	-0.0001	0.0008*	-0.0006***	-0.0002	-0.0003	0.0009*
	(-2.7122)	(-1.2218)	(-0.6124)	(1.6859)	(-3.1242)	(-0.9303)	(-1.2638)	(1.8559)
LOA_{t-1}	0.0460**	0.0197	-0.0218	-0.1117**	0.0632***	0.0322*	-0.0040	-0.0996**
	(2.4569)	(1.2044)	(-0.7636)	(-2.4435)	(3.0768)	(1.9223)	(-0.1337)	(-2.2447)
BIS_t	0.0325**	0.0419***	0.0468***	0.0510**	0.0556***	0.0359***	0.0711***	0.0423**
	(2.2964)	(2.7916)	(2.7717)	(2.4157)	(4.1287)	(2.7036)	(3.7811)	(2.2439)
$CONC_t$	0.0300	0.0228	0.0149	-0.0028	0.0179	0.0489**	-0.0069	0.0291
	(1.2400)	(0.9698)	(0.5707)	(-0.1018)	(0.8162)	(2.3739)	(-0.2846)	(1.2068)
SIZ_t	-1.2673	-1.6278*	-0.3235	-0.2814	-1.2033	-1.5442*	-0.3313*	-0.0570
	(-1.3084)	(-1.8334)	(-1.5673)	(-1.0639)	(-1.1217)	(-1.7161)	(-1.7762)	(-0.2273)
Constant	5.3954	9.4769	-1.7320	0.0000	5.3870	7.9791	-0.4439	-7.2684
	(0.4968)	(0.9438)	(-0.4096)	(.)	(0.4281)	(0.7547)	(-0.1030)	(-1.5703)
Observations	881	881	779	779	881	881	779	779
Number of banks	108	108	106	106	108	108	106	106
R-squared	0.827	0.827			0.802	0.832		
Bank FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Country FE	No	No	Yes	Yes	No	No	Yes	Yes
Hansen test, 2nd step, $\chi^2(79)$	N/A	N/A	91.03	81.49	N/A	N/A	89.00	82.64
AB test AR(1)	N/A	N/A	-2.37**	-2.33**	N/A	N/A	-2.39**	-2.32**
AB test AR(2)	N/A	N/A	-0.13	0.17	N/A	N/A	-0.25	0.10

Figure 1
The Non Performing Loans (NPLs) evolution over time

Figure 1 shows the gross level of Non-Performing Loans (NPLs) over total loans. In panel A, we compare Core EU countries and Non-Core countries. In panel B, we refine the country classification by comparing Northern, Central, Southern and Eastern European countries.

Panel A: Core vs Non-core European countries



Panel B: Northern, Central, Southern and Eastern European countries

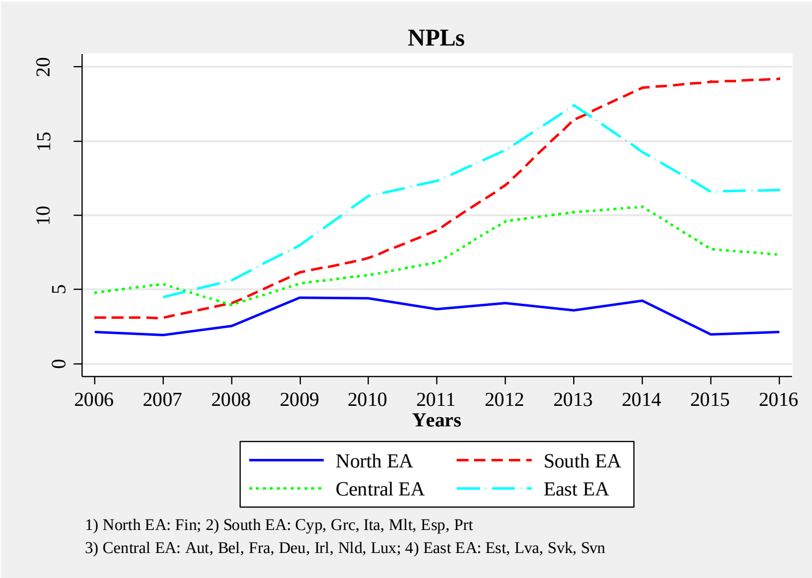
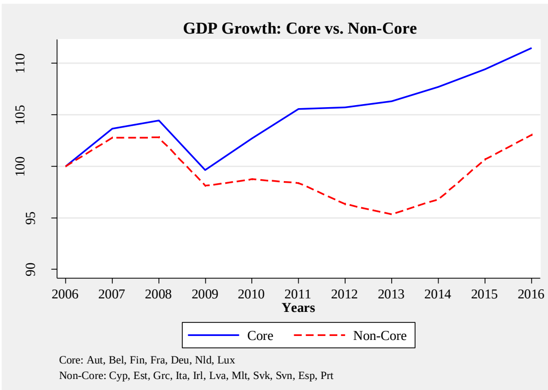
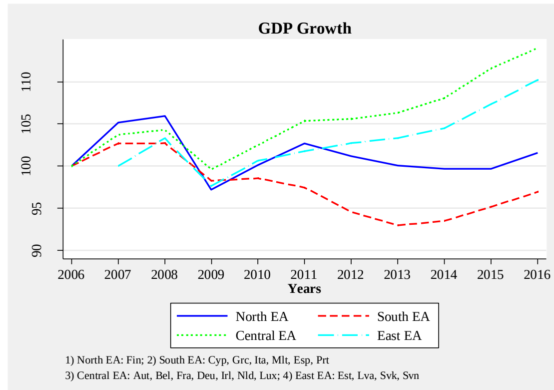


Figure 2
EU Macroeconomic factors evolution over time

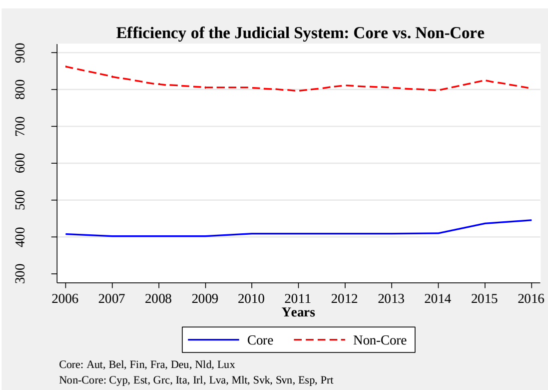
Figure 2 describes the evolution over time of the three macroeconomic variables investigated in the paper, i.e. the GDP annual growth rate in panel A, the efficiency of the judicial system in panel B, and the benchmark rates in Panel C. The variables are defined in Table 1.

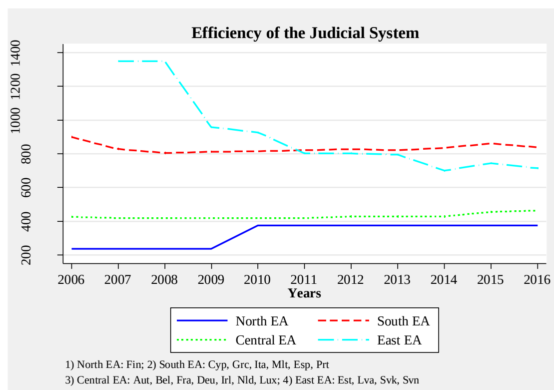
Panel A: The GDP growth rate (source of data: IMFWEO Database)



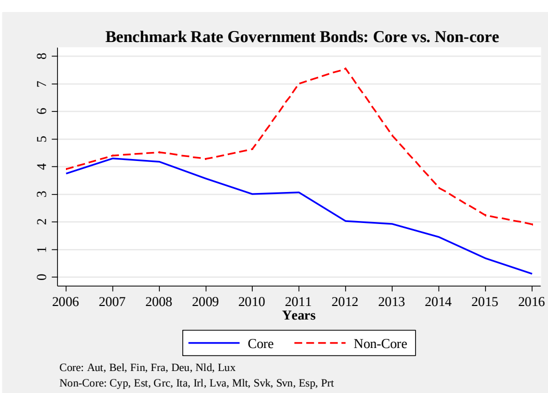


Panel B: The efficiency of the judicial system(source of data: World Bank Doing Business)





Panel C: Benchmark rates (source of data: Thomson Reuters Datastream)



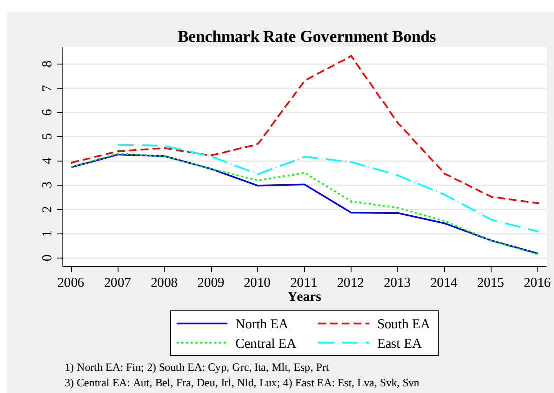
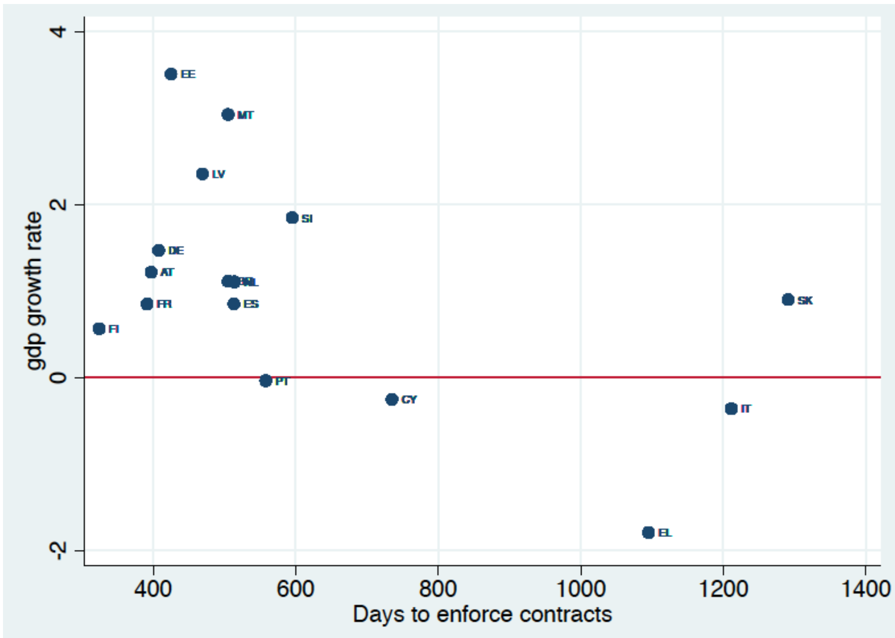


Figure 3
Combining Macro-Economic Variables

Panel A presents the two indicators of judicial efficiency (mean days to enforce a contract between 2006 and 2016) and economic growth (annual GDP growth rate) in the euro area. Panel B shows the mean NPLs ratio and our indicator representing both the economic stagnation and judicial inefficiency (i.e. 0 means maximum judicial efficiency and economic growth; 100 means maximum judicial inefficiency and economic stagnation). The variables are defined in Table 1.

Panel A: Judicial Inefficiency vs.annual GDP growth rate



Panel B: S4 (Judicial Inefficiency and Economic Stagnation) vs. NPL ratio

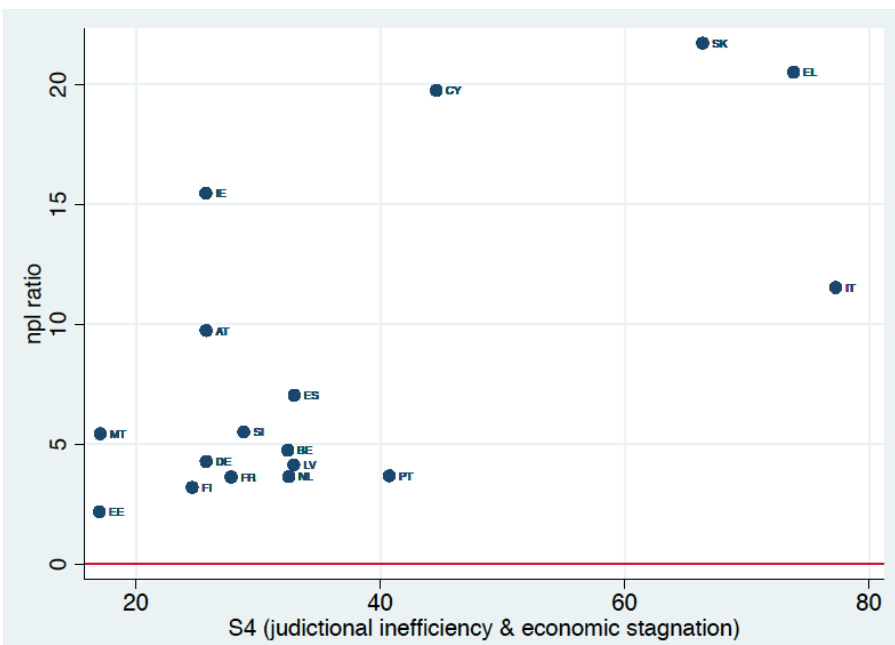
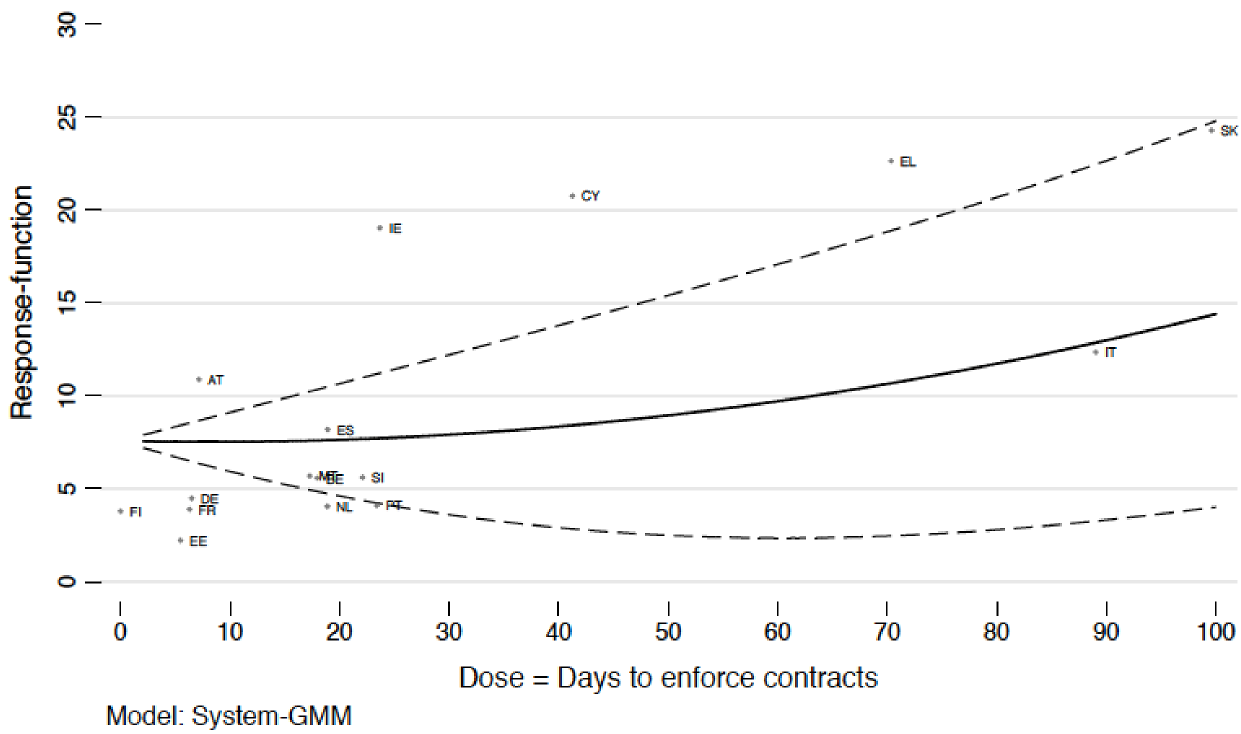


Figure 4: The effect of judicial efficiency on Non Performing Loan levels

Figure 4 shows system-GMM estimation of the response function $H(s)$ as described in section III.1. This is the pattern of NPLs predictions over different levels of judicial inefficiency. We standardize judicial inefficiency to range between 0 and 100. We obtain our results by adapting to our context a continuous treatment approach as set out in section III.1. We plot 95% confidence intervals curves for $H(s)$ at any level of judicial inefficiency. A polynomial function interpolates the response function with coefficients obtained through system-GMM. A second order polynomial curve provides the best fit. All variables are defined in Table 1.

Panel A – Dose response function reporting mean country-level data



Panel B – Dose response function reporting bank-level data and quality of the fit

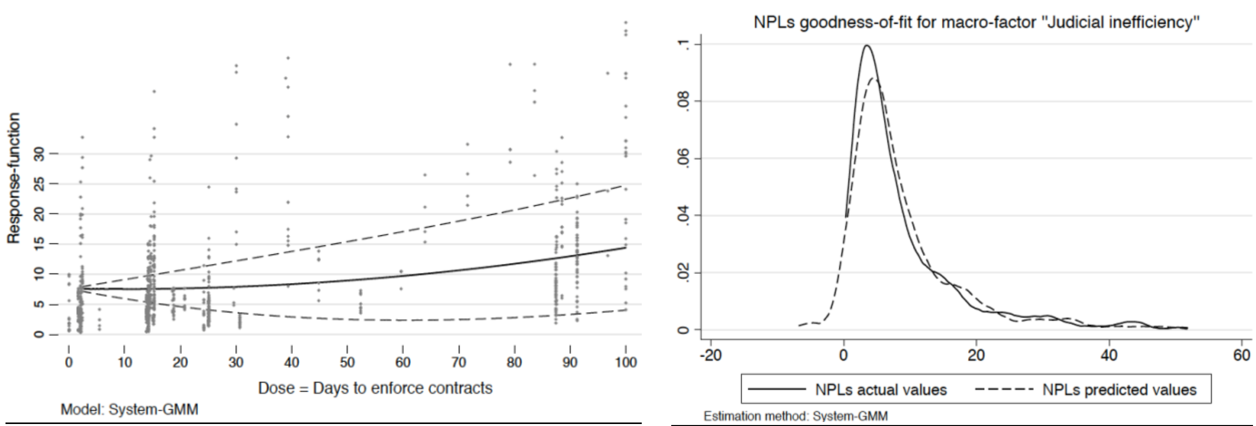
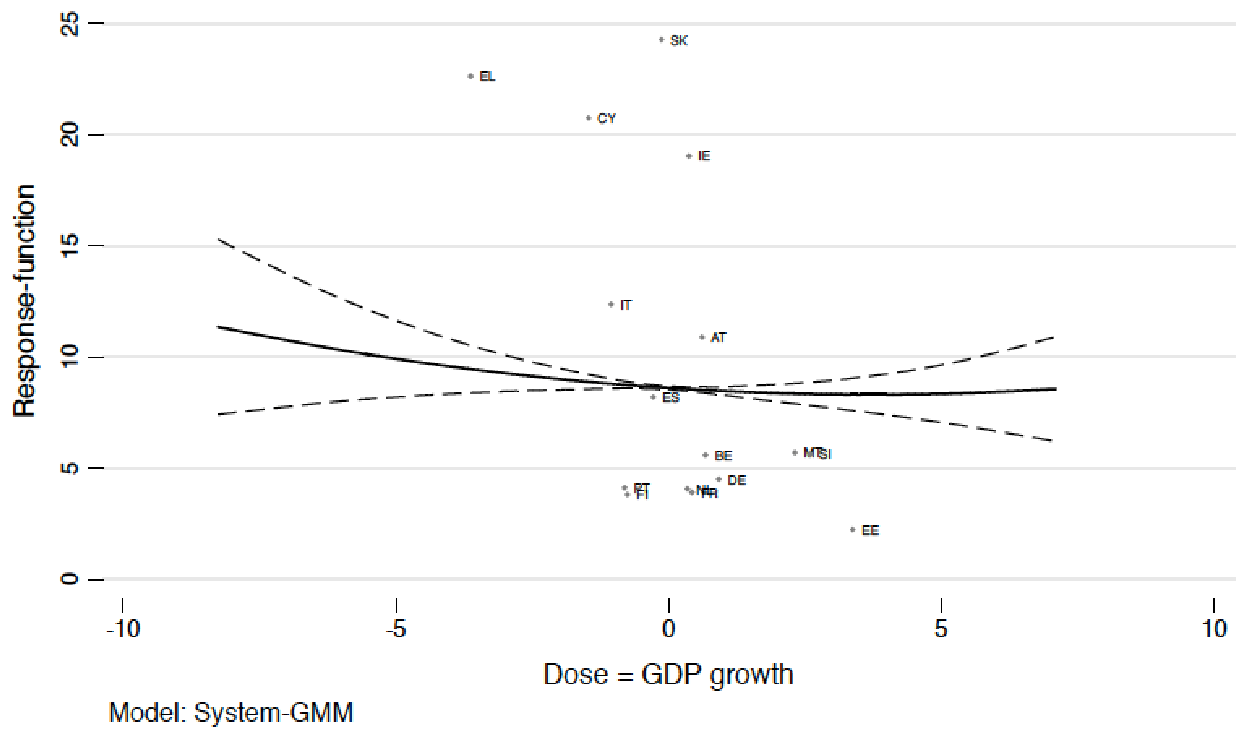


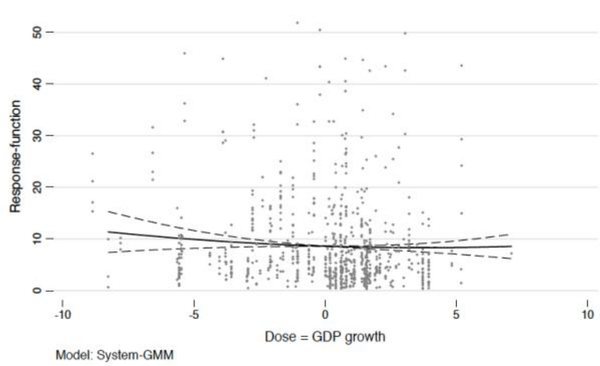
Figure 5: The effect of the annual GDP growth rate on Non Performing Loan levels

Figure 5 illustrates system-GMM estimation of the response function *H*(*s*) as described ok in section III.1. This is the pattern of NPLs predictions over different levels of GDP rate of growth. We obtain our results by adapting to our context a continuous treatment approach as set out in section III.1. We plot 95% confidence intervals curves for *H*(*s*) at any level of GDP rate of growth. A polynomial function interpolates the response function with coefficients obtained through system-GMM. A second order polynomial curve provides the best fit. All variables are defined in Table 1.

Panel A – Dose response function reporting mean country-level data



Panel B – Dose response function reporting bank-level data and quality of the fit



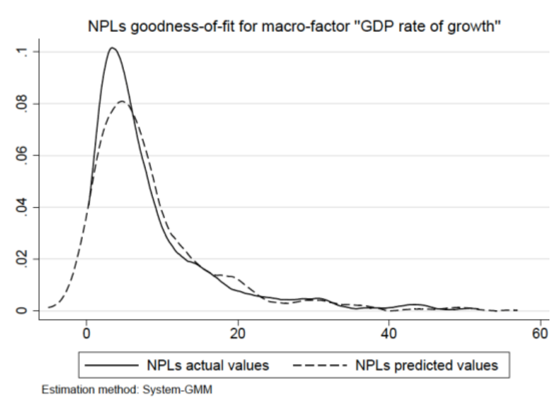
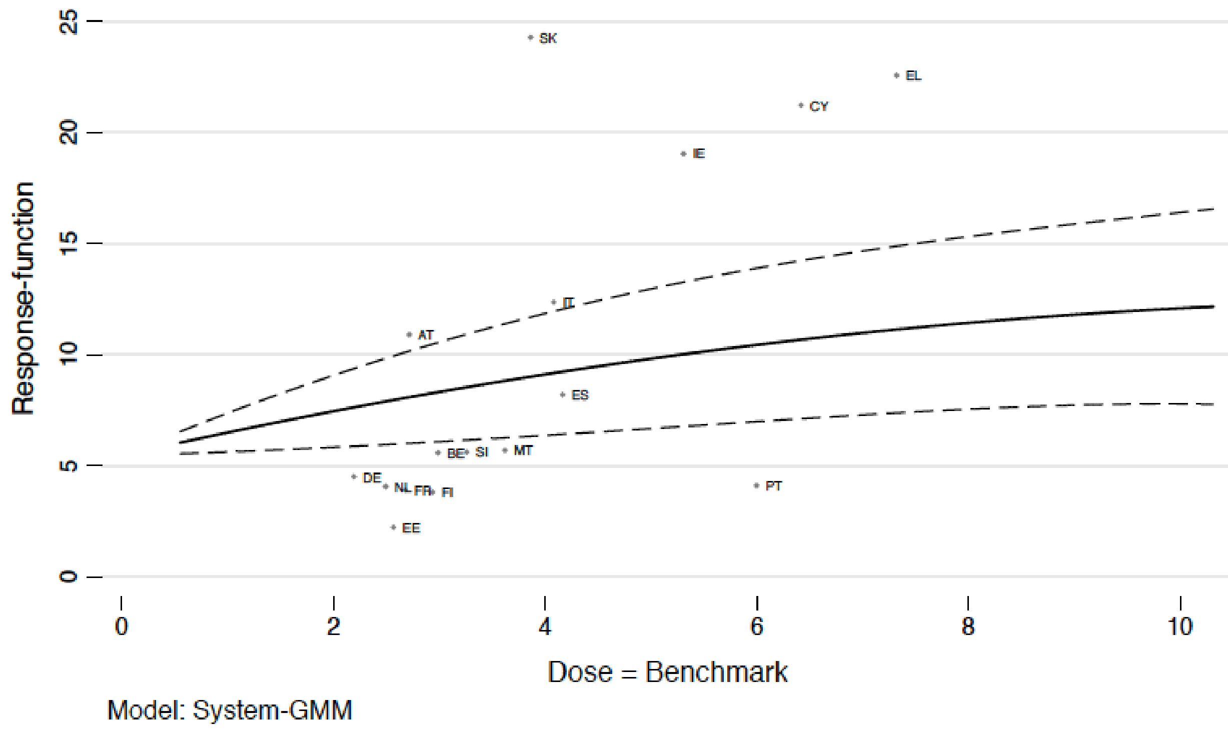


Figure 6: The effect of the benchmark rate on Non Performing Loan levels

Figure 6 illustrates system-GMM estimation of the response function *H*(*s*) as described in section III.1. This is the pattern of NPLs predictions over different levels of benchmark rate. We obtain our results by adapting to our context a continuous treatment approach as set out in section III.1. We plot 95% confidence intervals curves for *H*(*s*) at any level of benchmark rate. A polynomial function interpolates the response function with coefficients obtained through system-GMM. A second order polynomial curve provides the best fit. All variables are defined in Table 1.

Panel A – Response function reporting mean country-level data



Panel B – Response function reporting bank-level data and quality of the fit

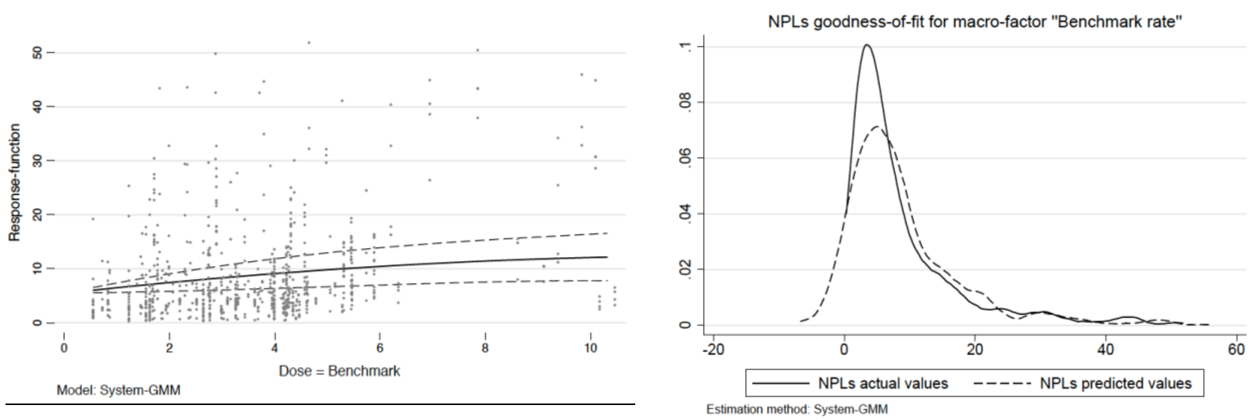
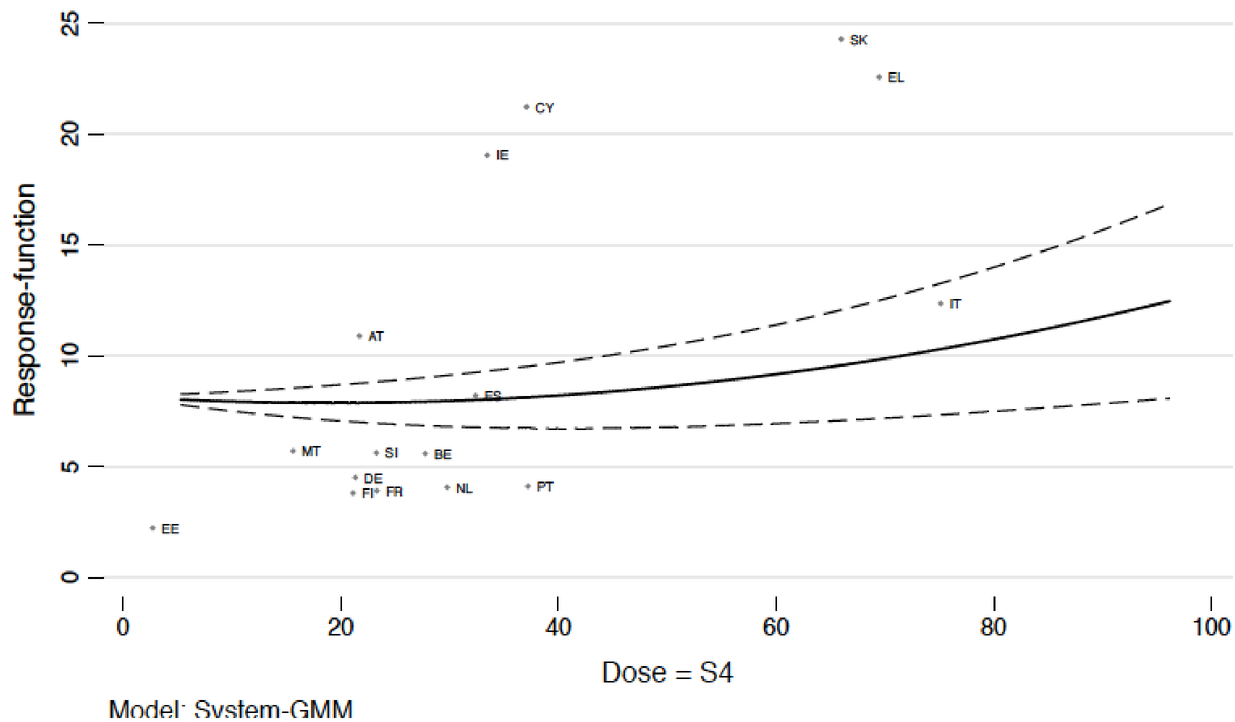


Figure 7: The effect of S_4 (GDP and Judicial efficiency) on Non Performing Loan levels

Figure 7 shows the system-GMM estimation of the response function *H*(*s*) as described in section III.1. This is the pattern of NPLs predictions over different levels of the variable S4. This variable – standardized to range from 0 to 100 – is obtained by combining high judicial inefficiency and low economic growth. We obtain our results by adapting to our context a continuous treatment approach as set out in section III.1. We plot the 95% confidence intervals curves for *H*(*s*) at any level of benchmark rate. A polynomial function interpolates the response function with coefficients obtained through system-GMM. A second order polynomial curve provides the best fit. All variables are defined in Table 1.

Panel A – Response function reporting mean country-level data



Panel B – Dose response function reporting bank-level data and quality of the fit