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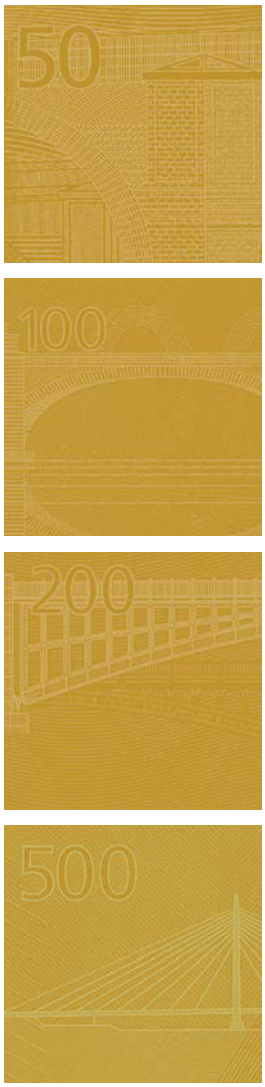

WORKING PAPER SERIES

NO 1515 / FEBRUARY 2013

NON-PERFORMING LOANS

WHAT MATTERS IN ADDITION TO THE ECONOMIC CYCLE?

Roland Beck,
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Anamaria Piloiu

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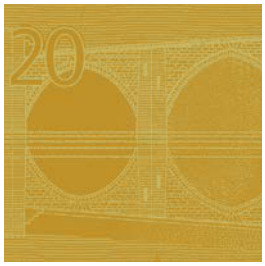

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Macroprudential Research Network
This paper presents research conducted within the Macroprudential Research Network (MaRs). The network is composed of economists from the European System of Central Banks (ESCB), i.e. the 27 national central banks of the European Union (EU) and the European Central Bank. The objective of MaRs is to develop core conceptual frameworks, models and/or tools supporting macro-prudential supervision in the EU.
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Acknowledgements
We thank Elitza Mileva, Jorn Zenhorst, Roland Straub, Philipp Hartmann, an anonymous referee and the Editorial Board of the ECB Working Paper Series for useful comments on an earlier draft. All remaining errors are ours.

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ISSN	1725-2806 (online)
EU Catalogue No	QB-AR-13-012-EN-N (online)

Abstract

Using a novel panel data set we study the macroeconomic determinants of non-performing loans (NPLs) across 75 countries during the past decade. According to our dynamic panel estimates, the following variables are found to significantly affect NPL ratios: real GDP growth, share prices, the exchange rate, and the lending interest rate. In the case of exchange rates, the direction of the effect depends on the extent of foreign exchange lending to unhedged borrowers which is particularly high in countries with pegged or managed exchange rates. In the case of share prices, the impact is found to be larger in countries which have a large stock market relative to GDP. These results are robust to alternative econometric specifications.

JEL Classification Numbers: G21, G28, G32, F34

Keywords: Non-performing loans, credit risk, currency mismatches

Non-technical Summary

Over the past decade, the credit quality of loan portfolios across most countries in the world remained relatively stable until the financial crises hit the global economy in 2007-2008. Since then, average bank asset quality deteriorated sharply due to the global economic recession. Yet the deterioration of loan performance was very uneven across countries. We are interested in explaining these differences in bank asset quality across countries and over time. In this paper, we therefore study the empirical determinants of non-performing loan (NPL) ratios using a novel data set for 75 countries covering the past decade.

Our econometric analysis suggests that real GDP growth was the main driver of non-performing loan ratios during the past decade. Therefore, a drop in global economic activity remains the most important risk for bank asset quality. At the same time, economic activity is not able to fully explain the evolution of non-performing loans across countries and over time. In fact, our empirical results suggest that additional factors may negatively affect asset quality in countries with specific vulnerabilities. In particular, exchange rate depreciations lead to an increase of non-performing in countries with a high degree of lending in foreign currencies to unhedged borrowers which we approximate by international claims which are mostly denominated in foreign currencies. We also find that a decline of stock prices can negatively affect bank asset quality, in particular in countries with large stock markets relative to GDP. Finally, we find that an increase in lending interest rates tends to increase non-performing loans,

While we do not have sufficient data to further investigate through which channels these variables affect bank asset quality, we believe that in the case of currency depreciations, the impact on non-performing loans would work via negative balance sheet effects in countries with currency mismatches. Typically, the exposure to balance sheet effects leads to 'fear of floating' considerations among the authorities which therefore often maintain tightly managed exchange rates against the dollar or the euro. When such exchange rate pegs collapse during a crisis due to insufficient foreign exchange reserves, currency depreciations increases the debt servicing costs in local currency terms for borrowers with loans denominated in foreign currency. If these borrowers have no income in foreign currency which would hedge them against

a depreciation, defaults on foreign-currency denominated loans will tend to rise. In countries without currency mismatches, on the other hand, a depreciation of the local currency could reduce non-performing loans through an increase in export volumes and thus an improvement of the financial position of the corporate sector.

In the case of share prices, the direct impact on NPLs is less obvious. To the extent that share prices are correlated with house prices (on which we do not have sufficient data for many countries) we suppose that our findings could reflect the notion that a drop in the value of collateral for housing loans could negatively affect the loan quality of consumer loans. With respect to corporate loans, our estimated marginal coefficient for share prices might also pick up more general financial conditions which appear to affect the ability of borrowers to repay loans in addition to economic activity. At the same time, shares, while rarely used directly as collateral, might be correlated with other risky assets which serve as collateral for loans. Finally, in the case of lending interest rates, the channel to non-performing loans is likely to work through a rise of debt service costs of borrowers with variable rate contracts.

Our results could serve as useful benchmark parameters for emerging market economies with limited data availability. For the calibration of stress tests in the major economies with more sophisticated financial systems though, higher quality NPL figures (at higher frequencies and disaggregated by sector) may be available and allow more precise country-specific estimates.

With respect to macro-prudential policy, the findings of this paper suggest that for "macro-stress tests" – which typically underpin scenarios for a rise in non-performing loans with a macroeconomic scenario for real GDP – policy makers might consider including exchange rates, stock prices and lending interest rates consistently into these scenarios. Since our panel results suggest that it is difficult to account for the impact of exchange rates and stock prices simultaneously, (advanced) economies might want to compare their models for NPLs to our specifications which include stock prices but exclude the exchange rate. For emerging economies with a lower level of capital market development and a higher exposure to exchange rates our specifications with a role for the exchange rate (via both the competitiveness and the balance sheet channel) excluding share prices are most likely more relevant.

1. Introduction

Over the past decade, the credit quality of loan portfolios across most countries in the world remained relatively stable until the financial crises hit the global economy in 2007-2008. Since then, average bank asset quality deteriorated sharply due to the global economic recession (see Charts 1 and 2 in the Appendix). The fact that loan performance is tightly linked to the economic cycle is well known and not surprising. Yet the deterioration of loan performance was very uneven across countries. For example, the Baltic countries which stand out in cross-country comparisons of GDP performance during the crisis had very large increases in non-performing loans (NPLs) even when controlling for the severity of the recession. In Latvia, the economy shrank by a stunning 18% in terms of real GDP in 2009. Yet during the same period, NPLs more than tripled even though they should have only doubled, according to a simple cross-country regression of NPL growth on real GDP growth rates (see Chart 3 in the Appendix). At the same time, it appears that the NPL ratio in e.g. Germany rose by less than one would have expected from a simple cross-country regression, given that the economy contracted by almost 5% in 2009 (see also Chart 3 in the Appendix).

We are interested in explaining these differences in bank asset quality across countries and over time. In this paper, we therefore study the empirical determinants of NPL ratios using a novel data set for 75 countries covering the past decade. In addition to economic activity and lending interest rates which are standard empirical determinants of bank asset quality, we highlight the importance of two additional factors: First, we find that in countries with widespread currency mismatches, exchange rate depreciations are associated with lower bank asset quality. Secondly, our empirical analysis shows that growth in NPLs is systematically related to a drop in share prices. These effects are found to be statistically and economically significant.

We do not have sufficient data to fully investigate through which channels these variables affect bank asset quality. Taking these data constraints into account, we investigate some possible channels through which our variables might impact NPLs. In the case of currency depreciations, we would expect that, in countries with currency mismatches, depreciations would tend to increase NPLs via negative balance

sheet effects. Typically, this leads to 'fear of floating' considerations among the authorities which therefore often maintain tightly managed exchange rates against the dollar or the euro (Hausmann et al, 2001). When such exchange rate pegs collapse during a crisis due to insufficient foreign exchange reserves, currency depreciations increase the debt servicing costs in local currency terms for borrowers with loans denominated in foreign currency. If these borrowers have no income in foreign currency which would hedge them against a depreciation, defaults on foreign-currency denominated loans will tend to rise. On the other hand, a depreciation of the local currency can also reduce NPLs through an increase in export volumes and thus an improvement of the financial position of the corporate sector. This effect is likely to dominate in countries without significant currency mismatches and relatively open economies. Finally, in the case of lending interest rates, the channel to non-performing loans is likely to work through a rise of debt service costs of borrowers with variable rate contracts.

In the case of share prices, the direct impact on NPLs is not obvious. To the extent that share prices are correlated with house prices (on which we do not have sufficient data for many countries) we suppose that our findings could reflect the notion that a drop in the value of collateral for housing loans could negatively affect the loan quality of consumer loans. With respect to corporate loans, our estimated marginal coefficient for share prices might also pick up more general financial conditions which appear to affect the ability of borrowers to repay loans in addition to economic activity. At the same time, shares, while rarely used directly as collateral, might be correlated with other risky assets which serve as collateral for loans. In addition, the inclusion of share prices which are more volatile than economic activity account for possible non-linear effects.

In terms of economic significance our findings indicate that changes in economic activity were the largest driver of the deterioration of bank asset quality during the crisis of 2008-2010. In countries with inflation targeting frameworks in place, interest rate cuts offset the rise in NPLs only marginally, in part because lower monetary policy rates did not fully pass through to lending interest rates. The changes in exchange rates made a notable contribution in countries which did not have enough foreign exchange reserves to defend their currency. The economic significance of

share price declines for bank asset quality, on the other hand, appears to be relatively moderate in size, albeit somewhat larger in countries with a relatively large stock market. Likewise, we find that the contribution of lending interest rates to the evolution of NPL ratios is relatively small - a finding which is to some extent driven by the fact that short-term policy rates set by central banks are not fully transmitted to lending interest rates.

Our analysis could be of interest to policy makers for two main reasons. First, the assessment of overall asset quality and credit risk in the financial sector is an important element of macro-prudential surveillance. A thorough understanding of its drivers facilitates the identification of key vulnerabilities of the financial sector. Second, regular stress tests of loan quality are increasingly based on macroeconomic assumptions in order to provide common scenarios for all financial institutions participating in such an exercise. Stress tests of loan quality were also an important element of recently conducted stress tests with the aim of restoring confidence in financial systems.

Finally, our results can serve as a cross-check for bank supervisors in emerging markets who wish to set up econometric models linking NPLs with macroeconomic indicators. For the calibration of stress tests in the major economies with more sophisticated financial systems though, higher quality NPL figures (at higher frequencies and disaggregated by sector) may be available and allow more precise country-specific estimates.

The remainder of the paper is organized as follows. The next section provides a short description of the literature related to asset quality. Section 3 presents a comprehensive description of the dataset and gives a scent of how NPLs have evolved during the last decade. The section also focuses on the econometric methodology that is applied for quantifying the relationship between NPLs and macroeconomic and financial indicators. In section 4 the results of different econometric specifications including several robustness checks are discussed. Section 5 concludes.

2. A brief review of related literature

Models linking credit risk to economic activity are not new in the literature. Theoretical papers, developing business cycle models in which the financial sector is introduced typically find a link between asset quality and economic activity. The classical literature studying the interactions between the macroeconomic environment and financial fundamentals goes back to the models developed by King and Plosser (1984), Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Bernanke, Gertler and Gilchrist (1998). A more recent paper, published by Pesaran, Schuermann, Treutler and Weiner (2006), develops a framework that links the value changes of a credit portfolio to a dynamic global macro-econometric model and concludes that the relationship between the firms and the business cycle is the main driver of default probabilities.

The empirical literature on the interaction between the macroeconomic conditions and asset quality is vast and diverse. A common finding of these studies is the positive relationship between asset quality and economic growth. Nevertheless, the measures of asset quality analyzed in many of these papers differ. Most of the studies linking credit risk to the real economy have looked at the development of expected default frequencies (EDF), loan loss provisions (LLP), loss given default (LGD) and NPLs as a measure of asset quality. According to Espinoza and Prasad (2010), who estimate a dynamic panel over 1995-2008 on around 80 banks in the Gulf Cooperation Council, lower economic growth and higher interest rates trigger an increase in NPLs. The paper also finds a positive relationship between lagged credit growth and NPLs. The findings are also in line with the results of Nkusu (2011), who uses panel data techniques on a sample of 26 advanced economies that spans from 1998 to 2009, to quantify the relationship between the quality of banks' loan portfolio and macro-financial vulnerabilities. Glen and Mondragón-Vélez (2011) look at 22 advanced economies during the period 1996-2008 and find that the developments of loan loss provisions are driven mainly by real GDP growth, private sector leverage and a lack of capitalization within the banking system.

A significant branch of this literature is related to stress-testing of bank balance sheets (e.g. Cihak, 2007; Jakubík and Sutton, 2012). Such exercises have been recently

applied by supervisors e.g. in the EU, the US and the United Kingdom.[5] Due to the crucial role of credit risk within stress test exercises via its impact on bank balance sheets, there are a lot of studies which model the link between credit risk and the macroeconomic environment (Pesola, 2005; Boss, Krenn, Schwaiger and Wegschaider, 2004; Peng, Lai, Leung and Shu, 2003). Some of these papers highlight the nonlinear relationship between macroeconomic shocks and credit risk (Drehmann, 2005; Jakubík, 2007). If appropriate data is available, the probability of default (PD) can be modelled directly (Hamerle, Liebig and Scheule, 2004) or indirectly (Fungačová and Jakubík, 2012). However, this information is often not available; therefore NPL data are typically used in credit risk models as a measure of credit risk. Contrary to original papers on stress tests (see Cihak, 2007) using a static balance sheet approach, more recent stress test methodologies are moving towards a dynamic approach i.e. they allow that at least some balance sheets items can change over time. Such dynamic stress tests can better capture the impact of de/releveraging driven by the decline/increase in lending on banks' capital and also NPL ratios (Jakubík and Schmieder, 2008; Schmieder, Puhr and Hasan, 2011). Models linking asset quality to the macroeconomic environment are also important ingredients of these more recent stress testing frameworks.

Nevertheless, most of the literature is based on country specific studies. For instance, Salas and Saurina (2002) analyze problem loans of the Spanish commercial and savings banks and find that credit risk is determined by microeconomic individual bank level variables, such as bank size net interest margin, capital ratio and market power, in addition to real GDP growth. Quagliariello (2007) looks at the Italian banking sector and analyzes banks' behaviour over the business cycle. The paper investigates whether loan loss provisions, NPLs and the return on assets have a cyclical pattern and concludes that banks' riskiness and profitability are affected by the evolution of the business cycle. Gerlach and Peng (2005) use a multivariate cointegration framework in order to examine the direction of the causality between bank lending and property prices in Hong Kong. They conclude that property prices determine bank lending, but the inverse appears not to be true. Moreover, the results indicate that bank lending in Hong Kong was not the source of the boom and bust

[5] See for example Committee of European Banking Supervisors (2010); European Banking Authority (2011), Board of Governors of the Federal Reserve System (2009a, 2009b); Bank of England (2008).

cycles of the property market. Blavy and Souto (2009) estimate the default frequencies and analyze the macro financial linkages in the Mexican banking sector. More recently, Louzis, Vouldis and Metaxas (2010) examine the determinants of NPLs in the Greek banking sector and find that credit quality among Greek banks can be explained mainly by macroeconomic fundamentals (GDP, unemployment and interest rates) and management quality.

This paper contributes to the current literature on the empirical determinants of NPLs mainly by employing a unique data sample covering a large number of countries. Exploiting cross-country variation in non-performing loan trends is likely to yield more robust results than an analysis of individual countries since time series for NPLs are typically short, covering at most 10 years of annual data. At the same time, studies based on bank-by-bank, while very useful in a micro-prudential context, are only available for a few economies so that the impact of cross-country differences with respect to structural characteristics on asset quality cannot be studied.

3. Empirical methodology

In this section, we look more systematically at possible determinants of asset quality. In particular, we consider whether - in addition to economic activity - exchange rate depreciations might negatively impact asset quality, especially in countries with a large amount of lending in foreign currency to unhedged borrowers. In addition, we investigate whether declines in stock prices help explaining differences in asset quality, e.g. via wealth effects among borrowers or via a decreased value of collateral. Finally, the lending interest rate which tends to negatively affect asset quality due to higher borrowing costs is also considered as a possible determinant. Therefore, to the extent that lending rates are affected by the policy rate set by central banks, we also take the swift monetary policy response to the crisis in countries with flexible exchange rates which pursue inflation targeting into account.

3.1. Data

Our dependent variable is the ratio of NPLs to total (gross) loans. For a large group of countries, such data are only available at an annual frequency with a relatively short

time dimension.[6] For this paper, a panel data set covering 75 countries over ten years was compiled by combining two data sets from the IMF and the World Bank (see Table 4 for an overview of all data sources used for our empirical analysis). The Financial Soundness Indicators database, from the IMF includes annual data for NPLs for a large number of countries starting from 2005 until 2010 while the World Bank provides for NPL data starting from 2000. We primarily use the dataset from the IMF and extend it backward using the World Bank data. We account for possible methodological differences across the definitions of NPLs by looking at the overlapping periods of the datasets, using the World Bank data only when there was no significant difference in levels during the overlap period. More formal tests confirmed that our final (unbalanced) panel data set (see Table 1 in the Appendix for a list of countries included) contains no structural breaks in the NPL series, i.e. a dummy variable that takes the value of one from 2005 onwards and zero otherwise proves not to be statistically significant when included in the regressions.

Since the definitions of NPLs vary across countries, comparisons of the levels of NPLs across countries and regions should be interpreted with caution. According to the most commonly used ("reference") definition, a default occurs when the bank considers that an obligor is unlikely to repay its credit obligations to the banking group in full, without recourse by the bank to actions such as realising security (if held); or the obligor is past due for more than 90 days on any material credit obligation to the banking group (Basel Committee on Banking Supervision, ibid., paragraph 452). Based on this definition, NPLs should include all loans which are 90 days overdue. However, some countries report in their statistics all loans which are 31 days overdue, in some cases 61 days overdue and some countries do not comply with the international standards at all. Based on the proposal of the Institute of International Finance (IIF) aimed at helping to improve cross-country comparisons, five categories of loans are commonly used for reporting purpose: "standard", "watch", "substandard", "doubtful" and "loss loans". Their precise definition varies, however, significantly among countries. In some cases, NPLs correspond to the last three categories, in other only to doubtful and loss loans, in some cases only to loss loans.

[6] While the bank supervisors in many advanced and some emerging economies collect quarterly NPL data such information is usually not publicly available. In addition, quarterly data often have an even shorter time dimension.

Apart from the number of days overdue, there are other differences among definitions. In some cases, NPL's classification criteria do not cover only one dimension (number of days overdue), but also other elements (e.g. Romania where loan classification takes into account also the financial performance of the debtor and whether or not a judicial procedure has been started). Another important feature of the NPLs definition is for example whether they are reported in *gross* terms (international standard) or *net* of provisions. Moreover, classification methods for multiple loans to the same client vary by country. In several countries if a loan is classified as impaired, all other loans to the same customer are classified in that same category. Another important aspect is the role of collateral and guarantees in the classification process. Several jurisdictions do not take collateral and guarantees into account for classification purposes.[7]

Against the backdrop NPL level differences across countries, we estimate our empirical model in logarithmic differences in order to avoid possible measurement error in our dependent variable. In addition, we carefully check our dataset for possible changes in the definition of NPLs over time, excluding observations following a change in such definitions.

A first descriptive look at our final NPL data set suggests that, among the advanced economies, bank asset quality gradually improved since the start of the last decade as non-performing loan ratios declined from around 3% of total loans in 2000 to around 1.5% in 2006 (see Chart 1). When problems in the US sub-prime mortgage sector started to emerge in 2007, NPLs began to increase and deteriorated further in 2008 and 2009.

In 2009, asset quality in the emerging markets also deteriorated but the growth rate of NPL ratios was at around 40% somewhat lower than in the advanced economies where average NPL ratios increased in 2009 by around 60% (see Chart 2).

At the country level, developments in assets quality were considerably heterogeneous, in particular with respect to the deterioration in 2009. Whereas in some countries

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

NPLs increased by more than 300% (e.g. in some Baltic countries), asset quality remained stable or even slightly improved in other countries. Given that asset quality should be closely linked to the economic cycle, one might wonder whether such cross-country differences are simply a reflection of the severity of recessions in 2009.

Our independent variables are commonly used country-specific macroeconomic and financial indicators which tend to affect bank asset quality. The data for real GDP, credit, lending interest rates and share prices are obtained from the IMF's International Financial Statistics Database (IFS). We include in our specifications the nominal effective exchange rate[8] (NEER) to capture the effect that a depreciation of the local currency had on the dynamics of NPLs in the economies included in our sample. Nominal effective exchange rates are calculated as geometric weighted averages of bilateral exchange rates taken from the Bank of International Settlements (BIS) statistics (with 58 economies included in the basket) and the IMF's International Financial Statistics.

We choose to interact the nominal effective exchange rate with a dummy variable in order to capture the impact of exchange rate dynamics on asset quality for countries with different levels of foreign currency denominated loans (high versus low). Since it is very difficult to find data for loans denominated in foreign currency, for all the countries included in the sample, we decided to use BIS data on international claims as a proxy for this indicator. International claims (relative to GDP) can be used as a reasonable proxy for foreign currency lending because cross-border lending tends to be denominated mainly in foreign currency[9]. Data on the share of foreign currency loans in total loans are only available for a significantly smaller subset of countries. For this subset, the data used in our analysis confirm that there is a positive correlation between international claims and foreign currency lending relative to GDP. Hence, we construct from the BIS data on international claims a dummy variable that takes the value of one for countries with an international claims-to-GDP ratio above the median and zero otherwise.

[8] An increase in the NEER represents an appreciation of the domestic currency.

[9] We use from the BIS'consolidated banking statistics total international claims of all BIS reporting banks to the respective country, including local lending in foreign currencies and cross-border claims which we assumed to be mainly denominated in foreign currency as in Lane and Shambaugh (2010)

Stock market capitalization data was taken from the Financial Development and Structure Dataset of the World Bank. In order to differentiate the impact of share prices in countries with large capital markets from that in countries with small capital markets we construct a dummy variable that takes the value of one for economies that have a stock market capitalization-to-GDP ratio above the median and zero otherwise. In some of our specifications we interact the share prices with this dummy variable.

3.2. Econometric framework

Typically, empirical models for non-performing loan ratios include a variable for economic activity, a lending interest rate and additional variables. In the econometric models employed for this analysis, real GDP (as a measure of the macroeconomic performance), nominal effective exchange rates, lending interest rates, share prices and total banks' credit are considered as possible determinants of NPLs. We use panel data techniques to analyze and quantify the impact of the macroeconomic and financial variables described above on asset quality during the last decade. This allows us to capture the country-specific effects and the unobservable differences between countries. Using a panel data approach, one can control for the biases generated by potential heterogeneity and omitted variable problems.

We start our analysis by testing for panel stationarity, using a unit root test for unbalanced panels. Maddala and Wu (1999) argue that the Fisher unit root test for panel data performs best when compared with other panel data unit root tests. Unlike most other panel unit roots tests, it does not require a balanced panel data set. We therefore apply the the Fisher test for a panel unit root using an augmented Dickey-Fuller test and find that the null hypothesis of non-stationarity can be rejected for all our variables when taken in logarithmic differences.

3.2.1. Static panel estimation

We first measure the effect of different macroeconomic indicators on asset quality using fixed effects estimations in order to also account for the time-constant unobserved heterogeneity between countries. Also, because our regression analysis is

limited to a specific set of countries and all our variables are time varying, we find it reasonable to use this estimation technique as one of our methods. The fixed effects estimation allows the unobserved country specifics to be arbitrarily correlated with the determinants of asset quality (Wooldridge, 2002) and under the assumption of strict exogeneity it also takes into account the country specific differences. Moreover, it addresses the omitted-variables bias problem by controlling for country-specific effects.[10]

3.2.2. Dynamic panel estimation

In order to capture the persistence of the NPL growth, we adopt a dynamic specification including the lagged logarithmic difference of the dependent variable in the econometric model, which gives rise to autocorrelation problems. The least square estimator of the fixed effects model becomes biased and inconsistent in the presence of the lagged dependent variable.

Moreover, we would like to treat real GDP and nominal effective exchange rates as endogenous, since the causality may run in both directions, and both variables might be correlated with the error term. Simple pair-wise regressions suggest that NPLs do have a significant impact on real GDP and the nominal effective exchange rate. For the other variables included in the model this is not the case. Finally, in order to evade problems of correlation amongst errors and to obtain additional efficiency gains a generalized method of moments (GMM) method with instrumental variables is needed for our analysis,

All the issues discussed above are addressed by the Arellano-Bond two-step difference GMM estimation, with robust standard errors.[11] The inclusion of the lagged dependent variable also assumes that the number of groups (temporal observations) is greater than the total number of regressors included in the model. The specifications used for the Arellano Bond analysis are the same that have been presented in the fixed effects estimation section. The Arellano Bond estimation uses

[10] One may also use the random effects method in order to deal with the unobserved heterogeneity problem but the additional orthogonality assumption between the unobserved country specifics and the determinants of NPLs may not hold. A Hausman test suggests that there is strong evidence in favour of the fixed effects estimation.

[11] See Roodman (2006) – How to do xtabond2: an introduction to "Difference" and "System" GMM in Stata.

the available lags of the dependent variables and the lagged values of the exogenous regressors as instruments. The variables considered as endogenous are instrumented with GMM-style instruments, more specifically the lagged values of the variables.

The number of instruments is always kept below the number of groups in all our GMM specifications. AR(1) and AR(2) are the Arellano-Bond tests for first and second order autocorrelation of the residuals. One should reject the null hypothesis of no first order serial correlation and not reject the null hypothesis of no second order serial correlation of the residuals. In our case the requirements are met as suggested by the p-values of the AR(1) and AR(2) tests. The Hansen test of overidentifying restrictions suggests that the instruments used in all the specifications are appropriate.

4. Empirical results

In Tables 2 and 3 in the Appendix we report the estimated coefficients and their p-values of the fixed effects and Arellano-Bond estimations. Overall, the estimated models are able to explain the development of non-performing loan ratios in advanced and emerging economies reasonably well. The fixed effects results confirm that real GDP growth has a negative impact on NPLs while the evidence on our additional variables is more mixed. Since NPLs exhibit a high degree of persistence, we do not discuss the static estimation results in more detail and refer the reader to Table 2 in the Appendix which contains all estimated coefficients and their statistical significance levels.

We prefer the dynamic Arellano-Bond estimations (Table 3), due to the high persistence of NPL growth. We start our analysis by looking at the effect of lagged NPLs growth, contemporaneous and lagged real GDP growth and contemporaneous and lagged nominal effective exchange rates (see Table 3, column 1). As expected, a rise in (contemporaneous) real GDP growth leads to a decline in non-performing loan ratios.[12] This finding is robust across all considered specifications and in line with existing research and the results of Glen, Mondragón-Vélez (2011) as well as Nkusu (2011). Lagged GDP growth also significantly affects NPL growth but with a positive sign. This finding lends support to the notion that bank asset quality deteriorates with

[12] Typically, a decline in economic activity tends to affect non-performing loans with a time lag of a few quarters. With annual data, the impact is attributed to the contemporaneous growth rate of real GDP.

a lag in response to positive growth due to loose credit standards applied during the boom period. At the same time, the overall impact of GDP growth (the sum of the lagged and the contemporaneous coefficient) is negative as expected. The contemporaneous NEER also proves to have a significant impact on NPLs. Our finding of a positive coefficient for the NEER suggests that a depreciation (appreciation) of the domestic currency would lead to a decline (increase) in non-performing loan ratios, i.e. that the competitiveness channel outweighs in our overall sample negative balance sheet effects which could be mitigated e.g. by natural hedges (such as revenues or income in foreign currency) in countries with high lending in foreign currencies.

In column 2 of Table 3, we add lagged lending interest rates to the regression. The coefficients and the p-values of our initial variables remain relatively similar and lending interest rates prove to have a significantly positive impact on the NPLs. In column 3 of Table 3, share prices are introduced as another explanatory variable which proves to have a statistically significant negative impact on NPLs, i.e. a drop (rise) in share prices leads to a rise (drop) in NPLs. While GDP, lagged GDP and lagged lending interest rates remain statistically significant in this specification with share prices, the NEER becomes statistically insignificant. We decided therefore to also estimate a model with share prices but without the NEER (column 4 of Table 3). In this specification share prices and lending interest rates become statistically and economically more significant. Model 4 could thus serve, in our view, as a parsimonious specification to be used as a benchmark for macro stress testing in (advanced) economies with a developed stock market and relatively little exposure to exchange rate risks (e.g. because the domestic industry matters more than the export sector and/or currency mismatches are less widespread because these countries can borrow in their own currencies or hedge against exchange rate risks).

In order to shed more light on the impact of the exchange rate on NPLs we look into the effect of the (contemporaneous and lagged) NEER on NPLs when interacted with a dummy variable that takes the value of one for the countries with levels of international claims to GDP above the median and zero otherwise (columns 5 to 8 of Table 3). Recall that we use international claims to GDP as a proxy variable for unhedged foreign currency loans. Hence, we would expect that in countries with a

high level of international claims relative to GDP (*High ICL*) the balance sheet channel might dominate, i.e. a depreciation would lead to an increase of NPLs. In countries with a low level of international claims relative to GDP (*Low ICL*), on the other hand, we would expect that the competitive channel prevails as in our model with the NEER without interaction terms (column 1, Table 3).

In a parsimonious model where we do not control for lending interest rates and share prices (column 5, Table 3) the NEER keeps its contemporaneous significant positive impact on NPLs in countries with a low level of international claims, i.e. the competitiveness channel prevails. However, the NEER is not statistically significant when interacted with the dummy variable for countries with a high level of international claims suggesting that two factors (the competitiveness channel and the balance sheet channel) could offset each other. However, when we control for lagged lending interest rates (column 6, Table 3) the results are qualitatively unchanged with the exception that now the lagged NEER is associated with lower NPLs in countries with high international claims, i.e. the balance sheet channel appears to prevail in such countries when we control for lending interest rates. If we include shares prices to this specification (column 7, Table 3) the statistical significance of the respective interaction term disappears though and the lagged NEER gets an incorrect sign when interacted with the dummy variable for countries with low international claims. This finding confirms our previous results suggesting that it is difficult to account for the impact of share prices and exchange rates simultaneously. We therefore also present a specification where only lending interest rates are included as control variable and insignificant lags of the NEER are excluded (i.e. the first lag interacted with the dummy variable for countries with low international claims and the contemporaneous NEER interacted with the dummy for countries with high international claims, see column 8, Table 3). In this specification, a depreciation of the NEER is associated with a statistically significant decrease (increase) of NPLs in countries with low (high) international claims. Model 8 would thus be our preferred model for (emerging) economies where the exchange rate matters a lot (either because of an important export industry or because of currency mismatches) and have less developed stock markets.

Finally, we investigate whether the impact of share prices on NPLs also depends on specific country characteristics, namely whether the stock market is large relative to the size of the economy. We therefore look at the effect of stock prices on NPLs when interacted with a dummy variable which takes the value of one for countries with a stock market capitalisation relative to GDP *(High Stock Mk. Cap)* above the median of our sample and zero otherwise *(Low Stock Mk. Cap)*. Using our initial specification (column 1, Table 3) including the NEER without interaction terms we find that share price increase are associated with statistically lower NPLs in countries where the stock market is large relative to GDP (column 9, Table 3). For countries with small stock markets, this effect is not statistically significant. When we control for lagged lending interest rates (column 10, Table 3) share price increases are associated with lower NPLs in countries with large and small stock markets, but the coefficient is larger in the case of countries with a large stock market.

Moving from statistical to economic significance of the variables considered, a contribution analysis is performed for a few illustrative cases (Chart 4), i.e. countries with certain policy choices in place (e.g. fixed or floating exchange rate regime) or certain structural characteristics (e.g. a large degree of FX lending or stock market capitalisation). For these illustrations we use model (8) for countries with high international claims (Latvia, Ukraine) where in both cases the dummy variable assumes the value one, i.e. the coefficients of NEER***High ICL* are applied whereas the coefficients of the interaction term *NEER*Low ICL* do not matter. For countries with a relatively large stock market (Germany, United Kingdom) we use model (10) where in both cases the dummy variable assumes the value one, i.e. the coefficients for Shares Prices * High Stock Mk. Cap are applied whereas the coefficients Share Prices*Low Stock Mk. Cap do not matter.[13]

While economic growth is the key driver of nonperforming-loans for all selected economies, the decline in the stock market has also significantly contributed to an increase in NPLs, especially in countries with a relatively large stock market., e.g. in Germany during 2009. The chart also depicts the case of two emerging economies which are both exposed to negative balance sheet effects via FX lending (Latvia and

[13] While stock market capitalisation in the UK is significantly larger than in Germany which has a more bank-based financial system, both countries have larger stock markets relative to GDP compared to the median of our sample.

Ukraine) but differ in terms of exchange rate volatility. In these cases, the contribution analysis reveals that the large depreciation of the exchange rate during the crisis has contributed to the a significant increase in NPLs in Ukraine in 2009 and 2010 due to the significant share of foreign currency denominated loans in total loans, especially on households' balance sheets. On the contrary, in Latvia, which maintained its currency board arrangement vis-à-vis the euro during the crisis, the exchange rate did not have a significant impact on NPLs. At the same time, since interest rates had to increase to defend the currency board, higher lending rates contributed, albeit marginally, to the large increase in NPLs in the case of Latvia. Finally, the case of the UK demonstrates how an accommodative monetary policy response to the crisis which led to decreasing lending interest rates, positively influenced the bank loan quality. In the case of Germany, however, the contribution of a more accommodative monetary policy stance to dampen NPL growth was more limited due to a less pronounced decline in lending interest rates compared to the UK.[14]

Robustness tests

As mentioned above we tested the robustness of our findings using alternative specifications. We applied Fixed Effects, Random Effects (not reported but available upon request) and Arellano Bond estimation techniques in order to check the robustness of our coefficients. Comparing Table 2 and Table 3 (see Annex) suggests that our estimated coefficients maintain their significance and order of magnitude in both our static and dynamic panel specifications. This also holds true when additional control variables (e.g. domestic credit to private sector) are included in the regressions

Because we merge data on NPLs from two different sources, we also investigate whether a break in the data in 2005 is statistically significant in our regressions, including a dummy variable that takes the value of one from 2005 onwards and zero

[14] The transmission of policy rates on bank lending rates depends on many factors such as the maturity of loans. For the empirical exercise aggregate lending interest rates from the IMF's International Financial Statistics have been used with the exception of Germany where lending interest rate data refer to mortgage rates for new housing loans as reported by the Deutsche Bundesbank.

otherwise. We find strong evidence in favour of no break in the data which allows us to argue that our dataset is reliable and consistent.

5. Concluding Remarks

The econometric analysis of the empirical determinants of NPLs presented in this paper suggests that real GDP growth was the main driver of non-performing loan ratios during the past decade. Therefore, a drop in global economic activity remains the most important risk for bank asset quality. At the same time, asset quality in countries with specific vulnerabilities may be negatively affected by additional factors. In particular, exchange rate depreciations might lead to an increase of non-performing loans in countries with a high degree of lending in foreign currencies to unhedged borrowers (approximated by international claims which are mainly denominated in foreign currencies). According to our analysis a drop in stock prices also negatively affects bank asset quality, in particular in countries with large stock markets relative to the economy.

To some extent these risks recently materialised. The depreciation of local currencies in Central, Eastern and Southeast Europe against the Swiss Franc and, to a lesser extent, against the euro has already negatively affected asset quality e.g. in Poland, Hungary and Croatia where lending in these currencies is widespread. The drop in global share prices in 2011 is also likely to negatively affect bank asset quality, in particular among the advanced economies with relatively large stock markets.

With respect to macro-prudential policy, the findings of this paper suggest that "macro-stress tests" – which typically underpin scenarios for a rise in NPLs with a macroeconomic scenario for real GDP – policy makers might consider including exchange rates, stock prices and interest rates consistently into these scenarios, taking their impact on asset quality also into account. Clearly, this recommendation presents a challenge to macroeconomic modelling which often abstracts from asset prices and (endogenous) exchange rates. Since our panel results suggest that it is difficult to account for the impact of exchange rates and stock prices simultaneously, (advanced) economies might want to compare their models for NPLs to our specifications which

include stock prices but exclude the exchange rate. For emerging economies with a lower level of capital market development and a higher exposure to exchange rates our specifications with a role for the exchange rate (via both the competitiveness and the balance sheet channel) excluding share prices are likely to be more relevant.

As regards monetary policy, the significant impact of lending interest rates on bank asset quality might be relevant for central banks not only because of its possible negative effect on financial stability but also because systemic banking crises typically lead to economic contractions via negative feed-back effects between the financial sector and the real economy. Therefore, such crises episodes can also lead to deflation which is at odds with the objective of price stability in the medium to longer term.

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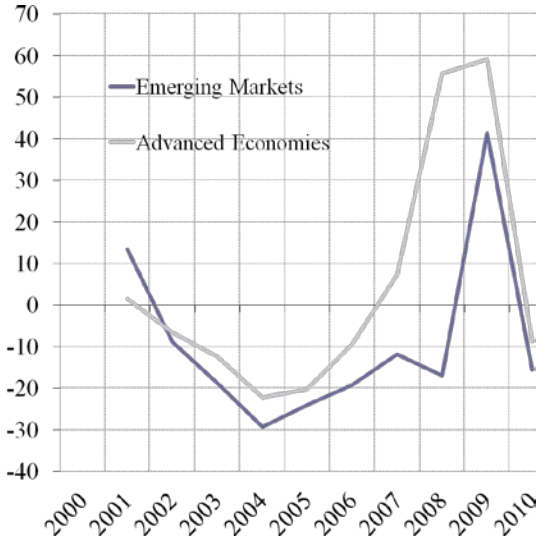
APPENDIX

Chart 1: Non-performing loans to total loans ratio (%)

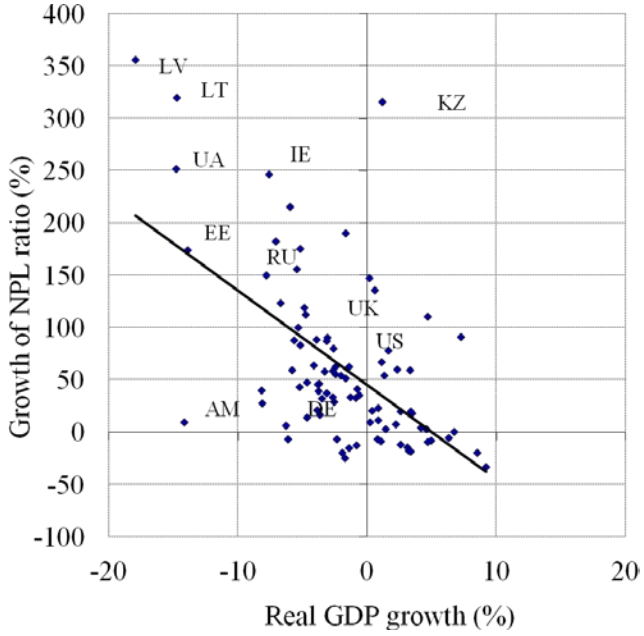
Sources: IMF, World Banks and authors' calculations.

Chart 2: Growth of NPL ratio (%)



Sources: IMF, World Banks and authors' calculations.

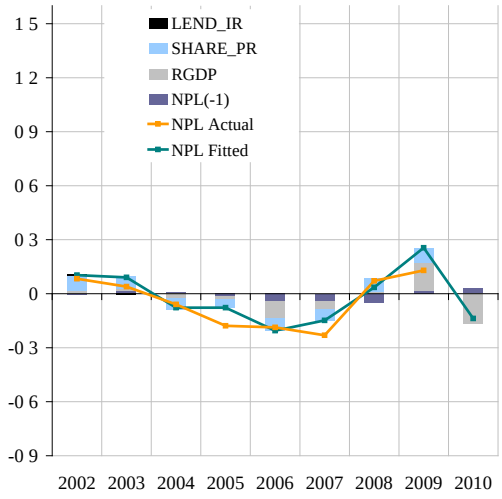
Chart 3: Growth of NPL ratio and real GDP growth in 2009



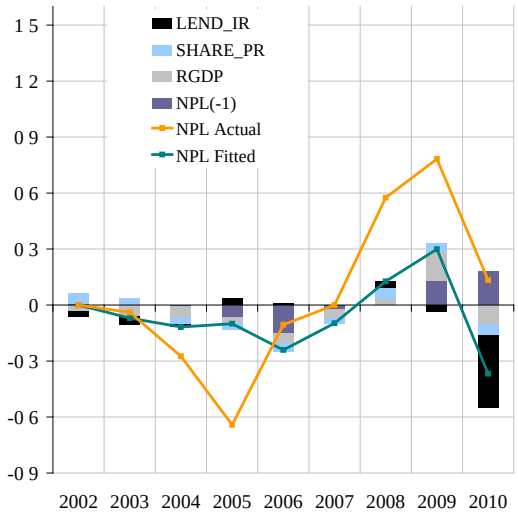
Sources: IMF, World Bank, ECB calculation

Chart 4: Contribution of independent variables to the growth of NPLs in selected economies

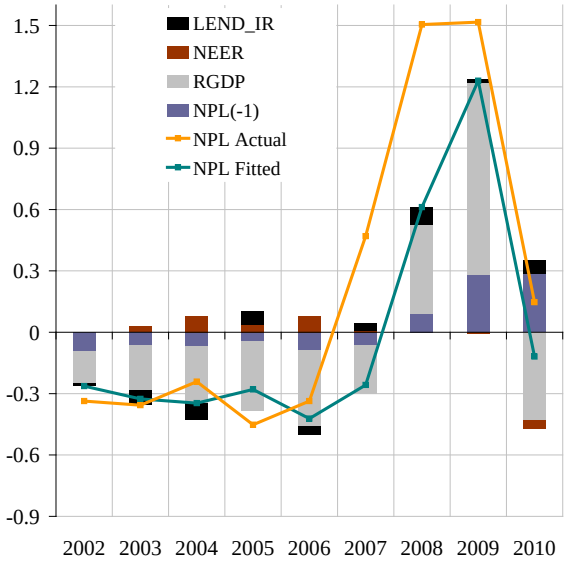
GERMANY



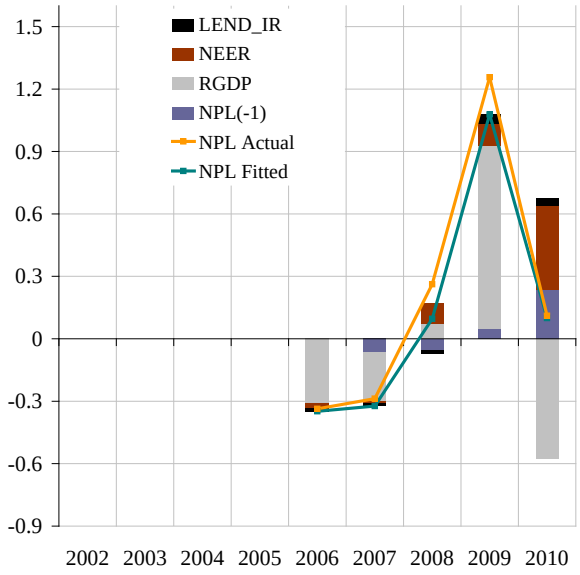
UK



LATVIA



UKRAINE



Sources: IMF, World Bank and ECB calculations.
Notes: All indicators are considered in logarithmic differences. The fitted values of logarithmic difference NPL are computed using Arellano Bond estimates for which the RGDP and NEER were treated as endogenous. For Ukraine, the time series on NPLs is starting in 2005 and for Germany data on NPLs is available until 2009. The contribution of each indicator is computed as the product of its coefficient and the actual value of the variable.

Table 1. Country sample

Argentina
Armenia
Australia
Austria
Belgium
Bolivia
Brazil
Bulgaria
Canada
Chile
China
Colombia
Costa Rica
Croatia
Czech Republic
Denmark
Dominican Republic
Ecuador
Egypt, Arab Rep.
Estonia
Finland
France
Gabon
Georgia
Germany
Ghana
Greece
Hong Kong, China
Hungary
India
Indonesia
Ireland
Israel
Italy
Japan
Korea, Rep.
Kuwait
Latvia
Lebanon
Lithuania
Luxembourg
Macedonia, FYR
Malaysia
Mexico
Moldova
Morocco
Netherlands
Norway
Oman
Pakistan
Paraguay
Peru
Philippines
Poland
Portugal
Romania
Russian Federation
Saudi Arabia
Singapore
Slovak Republic
Slovenia
South Africa
Spain
Sweden
Switzerland
Thailand
Tunisia
Turkey
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Venezuela, RB

Table 2. Determinants of non-performing loans (Fixed Effects estimation)

Fixed Effects Estimation	Dependent Variable NPL							
	1	2	3	4	5	6	7	8
RGDP	-5.761*** *(0.000)*	-5.465*** *(0.000)*	-4.578*** *(0.000)*	-5.748*** *(0.000)*	-5.395*** *(0.000)*	-4.494*** *(0.000)*	-4.806*** *(0.000)*	-4.385*** *(0.000)*
RGDP (-1)	1.103*** *(0.003)*	1.145*** *(0.003)*	0.768** *(0.029)*	1.144*** *(0.003)*	1.163*** *(0.003)*	0.712* *(0.067)*	0.818** *(0.019)*	0.893** *(0.015)*
NEER	0.207 *(0.422)*	0.314 *(0.267)*	0.184 *(0.539)*				0.157 *(0.568)*	0.150 *(0.602)*
NEER (-1)	-0.093 *(0.716)*	-0.103 *(0.705)*	-0.434* *(0.084)*				-0.318 *(0.223)*	-0.448* *(0.064)*
Lending IR (-1)		0.226** *(0.017)*	0.186** *(0.050)*		0.248*** *(0.007)*	0.222** *(0.018)*		0.179* *(0.062)*
Share Prices			-0.316*** *(0.000)*			-0.319*** *(0.000)*		
NEER * Low ICL				0.445 *(0.123)*	0.472 *(0.131)*	0.418 *(0.206)*		
NEER * Low ICL (-1)				0.037 *(0.896)*	0.067 *(0.825)*	-0.249 *(0.364)*		
NEER * High ICL				-0.940** *(0.023)*	-0.628 *(0.185)*	-0.824* *(0.080)*		
NEER * High ICL (-1)				-0.812** *(0.016)*	-1.015** *(0.030)*	-1.263** *(0.019)*		
Share Prices * Low Stock Mk. Cap.							-0.331*** *(0.008)*	-0.355** *(0.012)*
Share Prices * Low Stock Mk. Cap. (-1)							-0.064 *(0.514)*	-0.086 *(0.316)*
Share Prices * High Stock Mk. Cap.							-0.374*** *(0.000)*	-0.278*** *(0.004)*
Share Prices * High Stock Mk. Cap. (-1)							0.043 *(0.601)*	-0.001 *(0.987)*
Constant	0.133*** *(0.000)*	0.127*** *(0.000)*	0.126*** *(0.000)*	0.136*** *(0.000)*	0.133*** *(0.000)*	0.139*** *(0.000)*	0.132*** *(0.000)*	0.119*** *(0.000)*
No. of observations	620	498	379	620	498	379	458	378
No. of groups	75	67	52	75	67	52	57	52
R-squared	0.307	0.329	0.420	0.322	0.341	0.434	0.437	0.422

*Notes: Coefficients and p-values in parentheses from Fixed Effects estimation with robust standard errors. ***, ** and * denote significance at 1%, 5% and 10% levels, respectively. All variables are considered in logarithmic differences. An increase in the NEER suggests an appreciation. In models 4, 5 and 6 the nominal effective exchange rate is interacted with a dummy variable that takes values of one for countries with the levels of International Claims to GDP above the median and zero otherwise. In models 7 and 8 the share prices are interacted with a dummy variable that takes values of one for countries with the Stock Market Capitalization above the median and zero otherwise. The lower value of R-squared of model 8 compared to model 7 is attributed to the smaller number of observations that model 8 covers (lending interest rates for a number of countries were not available).*

Table 3. Determinants of non-performing loans (Arellano-Bond estimation)

Arellano-Bond Estimation	Dependent Variable NPL									
	1	2	3	4	5	6	7	8	9	10
NPL (-1)	0.191** *(0.037)*	0.223** *(0.034)*	0.248*** *(0.000)*	0.230*** *(0.000)*	0.213** *(0.014)*	0.191** *(0.050)*	0.293*** *(0.001)*	0.189** *(0.045)*	0.201*** *(0.010)*	0.247*** *(0.000)*
RGDP	-5.997*** *(0.000)*	-5.025*** *(0.000)*	-3.661*** *(0.000)*	-3.086*** *(0.000)*	-5.845*** *(0.000)*	-5.213*** *(0.000)*	-3.819*** *(0.000)*	-5.208*** *(0.000)*	-4.852*** *(0.000)*	-3.478*** *(0.000)*
RGDP (-1)	2.110*** *(0.000)*	2.220*** *(0.000)*	1.488** *(0.017)*	1.277* *(0.089)*	2.262*** *(0.000)*	2.282*** *(0.000)*	1.615** *(0.037)*	2.247*** *(0.000)*	0.969 *(0.286)*	1.490** *(0.033)*
NEER	0.994** *(0.014)*	1.257** *(0.015)*	0.639 *(0.273)*						0.440 *(0.398)*	0.496 *(0.303)*
NEER (-1)	-0.213 *(0.484)*	-0.222 *(0.491)*	-0.358 *(0.110)*						-0.054 *(0.892)*	-0.281 *(0.177)*
Lending IR (-1)		0.223** *(0.029)*	0.182** *(0.023)*	0.194** *(0.038)*		0.226** *(0.039)*	0.181*** *(0.010)*	0.207** *(0.033)*		0.198** *(0.011)*
Share Prices			-0.267** *(0.012)*	-0.299*** *(0.003)*			-0.229** *(0.025)*			
NEER * Low ICL					1.063** *(0.025)*	1.113*** *(0.006)*	0.821* *(0.056)*	1.159*** *(0.007)*		
NEER * Low ICL (-1)					0.117 *(0.780)*	0.063 *(0.852)*	-0.521** *(0.028)*			
NEER * High ICL					-0.732 *(0.424)*	0.406 *(0.659)*	0.052 *(0.975)*			
NEER * High ICL (-1)					-0.902 *(0.184)*	-1.430** *(0.026)*	-1.168 *(0.166)*	-1.388*** *(0.010)*		
Share Prices * Low Stock Mk. Cap.									-0.210 *(0.114)*	-0.265* *(0.055)*
Share Prices * Low Stock Mk. Cap. (-1)									0.048 *(0.761)*	-0.035 *(0.787)*
Share Prices * High Stock Mk. Cap.									-0.306*** *(0.001)*	-0.300*** *(0.001)*
Share Prices * High Stock Mk. Cap. (-1)									0.126 *(0.333)*	-0.015 *(0.903)*
No. of obs.	531	419	321	329	531	419	321	419	393	320
No. of groups	73	64	51	53	73	64	51	64	56	51
No. of instruments	63	46	47	47	60	61	34	61	49	50
AR(1), p-value	0.003	0.010	0.007	0.005	0.002	0.009	0.006	0.009	0.003	0.007
AR(2), p-value	0.404	0.392	0.718	0.662	0.326	0.370	0.673	0.376	0.854	0.742
Hansen, p-value	0.225	0.174	0.416	0.366	0.231	0.445	0.330	0.506	0.188	0.344
Chi-squared	163.351	130.810	228.486	170.307	153.478	141.176	239.538	174.298	273.814	250.577

*Notes: Coefficients and p-values in parentheses from Arellano-Bond two-step difference GMM estimation with robust standard errors (xtabond2 in Stata). ***, ** and * denote significance at 1%, 5% and 10% levels, respectively. All variables are considered in logarithmic differences. All variables including RGDP and NEER are treated as endogenous. An increase in the NEER suggests an appreciation. In models 4, 5 and 6 the nominal effective exchange rate is interacted with a dummy variable that takes values of one for countries with the levels of International Claims to GDP above the median and zero otherwise. In models 7 and 8 the share prices are interacted with a dummy variable that takes values of one for countries with the Stock Market Capitalization above the median and zero otherwise. The number of instruments is always kept below the number of groups. AR(1) and AR(2) are the Arellano-Bond tests for first and second order autocorrelation of the residuals. (One should reject the null hypothesis of zero first order serial correlation and not reject the null hypothesis of zero second order serial correlation of the residuals.) The Hansen test of overidentifying restrictions suggests that the instruments are appropriate.*

Table 4. Data sources

Indicator	Source
Non-performing loans (NPLs)	• International Monetary Fund – Financial Soundness Indicators • World Bank – World Development Indicators
Real Gross Domestic Product (RGDP)	• International Monetary Fund – International Financial Statistics
Nominal Effective Exchange Rate (NEER)	• International Monetary Fund – International Financial Statistics • Bank of International Settlements – BIS effective exchange rate indices (broad indices)
Lending Interest Rate	• International Monetary Fund – International Financial Statistics
Share Prices	• International Monetary Fund – International Financial Statistics
International Claims (ICL)	• Bank of International Settlements – Consolidated Banking Statistics (A – All reporting banks, A – International claims; cross-border claims in all currencies and local claims in non-local currencies)
Stock Market Capitalization	• World Bank – Financial Development and Structure Dataset