B   EMPIRICAL DETERMINANTS OF NON-PERFORMING LOANS[1]

This special feature reviews trends in the credit quality of banks' loan books over the past decade, measured by non-performing loans, based on an econometric analysis for a panel of 80 countries. 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 the main drivers thus facilitates the identification of key vulnerabilities in the financial sector.

Results suggest that – not surprisingly – real GDP growth has been the main driver of non-performing loans during the past decade. Exchange rate depreciations are also linked to an increase in non-performing loans in countries with a high degree of lending in foreign currencies to unhedged borrowers. In addition to these two factors, equity prices also have an impact on non-performing loans, in particular in countries with large stock markets relative to the size of the economy. Finally, interest rates also tend to affect loan quality.

While these findings are found to be robust in the heterogeneous panel dataset, such results should only be applied with great caution to individual countries where additional country and sector-specific factors might have an impact on non-performing loans.

INTRODUCTION

The credit quality of loan portfolios across most countries in the world remained relatively stable in the decade prior to the outbreak of the financial crisis which hit the global economy in 2007/08. Thereafter, the credit quality of loan portfolios deteriorated sharply – tightly linked to the subsequent global economic recession. The fact that loan performance is tightly linked to the economic cycle is well known and not surprising.[2] Notwithstanding a generalised deterioration of loan performance during the global recession, developments have been uneven across countries: the advanced and financially more developed

economies as well as countries with specific vulnerabilities have been greater affected. At the same time, some observers have wondered whether the increase in non-performing loans should have been even more pronounced, given the severity of the recession in many countries.

This special feature examines trends in non-performing loan ratios across 80 countries[3], explaining their variation over the past decade and across countries on the basis of an econometric model. Such an analysis is of interest from a financial stability perspective because an 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 thus facilitates the identification of key vulnerabilities in the financial sector.

The article presents new results on the empirical determinants of non-performing loans mainly by employing a novel dataset 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. In fact, time series for non-performing loans are typically short, often covering, at most, ten years of annual data, in particular among the emerging markets. At the same time, studies based on bank-by-bank data are only available for a few economies, meaning that the impact of cross-country differences with respect to structural characteristics on asset quality cannot be studied.

THE EVOLUTION OF BANK ASSET QUALITY DURING THE PAST DECADE

Among the advanced economies, bank asset quality gradually improved from the start of the last decade as non-performing loan ratios declined
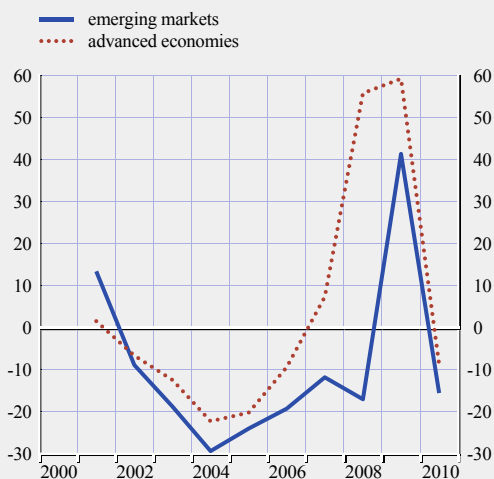
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1   The special feature draws on R. Beck, P. Jakubik and A. Piloiu, "Asset quality and macroeconomic performance: What role for the exchange rate and stock prices?", *ECB Working Paper Series*, forthcoming.
2   M.H. Pesaran, T. Schuermann, B. Treutler and S.M. Weiner, "Macroeconomic Dynamics and Credit Risk: A Global Perspective", *Journal of Money, Credit, and Banking*, No 38, Vol. 5, 2006.
3   For the regression analysis, the number of countries was reduced for some specifications owing to missing data for indicators employed as independent variables, as explained in more detail below.

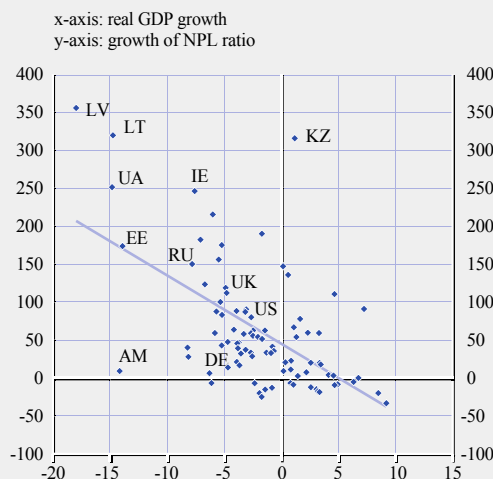**Chart B.1 Annual growth rate of non-performing loan ratios**

(percentage change per annum)

- emerging markets
- advanced economies

Sources: IMF, World Bank and ECB calculations.
Notes: Definitions for non-performing loan ratios have been harmonised to the extent possible, but may still vary across countries. Aggregates for "advanced economies" and "emerging markets" were computed following IMF classifications and weighted using national GDP based on purchasing power parity (PPP) valuation in US dollar terms.

Chart B.2 Rise in non-performing loan ratios versus real GDP growth in 2009, full sample
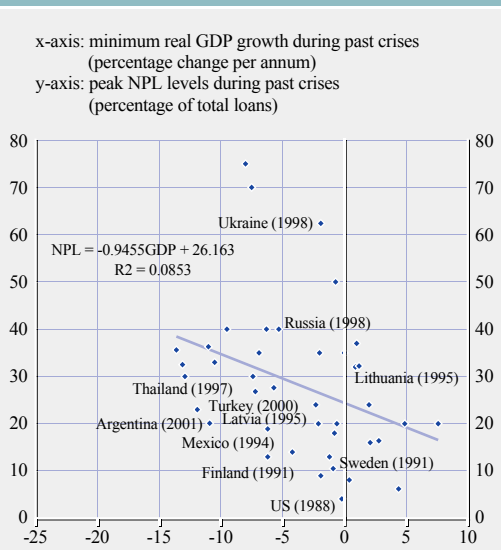
(percentage change per annum)

x-axis: real GDP growth
y-axis: growth of NPL ratio

Sources: IMF, World Bank and ECB calculations.

from around 3.0% of total loans in 2000 to around 1.5% in 2006.[4] When problems in the US sub-prime mortgage sector started to emerge in 2007, the amount of non-performing loans began to increase and grew further in 2008 and 2009.
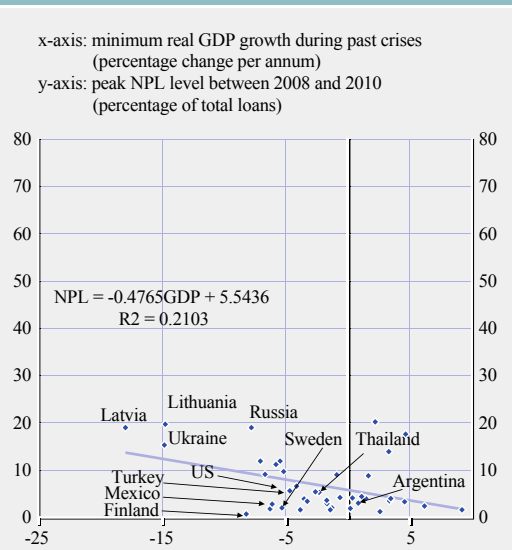
In the emerging markets, the level of non-performing loans was still considerably higher than in advanced economies[5] at the beginning of the last decade as banks still bore the consequences of past currency and banking crises in emerging markets, most notably those in Asia (1997), Russia (1998), Brazil (1999), Turkey (2001) and Argentina (2002). Thereafter, bank asset quality among the emerging markets improved substantially up until 2008, at which point emerging markets also began to feel the effects of the global financial crisis. In 2009 asset quality in the emerging markets deteriorated, but the growth rate of non-performing loan ratios was at around 40%, somewhat lower than in the advanced economies where average non-performing loan ratios increased in 2009 by around 60% (see Chart B.1).

4 For this article, two datasets from the IMF and the World Bank were combined. The IMF's list of Financial Soundness Indicators includes data for non-performing loans from 2005 until 2010 for a large number of countries. The World Bank also provides data for non-performing loans starting from 2000. The dataset from the IMF formed the basis and was complemented by the World Bank data in order to extend the time dimension of the final sample, as well as to take into consideration information on non-performing loans prior to 2005. Possible methodological differences across the definitions of non-performing loans were addressed by comparing the overlapping periods of the datasets: the World Bank dataset was included only when there were no significant differences in levels. Formal tests reject the hypothesis of a structural break in the sample.

5 Since the definitions of non-performing loans vary across countries, comparisons of the levels of non-performing loans 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 pay 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 more than 90 days on any material credit obligation to the banking group" (Basel Committee on Banking Supervision, paragraph 452). Based on this definition, non-performing loans 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 those which are 61 days overdue and some countries do not comply with the international standards at all. Therefore, the employed data sample was carefully checked and corrected, where possible, for apparent differences in the applied definitions for non-performing loans.

x-axis: minimum real GDP growth during past crises
(percentage change per annum)
y-axis: peak NPL levels during past crises
(percentage of total loans)

$$NPL = -0.9455GDP + 26.163$$
$$R2 = 0.0853$$

Sources: IMF, World Bank, ECB calculations and Laeven and Valencia, op. cit.
Notes: Both panels cover the same group of countries. Past crises refer to the systemic banking crises during the period 1981-2003 including 44 countries, covering among others, the Asian, Latin American and Scandinavian banking crises.

x-axis: minimum real GDP growth during past crises
(percentage change per annum)
y-axis: peak NPL level between 2008 and 2010
(percentage of total loans)

$$NPL = -0.4765GDP + 5.5436$$
$$R2 = 0.2103$$

Sources: IMF, World Bank, ECB calculations and Laeven and Valencia, op. cit.
Note: See notes to Chart B.3.

At the country level, developments in asset quality were considerably heterogeneous – in particular with respect to the deterioration in 2009. Whereas in some countries non-performing loans increased by more than 300% (e.g. in some Baltic countries), in other countries asset quality remained stable or even slightly improved. Previous studies have found that asset quality is closely linked to the economic cycle. Thus, the question arises of whether such cross-country differences are simply a reflection of the severity of the recessions in 2009. As Chart B.2 suggests, there is indeed a relatively close correlation between the decline in GDP and the rise in the non-performing loan ratio in 2009. However, some countries (e.g. Latvia, Lithuania, Ukraine and Ireland) saw very large increases in the non-performing loan ratio even when controlling for large declines in GDP among those countries.

A comparison of the performance of non-performing loans in 2008/09 with past crisis episodes, while subject to certain caveats[6], suggests that the level of non-performing loans[7]

was, on average, higher during past crises and that it was more heavily affected by economic recessions during past crises (see Charts B.3 and B.4).

These observations might, to some extent, reflect the fact that past systemic banking crises mainly materialised among the emerging markets, which tend to have higher non-performing loan ratios owing to weaknesses in their financial systems (with some notable exceptions, such as the savings and loans crisis in the United States in 1988 and the Nordic countries' banking crises of the early 1990s). Therefore, a direct comparison with the 2008/09 crisis, which more strongly affected the advanced economies, is subject to certain limitations. At the country level, it nevertheless appears that peak non-performing loan levels

6 A comparison can be performed only for countries which have experienced systemic banking crisis in the past, as documented in L. Laeven and F. Valencia, "Systemic Banking Crises: A New Database", *IMF Working Paper Series,* WP08/224, 2008.
7 Since longer time series are not available for non-performing loan ratios and, therefore, neither are growth rates for non-performing loans during past crises, a comparison is only possible in level terms.

were higher during past crises when controlling for GDP growth (e.g. in the United States, the Nordic countries and most emerging markets). Such observations could point to improvements in the regulatory environment and the cleaning up of bank balance sheets, mainly among the emerging markets, as suggested by the related literature.[8]

DETERMINANTS OF ASSET QUALITY

In addition to economic activity, exchange rate depreciations might also have a negative impact on asset quality, especially in countries with a large amount of lending in foreign currency to unhedged borrowers. Moreover, declines in stock prices might help to explain differences in asset quality. The potential channels through which stock prices could have an impact on non-performing loans are: (i) banks' direct exposure to the stock market; (ii) wealth effects among borrowers; or (iii) a decreased value of collateral. Finally, lending interest rates, which tend to negatively affect asset quality on account of higher borrowing costs, might be a further possible determinant of the level of non-performing loans. To the extent that lending rates are affected by the policy rate set by central banks, the swift monetary policy response to the crisis (mostly in countries with flexible exchange rates which pursue inflation targeting or other strategies aimed at price stability) is thus also taken into account.

Typically, empirical models for non-performing loan ratios include a variable for economic activity, a lending interest rate and other additional variables, such as unemployment and specific features of the banking sector (e.g. specialisation and concentration)[9]. In the econometric model employed for this article, real GDP, nominal effective exchange rates, lending interest rates and share prices are considered as possible determinants of the level of non-performing loans. The rationale for including these additional variables stems from the notion that: (i) an increase in lending interest rates tends to increase the debt service of borrowers with variable rate contracts; (ii) depreciations can negatively affect bank asset quality via balance

sheet effects; and (iii) a drop in share prices might lead to more defaults via wealth effects and a decline in the value of collateral. In addition, the inclusion of stock prices, which are more volatile than economic activity, account for possible non-linear effects. In order to capture the persistence of non-performing loans, the econometric specifications also include the lagged log difference of the dependent variable. Real GDP and nominal effective exchange rates are treated as endogenous, since the causality may run in both directions, and both variables might be correlated with the error term.[10] As the dataset has a short time dimension compared with the cross-sectional (country) dimension, the Arellano-Bond, two-step difference, generalised method of moments (GMM) estimation with robust standard errors is applied.[11, 12]

Overall, the estimated model is able to explain the development of non-performing loan ratios for the panel of advanced and emerging economies reasonably well (see Table B.1). As expected, a rise in (contemporaneous) real GDP growth leads to a decline in non-performing loan ratios.[13] This finding is robust across all

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8   J. Mitchell, "The Problem of Bad Debts: Cleaning Banks Balance Sheets in Economics in Transition", *CEPR Discussion Paper Series*, 1998; M.G. Bhide, A. Prasad and S. Ghosh, "Emerging Challenges in Indian Banking", *MPRA Papers*, No 1711, 2001; J. Hawkins and D. Mihaljek, "The banking industry in the emerging market economies: competition, consolidation and systemic stability", *BIS Papers*, No 4, 2001; and G. Ma, "Who Pays China's Bank Restructuring Bill?", *CEPII Working Papers*, No 2006-04.

9   G. Jiménez and J. Saurina, "Credit Cycles, Credit Risk, and Prudential Regulation", *International Journal of Central Banking*, Vol. 2(2), May 2006.

10 Simple pair-wise regressions suggest that non-performing loans do have a significant effect on real GDP and the nominal effective exchange rate. For the other variables considered in the model, this is not the case.

11 D. Roodman, "How to do xtabond2: an introduction to "Difference" and "System" GMM in Stata", *Center for Global Development Working Papers*, No 103, 2006.

12 Other static panel estimation procedures, such as fixed effects and random effects estimations, have also been applied, indicating that the results are robust (the magnitude and the significance levels of the coefficients remained largely the same). A Hausman specification test rejects the null hypothesis that the individual effects are uncorrelated with the other regressors, thus favouring fixed effects estimation.

13 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.

considered specifications and in line with existing research.[14] Lagged GDP growth also significantly affects growth in non-performing loans, but with a positive sign. This finding lends support to the notion that bank asset quality deteriorates with a lag in response to positive growth, on account of 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. With respect to the exchange rate, the results suggest that the effect of the nominal effective exchange rate differs between countries with low and high lending in foreign currency, approximated by international claims[15] relative to GDP. The effect of the nominal effective exchange rate on non-performing loans in countries with significant foreign currency lending is negative, suggesting that a depreciation of the domestic currency leads to a deterioration of asset quality (the balance sheet channel).[16] The inverse effect is observed in a sub-sample of countries with international claims to GDP below the median, meaning that a depreciation of the domestic currency leads to a decline in non-performing loan ratios (the competitiveness channel). A depreciation of the domestic currency can improve the competitiveness of the exporting firms on the foreign market owing to lower prices in the respective foreign currency. For this reason, companies can increase the volume of the exported goods and services and increase their profitability. However, the positive effect on the firms' creditworthiness typically materialises with some lag. All specifications suggest that higher interest rates lead to larger non-performing loan ratios. Higher interest rates tend to decrease the ability of borrowers to service new debt or debt with floating interest rates. Furthermore, during the last decade share prices have had a statistically significant, negative impact on asset quality in both countries with high and low stock market capitalisation. This impact has been slightly stronger in advanced economies in which stock markets are highly capitalised.

To illustrate how different factors affect non-performing loan rates, a contribution analysis (see Chart B.5) considers four countries which represent: (i) advanced economies with floating exchange rates and a bank-based financial system (Germany); (ii) advanced economies with floating exchange rates and a capital market-based financial system (United Kingdom); (iii) catching-up economies with fixed exchange rates and a high degree of foreign currency lending which kept the exchange rate stable during the 2008/09 crisis (Latvia); and (iv) catching-up economies which were subject to a large depreciation of the local currency during the crisis (Ukraine). While economic growth is the key driver of non-performing loans for all four selected economies, the decline in the stock market has also significantly contributed to an increase in non-performing loans, e.g. in Germany during 2009. The two emerging economies, Latvia and the Ukraine, are both exposed to negative balance sheet effects via foreign exchange lending, 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 contributed to a significant increase in non-performing loans in the Ukraine in 2009 and 2010 linked 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

14 J. Glen and C. Mondragón-Vélez, "Business Cycle Effects on Commercial Bank Loan Portfolio Performance in Developing Economies", International Finance Corporation, World Bank Group, January 2011.
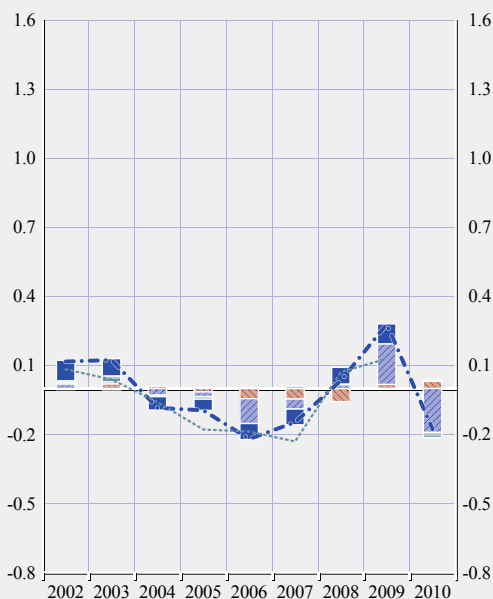15 International claims to GDP can be used as a reasonable proxy for foreign currency lending because cross-border lending tends to be denominated in foreign currency (see P.R. Lane and J.C. Shambaugh, "Financial Exchange Rates and International Currency Exposures", *American Economic Review,* Vol. 100, No 1, 2010). Data on the share of foreign currency loans in total loans are only available for a significantly smaller sub-set of countries. For this sub-set, the dataset used in the present analysis confirms that there is a positive correlation between international claims and foreign currency lending relative to GDP.
16 A depreciation of the domestic currency leads to an increase in debt payments in local currency terms. If the borrower has no income in foreign currency (as is often the case for households), this can, in extreme cases, lead to a debtor default.
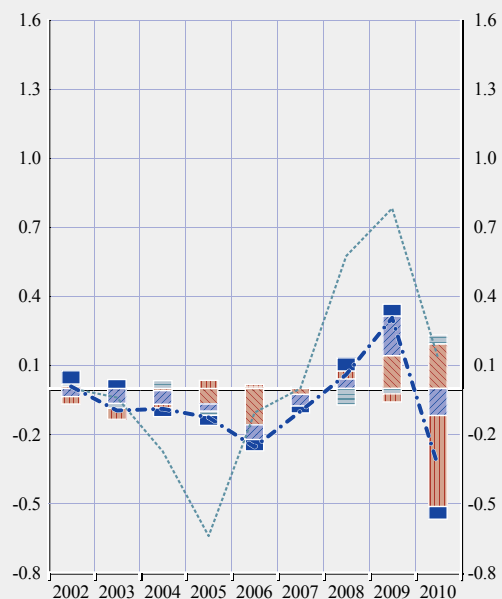
Chart B.5 Contribution of independent variables to the growth of non-performing loans in selected economies

Legend:
- share prices
- lending interest rate
- nominal effective exchange rate
- real GDP
- non-performing loans (-1)
- non-performing loans – actual
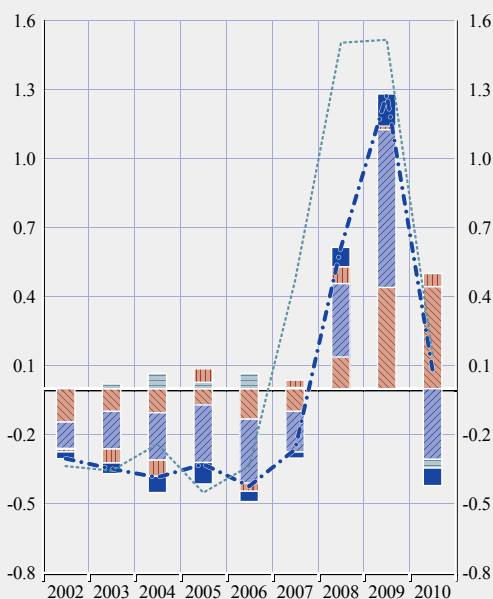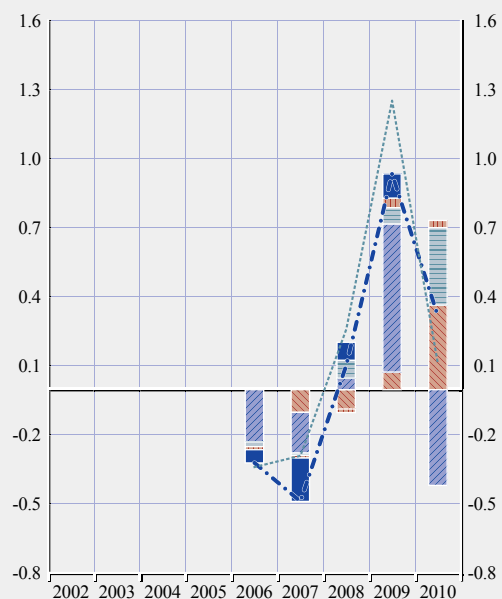- non-performing loans – fitted

Germany

United Kingdom

Latvia

Ukraine

Sources: IMF, World Bank and ECB calculations.
Notes: All indicators are considered in log differences. The fitted values of log difference non-performing loans are computed using Arellano-Bond estimates, for which real GDP and the nominal effective exchange rate were treated as endogenous. For the Ukraine, the time series on non-performing loans starts in 2005 and for Germany, data on non-performing loans is available until 2009. The contribution of each indicator is computed as the product of its coefficient and the actual value of the variable. In the case of Germany, lending interest rates marginally contributed to the decline of non-performing loans in 2010, but the decline is not visible in the chart.

Table B.I Determinants of non-performing loans

Arellano-Bond estimation	Change in non-performing loan ratio			
	Model 1	Model 2	Model 3	Model 4
Non-performing loan (-1)	0.248***	0.293***	0.191**	0.247***
	(0.000)	(0.001)	(0.050)	(0.000)
Real GDP	-3.661***	-3.819***	-5.213***	-3.478***
	(0.000)	(0.000)	(0.000)	(0.000)
Real GDP (-1)	1.488**	1.615**	2.282***	1.490**
	(0.017)	(0.037)	(0.000)	(0.033)
Nominal effective exchange rate	0.639			0.496
	(0.273)			(0.303)
Nominal effective exchange rate (-1)	-0.358			-0.281
	(0.110)			(0.177)
Lending interest rate (-1)	0.182**	0.181***	0.226**	0.198**
	(0.023)	(0.010)	(0.039)	(0.001)
Share prices	-0.267**	-0.229**		
	(0.012)	(0.025)		
Nominal effective exchange rate * low level of international claims		0.821*	1.113*	
		(0.056)	(0.006)	
Nominal effective exchange rate * low level of international claims (-1)		-0.521**	0.063	
		(0.028)	(0.852)	
Nominal effective exchange rate * high level of international claims		0.052	0.406	
		(0.975)	(0.659)	
Nominal effective exchange rate * high level of international claims (-1)		-1.168	-1.430**	
		(0.166)	(0.026)	
Share prices * low stock market capitalisation				-0.265*
				(0.055)
Share prices * low stock market capitalisation (-1)				-0.035
				(0.787)
Share prices * high stock market capitalisation				-0.300***
				(0.001)
Share prices * high stock market capitalisation (-1)				-0.015
				(0.903)
No of observations	321	321	419	320
No of groups	51	51	64	51
No of instruments	47	34	61	50
AR(1), p-value	0.007	0.006	0.009	0.007
AR(2), p-value	0.718	0.673	0.370	0.742
Hansen, p-value	0.416	0.330	0.445	0.344
Chi-squared	228.486	239.538	141.176	250.577

Notes: Coefficients and p-values in parentheses from Arellano-Bond two-step difference GMM estimations with robust standard errors (xtabond2 in Stata). ***, ** and * denote significance at 1%, 5% and 10% levels respectively. All variables are considered in log differences. All variables including real GDP and the nominal effective exchange rate are treated as endogenous. An increase in the nominal effective exchange rate suggests an appreciation. In models 2 and 3, the nominal effective exchange rate is interacted with a dummy variable that takes the value of one for countries with a level of international claims to GDP above the median, and zero otherwise. In model 4, the share prices are interacted with a dummy variable that takes the value of one for countries with stock market capitalisation 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 over-identifying restrictions suggests that the instruments are appropriate.

a significant impact on non-performing loans. 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 non-performing loans in Latvia. The case of the United Kingdom demonstrates how an accommodative monetary policy response to the crisis, which led to a decrease in lending interest rates, positively influenced the quality of bank loans. In the case of Germany, however, the contribution of a more accommodative monetary policy stance to dampening growth in non-performing loans was more limited owing to a less pronounced decline in lending interest rates compared with the United Kingdom.[17]

17 The transmission of policy rates to 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.

CONCLUDING REMARKS

This special feature reviewed developments in non-performing loans over the past decade, in particular during 2008/09, amid the ongoing crisis. The econometric analysis of the empirical determinants of non-performing loans suggests that real GDP growth has been the main driver of non-performing loans during the past decade. Therefore, a drop in global economic activity remains the most important risk for bank asset quality in the current circumstances. 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 in non-performing loans in countries with a high degree of lending in foreign currencies to unhedged borrowers. A further decline in stock prices would also negatively affect banks' asset quality, in particular in countries with large stock markets relative to the size of the economy. To some extent, these risks have already materialised: the depreciation of local currencies in central, eastern and south-east Europe against the Swiss franc has negatively affected asset quality in countries with a significant share of foreign exchange lending. The drop in global share prices since the summer of 2011 is also likely to negatively affect bank asset quality, in particular in advanced economies with relatively large stock markets.