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The Influence of Bank Performance, Market Condition and Economic Growth on Non-Performing Loans[a]

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The paper contributes to the literature on the determinants of non-performing loans by applying panel fixed effects and dynamic Generalised Method of Moments (GMM) estimations to a relatively large panel of 80 countries over the period 1999-2017. The paper considers three categories of explanatory variables; bank-level, industry-level, and macroeconomic-level. The bank-level variables highlight the relevance of bank profitability and efficiency to avoid non-performing loans. The industry-level variables, for the entire period and particularly after the onset of the Global Financial Crisis (years 2009-2017), show that bank market concentration promoted non-performing loans, while bank market competition and bank stability did not contribute to increasing non-performing loans. The macroeconomic-level variable, real per capita gross domestic product, provides very convincing evidence that promoting economic growth looks like the best way to avoid non-performing loans. Analyses with different sub-samples show that the determinants of non-performing loans are not particularly dependent on the level of income of the country.

JEL codes: G21, G15, G32, F39, C3

Keywords: Non-performing loans, Bank performance, Bank market conditions, Panel estimates

1 Introduction

Over the past years, and particularly in the aftermath of the Global Financial Crisis (GFC, 2008/09), considerable attention has been paid to bank risks. Bank risks have been affected by innovations in the banking industry, namely the changes in technology and the impact of off-balance sheet activities. The financial crisis increased the problems related to asymmetric information, fomenting adverse selection and moral hazard problems. These problems incentivised both thinly and highly capitalised banks to augment their levels of risk to maximise revenues (Fiordelisi et al., 2011).

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The crisis has highlighted the fragility of individual banks as well as the collective fragility of the financial institutions, underlying the serious threats to the overall stability and the functioning of financial institutions and systems. The understanding of bank risks acquired increased importance for a wide range of financial market participants.

There is a large strand of literature dedicated to the measurement of bank risks and the analysis of bank risk determinants. Despite the discussion about the different aspects of banks' risks and the potential proxies to measure them (Haq & Heaney, 2012; Öztürk Danışman & Demirel, 2019; Badarau & Lapteacru, 2020), the non-performing loans to total loans ratio persists as a crucial and commonly used measure of bank risk.

The high level of non-performing loans is widely recognised as a relevant indicator of the banks' assets quality, and it directly affects the overall financial performance of the whole banking sector (Berger & DeYoung, 1997). The level of non-performing loans provides an important signal of potential future losses for the banking system and can be used to mark the onset of a financial crisis (Vouldis & Louzis, 2018).

This paper contributes to the strand of literature analysing the determinants of non-performing loans, considering a relatively large sample of countries and aiming to provide answers to the following questions:

1) Do non-performing loans depend mostly on bank behaviour or on the market and macroeconomic conditions?
2) Is it possible to identify differences related to the level of income of the countries?
3) Is it possible to identify differences related to the countries' integration in an international organisation, such as the Organisation for Economic Cooperation and Development (OECD)?
4) Is it possible to identify differences for the years after the GFC?
5) Which are the recommended ways to prevent non-performing loans?

In order to provide answers to these questions, the papers analysing the evolution of the bank non-performing loans to total loans ratio use three sets of explanatory variables: bank performance indicators, bank market conditions, and economic growth indicators.

The paper applies panel fixed effects and dynamic Generalised Method of Moments (GMM) estimations to a panel of 80 countries over the period 1999-2017. It assesses the relevance of the level of development by comparing the results for high-income countries with those for non-high-income countries. In addition, the relevance of the degree of integration of the countries is tested by comparing the results for the OECD member countries with those of the non-OECD countries. For all panels and sub-panels, the analyses are conducted for the whole period (1999-2017) and the years after the GFC (2009-2017).

The paper follows the relevant contributions of authors, such as Klein (2013), Makri et al. (2014), and Beck et al. (2015), but enlarges the period of analysis (1999-2017) and considers a larger number of countries. To our knowledge, not many authors have analysed the influence of different categories of variables (bank-level, industry-level, and macroeconomic-level variables) in such a large sample, including different countries and regions, nor compared the results obtained after the GFC, taking into account the level of development of the countries or the relevance of belonging to a particular international organisation.

Overall, the results confirm the relevance of the considered variables to explain the evolution of non-performing loans, allowing the conclusion that there are no significant differences in the behaviour of high-income and non-high-income countries, nor the OECD

member and non-member countries. There is clear evidence that bank performance, in particular the increase of the return on assets, is important to prevent non-performing loans. Moreover, the results clearly highlight the relevant role of the political and regulatory authorities in providing legislation and conditions assuring bank market competition and promoting bank market stability, as well as specific bank regulations, particularly after the onset of the GFC. Finally, the results in all panels very clearly demonstrate the relevance of increasing economic growth in the prevention of bank non-performing loans.

The remainder of this paper is organised as follows: Section 2 presents some relevant literature; Section 3 describes the used data and the methodology; Section 4 discusses the results obtained; Section 5 concludes.

2 Relevant Literature

After the GFC and particularly during the last decade, there was an increase in studies focusing on the definition, measurement and testing determinants of bank risks.

Considering five different measures of bank risk, Haq & Heaney (2012) investigated the factors determining European bank risks using the information on 117 financial institutions across 15 European countries over the period 1996-2010 and found evidence of a convex (u-shaped) relation between bank capital and two bank risk measures: bank systematic risk and credit risk. They also found that an adequately capitalised institution was a necessary but not a sufficient condition to decrease bank risk. Moreover, a high level of off-balance activities contributed to increased bank risk.

Using three alternative measures of bank risk, including the bank non-performing loans, Craig & Dinger (2013) analysed the effect of bank competition on bank risk, considering a sample of 589 US banks between September 1997 and July 2006. Their empirical estimation showed a robust positive link between the intensity of deposit market competition faced by a bank and the risk of the bank, suggesting that banks with less deposit market power were more likely to choose riskier strategies. The same kind of conclusions was obtained by Öztürk Danışman & Demirel (2019), who explored the link between competition, bank regulatory variables and different measures of bank risk, using a sample of 6,936 banks in 25 developed countries between 2007 and 2015, confirming that higher market power in banking decreased the risk behaviour of banks.

Focussing on the Japanese case, Tongurai & Vithessonthi (2020) found that bank competition was positively associated with *ex-ante* bank risk-taking (measuring this *ex-ante* risk with the loan growth and the interest margin), considering the sample of the publicly listed banks in Japan, during the period 1993-2016. Using US bank data between 1996 and 2013, Chen et al. (2021) found that during the subprime crisis of 2007-09, banks with higher pre-crisis liquidity risk exposure had a lower survival probability, particularly those banks with lower capital ratios and higher credit risk. Also focussing on US banks but using a sample of 472 individual bank holding companies covering the period between 2003Q4 and 2016Q4, Davidov et al. (2021) analysed the linkage between bank liquidity creation and systemic risk concluding that, although liquidity creation strengthened the systemic linkage of individual banks to severe shocks in the financial system, the riskiness of individual banks was negatively linked to liquidity creation.

Badarau & Lapteacru (2020) provided a survey on significant works addressing the main determinants of bank lending and risk-taking decisions, emphasising the importance and

potential measures of systemic risk, which should take into account the evolution of returns of banks' stocks, as well as the default frequency in the banking sector, the network of the financial market infrastructure, or the regulatory environment.

Despite discussing the relevance of the different aspects and potential measures of bank risk, the traditional non-performing loans to total loans ratio persists as a crucial and commonly used measure. A high level of non-performing loans affects not only the efficiency of the individual banking institutions but also the whole financial and economic system. The level of non-performing loans became a serious concern to a wide range of banking and financial market participants as well as to the regulators and the political authorities, namely due to the contribution of non-performing loans to the failure of many institutions around the world during the GFC (Louzis et al., 2012; Ozili, 2019).

Focussing on the macroeconomic determinants, Nkusu (2011) considered a sample of 26 developed economies over the period 1998-2009, concluding that the deterioration of the macroeconomic performance (lower economic growth and higher unemployment levels) contributed to higher non-performing loans. The same kind of conclusions was obtained by De Bock & Demyanets (2012), who analysed the quality of bank assets using data for 25 emerging economies during 1996-2010 and found that lower economic growth, exchange rate depreciation, weaker terms of trade, and fall in debt-creating capital inflows reduced the quality of the provided bank loans.

Beck et al. (2015) analysed the influence of some macroeconomic determinants on non-performing loans in a sample of 75 countries, covering 2000-2010, and concluded that real Gross Domestic Product (GDP) growth, share prices, exchange rate, and lending interest rates significantly affected non-performing loans. Radivojevic & Jovovic (2017) examined the determinants of non-performing loans, using a sample of 25 emerging countries for the period from 2000 to 2011, and concluded that non-performing loans could be mainly explained by crucial macroeconomic factors, such as the GDP and inflation rate, as well as bank-specific factors, such as the return on assets, and the capital to assets ratio.

Dimitrios et al. (2016) considered the banking sectors of 15 Euro area countries over the period 1990Q1-2015Q2 and found that macroeconomic indicators, such as unemployment rate, growth rates, taxes on personal income, and output gap had a significant influence on non-performing loans. Also, for 14 Euro area countries and the period between 2000 and 2008, Makri et al. (2014) analysed the factors influencing non-performing loans, finding strong correlations between non-performing loans and some macroeconomic variables, namely, public debt, unemployment, and GDP growth rate, as well as with some bank-specific factors, such as capital adequacy and return on equity.

Klein (2013) investigated the determinants of non-performing loans in 16 Central, Eastern and South-Eastern European countries from 1998 to 2011, concluding that non-performing loans were found to respond to macroeconomic conditions, such as GDP growth, unemployment, and inflation. The analysis also indicated the presence of other relevant effects from the banking system, which were significant during both the pre- and post-crisis periods. More precisely, the higher quality of the bank's management contributed to lower non-performing loans, while moral hazard incentives, such as low equity and excessive bank risk-taking, tended to increase non-performing loans.

Considering also the situation of Central, Eastern and South-Eastern European countries, but with a sample of 12 countries during the 2006 to 2013 period, Tanasković & Jandrić (2015), concluded that the increase of non-performing loans was negatively related

to financial market development and GDP growth, whereas it was positively related to foreign currency loans ratio and the level of the exchange rate.

Ozili (2019) used an unbalanced panel including data for 103 countries over the 2003-2014 period, concluding that non-performing loans increased with greater foreign bank presence and greater financial intermediation. Moreover, non-performing loans were negatively associated with bank efficiency, loan loss coverage ratio, competition, and banking system stability; on the other hand, non-performing loans were positively associated with bank concentration and banking crisis.

Several papers have analysed the determinants of non-performing loans at the country level. For example, Louzis et al. (2012) used data for the nine largest Greek banks over the period 2003Q1-2009Q3, concluding that non-performing loans in the Greek banking system could be explained mainly by macroeconomic variables (GDP, unemployment, interest rates, public debt) and by the bank management quality. Rachman et al. (2018) considered a sample of 36 commercial banks listed in the Indonesian Stock Exchange during the period 2008-2015, concluding that banks' profitability and bank credit growth had a negative influence on non-performing loans. Dao et al. (2020) analysed different aspects that impact non-performing commercial bank loans, using data from 200 identified banks of Ho Chi Minh City Stock Exchange and Hanoi Stock Exchange, covering the period 2008-2017, and concluded that higher interest rates, as well as a rise in bank performance and in credit growth, led to a reduction of non-performing loans. Khan et al. (2020) using a sample including the commercial banks listed in the Pakistan Stock Exchange, over the period 2005-2017, found that operating efficiency and profitability had a negative association with non-performing loans and were statistically significant, while capital adequacy and income diversification had a negative association but were statistically insignificant.

3 Data

The data used in this paper covers 1999-2017 and are extracted from the World Bank database "Global Financial Development". Table 1 presents details of all variables.

The World Bank defines the bank non-performing loans-to-gross loans ratio (%) as the ratio of defaulting loans (payments of interest and principal past due by 90 days or more) to total gross loans (total value of loan portfolio), specifying that the amount of non-performing loans, includes the gross value of the loan as recorded in the balance sheet, not just the overdue amount. Here the bank non-performing loans-to-gross loans ratio (NPL) is the dependent variable in the analysis, which will be explained by bank-level, industry-level and macroeconomic-level variables.

The bank-level variables used in the paper include some bank performance indicators, measuring bank liquidity, efficiency and different aspects of bank profitability.

- The bank credit-to-bank deposits ratio (BCBD, %) is a measure of bank liquidity. The World Bank computes it as the financial resources provided to the private sector by domestic money banks as a share of total deposits. The increase of BCBD is usually associated with higher levels of bank non-performing loans, (as used and discussed by, e.g., Dimitrios et al., 2016; Van den End, 2016; Ozili, 2019).
- The bank cost-to-income ratio (BCI, %) is a measure of bank efficiency, representing the operating expenses of a bank as a share of the sum of the net interest revenue and other operating income. The higher the BCI, the lower will be bank cost efficiency

Table 1: Dependent and independent variables

	Series Code (World Bank)	**Definition**
Dependent variable:		
NPL = Bank non-performing loans-to-gross loans ratio (%)	GFDD.SI.02	Measure of bank risk
Independent variables:		
Bank performance indicators:		
BCBD = Bank credit-to-bank deposits ratio (%)	GFDD.SI.04	Measure of bank liquidity
BCI = Bank cost-to-income ratio (%)	GFDD.EI.07	Measure of bank efficiency
BNIM = Bank net interest margin (%)	GFDD.EI.01	Measure of bank profitability
BNIITI = Bank non-interest income-to-total income ratio (%)	GFDD.EI.03	Measure of bank profitability from non-loan sources
BROA = Bank return on assets (%, after tax)	GFDD.EI.05	Measure of bank profitability (profits generated by the bank-owned assets)
Market condition indicators:		
BConc = Bank concentration (%)	GFDD.OI.01	Measure of bank market concentration
LI = Lerner index	GFDD.OI.04	Measure of bank market competition
BZ = Bank Z-score	GFDD.SI.01	Measure of bank market stability
BRC = Bank regulatory capital-to-risk-weighted assets ratio (%)	GFDD.SI.05	Measure of bank capital regulation
Bcris = Banking crisis dummy	GFDD.OI.19	1=banking crisis, 0=none
Economic growth indicator:		
GDP = GDP per capita (constant 2005 US$)	NY.GDP.PCAP.KD	Measure of real Gross Domestic Product per capita

Source: The World Bank "Global Financial Development" database, October 2021.

which is associated with increased bank non-performing loans (supporting the "bad management hypothesis" that is well discussed, among others, in Louzis et al. (2012)).

- The bank net interest margin (NIM, %) is one of the measures of bank profitability, representing the accounting value of the bank's net interest revenue as a share of its average interest-bearing (total earning) assets. The increase of the NIM can be positively associated with non-performing loans as banks charge higher interest rates to riskier clients, and higher interest rates contribute to the increase of non-performing loans (see De Bock & Demyanets, 2012; Louzis et al., 2012; Dimitrios et al., 2016).
- The bank non-interest income-to-total income ratio (NIITI, %) is a measure of bank profitability from non-loan sources. More precisely, it is computed as the bank income generated by non-interest-related activities as a percentage of total income (net-interest income plus non-interest income). The bank's NIITI is used to capture income diversification, but there is no robust consensus on its potential effects on non-performing loans. For example, Louzis et al. (2012) tested the "diversification hypothesis", supposing that diversification was negatively related to non-performing loans, but the results obtained were not sufficiently robust to validate this hypothesis. Fiordelisi et al. (2011) found a negative and statistically significant link between income diversification and cost efficiency, suggesting that more specialised banks benefit from scale and learning economies that enable them to reduce costs more than their diversified counterparts.
- The bank return on assets (BROA, %, after tax) is another measure of banks profitability, representing the profits (after the payment of the taxes) generated by the assets owned by the bank. It is not usually supposed that banks with a solid profitability

position will increase their investments in too-risky loans, and several authors (e.g., Godlewski, 2005; Makri et al., 2014; Khan et al., 2020) have demonstrated empirically that the BROA has a negative relation with non-performing loans.

At industry-level the paper includes indicators representing the market conditions and financial structure that affect banking activities:

- The bank concentration (BCon, %) is a proxy for the market structure and is computed as the assets of the three largest commercial banks as a share of the total assets of commercial banks. Total assets include total earning assets, cash and due from banks, foreclosed real estate, fixed assets, goodwill, other intangibles, current tax assets, deferred tax assets, discontinued operations and other assets. The influence of BCon on non-performing loans is far from consensual. Louzis et al. (2012) consider that ownership concentration is negatively related to non-performing loans as higher ownership concentration tends to promote prudent risk-taking through tighter control of the bank's management. On the other hand, some authors (e.g., Berger & Hannan, 1998; Delis & Tsionas, 2009; Fare et al., 2015) consider that high bank market concentration promotes the quiet-life hypothesis and can, therefore, be positively associated with non-performing loans. Çifter (2015), on the other hand, found that bank concentration reduces non-performing loans in some countries but increases them in other countries, concluding that the relationship between bank concentration and non-performing loans is ambiguous.
- The Lerner index (LI) is a usual measure of market competition and market power in the banking market. It is the difference between output prices and marginal costs (relative to prices). Prices are calculated as total bank revenue over assets, whereas marginal costs are obtained from an estimated translog cost function with respect to output. High values of the LI indicate less bank competition that is often associated with the quiet life hypothesis but still raise doubts about its specific influence on non-performing loans. Several authors consider that too much competition can encourage banks to take on more risk (e.g., Manove et al., 2001; Dam & Zendejas-Castillo, 2006; De Nicoló & Turk-Ariss, 2010), while others found that as competition in bank markets increases, lending rates reduce as well as the probability of borrower default (among others, Boyd et al., 2009; Martinez-Miera & Repullo, 2010; Schaeck & Cihák, 2014).
- The Bank Z-score (BZ) is a proxy for bank market stability and captures the probability of default of a country's commercial banking system. It compares the buffer of a country's commercial banking system (capitalisation and returns) with the volatility of those returns. A higher bank BZ indicates increasing stability (or lower probability of default risk) and is not supposed to be positively associated with non-performing loans. This negative relationship was empirically demonstrated by Atoi (2018).
- The bank regulatory capital-to-risk-weighted assets ratio (BR, %) is a proxy of the bank capital regulation (international banking regulations and requirements of the Basel agreements). It represents the capital adequacy of deposit takers, and it is computed as the ratio of total regulatory capital to its assets held, weighted according to the risk of those assets. The relevance of the BR to bank risk is discussed and empirically tested, among others, by Berger & DeYoung (1997) stating that risk weights are positively related to the probability of failure and some accounting and market measures of risk, but the correspondence is relatively weak. Godlewski (2005) provide empirical evidence

on the role of the regulatory, institutional and legal environment in driving bank capitalisation and credit risk-taking behaviour (measuring bank risk with non-performing loans-to-total loans ratio) and demonstrate the importance of bank capital regulation for the healthy banking industry in emerging market economies. The relevance of appropriate capital requirements to the banks' risk-taking behaviour is well discussed by Baselga-Pascual et al. (2015). Moreover, Ozili (2019) empirically demonstrates that non-performing loans are negatively associated with regulatory capital.

- The banking crisis dummy (Bcris) is defined by the World Bank as the presence of a banking crisis (1=banking crisis). A banking crisis is systemic if: *(i)* significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations), *(ii)* significant banking policy intervention measures in response to significant losses in the banking system. The first year that both criteria are met is the year when the crisis becomes systemic. The end of a crisis is defined as the year before both real GDP growth and real credit growth are positive for at least two consecutive years. Following this definition, Bcris are expected to be positively associated with non-performing loans.

The paper includes per capita GDP (in constant 2005 US$) as the macroeconomic-level variable. It is calculated by dividing GDP by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. In this paper, it represents the macroeconomic conditions as several authors (e.g., Nkusu, 2011; Beck et al., 2015; Dimitrios et al., 2016) have already concluded that a favourable macroeconomic environment (and in particular a higher GDP growth) is not supposed to increase the level of non-performing loans.

Using panel data regression estimations, the paper analyses the influence of these indicators, measuring bank performance, market conditions and financial structure, and economic growth on non-performing loans. Panel data techniques have relevant advantages, namely the possibility of getting more informative data, more degrees of freedom and more efficient estimations, as well as less collinearity among the considered variables (Wooldridge, 2010; Baltagi, 2013), which also underline some recognised disadvantages of panel data.

The following equation represents a basic panel regression model:

$$y_{it} = \alpha_t + \beta X_{it} + u_{it} \tag{1}$$

where y_{it} is the dependent variable (the bank non-performing loans-to-gross loans ratio, i (1, ..., N) is the cross units (countries), t (1, ..., T) is the time periods (years between 1999-2017), α_t is the intercept (varying with t but independent of i), X_{it} is the matrix of independent variables that can vary both with i and t (here, the chosen bank performance indicators, the market conditions, and the economic growth indicator), and u_{it} is the error term which is assumed to vary both with i and t.

Among the available estimation methods for panel data, this paper applies both fixed effects estimations and dynamic one-step system GMM (Generalized Method of Moments) estimations. Fixed effect estimates are particularly appropriate to analyse the impact of variables that vary over time. As well explained by Greene (2018), fixed effects explore the

relationship between the variables and the outcome within each cross-unit, considering that each cross-unit has its characteristics that may (or not) influence the variables. However, fixed effects estimates are not appropriate to deal with endogenous regressors, which may be an important concern in the context of the considered model. To deal with this limitation, the paper applies dynamic panel estimates, which not only address the endogeneity problems but also reduce the potential bias of the estimated coefficients by following the method proposed by (e.g., Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998).

The dynamic system GMM method uses cross-unit information and jointly estimates the equations in levels (instrumented by first differences of the regressors) and first difference (instrumented by lagged levels of the dependent and independent variables). The advantages of using GMM estimations in analysing the determinants of non-performing loans are highlighted by Radivojevic et al. (2019).

The validity of the GMM estimations is analysed with the tests proposed by Arellano & Bond (1991), which are used to test autocorrelation, that is, the assumption that the error term is not serially correlated using the differenced error term. By construction, the autocorrelation of the first order, AR(1), is supposed to be validated but not the autocorrelation of the second order, AR(2), or the autocorrelation of a higher order. Moreover, the validity of the instruments is analysed through the Sargan-Hansen statistic, which is supposed to be robust to heteroskedasticity and autocorrelation.

The paper considers first a panel including 80 countries and then different sub-panels to analyse potential differences regarding the level of development of the countries (more precisely, their level of income) and the countries' integration in the OECD. In this respect, the analyses are conducted for five different panels[1]. Panel 1 includes the whole sample of 80 countries; Panel 2A (Panel 2B) includes 44 high-income (36 non-high-income) countries following the World Bank criteria. Finally, Panel 3A (Panel 3B) includes 38 OECD member (42 non-OECD member) countries.

4 Empirical results

The paper first presents the results obtained for all the considered panels over 1999-2017 using fixed effects estimations and dynamic GMM estimations. For all panels, the paper reports the results of a model including all variables (Model 1) and a simplified model (Model S), considering only those explanatory variables that were statistically robust.

Table 2 reports the results for Panel 1[2] using fixed effects and dynamic one-step GMM panel estimations. The F and Wald statistics confirm the overall robustness of the results. The validity of the GMM estimations is also confirmed as there is clear evidence of autocorrelation of the first order, AR(1), but not of the second order, AR(2). The overall validity of the considered instruments is corroborated by the results of the Sargan test.

[1] The specification of the countries included in each panel is provided in Appendix A.

[2] Appendix B presents the descriptive statistics and the correlation matrix for Panel 1. For the other panels, the results are available upon request).

Table 2: Results obtained with FE and GMM estimations: Panel 1

	Panel 1 – 80 countries			
	FE		**GMM**	
	Model 1	**Model S**	**Model 1**	**Model S**
Bank credit-to-bank deposits ratio	0.019*** (3.06)	0.017*** (2.84)	-0.028 (-0.74)	
Bank cost-to-income ratio	0.0117 (0.85)		0.418*** (3.93)	0.433*** (4.33)
Bank net interest margin	0.114 (1.09)		0.354 (0.647)	
Bank non-interest income-to-total income ratio	0.071*** (4.55)	0.069*** (4.69)	0.029 (0.22)	
Bank return on assets	-0.321*** (-5.14)	-0.321*** (-5.32)	-1.695*** (-4.91)	-1.723*** (-5.43)
Bank concentration	0.068*** (4.33)	0.070*** (4.43)	0.455*** (4.17)	0.471*** (4.43)
Lerner index	-4.255*** (-3.53)	-4.592*** (-3.96)	27.35** (2.18)	26.27** (2.12)
Bank Z-score	-0.044 (-1.16)		-0.954*** (-3.43)	-0.939*** (-4.85)
Bank regulatory capital-to-risk-weighted assets ratio	0.0414 (0.88)		3.156*** (8.51)	3.187*** (9.79)
Banking crisis dummy	3.547*** (6.49)	3.578*** (6.56)	1.819 (0.53)	
Economic growth	-17.89*** (-14.05)	-18.45*** (-15.10)	-8.715*** (-5.01)	-9.789*** (-9.44)
Constant	-360.8*** (-4.96)	-372.0*** (-5.43)	-443.8* (-1.72)	-479.4** (-2.00)
Year fixed Effect	Yes	Yes	Yes	Yes
Country fixed Effect	No	No	No	No
F or Wald test (Prob > F) or (Prob > chi2)	46.16 (0.000)	68.83 (0.000)	498.4 (0.000)	480.96 (0.000)
R-squared within	0.2795	0.2777		
AB AR(1) z (Pr > z)			-6.09 (0.000)	-6.64 (0.000)
AB AR(2) z (Pr > z)			-1.53 (0.127)	-1.51 (0.13)
Sargan test chi2 (Prob > chi2)			2.42 (0.933)	5.65 (0.896)
Number of observations	1,520	1,520	1,520	1,520

Source: Author's estimations.
Note: t-statistics are provided in parenthesis, and *, **, *** indicate statistical significance at 10%, 5%, 1%, respectively.

The results in Table 2 clearly demonstrate that banks with high profitability (measured by the return on assets, e.g., the profits generated by bank-owned assets), banks benefiting from bank market stability (measured by the Z-score) and banks located in countries with increasing economic growth (real per capita GDP) are not supposed to have high levels of non-performing loans. Overall, these results meet the expected findings and corroborate the conclusions on the influence of the returns on assets (Godlewski, 2005; Makri et al., 2014; Khan et al., 2020); on the effects of bank market stability (Atoi, 2018); as well as on the overall consensus regarding the importance of economic growth to prevent non-performing loans, clearly highlighted, (e.g., Nkusu, 2011; Beck et al., 2015; Dimitrios et al., 2016).

On the other hand, high levels of non-performing loans are robustly associated with bank market concentration, in line with the conclusions of Berger & Hannan (1998); Delis & Tsionas (2009); Fare et al. (2015), and overall confirming the view that associates bank market concentration with the quiet-life hypothesis. Moreover, and not surprisingly, non-performing loans are positively associated with bank crises.

Although not always with the same statistical robustness, there is also evidence of a positive relation between non-performing loans and the bank cost-to-income ratio (a measure of bank efficiency), the ratio of bank non-interest income-to-total income (representing the measure of bank profitability from non-loan sources), with the measure of bank regulation (more precisely, the bank regulatory capital-to-risk-weighted assets ratio). Moreover, the results regarding the positive influence of the bank cost-to-income ratio are statistically robust when they were obtained with dynamic GMM estimations. In line with the arguments of Louzis et al. (2012), these results validate the "bad management hypothesis". There is also a positive relation between the ratio of bank non-interest income-to-total income and the non-performing loans, but now particularly when using fixed effects estimations, revealing that contrary to the views expressed by Fiordelisi et al. (2011) and Louzis et al. (2012), the diversification of the bank income sources is not associated with the decrease of non-performing loans. Also, when looking at the results obtained only with fixed effects estimations, it is possible to conclude that the increase of bank liquidity (e.g., the bank credit-to-bank deposits ratio) contributes to higher non-performing loans, supporting the findings of Dimitrios et al. (2016), Van den End (2016) and Ozili (2019).

The results reporting the influence of the bank regulatory capital-to-risk-weighted assets ratio, especially those obtained with dynamic GMM estimations, reveal the non-adequacy of this regulatory measure to prevent the increase of non-performing loans. These results are overall in line with the arguments of Fiordelisi et al. (2011), confirming that banks can respond to regulatory actions that force them to hold more capital by increasing their portfolio risks. Another possible explanation for these results is the admission that when capital is lower than the regulatory minimum, banks tend to choose a very risky loan portfolio, as well discussed by Baselga-Pascual et al. (2015).

The results regarding the measure of bank competition (Lerner index) are statistically very robust but do not clearly indicate a positive or negative influence of this index on the non-performing loans, as the results depend on the estimation method (fixed effects or dynamic GMM estimates). In this case, the results do not allow the validation of the hypothesis that too much competition can encourage banks to take on more risk, supported by Dam & Zendejas-Castillo (2006) and De Nicoló & Turk-Ariss (2010); nor of the hypothesis that more competition increases bank efficiency and should not be associated with the increase of non-performing loans, confirming the arguments of Martinez-Miera & Repullo (2010) and Schaeck & Cihák (2014).

Table 3 presents the results obtained for Panel 2.A, which includes the sub-sample of the 44 high-income countries, and Panel 2.B, the sub-sample of 36 non-high-income countries. The results for these two sub-panels are overall in line with those previously reported for Panel 1 in terms of the expectations of low levels of non-performing loans for banks with high profitability (return on assets) and located in countries with increasing economic growth. Bank stability (proxied with the Z-score) is also not supposed to contribute to non-performing loans but now only evidently in Panel 2-B (including the non-high income countries) and when using fixed effects estimations.

Table 3: Results obtained with FE and GMM estimations: Panels 2.A and 2.B

	Panel 2.A - High-income countries				**Panel 2.B - Non-high-income countries**			
	FE		**GMM**		**FE**		**GMM**	
	Model 1	**Model S**	**Model 1**	**Model S**	**Model 1**	**Model S**	**Model 1**	**Model S**
Bank credit-to-bank deposits ratio	0.051***	0.049***	0.019		(0.005)		0.171***	0.168***
	(7.27)	(7.31)	(0.82)		(-0.47)		(3.54)	(3.61)
Bank cost-to-income ratio	0.0004		0.0507		0.0038		0.1056	
	(0.03)		(0.6)		(0.13)		(0.88)	
Bank net interest margin	0.1646		-1.455**	-1.385**	0.1344		(0.4317	
	(1.1)		(-2.25)	(-2.14)	(0.92)		(-0.68)	
Bank non-interest income-to-total income ratio	0.051***	0.046***	-0.206***	-0.232***	0.076***	0.073***	0.569***	0.596***
	(2.92)	(2.75)	(-3.06)	(-3.66)	(2.99)	(3.08)	(5.53)	(6.33)
Bank return on assets	-0.235***	-0.225***	-1.512***	-1.554***	-0.509***	-0.514***	-0.571**	-0.595**
	(-4.00)	(-3.93)	(-5.12)	(-6.65)	(-3.32)	(-3.65)	(-1.96)	(-2.11)
Bank concentration	0.0342	0.0359*	(0.0533		0.071***	0.064***	0.494***	0.518***
	(1.59)	(1.7)	(-0.52)		(3.23)	(2.97)	(3.78)	(4.22)
Lerner index	-6.465***	-6.329***	(2.046		(2.201		-28.67*	-38.72***
	(-4.56)	(-4.57)	(-0.37)		(-1.15)		(-1.74)	(-2.73)
Bank Z-score	0.0137		0.3479		-0.121**	-0.120**	0.0854	
	(0.27)		(1.43)		(-2.21)	(-2.35)	(0.43)	
Bank regulatory capital-to-risk-weighted assets ratio	0.427***	0.431***	1.692***	1.752***	-0.317***	-0.314***	1.700***	1.550***
	(6.63)	(6.77)	(5.28)	(7.64)	(-4.60)	(-4.59)	(4.58)	(4.75)
Banking crisis dummy	2.274***	2.269***	(3.86	-5.632***	5.792***	5.914***	7.99	7.274
	(4.39)	(4.44)	(-1.55)	(-2.84)	(4.09)	(4.2)	(1.62)	(1.59)
Economic growth	-12.01***	-12.17***	-21.92***	-19.63***	-16.97***	-16.85***	-21.90***	-20.61***
	(-7.90)	(-8.06)	(-6.39)	(-10.17)	(-7.98)	(-15.06)	(-8.95)	(-10.12)
Constant	-278.9***	-276.5***	(339.2	(190.2	61.01	146.6***	-1307.2***	-1323.0***
	(-3.44)	(-3.43)	(-1.21)	(-1.00)	0.43	(15.03)	(-2.88)	(-3.34)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	No	No	Yes	Yes	No	No	Yes	Yes
F or Wald test	26.86	35.73	599.15	576.32	34.96	59.73	598.49	598.66
(Prob > F) or (Prob > chi2)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared within	0.2924	0.2911			0.3974	0.3948		
AB AR(1) z			(5.45)	(6.07)			(1.76)	(2.06)
(Pr > z)			(0.000)	(0.000)			(0.78)	(0.039)
AB AR(2) z			(1.59)	(1.7)			(2.55	(2.64
(Pr > z)			(0.113)	(0.089)			(0.011)	(0.008)
Sargan test chi2			4.11	9.43			2.24	7.76
(Prob > chi2)			(0.662)	(0.582)			(0.896)	(0.558)
Number of observations	836	836	836	836	684	684	684	684

Source: Author's estimations.

Note: t-statistics are provided in parenthesis, and *, **, *** indicate statistical significance at 10%, 5%, 1%, respectively.

According to the results presented in Table 3, it is possible to conclude that they are overall in line with the results obtained for Panel 1 regarding bank liquidity (the bank credit-to-bank deposits ratio) and bank market concentration, confirming that these indicators are likely to contribute to the increase of bank non-performing loans.

However, now there is overall evidence that banks facing strong bank market competition (measured through the Lerner index) are also not associated with high levels of non-performing loans, confirming in these cases the views of Martinez-Miera & Repullo (2010) and Schaeck & Cihák (2014) and indicating that the effects of bank market competition on non-performing loans depend not only on the estimation methods (as in the previous table, reporting the results for Panel 1) but also on the homogeneity of the considered panels in terms of the levels of income of the countries included in each panel.

Comparing the results for the high-income and non-high-income countries does not highlight significant differences regarding the statistical robustness of the effects of the bank non-interest income-to-total income ratio, the bank regulatory capital-to-risk-weighted assets ratio, and the banking crisis dummy on non-performing loans. Despite the possible overall conclusion that the increase of these indicators contributes to the growth of non-performing loans (in line again with the results for Panel 1), but now some of the results are not fully unanimous, as they depend on the estimation methods, raising doubts about the direction of the effects (positive or negative) on non-performing loans.

The results reported in Table 4, not surprisingly, do not clearly highlight the importance of integration in the OECD to explain differences in the levels of bank non-performing loans. As in the previous tables, there is clear evidence that non-performing loans are not associated with the bank's return on assets nor with increasing economic growth; the same happens, although not so evident, with the Lerner index and the bank Z-score. On the other hand, there is robust evidence that the bank's non-interest income-to-total income ratio and bank market concentration are likely to contribute to bank non-performing loans. With few exceptions (and again, related to the different estimation methods), the results also demonstrate that bank credit-to-bank deposits and bank cost-to-income ratios, bank interest margin, and banking crisis dummy are positively related to bank non-performing loans. Regarding the bank regulatory capital-to-risk-weighted assets ratio, the results obtained for the OECD and non-OECD countries are always statistically very robust, but to do allow clear conclusions about the positive or negative influence on bank non-performing loans.

Table 4: Results obtained with FE and GMM estimations: Panels 3.A and 3.B

	Panel 3.A - OECD countries				**Panel 3.B – non-OECD countries**			
	FE		**GMM**		**FE**		**GMM**	
	Model 1	**Model S**	**Model 1**	**Model S**	**Model 1**	**Model S**	**Model 1**	**Model S**
Bank credit-to-bank deposits ratio	0.029***	0.028***	-0.0096	-0.048**	0.0137		0.215***	0.249***
	-4.81	-4.83	(-0.40)	(-1.98)	-1.2		-4.23	-6
Bank cost-to-income ratio	0.0063		0.134***	0.105*	0.0446		-0.1141	
	-0.57		-2.59	-1.92	-1.42		(-0.74)	
Bank net interest margin	0.1205		0.8192		0.298**	0.312**	-0.445	
	-0.8		-1.31		-2.03	-2.15	(-0.53)	
Bank non-interest income-to-total income ratio	0.055***	0.052***	0.159**	0.168***	0.067***	0.082***	0.715***	0.697***
	-3.56	-3.48	-2.42	-2.52	-2.69	-3.3	-5.2	-5.97
Bank return on assets	-0.214***	-0.218***	-1.091***	-1.208***	-0.634***	-0.741***	-0.960***	-1.186***
	(-4.43)	(-4.63)	(-5.92)	(-6.86)	(-4.00)	(-5.01)	(-2.88)	(-4.01)
Bank concentration	0.051***	0.053***	0.1768	0.506***	0.076***	0.069***	0.728***	0.775***
	-2.9	-3.07	-1.48	-4.46	-3.21	-2.96	-5.81	-6.97
Lerner index	-4.427***	-4.542***	-11.7	21.72**	-1.536		-22.03*	-19.64***
	(-3.37)	(-3.54)	(-1.01)	-2.07	(-0.79)		-1.86	(-2.05)
Bank Z-score	-0.029		-0.316*		-0.0884	-0.114**	-0.565**	-0.668***
	(-0.64)		(-1.78)		(-1.58)	(-2.10)	(-2.29)	(-3.28)
Bank regulatory capital-to-risk-weighted assets ratio	0.237***	0.232***	-0.587*	-1.070***	-0.194***	-0.197***	1.417***	1.324***
	-3.97	-3.96	(-1.72)	(-2.86)	(-2.66)	(-2.71)	-4.21	-4.33
Banking crisis dummy	1.986***	2.039***	-2.891**		7.398***	7.446***	6.653	
	-4.57	-4.76	(-1.92)		-5.64	-5.71	-1.22	
Economic growth	-17.49***	-17.83***	-18.15***	-18.57***	-13.85***	-13.82***	-12.68***	-13.35***
	(-10.82)	(-11.32)	(-8.48)	(-13.60)	(-7.38)	(-11.74)	(-6.47)	(-9.21)
Constant	-450.7***	-442.1***	-2361.1***	-2259.3***	77.01	122.3***	-941.8***	-1208.3***
	(-5.73)	(-5.67)	(-8.05)	-8.19	-0.62	-11.34	(-2.70)	(-4.13)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Country fixed effect	No	No	Yes	No	No	No	Yes	Yes
F or Wald test	27.85	37.11	649.76	453.8	30.23	44.71	455.17	457.13
(Prob > F) or (Prob > chi2)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared within	0.3322	0.331			0.3278	0.3235		
AB AR(1) z			-4.92	-4.18			-1.72	-1.36
(Pr > z)			(0.000)	(0.000)			-0.085	-0.175
AB AR(2) z			-2.02	-2.57			-2.82	-2.91
(Pr > z)			-0.044	-0.01			-0.005	-0.004
Sargan test chi2			2.22	6.88			1.71	5.13
(Prob > chi2)			-0.898	-0.737			-0.945	-0.823
Number of observations	722	722	722	722	798	798	798	798

Source: Author's estimations.

Note: t-statistics are provided in parenthesis, and *, **, *** indicate statistical significance at 10%, 5%, 1%, respectively.

The paper also seeks to identify any potential differences after the onset of the GFC (here, the years 2009-2017). Table 5 reports the results for this period, considering all panels but using only fixed effects panel estimations. Overall, the results confirm that there are no remarkable differences when comparing the results obtained in the different panels, meaning that the determinants of non-performing loans are not particularly dependent on the level of income of the considered countries nor on their integration in the OECD.

The results reported in Table 5 reveal that contrary to the findings presented in the previous tables, the increase of bank market stability (proxied with the Z-score) is not associated with the decrease of non-performing loans, probably due to the turbulent consequences of the crisis, affecting the stability of the banking institutions. Moreover, Table 5 emphasises the importance of the bank regulatory capital-to-risk-weighted assets ratio, revealing the increasingly relevant role of the regulatory authorities in fighting and preventing the bank non-performing loans, after the onset of the GFC.

On the other hand, the effects of other explanatory variables on non-performing loans reported in Table 5 are overall in line with the results presented in the previous tables, although not always with the same statistical robustness. These results also validate the previous findings regarding the positive influence of the bank credit-to-bank deposits ratio (e.g., Dimitrios et al., 2016; Van den End, 2016; Ozili, 2019); the positive influence of the bank cost-to-income ratio (Louzis et al., 2012); the positive influence of the net interest margin (De Bock & Demyanets, 2012; Louzis et al., 2012; Dimitrios et al., 2016); the negative effect of the bank return on assets (Godlewski, 2005; Makri et al., 2014; Khan et al., 2020); the positive influence of bank concentration (Berger & Hannan, 1998; Delis & Tsionas, 2009; Fare et al., 2015); the negative influence of the Lerner index (measuring bank competition, Boyd et al., 2009; Martinez-Miera & Repullo, 2010; Schaeck & Cihák, 2014); and, finally, the negative influence of GDP growth (Nkusu, 2011; Beck et al., 2015; Dimitrios et al., 2016).

According to the results reported in Table 5, there is evidence of the positive influence on non-performing loans of the bank's non-interest income-to-total income (reflecting the bank income diversification), confirming the results presented in the previous tables, but not clearly validating the "diversification hypothesis" admitted by Louzis et al. (2012).

Overall, Table 5 reinforces the evidence that to avoid non-performing loans, banks should increase their profitability and efficiency and should be acting in competitive and stable markets as well as in countries with strong economic growth.

Table 5: Results obtained with FE: all panels, years after the onset of the GFC

	Panel 1		**Panel 2.A**		**Panel 2.B**		**Panel 3.A**		**Panel 3.B**	
	Model 1	**Model S**	**Model 1**	**Model S**	**Model 1**	**Model S**	**Model 1**	**Model S**	**Model 1**	**Model S**
Bank credit-to-bank deposits ratio	0.052***	0.053***	0.087***	0.083***	-0.048***	-0.050***	0.0633***	0.0615***	0.0243	
	(5.45)	(5.52)	(6.15)	(6.59)	(-3.67)	(-4.03)	(6.1)	(6.39)	(1.44)	
Bank cost-to-income ratio	0.043**	0.049**	0.061**	0.056**	0.0006		0.046**	0.039**	0.024	
	(1.93)	(2.3)	(2.29)	(2.45)	(0.02)		(2.13)	(1.97)	(0.53)	
Bank net interest margin	0.0216		0.3285**	0.3638**	0.1843		0.7842***	0.7825***	-0.0722	
	(0.16)		(2.01)	(2.43)	(0.99)		(3.32)	(3.65)	(-0.40)	
Bank non-interest income-to-total income ratio	0.039**	0.040**	0.040*	0.043*	0.052*	0.045**	0.004		0.066*	0.065***
	(2.09)	(2.25)	(1.68)	(1.92)	(1.85)	(2.04)	(0.2)		(1.87)	(2.48)
Bank return on assets	-0.131***	-0.133***	-0.0145		-0.549***	-0.537***	0.0044		-0.470***	-0.557***
	(-2.70)	(-2.74)	(-0.28)		(-5.26)	(-5.23)	(0.11)		(-3.31)	(-4.08)
Bank concentration	0.0471**	0.0470**	-0.0122		0.0909***	0.0903***	0.0261		0.0574*	
	(2.04)	(2.04)	(-0.35)		(3.57)	(3.6)	(0.98)		(1.68)	
Lerner index	-4.284		-0.4638		-7.033***	-7.335**	-6.132**	-6.209**	-1.709	
	(-1.49)		(-0.12)		(-2.15)	(-2.30)	(-1.98)	(-2.03)	(-0.39)	
Bank Z-score	0.2658***	0.271***	0.0901		0.149	0.171*	0.057		0.471***	0.460***
	(3.52)	(3.76)	(0.96)		(1.41)	(1.73)	(0.76)		(3.67)	(3.95)
Bank regulatory capital-to-risk-weighted assets ratio	-0.183***	-0.189***	0.104		-0.366***	-0.360***	-0.0003		-0.148	
	(-2.83)	(-2.93)	(1.13)		(-4.71)	(-4.69)	(-0.00)		(-1.45)	
Banking crisis dummy	1.398**	1.446**	0.289		6.312***	6.468***	-1.105	-1.284**	6.076***	6.487***
	(2.26)	(2.35)	(0.42)		(4.92)	(5.09)	(-1.99)	(-2.41)	(4.1)	(4.43)
Economic growth	-27.60***	-27.61***	-41.72***	-42.11***	-1.424		-36.13***	-36.23***	-19.97***	-19.57***
	(-11.17)	(-11.18)	(-10.82)	(-11.41)	(-0.48)		(-11.55)	(-11.82)	(-5.58)	(-5.55)
Constant	-1245.8***	-1213.0***	-1357.3***	-1486.3***	-495.4***	-417.2***	-923.1***	-951.9***	-1207.6***	-1114.8***
	(-9.08)	(-8.95)	(-6.91)	(-9.13)	(-3.01)	(-3.33)	(-5.65)	(-6.57)	(-5.91)	(-5.61)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F test	19.52	23.19	24.14	48.09	14.4	19.15	25.49	43.94	10.53	19.83
(Prob > F)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared within	0.2717	0.2691	0.4601	0.4547	0.3851	0.3819	0.5116	0.5088	0.2806	0.265
Number of observations	720	720	396	396	324	324	342	342	378	378

Source: Author's estimations.

Note: Panel 1 includes the whole sample of 80 countries; Panel 2A (Panel 2B) includes high-income (non-high-income) countries, and Panel 3A (Panel 3B) includes OECD member (non-OECD member) countries. t-statistics are provided in parenthesis, and *, **, *** indicate statistical significance at 10%, 5%, 1%, respectively.

5 Concluding remarks

This paper contributes to the literature analysing the determinants of non-performing loans. Using data extracted from the Word Bank databases, the paper explains the evolution of the bank non-performing loans-to-total loans ratio using three sets of explanatory variables: bank performance indicators (bank credit-to-bank deposits ratio, bank cost-to-income ratio, bank net interest margin, bank non-interest income-to-total income ratio, bank return on assets), market conditions indicators (bank concentration, Lerner index, bank Z-score, bank regulatory to risk-weighted assets, bank crisis dummy), and economic growth indicator (natural logarithm of real per capita GDP).

The paper tests the relevance of these determinants to bank non-performing loans using panel fixed effects and dynamic Generalised Method of Moments (GMM) estimations and a panel of 80 countries over the period 1999-2017 using only fixed effects estimations for the years after the onset of the GFC (2008-2017). The paper also analyses the relevance of the countries' level of development as well as their integration in the OECD considering different sub-samples of countries, concluding that the determinants of non-performing loans are not particularly dependent on the level of income of the considered countries nor on their integration in the OECD.

The findings of this paper allow the following answers to the specified questions:

1) The evolution of non-performing loans depends not only on the banks' performance measured by their efficiency and profitability but also on the market conditions (mainly on the bank market concentration and competition as well as on the regulatory conditions). However, the best way to prevent the increase in non-performing loans is assuring an increase in economic growth.
2) Our findings do not identify very relevant differences related to the level of income of the countries.
3) There are no significant differences related to the countries' integration in the Organisation for Economic Cooperation and Development (OECD).
4) The main differences identified for the years after the GFC were the effects related to the bank market stability, as, after the crisis, stability did not avoid non-performing loans. Moreover, the crisis highlighted the relevant role of the regulatory authorities in fighting and preventing non-performing loans.
5) The findings point to the following overall conclusions and to some recommended ways to prevent non-performing loans:

    - At bank-level (bank performance): to avoid non-performing loans, banks should mainly increase their profitability, more precisely, their return-to-assets ratio (%, after tax) measuring the profits generated by bank-owned assets. The other potential determinants of non-performing loans analysed in this paper (the bank credit-to-bank deposits and bank cost-to-income ratios and bank net interest margin) were positively associated with non-performing loans, revealing that the banks included in this analysis during the considered period were not able to conciliate the evolution of bank liquidity, efficiency, and net interest margin with the decrease of non-performing loans.
    - At industry-level (financial structure and market conditions): in general, these conditions are revealed to be very relevant to prevent non-performing loans. In

the entire sample, and particularly after the onset of the GFC, bank market concentration promoted non-performing loans, while bank market stability and competition had a negative influence on the levels of non-performing loans. Moreover, the role of bank capital regulation prevents these loans from increasing after the banking crisis. These results clearly underline the relevant role of the political and regulatory authorities in controlling bank risks and decreasing crisis threats. Therefore, the authorities should not only improve the specific bank regulations but also provide legislation and conditions assuring bank market competition and promoting market stability.

- At macroeconomic-level (in terms of the real per capita GDP growth): there is very convincing evidence that economic growth is not in line with bank non-performing loans, looking like the best way to avoid the increase of these undesired loans and preventing bank risks.

In summary, the results clearly point out the overall conclusion that bank liquidity, bank efficiency and bank profitability are important to prevent bank risks and banking crises. In addition, appropriate bank regulation and good bank market conditions are surely relevant. However, a much more important determinant is economic growth, meaning that countries with solid and sustainable growth of the real per capita GDP are less likely to have the problems associated with bank non-performing loans, namely banking and financial crisis.

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Appendices

Appendix A: Countries included in the considered panels

Panel 1 –whole sample of 80 countries	Argentina, Australia, Austria, Belarus, Belgium, Bolivia, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Gabon, Georgia, Germany, Greece, Guatemala, Honduras, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kenya, Rep. Korea, Latvia, Lebanon, Lesotho, Lithuania, Luxembourg, Malaysia, Malta, Mexico, Morocco, Namibia, Netherlands, New Zealand, Nigeria, Norway, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Serbia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Tanzania, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Zambia
Panel 2A – 44 high-income countries (following the World Bank criteria)	Argentina, Australia, Austria, Belgium, Canada, Chile, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Rep. Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Panama, Poland, Portugal, Romania, Saudi Arabia, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States, Uruguay.
Panel 2B – 36 non-high-income countries (following the World Bank criteria)	Belarus, Bolivia, Brazil, Bulgaria, China, Colombia, Costa Rica, Egypt, Gabon, Georgia, Guatemala, Honduras, India, Indonesia, Jordan, Kenya, Lebanon, Lesotho, Malaysia, Mexico, Morocco, Namibia, Nigeria, Paraguay, Peru, Philippines, Russian Federation, Rwanda, Senegal, Serbia, South Africa, Tanzania, Tunisia, Turkey, Ukraine, Zambia
Panel 3A – 38 OECD member countries	Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Rep. Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States
Panel 3B – 42 non-OECD member countries	Argentina, Belarus, Bolivia, Brazil, Bulgaria, China, Croatia, Cyprus, Egypt, Gabon, Georgia, Guatemala, Honduras, India, Indonesia, Jordan, Kenya, Lebanon, Lesotho, Malaysia, Malta, Morocco, Namibia, Nigeria, Panama, Paraguay, Peru, Philippines, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Serbia, Singapore, South Africa, Tanzania, Tunisia, Ukraine, United Arab Emirates, Uruguay, Zambia

Appendix B: Descriptive statistics and correlation matrix for Panel 1

Table B.1: Descriptive statistics

Variables(**)	Mean	Std. Dev.	Min	Max
NPL	6.719	7.753	0.1	74.1
BCBD	110.377	51.329	17.795	367.077
BCI	57.922	14.037	19.895	218.087
BNIM	4.051	2.847	0.009	23.167
BNIITI	38.345	13.100	0.404	96.170
BROA	1.402	2.541	-21.684	66.262
BConc	63.898	18.743	20.846	100
LI	0.259	0.177	-1.609	1.534
BZ	14.699	9.783	0.017	61.164
BRC	15.581	4.135	1.755	41.8
Bcris	0.083	0.276	0	1
GDP	9.268	1.301	5.779	11.626

Note: Panel 1 includes the whole sample of 80 countries over the period 1999-2017. The total number of observations is 1,520

Table B.2: Correlation matrix

Variables	NPL	BCBD	BCI	BNIM	BNIITI	BROA	BConc	LI	BZ	BRC	Bcris	GDP
NPL	1											
BCBD	-0.09	1										
BCI	0.11	-0.08	1									
BNIM	0.23	-0.23	0.09	1								
BNIITI	0.07	-0.01	0.26	-0.13	1							
BROA	-0.13	-0.13	-0.18	0.32	0.01	1						
BConc	-0.06	0.23	-0.04	-0.13	0.06	0.04	1					
LI	-0.09	-0.02	-0.34	0.11	-0.24	0.21	-0.03	1				
BZ	-0.1	-0.16	-0.16	-0.09	-0.18	0.07	-0.13	0.19	1			
BRC	0.1	-0.17	-0.04	0.31	0.16	0.19	0.002	0.08	-0.06	1		
Bcris	0.18	0.09	0.07	-0.11	0.06	-0.28	-0.04	-0.15	-0.14	-0.06	1	
GDP	-0.39	0.29	-0.06	-0.69	0.16	-0.21	0.22	-0.09	-0.02	-0.18	0.14	1

Note: The variables are:
NPL = Bank non-performing loans-to-gross loans ratio (%)
BCBD = Bank credit-to-bank deposits ratio (%)
BCI = Bank cost-to-income ratio (%)
BNIM = Bank net interest margin (%)
BNIITI = Bank non-interest income-to-total income ratio (%)
BROA = Bank return on assets (%, after tax)
BConc = Bank concentration (%)
LI = Lerner index
BZ = Bank Z-score
BRC = Bank regulatory capital to risk-weighted assets (%)
Bcris = Banking crisis dummy
GDP = natural logarithm of per capita GDP (constant 2005 US$)