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Determinants of non-performing loans: a panel data approach

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Abstract

This paper analyses the evolution of the bank non-performance loans to total loans ratio using three categories of explaining variables: bank performance indicators (bank credit to bank deposits ration, bank cost to income ratio, bank net interest margin, bank noninterest income to total income, and bank return on assets), market conditions and financial structure indicators (bank concentration, Lerner index, bank Z-score, bank regulatory to risk-weighted assets, and bank crisis dummy), and economic growth indicator (natural logarithm of real GDP per capita). The paper applies panel fixed effects and dynamic Generalised Method of Moments (GMM) estimates to a panel of 80 countries spread by all Continents, over the period 1999-2017. The results obtained clearly demonstrate that bank performance, bank market conditions, and bank capital regulation are relevant to explain the evolution of non-performance loans, but the promotion of economic growth is always much more important to assure the decrease the levels of non-performing loans, preventing the losses of the banking system as well as potential financial crisis.

Key words: Bank risk, non-performing loans, bank performance, bank market conditions, panel estimates.

JEL categories: G21, G15, G32, F39, C33.

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1. Introduction

Over the past years, and particularly in the aftermath of the latest global financial crisis, considerable attention has been paid to bank risks. Bank risks have been affected by the innovations in the banking industry, namely the changes in the technology, and the impact of the off-balance sheet activities. Financial crisis increased the problems related to asymmetric information, fomenting adverse selection and moral hazard problems. These problems incentivised the thinly capitalised banks to augment their level of risk, and as capital is costly, also highly capitalised banks, on average, increased their level of risk to maximize revenues (Fiordelisi et al, 2011).

The crisis has highlighted the fragility of individual banks as well as of 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 stand 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 and Heaney, 2012; Danisman and Demirel, 2019; Badarau and 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' asset quality, and it directly affects the overall financial performance of the whole banking sector (Berger and De Young, 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 and Louzis, 2018).

This paper contributes to the strand of literature that analyses the determinants of non-performing loans. More precisely, it explains the evolution of the bank non-performance loans to total loans ratio using three categories of explaining variables: bank performance indicators, market conditions and financial structure indicators, and economic growth indicator.

The paper applies panel fixed effects and dynamic Generalised Method of Moments (GMM) estimates to a panel of 80 countries spread by all Continents, over the period 1999-2017. It assesses the relevance of the level of developments, as well as of the degree of integration of the countries, considering different sub-samples of countries and comparing the results obtained for high-income countries with those obtained for the non-high-income countries; also the results obtained for the countries that are members of the Organisation for Economic Cooperation and Development (OECD), with those obtained for the non-OECD countries. For all panels and sub-panels, the paper analyses the results obtained for the whole period (1999-2017) with those obtained for the years after the global financial crisis (2009-2017).

Overall, the results obtained confirm the relevance of the considered variables to explain the evolution of non-performing loans, concluding that there are no significant differences in the behaviour of the countries with high income, versus the countries with non-high income; nor between countries members of the OECE versus the countries that are not members of the OECE.

In all situations, there is clear evidence that bank performance, in particular the increase of the return on assets, is important to prevent non-performing loans (and bank risks). Moreover, the results obtained 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 last global crisis. Finally, the results obtained in all considered 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 methodological aspects; Section 4 presents the used data and discusses the results obtained; Section 5 concludes.

2. Relevant literature

After the recent global financial crisis and particularly during the last decade, there was an increase in studies focusing the definition, measurement and testing of the determinants of bank risks.

Considering five different measures of bank risk, Haq and Heaney (2012) investigated the factors determining European bank risks using information for 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, the increase in the level of off-balance activities contributed to the increase of bank risk.

Using three alternative measures of bank risk, including the bank non-performing loans, Craig and Dinger (2013) analysed the effect of bank competition on bank risk, considering a sample of 589 US banks over a period between September 1997 and July 2006. This 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 were obtained by Danisman and Demirel (2019) who explored the link between competition, bank regulatory variables and different measures of bank risk, using a sample of 6936 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 and 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 and Lapteacru (2020) provided a relevant 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 not only the evolution of returns of banks' stocks, but also the default frequency in the banking sector, the network of the financial market infrastructure or the regulatory environment.

Despite the discussion of 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 of bank risk. A high level of non-performing loans affects not only the efficiency of the individual banking institutions but also of 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 latest global financial crisis (Louzis et al, 2012; Ozili, 2017).

These concerns contributed to the development of the strand of literature analysing and empirically estimating the bank performance determinants as well as the macroeconomic determinants of non-performing loans.

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, namely the decrease of economic growth and the increase of the unemployment levels, contributed to higher non-performing loans. The same kind of conclusions were obtained by De Bock and 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 a 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-performance loans, in a sample of 75 countries, covering the decade 2000-2010, and concluded that real GDP growth, share prices, the exchange rate, and the lending interest significantly affected non-performance loans. Anastasiou et al (2016) considered the banking system of 15 Euro area countries, over the period 1990Q1-2015Q2, and found that macroeconomic indicators, such as unemployment rate and growth rates, as well as taxes on personal income and output gap had significant influence on non-performing loans. Also, for the Euro area, but considering 14 countries and the period between 2000 and 2008, Makri et al (2014) analysed the factors influencing non-performance 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 Europe countries, in the period of 1998–2011, concluding that while 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. More precisely, higher quality of the bank's management, contributed to lower non-performing loans, while moral hazard incentives, such as low equity as well as excessive bank risk-taking, tended to increase non-performing loans. Moreover, the bank-level effects were found significant during both the pre-crisis and post-crisis periods.

Considering also the situation of Central, Eastern and South-Eastern Europe countries, but with a sample of 12 countries during the 2006 to 2013 period, Tanaskovic and Jandric (2015), concluded that the increase of non-performing loans was negatively related with financial market development and GDP growth, and that it was positively related with foreign currency loans ratio and the level of exchange rate.

Ozili (2017) used an unbalanced panel including data for 103 countries over the 2003 to 2014 period, concluding that non-performing loans increased with greater foreign bank presence and greater financial intermediation (i.e., private credit banks to GDP ratio). 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 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 the number of non-performing loans. Dao et al (2020) analysed different aspects that impact non-performing commercial bank loans, using data of 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 raise in bank performance and in credit growth leaded 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. Methodology and data

Using panel data regression estimations the paper analyses the influence of different indicators, measuring bank performance, market conditions and financial structure, as well as economic growth on non-performance 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 (as explained, for example, in Baltagi, 2013; Wooldridge, 2010, who also underline some recognised disadvantages of panel data).

The following equation represents a basic panel regression model:

$$y_{it} = \alpha_t + \beta X_{it} + u_{it} \quad (1)$$

Where:

y_{it} = dependent variable (here: the bank non-performing loans to gross loans ratio);

$i = 1, \dots, N$ = cross units (the considered countries);

$t = 1, \dots, T$ = time periods (years between 1999-2017);

α_t = intercept (varying with t but independent of i);

X_{it} = independent variables that can vary both with i and t (here, the chosen bank performance indicators, market conditions and financial structure indicators, and economic growth indicator);

u_{it} = 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 the time. As well explained, for example, in Green (2018) fixed effects explore the relationship between the explaining variables and the outcome within each cross unit (for example, each country), considering that each cross unit has its own characteristics, that may (or not) influence the explaining 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. In order 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 (following the method proposed, among others by Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998).

Dynamic system GMM method uses cross-country information and jointly estimates the equations in first difference and in levels, with first differences instrumented by lagged levels of the dependent and independent variables and levels instrumented by first differences of the regressors.

The validity of the GMM estimations is analysed with the tests proposed by Arellano and 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 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.

All the data used in this paper cover the period 1999-2017 and were extracted from the World Bank database “Global Financial Development”. Table 1 presents all the variables included in the estimations.

Table 1 – Dependent and explaining variables

DESIGNATION	SERIES CODE (World Bank)	MEANING
DEPENDENT VARIABLE:		
NPL = Bank non-performing loans to gross loans (%)	GFDD.SI.02	Measure of bank risk
EXPLAINING VARIABLES:		
Bank performance indicators:		
BCBD = Bank credit to bank deposits (%)	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 noninterest income to total income (%)	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 assets owned by the bank)
Market conditions and financial structure 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 (%)	GFDD.SI.05	Measure of bank capital regulation
Beris = 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

All the data were sourced from the World Bank database “Global Financial Development” in October 2021.

The paper considers first a panel including 80 countries spread by all continents, and then different sub-panels, in order to analyse potential differences regarding the level of development of the countries (more precisely, their level of outcome), and the countries' integration in a relevant international organization: the Organisation for Economic Cooperation and Development (OECD).

The panels² considered in the estimations are:

Panel 1 – including the whole sample of 80 countries³

Panel 2A – including sub-sample of 44 countries included in the category of “high income” countries, following the World Bank criteria

Panel 2B – including the sub-sample of the 36 “non-high income” countries

Panel 3A – including the 38 countries that are members of the OECD

Panel 3B – including the other 42 countries that are not members of the OECD

4. Empirical results

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

Table 2 reports the results obtained for Panel 1 (including the whole sample of 80 countries) using both fixed effects and dynamic one step GMM panel estimations. The overall robustness of the results is confirmed by the results of the F and Wald statistics. The validity of the GMM estimations is confirmed as there is clear evidence of autocorrelation of the first

² The specification of the countries included in each panel is provided in Annex I.

³ Annex II presents the descriptive statistics and the correlation matrix for Panel 1 (for the other panels the results are not provided in the paper but will be available under request).

order, AR(1) but not of second order, AR(2). The overall validity of the considered instruments is corroborated with the results obtained with the Sargan test.

In what regards to the influence of the explaining variables on non-performing loans, there is robust evidence that banks with high profitability (measured through the return on assets, that is, the profits generated by the assets owned by the bank), banks benefiting from bank market stability (measured through the Z-score) and banks located in countries with increasing economic growth (the growth of the real GDP per capita) are not expected to have high levels of non-performing loans.

On the other hand, high levels of non-performing loans are robustly associated with bank market concentration and bank crisis, and although not always with the same statistical robustness, also with the bank cost to income ratio (a measure of bank efficiency), the ratio 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). In the other cases, and very particularly in what regards to the measure of bank competition (Lerner index) the results obtained are statistically very robust but there is no evident positive or negative influence on the non-performance loans, as the results obtained depend on the estimation method (fixed effects or dynamic GMM estimates).

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	.0192*** (3.06)	.0171*** (2.84)	-.0282 (-0.74)	
Bank cost to income ratio	.0117 (0.85)		.4176*** (3.93)	.4332*** (4.33)
Bank net interest margin	.1140 (1.09)		.3544 (0.647)	
Bank noninterest income to total income	.0710*** (4.55)	.0694*** (4.69)	.0285 (0.22)	
Bank return on assets	-.3212*** (-5.14)	-.3210*** (-5.32)	-.1695*** (-4.91)	-1.723*** (-5.43)
Bank concentration	.0682*** (4.33)	.0696*** (4.43)	.4545*** (4.17)	.4705*** (4.43)
Lerner index	-4.255*** (-3.53)	-4.592*** (-3.96)	27.35** (2.18)	26.27** (2.12)
Bank Z-score	-.0440 (-1.16)		-.9536*** (-3.43)	-.9390*** (-4.85)
Bank regulatory capital to risk-weighted assets	.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)	498.40 (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 (0.130)
Sargan test chi2 (Prob > chi2)			2.42 (0.933)	5.65 (0.896)
No.observations	1520	1520	1520	1520

Source: Author's estimations.

Table 3 presents the results obtained for Panel 2.A (which includes the sub-sample of the 44 countries classified as high-income countries) and Panel 2.B (with the other 36 countries considered in these estimations and classified as non-high income countries). The results obtained for these two sub-panels are fully in line with those previously reported for the whole sample in what regards to the expectations of low levels of non-performing loans for banks with high profitability and located in countries with increasing economic growth. In addition, although not with the same statistical robustness, banks facing strong bank market competition (measured through the Lerner index) are also not associated with high levels of non-performing loans.

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	.0505*** (7.27)	.0492*** (7.31)	.0189 (0.82)		-.0051 (-0.47)		.1714*** (3.54)	.1679*** (3.61)
Bank cost to income ratio	.0004 (0.03)		.0507 (0.60)		.0038 (0.13)		.1056 (0.88)	
Bank net interest margin	.1646 (1.10)		-1.455** (-2.25)	-1.385** (-2.14)	.1344 (0.92)		-.4317 (-0.68)	
Bank noninterest income to total income	.0514*** (2.92)	.0463*** (2.75)	-.2059*** (-3.06)	-.2317*** (-3.66)	.0759*** (2.99)	.0732*** (3.08)	.5694*** (5.53)	.5956*** (6.33)
Bank return on assets	-.2346*** (-4.00)	-.2252*** (-3.93)	-1.512*** (-5.12)	-1.554*** (-6.65)	-.5089*** (-3.32)	-.5144*** (-3.65)	-.5712** (-1.96)	-.5946** (-2.11)
Bank concentration	.0342 (1.59)	.0359*** (1.70)	-.0533 (-0.52)		.0713*** (3.23)	.0641*** (2.97)	.4938*** (3.78)	.5177*** (4.22)
Lerner index	-6.465*** (-4.56)	-6.329*** (-4.57)	-2.046 (-0.37)		-2.201 (-1.15)		-28.67* (-1.74)	-38.72*** (-2.73)
Bank Z-score	.0137 (0.27)		.3479 (1.43)		-.1206** (-2.21)	-.1197** (-2.35)	.0854 (0.43)	
Bank regulatory capital to risk-weighted assets	.4271*** (6.63)	.4308*** (6.77)	1.692*** (5.28)	1.752*** (7.64)	-.3173*** (-4.60)	-.3143*** (-4.59)	1.700*** (4.58)	1.550*** (4.75)
Banking crisis dummy	2.274*** (4.39)	2.269*** (4.44)	-3.860 (-1.55)	-5.632*** (-2.84)	5.792*** (4.09)	5.914*** (4.20)	7.990 (1.62)	7.274 (1.59)
Economic growth	-12.01*** (-7.90)	-12.17*** (-8.06)	-21.92*** (-6.39)	-19.63*** (-10.17)	-16.97*** (-7.98)	-16.85*** (-15.06)	-21.90*** (-8.95)	-20.61*** (-10.12)
Constant	-278.9*** (-3.44)	-276.5*** (-3.43)	-339.2 (-1.21)	-190.2 (-1.00)	61.01 0.43	146.6*** (15.03)	-1307.2*** (-2.88)	-1323.0*** (-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 (Prob > F) or (Prob > chi2)	26.86 (0.000)	35.73 (0.000)	599.15 (0.000)	576.32 (0.000)	34.96 (0.000)	59.73 (0.000)	598.49 (0.000)	598.66 (0.000)
R-squared within	0.2924	0.2911			0.3974	0.3948		
AB AR(1) z (Pr > z)			-5.45 (0.000)	-6.07 (0.000)			-1.76 (0.78)	-2.06 (0.039)
AB AR(2) z (Pr > z)			-1.59 (0.113)	-1.70 (0.089)			-2.55 (0.011)	-2.64 (0.008)
Sargan test chi2 (Prob > chi2)			4.11 (0.662)	9.43 (0.582)			2.24 (0.896)	7.76 (0.558)
No.observations	836	836	836	836	684	684	684	684

Source: Author's estimations.

Still according to the results presented in Table 3 it is possible to conclude that overall, bank liquidity (the bank credit to bank deposits ratio), and bank market concentration are likely to contribute to bank non-performing loans.

In what regards to the comparison of the results obtained for the “high income” and “non-high income” countries, Table 3 does not highlight significant differences. The non-unanimity of the results (namely regarding the influence of the net interest margin, the noninterest income to total income ratio, the measure of bank regulation, and the banking crisis dummy) is mainly associated with the use of either fixed effects or dynamic GMM panel estimations.

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	.0292*** (4.81)	.0279*** (4.83)	-.0096 (-0.40)	-.0477** (-1.98)	.0137 (1.20)		.2151*** (4.23)	.2488*** (6.00)
Bank cost to income ratio	.0063 (0.57)		.1343*** (2.59)	.1047* (1.92)	.0446 (1.42)		-.1141 (-0.74)	
Bank net interest margin	.1205 (0.80)		.8192 (1.31)		.2984** (2.03)	.3123** (2.15)	-.4450 (-0.53)	
Bank noninterest income to total income	.0554*** (3.56)	.0523*** (3.48)	.1590** (2.42)	.1682*** (2.52)	.0696*** (2.69)	.0816*** (3.30)	.7147*** (5.20)	.6972*** (5.97)
Bank return on assets	-.2138*** (-4.43)	-.2181*** (-4.63)	-1.091*** (-5.92)	-1.208*** (-6.86)	-.6336*** (-4.00)	-.7412*** (-5.01)	-.9596*** (-2.88)	-1.186*** (-4.01)
Bank concentration	.0508*** (2.90)	.0531*** (3.07)	.1768 (1.48)	.5060*** (4.46)	.0763*** (3.21)	.0694*** (2.96)	.7284*** (5.81)	.7751*** (6.97)
Lerner index	-4.427*** (-3.37)	-4.542*** (-3.54)	-11.70 (-1.01)	21.72** (2.07)	-1.536 (-0.79)		-22.03* (1.86)	-19.64*** (-2.05)
Bank Z-score	-.0290 (-0.64)		-.3164* (-1.78)		-.0884 (-1.58)	-.1139** (-2.10)	-.5654** (-2.29)	-.6683*** (-3.28)
Bank regulatory capital to risk-weighted assets	.2371*** (3.97)	.2323*** (3.96)	-.5870* (-1.72)	-1.070*** (-2.86)	-.1939*** (-2.66)	-.1974*** (-2.71)	1.417*** (4.21)	1.324*** (4.33)
Banking crisis dummy	1.986*** (4.57)	2.039*** (4.76)	-2.891** (-1.92)		7.398*** (5.64)	7.446*** (5.71)	6.653 (1.22)	
Economic growth	-17.49 (-10.82)	-17.83*** (-11.32)	-18.15*** (-8.48)	-18.57*** (-13.60)	-13.85*** (-7.38)	-13.82*** (-11.74)	-12.68*** (-6.47)	-13.35*** (-9.21)
Constant	-450.7*** (-5.73)	-442.1*** (-5.67)	-2361.1*** (-8.05)	-2259.3*** (8.19)	77.01 (0.62)	122.3*** (11.34)	-941.8*** (-2.70)	-1208.3*** (-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 (Prob > F) or (Prob > chi2)	27.85 (0.000)	37.11 (0.000)	649.76 (0.000)	453.80 (0.000)	30.23 (0.000)	44.71 (0.000)	455.17 (0.000)	457.13 (0.000)
R-squared within	0.3322	0.3310			0.3278	0.3235		
AB AR(1) z (Pr > z)			-4.92 (0.000)	-4.18 (0.000)			-1.72 (0.085)	-1.36 (0.175)
AB AR(2) z (Pr > z)			-2.02 (0.044)	-2.57 (0.010)			-2.82 (0.005)	-2.91 (0.004)
Sargan test chi2 (Prob > chi2)			2.22 (0.898)	6.88 (0.737)			1.71 (0.945)	5.13 (0.823)
No.observations	722	722	722	722	798	798	798	798

Source: Author's estimations.

The results reported in Table 4 are not surprising, and they do not clearly highlight the importance of the integration in a relevant international organization: the Organisation for Economic Cooperation and Development (OECD) to explain differences in bank non-performing loans. As in the previous tables, there is clear evidence that non-performing loans are not associated with the bank return on assets nor with increasing economic growth; the same happens, although not so evidently, with the Lerner index and the bank Z-score.

On the other hand, there is robust evidence that the bank noninterest income to total income ratio and bank market concentration are likely to contribute to bank non-performance loans. With few exceptions (and again, related to the different estimation methods) the results also

demonstrate that bank credit to bank deposits, bank cost to income ratio, bank interest margin, and banking crisis dummy are positively related to bank non-performance loans.

In what regards to the bank regulatory capital to risk-weighted assets, 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-performance loans.

The paper also seeks to identify any potential differences after the onset of the last global financial crisis (here the years 2009-2017). Table 5 reports the results obtained for this period, considering all mentioned 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 considered panels, meaning that the determinants of non-performance loans are not particularly dependent on the level of the income of the considered countries nor on their integration in the OECD.

A more careful analysis of Table 5 reinforces the evidence that in order to avoid non-performing loans, banks should increase their profitability, should be acting in competitive and stable markets as well as in countries with strong economic growth. These results also emphasise the role of bank regulatory capital to risk-weighted assets, revealing the increasing relevant role of the regulation authorities in fighting and preventing the bank non-performance loans, after the onset of the last global financial crisis.

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

	Panel 1 – 80 countries		Panel 2.A - High income countries		Panel 2.B - Non-high income countries		Panel 3.A - OECD countries		Panel 3.B – non-OECD countries	
	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	.0524*** (5.45)	.0530*** (5.52)	.0868*** (6.15)	.0832*** (6.59)	-.0480*** (-3.67)	-.0495*** (-4.03)	.0633*** (6.10)	.0615*** (6.39)	.0243 (1.44)	
Bank cost to income ratio	.0425** (1.93)	.0492** (2.30)	.0611** (2.29)	.0594** (2.45)	.0006 (0.02)		.0459** (2.13)	.0388** (1.97)	.0238 (0.53)	
Bank net interest margin	.0216 (0.16)		.3285** (2.01)	.3638** (2.43)	.1843 (0.99)		.7842*** (3.32)	.7825*** (3.65)	-.0722 (-0.40)	
Bank noninterest income to total income	.0390** (2.09)	.0398** (2.25)	.0396* (1.68)	.0426* (1.92)	.0518* (1.85)	.0446** (2.04)	.0040 (0.20)		.0662* (1.87)	.0649*** (2.48)
Bank return on assets	-.1314*** (-2.70)	-.1333*** (-2.74)	-.0145 (-0.28)		-.5486*** (-5.26)	-.5371*** (-5.23)	.0044 (0.11)		-.4699*** (-3.31)	-.5574*** (-4.08)
Bank concentration	.0471** (2.04)	.0470** (2.04)	-.0122 (-0.35)		.0909*** (3.57)	.0903*** (3.60)	.0261 (0.98)		.0574* (1.68)	
Lerner index	-.4284 (-1.49)		-.4638 (-0.12)		-.7033*** (-2.15)	-.7335** (-2.30)	-.6.132** (-1.98)	-.6.209** (-2.03)	-1.709 (-0.39)	
Bank Z-score	.2658*** (3.52)	.2705*** (3.76)	.0905 (0.96)		.1493 (1.41)	.1709* (1.73)	.0571 (0.76)		.4708*** (3.67)	.4600*** (3.95)
Bank regulatory capital to risk-weighted assets	-.1832*** (-2.83)	-.1893*** (-2.93)	.1043 (1.13)		-.3695*** (-4.71)	-.3600*** (-4.69)	-.0003 (-0.00)		-.1478 (-1.45)	
Banking crisis dummy	1.398** (2.26)	1.446** (2.35)	.2893 (0.42)		6.312*** (4.92)	6.468*** (5.09)	-.1.105 (-1.99)	-.1.284** (-2.41)	6.076*** (4.10)	6.487*** (4.43)
Economic growth	-27.60*** (-11.17)	-27.61*** (-11.18)	-41.72*** (-10.82)	-42.11*** (-11.41)	-1.424 (-0.48)		-.36.13*** (-11.55)	-.36.23*** (-11.82)	-19.97*** (-5.58)	-19.57*** (-5.55)
Constant	-1245.8*** (-9.08)	-1213.0*** (-8.95)	-1357.3*** (-6.91)	-1486.3*** (-9.13)	-495.4*** (-3.01)	-417.2*** (-3.33)	-.923.1*** (-5.65)	-.951.9*** (-6.57)	-1207.6*** (-5.91)	-1114.8*** (-5.61)
Year fixed effect	yes	yes	Yes	yes	yes	yes	Yes	yes	yes	yes
F test (Prob > F)	19.52 (0.000)	23.19 (0.000)	24.14 (0.000)	48.09 (0.000)	14.40 (0.000)	19.15 (0.000)	25.49 (0.000)	43.94 (0.000)	10.53 (0.000)	19.83 (0.000)
R-squared within	0.2717	0.2691	0.4601	0.4547	0.3851	0.3819	0.5116	0.5088	0.2806	0.2650
No. observations	720	720	396	396	324	324	342	342	378	378

Source: Author's estimations.

5. Concluding remarks

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

The paper tests the relevance of these determinants to bank non-performance loans using panel fixed effects and dynamic Generalised Method of Moments (GMM) estimates to a panel of 80 countries spread by all Continents, over the period 1999-2017, and using only fixed effects estimations for the years after the onset of the last global financial crisis (2008-2017). The paper also analyses the relevance of the countries' level of development as well as of their integration in the OECD considering different sub-samples of countries.

The results obtained confirm the overall relevance of the considered variables to the evolution of non-performing loans and allow the following conclusions and policy recommendations:

- 1) In what regards to **bank performance**: in order to avoid non-performing loans, banks should mainly increase their profitability, more precisely, their return to assets (%) after tax) measuring the profits generated by the assets owned by the banks. The other potential determinants of non-performing loans, considered in this paper (the ratios bank credit to bank deposits, bank cost to income, and bank net interest margin), were overall positively associated to 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.
- 2) In what regards to **financial structure and market conditions**: overall, these conditions revealed to be much more important to prevent non-performing loans than the considered bank performance indicators. In almost all situations, and particularly after the onset of the global financial crisis, bank market concentration promoted non-performing loans, while bank market stability and competition had a negative influence on the levels bank non-performing loans. Moreover, the role of bank capital regulation is preventing these loans increased after the banking crisis. These results clearly underline the relevant role of the political and regulatory authorities in

controlling bank risks and decreasing the 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 bank market stability.

- 3) In what regards to **macroeconomic conditions**, here proxied by the growth of the real GDP per capita: 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, preventing bank risk.

Summarising, the results obtained in all considered panels in this paper clearly point to the overall conclusion that to prevent bank risks (and banking crisis) bank liquidity, bank efficiency and bank profitability are important; also, appropriate bank regulation and good bank marker conditions are surely relevant. However, much more determinant is economic growth, meaning that countries with solid and sustainable growth of the real GDP per capita are less likely to have the problems associated to bank non-performing loans, namely banking and financial crisis.

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Annex I – 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 no 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

Annex II – Descriptive statistics and correlation matrix (Panel 1^(*))

Descriptive statistics

Variables ^(*)	Mean	Std. Dev.	Min	Max
NPL	6.719368	7.753046	.1	74.1
BCBD	110.3765	51.32909	17.7947	367.077
BCI	57.92247	14.03695	19.8953	218.087
BNIM	4.05079	2.847222	.009582	23.1671
BNIITI	38.34481	13.10031	.40404	96.1704
BROA	1.401606	2.540911	-21.684	66.2621
BConc	63.89789	18.74337	20.8464	100
LI	.2595123	.1768946	-1.60869	1.53407
BZ	14.69864	9.782757	.0167	61.1642
BRCA	15.58108	4.134671	1.75475	41.8
Beris	.0828947	.2758138	0	1
GDP	9.267933	1.300595	5.77901	11.62597

(*) Panel 1 includes the whole sample of 80 countries, over the period 1999-2017,
total number of observations = 1520

Correlation matrix

Variables ^(**)	NPL	BCBD	BCI	BNIM	BNIITI	BROA	BConc	LI	BZ	BRCA	Beris	GDP
NPL	1.00											
BCBD	-0.09	1.00										
BCI	0.11	-0.08	1.00									
BNIM	0.23	-0.23	0.09	1.00								
BNIITI	0.07	-0.01	0.26	-0.13	1.00							
BROA	-0.13	-0.13	-0.18	0.32	0.01	1.00						
BConc	-0.06	0.23	-0.04	-0.13	0.06	0.04	1.00					
LI	-0.09	-0.02	-0.34	0.11	-0.24	0.21	-0.03	1.00				
BZ	-0.10	-0.16	-0.16	-0.09	-0.18	0.07	-0.13	0.19	1.00			
BRCA	0.10	-0.17	-0.04	0.31	0.16	0.19	0.002	0.08	-0.06	1.00		
Beris	0.18	0.09	0.07	-0.11	0.06	-0.28	-0.04	-0.15	-0.14	-0.06	1.00	
GDP	-0.39	0.29	-0.06	-0.69	0.16	-0.21	0.22	-0.09	-0.02	-0.18	0.14	1.00

(**) The variables are:

NPL = Bank non-performing loans to gross loans (%)

BCBD = Bank credit to bank deposits (%)

BCI = Bank cost to income ratio (%)

BNIM = Bank net interest margin (%)

BNIITI = Bank noninterest income to total income (%)

BROA = Bank return on assets (%), after tax

BConc = Bank concentration (%)

LI = Lerner index

BZ = Bank Z-score

BRCA = Bank regulatory capital to risk-weighted assets (%)

Beris = Banking crisis dummy

GDP = natural logarithm of the GDP per capita (constant 2005 US\$)

Source: Author's calculations.