Non-performing loans and bank lending: Evidence for Portugal

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Abstract

This article analyses the impact of Portuguese banks' non-performing loans (NPLs) on the loan supply to non-financial corporations in the 2009-2018 period by exploring the granularity of the Portuguese Central Credit Register. We conclude that, when controlling for loan demand and several bank characteristics, there is no evidence that NPL ratios per se constrained bank loan supply to performing corporates in this period. This result is robust to different econometric specifications and holds both for the crisis and the post crisis periods, as well as regardless of the firm size. Nonetheless, we find that the relevance of banks' NPLs on credit supply differs according to debtors' credit risk profile, namely that banks with higher NPL ratios granted more credit to performing high credit risk NFCs, while no differentiation was found for low and medium credit risk firms. Finally, we also explore the extensive margin of credit and find that a higher level of NPLs in banks' balance sheet is associated, in the post crisis period, with a lower propensity to initiate new credit relationships. (JEL: E51, G21)

Introduction

T he vulnerabilities associated with European banks' balance sheets have been brought to the fore by the international financial crisis and were subsequently exacerbated by the sovereign debt crisis. One consequence of these crises was the pronounced and system-wide increase of non-performing loans (NPLs), although with considerable heterogeneity

across countries, both in terms of the magnitude and the timing of the increase (Figure 1)[1].

The high level of NPLs in banking systems merited particular attention from competent authorities due to its systemic nature, not only because it reflected an excessively leveraged non-financial private sector but also given its possible influence in terms of banks' ability and willingness to finance the economy, with the potential to constitute a drag on economic growth. The latter and, ultimately, the need for a swift reduction of NPLs has been a focal point much discussed among national and international policymakers in recent years, especially in countries where credit risk materialisation was more pronounced.

In Portugal, this topic has also been intensively debated. The significant accumulation of NPLs by the banking sector, which at its peak, in mid-2016, accounted for almost 18%[2] of banks' total loans, and the importance of bank lending for the financing of the Portuguese economy were at the core of the discussion.

This paper contributes to this discussion by exploring the relation between NPLs and credit granted to non-financial corporations (NFCs), in Portugal, during the 2009-2018 period. The focus of the analysis on bank lending to firms is justified not only by the relevance of this sector to economic activity but also given that, in Portugal, corporate NPLs account for the bulk of the stock of NPLs.

Estimating the impacts of any variable on bank lending decisions is a difficult task. The existence of shocks that affect both supply and demand of bank loans, especially in periods of severe economic recessions and financial stress, make it difficult to ascertain whether credit dynamics is driven by supply side decisions or weak loan demand related with firm fundamentals. Building on the Portuguese Central Credit Register (CCR) granular data at the level of individual bank-firm relationship we take advantage of the high prevalence of Portuguese firms with multiple bank relationships which, combined with firm-time fixed effects, allows disentangling demand and supply effects.

The remainder of the paper proceeds as follows. In the next section we describe the recent national and European developments concerning NPLs and discuss the link between NPLs and bank lending, including a brief literature review. In the following sections data and econometric specifications are described and estimation results are presented. The last section concludes.

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1. The ESRB report on "Macroprudential approaches to non-performing loans" of January 2019 relies on the experience of Member States where system-wide increases in NPLs were observed in the aftermath of the recent crisis to identify the main triggers, vulnerabilities and amplifiers that can drive system-wide increases in NPLs.

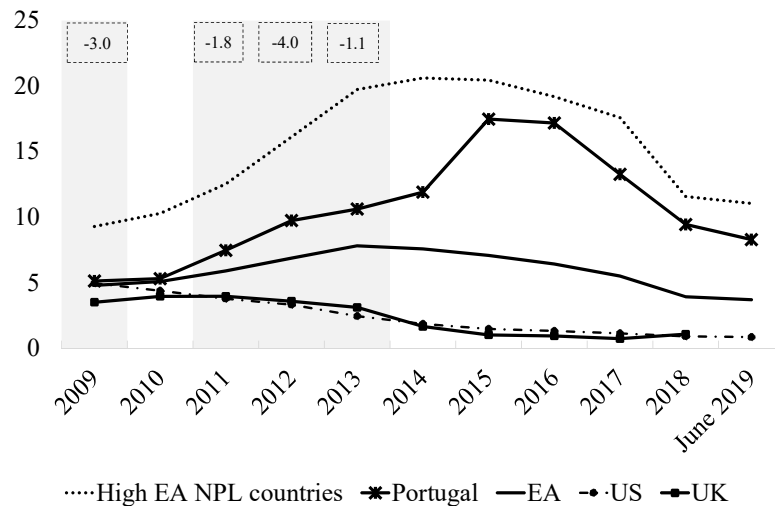2. NPLs according to the EBA definition.

FIGURE 1: NPL ratio | in percentage

Notes: The light grey bars denote years of real negative GDP growth rates in Portugal. The NPL ratio is calculated by taking the value of NPLs as numerator and the total value of loan portfolio as the denominator. National definitions on NPLs may vary across countries and, for each country, over time. High EA NPL countries refers to the five Euro Area countries with highest average NPL ratio for the 2009-2019Q2 period: Cyprus, Greece, Ireland, Italy and Lithuania. Source: IMF Financial Soundness Indicators (FSIs).

Background and motivation

In recent years the stock of NPLs in European banks' balance sheets decreased significantly, even though it is still high in some countries, including Portugal. The composition of NPL portfolios is not homogeneous within the Euro Area (EA). In particular, while corporate loans account for the bulk of the stock in Portugal as in most countries, there are a few cases where NPLs associated to households' credit prevail (e.g., Spain and Ireland). The levels of overall coverage by impairments have also increased, particularly in countries with higher gross NPL ratios, affecting banks' profitability and ultimately banks' capital, but also facilitating the further decline of NPL ratios.

Against this background, NPLs rank high in the agenda of both policymakers and supervisors. Several initiatives at national and European levels have been put in place in recent years targeting NPLs due to their negative impact of NPLs on banks' financial soundness which, ultimately, may affect banks' lending to the economy and the market perception of the

European banking sector, especially within the Banking Union. The various initiatives address the existing stocks of NPLs as well as the buildup of new NPLs on banks' balance sheets, covering areas such as prudential supervision, macroprudential policy, secondary market for NPLs and the underlying legal and judicial framework[3].

In Portugal, one can identify periods with different credit and NPL dynamics. Between end-2008 and mid-2016, in the midst and the aftermath of the global financial crisis and the subsequent sovereign debt crisis, the Portuguese banking system's NPLs more than tripled as a percentage of total bank credit, driven mostly by the increase in NPLs associated to NFCs. During this period, the annual growth rate of bank loans to NFCs dropped significantly to negative figures. As from mid-2016, NPLs exhibited a downward path, whilst bank loans gradually recovered, resuming slightly positive growth rates in 2018 (Figure 2).

These developments convey a negative correlation between NPL ratio and bank loans but do not necessarily endorse a causal relation. They occurred in a period of exceptionally challenging economic and financial conditions for Portugal and the observed correlation could be the reflection of cross-cutting macroeconomic factors that brought about both a decrease in loans, driven by demand and supply factors, and an increase in NPLs.

Furthermore, the correlation observed at aggregated level might conceal a significant heterogeneity between banks and borrowers, which is particularly relevant in the Portuguese case where the corporate sector largely consists of small NFCs. Namely, between 2008 and 2018 about 57% of bank loans to NFCs were granted to micro and small corporations. Micro and small NFCs also account for most of the NPLs. The risk profile of these corporations is quite heterogeneous and, consequently, analysis based on aggregate data may lead to misleading conclusions[4].

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3. The 'Action plan to tackle non-performing loans in Europe', agreed by the Economic and Financial Affairs Council (ECOFIN) in July 2017, outlines a comprehensive set of measures to be adopted by various European authorities and by the Member States (http://www.consilium.europa.eu/en/press/press-releases/2017/07/11-conclusions-non-performing-loans/). In addition, the ECB has also implemented several measures from the supervisory perspective to tackle NPLs in the "SSM banks". For more details about the strategy to address NPLs implemented in Europe and in Portugal, see the Special Issue "Strategy to address the stock of non-performing loans (NPLs)", Financial Stability Report, Banco de Portugal, December 2017 and Box 3 "Action plan to tackle non-performing loans in Europe – main measures and state of play regarding its implementation", Financial Stability Report, Banco de Portugal, June 2018.

4. In effect, when considering micro data at individual bank-firm credit relationships, we find some evidence that during this period banks with higher NPL ratio presented less negative credit growth rates to NFC when compared to lower NPL banks (c..f. Summary statistics in Table 1, computed for the benchmark specification sample).
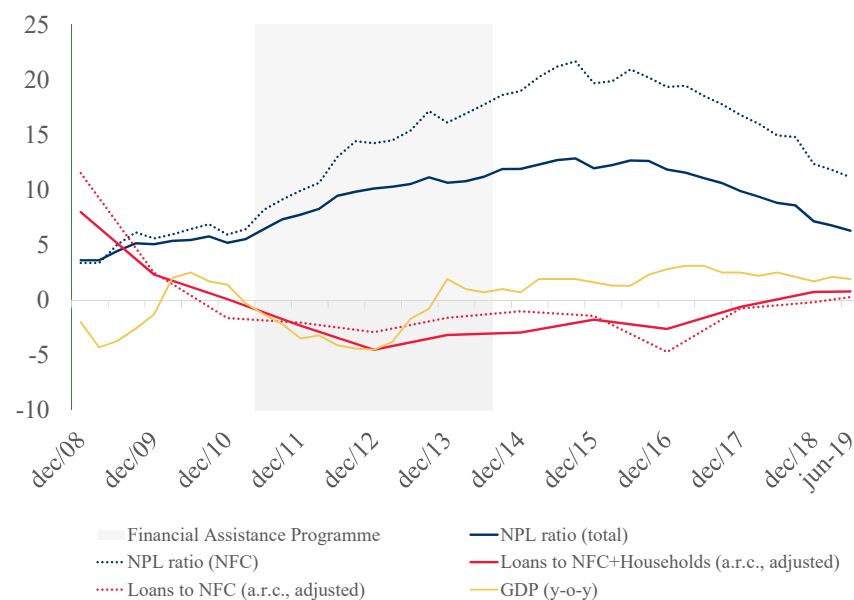
FIGURE 2: Bank loans and NPLs | in percentage

Notes:Up to December 2016 the NPL ratios refer to credit at risk reported by banks. From March 2017 onwards, the figures are estimated based on the changes in the NPL ratio according to the EBA. (2) Annual rate of change (a.r.c.) adjusted for securitizations and loan sales. (3) Vertical lines flag Banco de Portugal / SSM relevant measures, namely in terms of capital requirements (solid line) and asset quality review (dashed line)^a. The light grey area denote the Financial Assistance Programme.

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a. Full list of measures taken by Banco de Portugal and SSM, namely in terms of capital requirements and asset quality review, are available at https://www.bportugal.pt/en/list/medidas-do-banco-de-portugal-no-ambito-do-paef.

Despite the positive developments, Portuguese banks' aggregate NPL ratio still remains high in the European context, representing, therefore, a vulnerability of the banking system. In this context it is relevant to understand the potential impact of NPLs, especially as there is a degree of uncertainty regarding some of the underlying transmission mechanisms at play and how they have potentially evolved over time.

In particular, a relevant question relates to whether non-performing assets may impair the supply of bank credit. A high proportion of NPLs in a given banking system is typically associated with a poorer credit allocation and tends to be symptomatic of a highly indebted and, therefore, more vulnerable economy. During times of prolonged economic contraction, more indebted economic agents (non-financial corporations and/or households) have greater difficulties in servicing debt, thus eventually defaulting. In this context, banks

may have an incentive to maintaining a flow of financing towards these indebted agents in order to prevent the materialization of default[5] and allow them to recover. Still, this can reflect a credit support to firms that, ex-post, turn out to be non-viable at the expense of viable and/or new ones[6].

The problem of credit misallocation, combined with the cost of funding, the profitability and the capital consumption channels support the commonly-held view that high NPL ratios constrain banks' ability to lend to the economy (IMF (2015), Balgova et al (2016), ESRB (2017), Fell et al (2018)). This view is, however, partially challenged by the idea that high NPL may create incentives to increase credit supply to riskier customers, following a 'gamble for resurrection' type of logic (Acharya and Steffen, 2015, Altavilla et al, 2017). Moreover, Angelini (2018) argues that such channels may be dampened, or neutralized altogether, if the bank is sufficiently profitable and/or capitalized.

Even though several studies have recently explored the link between NPLs and credit growth, most of them use aggregated credit data[7]. Bending et al (2014) analyse the effects of NPL evolution on corporate sector credit growth, focusing on the Euro Area largest banks. Using a dynamic panel model, they find that a 1 percentage point increase in the NPL ratio decreases net lending by around 0.8 percentage points. In the same vein, Cucinelli (2015) estimates a fixed effect model where the dependent variable is measured by the growth rate of gross loans and the regressors include both macroeconomic and banks' specific variables. According to estimated results, credit risk of previous years is an important determinant of banks' lending behaviour, exhibiting a statistically significant negative coefficient.

More recently, Chiesa et al (2018) develop a theoretical model to analyse the transmission channels of NPL in the Euro area and test it by estimating an autoregressive distributed lags model. The empirical results confirm the model's predictions and suggest that holding NPLs increases the cost of capital for banks which, in turn, reduces credit and liquidity creation. The authors claim to control for possible endogeneity issues, stemming from macroeconomic conditions, through the use of variables such as GDP growth and unemployment rate. In addition, Fell et al (2018) explore differences between banks' NPL ratios and the respective volumes of credit provision over a period characterized by strong and improving loan demand. The

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5. This should be mitigated with the implementation of the Addendum to the ECB guidance, the prudential backstop for NPEs and the adoption of IFRS 9, which create incentives for recognizing more promptly impairment losses in credit agreements, allowing a swifter exit of non-performing assets from institutions' balance sheets.

6. Azevedo et al (2018) find evidence of misallocation of credit by Portuguese resident banks towards unproductive non-financial corporations in the 2008-2013 period. In the same vein, Shivardi et al (2017) find that during the Euro Area financial crisis undercapitalised Italian banks were more reluctant to cut credit to non-viable firms.

7. By aggregated data we mean credit data at the country level or at the bank level, i.e. micro data (typically coming from Credit Register Databases) are not used in these studies.

authors conclude that the presence of high NPL stock may hinder individual bank's lending and contend that using such approach controls for credit demand effects.

The NPL-credit relation has also been explored in VAR frameworks. Espinoza and Prasad (2010), for instance, focus on the relation between macroeconomic variables and NPL in banks' books. They find that a one-standard deviation increase in the NPL ratio reduces credit growth by 1.5 and 2.2 p.p. after two and three years, respectively. Similarly, Klein (2013) suggests that high and rising levels of NPL exert strong pressure on banks' balance sheet, with possible adverse effect on banks' lending operations. In particular, using a panel VAR analysis the author concludes that a one percentage point increase in NPL ratio results in a cumulative decline of 1.7 p.p. in credit-to-GDP ratio.

In order to estimate the impact of any relevant variable on bank lending decisions, it is necessary to employ a proper identification strategy that allows disentangling the roles of credit demand and credit supply. These strategies are particularly relevant during prolonged periods of economic recession, as the balance sheet of both banks and corporates are significantly affected. The use of loan-level data is a key source of identification, as it allows to control for changes in loan demand. In particular, in a setting where solely firms with multiple bank relationships are considered and firm-time fixed effects are used, one can effectively control for unobserved firm-specific loan demand effects (Khwaja and Mian, 2008).

This approach has been used by several authors in various empirical applications related to financial stability[8]. Accornero et al (2017), for example, use an extensive borrower-level dataset to study the influence of NPLs on the supply of bank credit to non-financial corporates in Italy between 2009 and 2015. The authors conclude that NPL ratios per se have no impact on banks' lending behaviour. In addition, the authors also exploit the results of the 2014 asset quality review carried out by ECB together with national supervisors and conclude that unanticipated increases in the reported level of NPLs can temporarily reduce the supply of credit. The authors argue, however, that such effect was quantitatively small and compensated by the positive impact arising from higher confidence and transparency in banks' balance sheets.

Our paper adds to the literature as we employ a similar methodology and identification strategy for Portugal, building on micro data at the bank and firm levels. Moreover, our sample spans over a ten year period, which includes a period where a significant increase in banks' NPLs co-existed with a sharp reduction in credit but also covers other phases of the economic and credit cycles. This is particularly relevant as in a crisis/NPL buildup period the lack of credit demand and heightened uncertainty may dominate credit

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8.   See, e.g., Alves et al (2016), De Jonghe et al (2016), Beck et al (2017), Sivec et al (2018).

dynamics, rendering supply side credit restrictions, namely those associated to NPLs, less relevant. In turn, such restrictions may become more relevant in a post-crisis period marked by a pick-up in firm investment and credit demand. Finally, even though the analysis relates mainly to the intensive margin of credit, we also explore the extensive margin to achieve a more comprehensive view about the relation between banks' NPLs and firms' access to credit.

Data and model specification

Data

Different indicators can be used to assess credit quality. One of them is the so called credit at risk, which was developed by Banco de Portugal in 2011, and, during most of the period under analysis in this study, was regularly reported by banks to the supervisory authorities and disclosed to the market. At a later stage (2013), a harmonized NPL definition, at EU level, was developed by the European Banking Authority (EBA) and started to be published by Banco de Portugal, for the whole Portuguese banking sector, by end-2015[9]. Although the credit at risk is a concept narrower than the NPL as defined by the EBA, both indicators presented a similar dynamic from 2016 onwards -when both were available-, while credit at risk is available for a longer period. Thus, in our model and for the remainder of this paper, the credit quality indicator used is credit at risk, although, for simplification, the term NPL is used.

Loan-level data used in the model estimation is largely drawn from the Portuguese Central Credit Register (CCR)[10] that provides information on credit by resident credit institutions and borrowers, allowing to keep track of individual bank-firm credit relationships over time. The CCR covers information on both outstanding and undrawn credit liabilities[11]. It also allows for the identification of the amount and vintage of overdue credit. Furthermore, the identification of individual NFCs allows to match the data with other micro-databases, supplementing the analysis with firm specific variables (e.g. size and activity sector).

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9. The EBA NPL concept is more complex and comprises a higher degree of subjectivity than most of the previously used credit quality indicators, such as credit at risk. Subsequently, the application of the harmonized NPL concept was challenging, thus constraining, especially in the first years, the comparison across countries and across banks. For more details, see the Special Issue on "Concepts used in the analysis of credit quality", Financial Stability Report, Banco de Portugal, November 2016.

10. Central Credit Register (CCR) is a micro-database managed by Banco de Portugal, with detailed monthly information regarding credit granted by resident institutions. Debt securities (including commercial paper) are excluded. The report to CCR is on a debtor-by-debtor basis, classifying the credit responsibilities according to an extensive list of dimensions.

11. Undrawn credit liabilities take the form of irrevocable commitments (e.g. undrawn credit lines or unused amounts on credit cards).

Only banks subject to own funds regulatory requirements in Portugal are considered, i.e. Portuguese branches of non-resident banks are excluded. This choice mitigates situations where the decision to grant credit is influenced or decided by institutions outside the Portuguese financial system in which the relevant NPL indicator would be that of the non-resident head office and not of its branch located in Portugal.

Where applicable, each bank is considered on a group basis, i.e. including all the resident credit-granting financial institutions in its supervisory perimeter. Additionally, only banks with at least 100 credit relationships with NFCs, in each period, are considered. This results in a sample of 20 banks (considering banking groups and individual banks which do not belong to any group), which accounts for, on average, 87% of the stock of bank loans to NFCs between 2009 and 2018.

Our sample includes NFCs with no material overdue credit for more than 90 days and with no written-off loans in the entire period. The exclusion of firms with overdue loans is justified by two main arguments. Firstly, credit dynamics would be unduly influenced by the rolling over of loans associated with banks' intention to prevent the materialization of default and by the accumulation of unpaid interest, causing a bias in the credit growth distribution, especially in a period dominated by credit contraction. Secondly, the funds lent to some of these firms may be, in many aspects, similar to sunk resources with low contribution to economic growth[12].

Due to methodological requirements, only NFCs with credit relationships with at least two banks are considered. The sample thus comprises an average of 74 thousand observations per year, where each observation corresponds to a credit relationship between a bank and a firm, covering about 33% of the stock of bank loans to NFCs (Figure 3).

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12. The sensitivity of the results to the exclusion of these NFCs is addressed in the robustness analysis section.
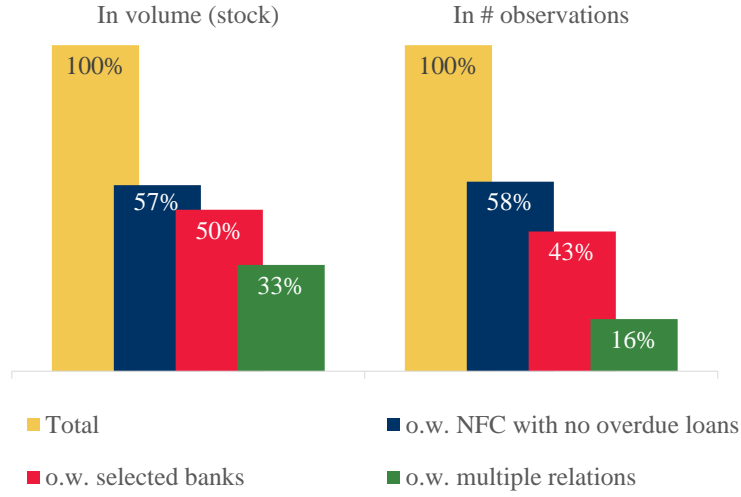
FIGURE 3: Sample representativeness | 2009 – 2017 average

Model specification

The econometric analysis is based on panel data, with annual frequency, from 2009 to 2018[13], focusing on bank loans to resident NFCs (at the micro level of each bank and individual firm). Our benchmark econometric specification is the following:

$$\Delta Loans_{i,j,t} = \theta_j NPL_{j,t-1} + \beta_j X_{j,t-1} + \alpha_{i,t} + \varepsilon_{i,j,t} \qquad (1)$$

where $\Delta Loans_{i,j,t}$ corresponds to the year on year rate of change (in logs) of credit granted to firm i by bank j in period t, $NPL_{j,t-1}$ is the net NPL ratio and $X_{j,t-1}$ represents a vector of bank-level controls of bank j. $\alpha_{i,t}$ is a vector of firm-time fixed-effects, capturing time-varying firm characteristics, including shifts in credit demand. The estimation of $\alpha_{i,t}$ is the basis of our identification strategy to disentangle credit supply side effects from credit demand shocks, which requires a setting where only firms with multiple bank relationships are included. Assuming that a credit demand shock affecting a given firm impacts

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13. 2018 credit data refers only to the January – August period due to data constraints.

all its lending relationships in the same degree[14], the coefficients on the bank-level variables would capture supply side effects, while the firm-time fixed-effects would absorb the demand dynamics (Khwaja and Mian, 2008).

Explanatory variables are lagged one period. Banks' overall position in the beginning of the year[15] is expected to influence the loans granted during that year as it is reasonable to assume that the analysis and decisions underlying banks' lending policy are carried out in advance and with a certain lag.

The dependent variable considers bank loans granted to NFCs at the individual bank-firm level and is defined as the end of period stock change, with no adjustment for write-offs or sales. This should not be a relevant limitation given that our sample is limited to NFCs with no overdue credit and no relevant sales of such loans were observed in this period.

In most of the estimated specifications only credit drawn is considered. Arguably, the inclusion of undrawn credit liabilities would better capture supply side decisions, as it would rule out changes in credit associated with the use of credit lines and other irrevocable commitments that depend on current firms' decisions. However, the evaluation of what actually constitutes an irrevocable commitment is not straightforward and may result in data comparability issues. As a robustness check, a specification with the broader loan concept (drawn and undrawn) was also estimated.

The explanatory variable of interest is the bank total NPL ratio, net of impairments[16]. Within the robustness analysis, some alternative specifications were considered, namely, the NPL ratio was taken gross of impairments and the impairment coverage ratio was added as an independent variable. Additionally, the net NFC NPL ratio was also considered. Both of these alternatives can help to evaluate the transmission mechanisms through which NPLs may affect credit supply in the period under analysis. Notwithstanding, the net NPL ratio is a better indicator of the overall risk on banks' balance sheet as it excludes the part covered by impairments, i.e. losses already recognized in the banks' profit and loss account.

The benchmark specification includes three bank-level controls which are commonly used in the related literature: the voluntary capital buffer, the share of ECB funding on total assets and the share of household credit in total assets.

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14. This assumption commonly used in these settings, including in the papers described in the section 'Backgound and motivation', is not free from criticism as the matching between banks and firms is not necessarily random. Firms can have stronger relationships with one bank than with others and, therefore, when facing a borrowing need do not necessarily interact with all banks in the same manner.

15. Which, in this case, is equal to the one observed at the end of the previous year.

16. Taken as the NPL stock, less associated impairments, over total credit.

The voluntary capital buffer relates to banks' excess / shortage of capital with reference to the regulatory requirements[17]. This can be seen as an indicator of banks' capacity to withstand adverse shocks while maintaining the flow of credit to the economy. A positive relation with credit growth is thus expected. However, there are several other factors that may challenge this view. For example, considering the relatively higher cost of capital compared to other sources of financing, banks may choose to operate with thinner capital ratios if they are able to generate capital organically.

The share of ECB funding on total assets is associated with bank's liquidity position. Banks with a higher share of ECB financing are arguably more liquidity constrained thus negatively impacting credit supply. The increase in ECB funding or, at least, the maintenance of a high recourse to the ECB might, however, be driven by the opportunity to access cheaper funding compared to alternative sources and carry-trade strategies. The impact in banks' credit supply depends on how such funds are applied, and the possibility of crowding-out effects cannot be discarded.

The share of household credit in total assets aims to capture differences in banks' business models, even if most banks considered in the sample could be broadly classified as retail banks[18]. Housing credit is perceived as having lower credit risk. Consequently, in times of stress, banks more engaged on household credit, that are typically more risk averse, tend to flee from NFC loans, favoring their traditional areas of investment where they have more information and skills.

Table 1 presents summary statistics for the variables explored in the econometric setup[19].

Model estimation

We estimate a set of linear regression models linking credit growth with NPLs, progressively controlling for other bank characteristics and firm heterogeneity. In addition, we evaluate the robustness of the main results considering a different credit metric, other bank-level variables, alternative loan demand controls and other relevant specifications.The benchmark

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17. Regulatory capital requirements are time and bank-specific, including the temporary capital buffer against sovereign debt exposures set in the context of the 2011/2012 EU capital exercise and, from 2015 onwards, Pillar 2 measures. In the analysed period, three capital requirements were in place: common equity/core tier 1, tier 1 and total capital. The difference is computed vis-à-vis each of these three metrics and the voluntary buffer considers the lowest figure. This variable has a more direct link with banks' decision than banks' capital ratio, given that the latter is inherently linked with the regulatory minimum requirements.

18. Even with cooperative and savings banks included.

19. Table A.1 in Appendix describes all the variables used.

VARIABLES	Units	Mean	Standard deviation	P10	Median	P90	High NPL banks P50	Low NPL banks P50
Loans to NFC growth	log change	-13,5	82,6	-84,4	-15,0	62,4	-14,2	-15,6
NPL ratio	%	9,5	5,4	3,5	9,4	16,3	12,0	5,9
Net NPL ratio	%	3,7	2,9	0,8	3,2	8,8	6,0	1,4
Impairment coverage ratio	%	64,7	17,1	46,1	66,5	83,4	50,8	72,9
NPL ratio: NFC	%	20,4	149,5	3,7	12,9	22,1	19,7	7,8
Net NPL ratio: NFC	%	3,9	8,1	0,1	2,5	10,7	8,5	1,2
Impairment coverage ratio: NFC	%	73,1	22,0	42,3	71,8	99,6	58,6	82,1
Voluntary capital buffer	pp	0,4	5,4	-1,6	0,8	2,8	1,1	0,5
ECB funding	%	8,8	5,3	2,8	8,3	14,9	10,8	6,7
Share of HH credit	%	55,6	14,5	34,4	58,1	71,1	51,8	64,6
Loan to deposits ratio	%	113,1	34,3	78,7	107,4	153,0	117,3	98,4
Return on assets (ROA)	%	-0,1	1,0	-1,3	0,1	0,8	0,0	0,3
Tier 1 ratio	%	10,7	5,6	8,4	10,9	13,5	11,0	10,9
# Observations				612 458			263 888	348 570

TABLE 1. Summary descriptive statistics (2009 – 2017, for the benchmark specification sample)

Notes: (1) High (Low) NPL banks present an average NPL ratio above (below) the median; (2) Two institutions were excluded from the computation of the loan-to-deposits ratio as they presented abnormal values (as these institutions presented virtually no deposits).

regression, most of its decompositions and robustness specifications are estimated for existing credit relationships (intensive margin). We also estimate related specifications to look into the impact of NPLs on new credit relationships (extensive margin).

Main results

The first set of results is presented in Table 2. Starting with a simple linear regression (column 1), we estimate the relation of NPLs with credit changes without taking into account bank and loan demand controls. In this setting, the net NPL ratio coefficient is positive and statistically significant at a 10% significance level, consistent with the descriptive statistics based on individual bank-firm data presented above (table 1) where banks with higher NPL ratios granted more (or restricted less)[20] credit to NFCs.

We then proceed with the inclusion of the bank-level controls (column 2): voluntary capital buffer, ECB funding over total assets and loans to households over total credit. In this case, the net NPL ratio coefficient, albeit still being positive, is not statistically different from zero at the conventional significance levels, thus highlighting the importance of controlling for other bank-level features.

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20. In fact, in 2010-2018 period, the pooled distribution of loan's rate of change has more density around negative figures.

Results do not change qualitatively when we move to a setting where exclusively NFCs with multiple bank loan relationships are considered (column 3), despite the significant reduction in the number of observations.

Finally, we take one additional step and include time–varying fixed-effects at the firm level (column 4). As previously mentioned, this specification, which we will refer to as the benchmark, allows us to disentangle supply side effects from credit demand shocks and can only be estimated for firms with multiple bank relationships. Although this reduces the statistical significance of most bank-level variables, we continue to observe no relevant impact in terms of the net NPL ratio, i.e. no systematic difference is found between banks with high and low NPL ratios in terms of credit granted. Put differently, on average, and ceteris paribus, a firm borrowing from two different banks, a low-NPL bank and a high-NPL bank, does not observe any significant difference in the respective loan growth.

Regarding the remainder bank-level variables we find two statistically significant relations for the sample the period as a whole. Namely, a negative relation between the recourse to ECB funding and the NFC loan growth, which could be brought about by liquidity constraints and/or the crowding out effects mentioned earlier, and a negative relation between the share of household credit and the NFC loan growth, potentially reflecting the impact of differences in banks' risk appetite, especially given that our sample is dominated by a period of stress.

EXPLANATORY VARIABLES	(1) Simple univariate regression	(2) (1) + additional bank-level controls	(3) (2) restricted to firms with multiple loans	(4) (3) + Firm TVFE "Benchmark regression"
Net NPL ratio	0,458*	0,355	0,449	0,204
Voluntary capital buffer		0,182**	0,222***	0,102
ECB funding		-0,563***	-0,550***	-0,381**
Share of HH credit		-0,216***	-0,268***	-0,262***
# Observations	1 267 024	1 256 528	612 458	612 458
R-squared	0,000	0,002	0,004	0,402
Multiple bank loan relations			✓	✓
Firm TVFE				✓

*** p<0,01, ** p<0,05, * p<0,1

TABLE 2. Main estimation results: full sample period (2009 - 2018)

Table 3 presents the results of the benchmark specification estimated in different subsamples according to firm size and credit risk and in the periods of buildup and reduction of NPLs. Overall the non-significance of the NPL ratio is robust across virtually every subsample while, for the voluntary capital buffer and the share of ECB funding, the significance differs. The significance of the share of housing loans remains virtually unchanged across the subsamples considered.

Columns 2 and 3 explore a potential heterogeneity related to firm size, proxied by the size of firms' total loans (in each year, retail firms are identified as NFCs with total loans below 1 million euros). The NPL ratio is not statistically significant for both subsamples. The estimated relation between the voluntary capital buffer and credit growth is positive and statistically significant for non-retail (larger) firms at a 10% significance level, suggesting that bank loans' supply to these firms was influenced by banks' capital position. In turn, the negative coefficient associated with ECB funding is only statistically significant for retail (smaller) firms, suggesting that these firms experienced a change in the supply of credit from banks more liquidity constrained or due to crowding out effects, whereas for larger firms this impact was not significant.

Columns 4 to 6 explore differences in debtors' credit risk profile[21]. The main conclusion that can be drawn from these regressions is that there is no evidence that NPL ratio constrained credit supply to low and medium risk firms (which account for about 80 per cent of the sample). In turn, we find a positive link to credit granted to high credit risk firms, though only statistically significant at a 10% significance level. In different words, a given high credit risk firm borrowing from two banks that only differ in the level of the NPL ratio was granted slightly more, or restricted slightly less, credit from the bank with the higher NPL ratio. More specifically, a bank with a NPL ratio 1 percentage point higher is estimated to present, on average, a 0,47 pp higher loan growth to high credit risk NFCs. Still, this result could reflect the credit support to riskier firms which could turn out to be viable or non-viable. The distinction between these outcomes is usually difficult to make ex-ante, especially with riskier firms and during a period of challenging and less predictable macroeconomic circumstances, although it should be noted that our sample excludes firms that defaulted during the period under analysis. The identification of the relative importance of these two situations is beyond the scope of our analysis.

The regressions underlying columns 7 and 8 aim at distinguishing between the crisis / NPL buildup period – characterized by a strong deleveraging, a reduction of demand for credit and heightened uncertainty –, and a period of economic activity recovery, pick-up in investment, decrease in NPLs and slowdown in NFC deleveraging. As regards the net NPL ratio, despite the change in the sign of the estimated coefficients, they are both not statistically different from zero up to a 10% significance level. Interestingly, however, we observe that the relation between the growth rate of loans granted to NFCs with the voluntary capital buffer is only statistically relevant during

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21. Credit risk profile is based on each NFC credit notation assigned by Banco de Portugal in-house Credit Assessment System (ICAS). The low-risk bucket consists of firms with a 12-month probability of default (PD) below 1%, the medium-risk bucket refers to firms with a PD above 1% and below 5% and the high-risk bucket comprises firms with a PD above 5%.

the crisis period. The absence of significance in the post-crisis period could be associated with the lower variability in the voluntary capital buffer across banks in this period[22].

EXPLANATORY VARIABLES	(1) Benchmark (full sample)	(2) Retail firms	(3) Non-retail firms	(4) Low-risk firms	(5) Medium-risk firms	(6) High-risk firms	(7) 2010 - 2015	(8) 2016 - 2018
Net NPL ratio	0,204	0,104	0,45	-0,34	0,296	0,469*	0,432	-0,128
Voluntary capital buffer	0,102	0,092	0,128*	0,033	0,128	0,103	0,156**	-0,372
ECB funding	-0,381**	-0,415**	-0,286	-0,563***	-0,393**	-0,171	-0,382*	-0,505**
Share of HH credit	-0,262***	-0,283***	-0,210***	-0,319***	-0,284***	-0,178***	-0,266***	-0,272***
# Observations	612 458	464 547	147 911	152 550	316 975	136 616	424 685	187 773
R-squared	0,402	0,436	0,310	0,391	0,399	0,418	0,402	0,399

*** p<0,01, ** p<0,05, * p<0,1

TABLE 3. Main estimation results (subsamples)

Robustness analysis

In this section, we assess the sensitivity of results underlying the benchmark regression when using: (i) a different credit definition, (ii) alternative firm selection criteria, (iii) additional bank-level and relationship controls and (iv) alternative demand controls. Table 4 summarizes the most relevant results.
Firstly, as previously mentioned, we consider a broader loan concept, including both drawn and undrawn credit granted to NFCs, which arguably allows to capture supply side decisions more effectively[23]. The results do not qualitatively change as the sign and magnitude of coefficients remain virtually unchanged (column 2).

Secondly, it is also important to assess the sensitivity of results to alternative firm selection criteria. In column 3 we assume less restrictive criteria in the exclusion of firms with overdue credit by eliminating firms only in periods for which overdue credit is observed[24]. In column 4 we further relax the criteria and include all firms, regardless of having overdue credit or not. Interestingly, the NPL coefficient turns positive and is statistically significant in these two regressions (even more so in the second case). To some extent, these results are in line with the results presented in the previous section, namely the positive NPL coefficient obtained for the 'high-risk' firms specification, and the same rational applies since we now consider a greater proportion of seemingly riskier firms. Finally, even though we work in a multiple relationship setting for identification purposes, it may be difficult

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22. The recent period is associated with the implementation of the CRD IV, which include some bank-specific requirements (e.g. Pillar 2).

23. Moreover, a slight increase in the number of observations occurs as additional multiple relationships are now identified.

24. As opposed to excluding firms with overdue credit from the entire sample, including in periods when they had no overdue credit.

to identify statistically significant relationships if a significant share of firms borrow from banks with similar NPL ratios. In order to ensure that we have sufficient variability in the NPL variable, we estimate a regression exclusively for firms which have credit relationships, in each year, with at least a high and a low-NPL bank (column 5). Despite the decrease in the number of observations, both the magnitude and sign of the NPL ratio does not change vis-à-vis the benchmark specification.

Thirdly, we test the relevance of using alternative NPL metrics and including additional explanatory variables. We begin by replacing the total net NPL ratio with the net NPL ratio for NFCs (column 6). The former is a broader indicator of banks' overall asset quality and, in light of the transmission channels mentioned before (e.g. cost of funding), more adequate to capture its potential effects over credit supply. However, since our paper focus on credit to NFCs and the NPL ratio increased more significantly for firms in Portugal, during the period under analysis, one could argue that this alternative metric would be more relevant for identification purposes. A positive coefficient is also estimated for firm NPL ratio (albeit statistically significant at 10% only) and the results do not qualitatively change for the other variables. Column 7 presents the results of a less parsimonious regression which disentangles the effects between the gross NPL ratio and the coverage ratio. The results are similar to those of the benchmark regression and the conclusions seem to hold as no statistical significance is found for these two variables. In column 8 we augment the benchmark equation with two controls which capture the depth of firm-bank relationships, namely the weight of the loan exposure in total loans obtained by the firm in banking sector and the number of credit products a firm has in a given bank. Although statistically significant, the introduction of such controls does not change the findings of the benchmark regression. Similarly, adding other bank-level controls used in previous empirical studies such as the loan-to-deposits ratio, return-on-assets (ROA) or replacing the voluntary buffer with a more commonly used solvency variable, such as the Tier 1 ratio, does not meaningfully impact results (columns 9-11). The key finding is that, despite the relevance of these variables, the main result does not change, in particular NPL coefficient remains as statistically non-significant.

EXPLANATORY VARIABLES	(1) Benchmark (full sample)	(2) Commited credit (drawn and undrawn) as dependent variable	(3) Less restrictive firm sample selection	(4) All firms - with and without overdue	(5) Only firms with credit relations both with a high- and a low-NPL bank	(6) Alternative NPL variable (NFC)	(7) Alternative NPL variable (Gross + coverage)	(8) Relationship controls	(9) Alternative explanatory variables (1)	(10) Alternative explanatory variables (2)	(11) Alternative explanatory variables (3)	(12) Alternative demand control (Industry * Size * Time FE + Firm-level variables)
Net NPL ratio	0,204	0,056	0,402*	0,549***	0,212			0,195	0,207	-0,219	0,212	0,034
Voluntary capital buffer	0,102	0,063	0,109	0,243***	0,107	0,094	0,086	0,131	0,103	0,243***	0,212	0,003
ECB funding	-0,381**	-0,386**	-0,332**	-0,131	-0,395**	-0,379**	-0,350**	-0,416**	-0,357***	-0,503***	-0,391**	-0,367**
Share of HH credit	-0,262***	-0,277***	-0,230***	-0,176***	-0,247***	-0,267***	-0,254***	-0,275***	-0,143***	-0,241***	-0,265***	-0,237***
Gross NPL ratio							0,002					
Impairment coverage ratio							-0,046					
Net NPL ratio: NFC						0,085*						
Loan to deposits ratio									-0,001***			
ROA										-3,289***		
Tier 1 ratio											-3,289***	
Weight of credit relationship								-0,195***				
Number of credit products								-0,019***				
# Observations	612 458	701 591	773 456	1 112 570	443 504	612 458	612 458	612 458	606 404	612 458	612 458	1 160 794
R-squared	0,402	0,390	0,401	0,400	0,372	0,402	0,402	0,405	0,404	0,402	0,402	0,011

*** $p<0,01$, ** $p<0,05$, * $p<0,1$

TABLE 4. Robustness analysis

Lastly, it is important to evaluate the validity of our conclusions with respect to firms with a single bank relationship, particularly considering the relevance of such firms operating in Portugal (as documented in Figure 3). Working in a multiple relationship setting has a clear methodological advantage – as it allows us to effectively control demand through firm-time fixed effects – but also a high cost, as it implies a significant reduction in the sample size, arguably limiting the extrapolation of results for the whole sample of firms. Relaxing this assumption requires the use of an alternative demand control, such as industry-size-time fixed effects and firm level controls[25] (column 12). While the number of observations significantly increase, as expected, the estimates remain similar to those of the benchmark regression.

Overall, the main conclusions presented in the previous section are robust to different definitions of both dependent and explanatory variables and to alternative/additional bank-level and credit demand controls. Despite slight differences in the magnitude and statistical significance of some coefficients, we find no evidence in support of a relation between the NPL ratio and credit growth during the period under analysis as whole[26].

Extensive Margin

In this section we investigate the potential impact of NPL ratios on the extensive margin of credit, in particular, on the banks' propensity to initiate new credit relationships. This analysis complements the main results for the intensive margin, with the aim to obtain a more comprehensive view about the relation between banks' NPLs and firms' access to credit. In this setting some concerns previously mentioned are less pronounced, namely those associated with the role of relationship lending that may influence the matching between banks and firms.

In these regressions the dependent variable is a dummy that takes the value of 1 if a bank-firm relation exists in period t but not in t-1 and takes the value of 0 otherwise. The inclusion of firm-time fixed effects to control for credit demand is only possible in a setting where NFCs with new credit relationships maintain at least one previous credit relationship with a different bank. As such the regressions only consider new relationships with firms that were already in the credit market.

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25. Firm-level controls include: Sales over Assets, EBITDA over assets, Financial debt over assets and the Leverage ratio which, for simplification purposes, are not reported in Table 4.

26. Additional specifications were explored, namely using bank fixed-effects to control for time-invariant heterogeneity at the bank-level, such as associated with business models, risk propensity and risk management practices. The results are not presented in the paper as the inclusion of bank-fixed effects change the interpretation of the coefficients associated with the variable of interest and all other bank-specific variables, setting the focus on an analysis within-bank, thereby impairing a comparison between banks.

Table 5 presents the extensive margin results for the main sample decompositions (presented in Table 3). A lack of statistical significance is observed across most specifications and coefficients. Interestingly, in firm size and firm risk decompositions no relation between the banks' propensity to initiate a new credit relation and NPL ratio is found. In particular, for higher-risk firms, this differs from the intensive margin results, where a positive although weak relation was documented.

For the 2016-2018 period (column 8), a negative relation between the NPL ratio and propensity to initiate new credit relationships is estimated. On the one hand, it could be that high-NPL banks were not competitive enough in terms of pricing and other loan conditions, compared to low-NPL banks, when faced with new loan requests, and this disadvantage may be particularly evident in a period of economic recovery and pick-up in credit demand. On the other hand, it could be that banks with higher NPLs adopted tighter credit standards in the recent period. Arguably, these changes would be more relevant for borrowers that are new to the bank, as credit history information and other information relevant for credit risk profiles would be more limited or inexistent.

The analysis of banks' propensity to initiate new credit relationships with firms new to the credit market would complement the extensive margin results but in this settings it would not be possible to use firm-time fixed effects to control for credit demand.
Extending the analysis beyond the intensive margin provides useful insights and a broader perspective on the impact of NPLs on credit supply. Notwithstanding, the credit demand control used in the extensive margin has some shortcomings. A more effective credit demand control would, for example, require taking into consideration data on loan applications and their outcome, which would allow to distinguish between loan acceptances and refusals. This vein is not explored due to data constraints.

EXPLANATORY VARIABLES	(1) Benchmark (full sample)	(2) Retail firms	(3) Non-retail firms	(4) Low-risk firms	(5) Medium-risk firms	(6) High-risk firms	(7) 2010 - 2015	(8) 2016 - 2018
Net NPL ratio	0,064	0,075	0,016	0,138	0,083	-0,096	0,185	-0,152**
Voluntary capital buffer	-0,023	-0,03	-0,013	-0,014	-0,033	-0,039	-0,018	0,055
ECB funding	-0,014	0,013	-0,119	-0,098	-0,097	-0,003	-0,082	0,081
Share of HH credit	-0,013	-0,006	-0,044	-0,079**	-0,031	0,004	-0,002	-0,048***
# Observations	1 612 282	1 266 545	315 094	257 848	559 542	442 644	1 200 427	411 855
R-squared	0,396	0,415	0,294	0,367	0,380	0,399	0,389	0,417

*** p<0,01, ** p<0,05, * p<0,1

TABLE 5. Extensive margin results

Conclusion

The implications for financial stability of a significant increase in NPLs on banks' balance sheets has become a topic of great interest following the international financial crisis. In particular, the discussion has focused on the consequences over credit supply with the potential to constitute a drag on economic growth, which justified several initiatives at the national and European levels to promote a swift reduction of NPLs.

Conceptually there are several channels through which NPLs may influence credit supply, not necessarily in the same direction. For example, to the extent that banks with significant NPLs are difficult to value, they influence risk perceptions by market participants, thus potentially increasing banks' funding costs, which ultimately might be passed on to credit supply. On the contrary, high NPLs may create incentives to increase banks' credit supply to riskier customers in order to prevent the materialization of default. This paper contributes to this debate as in Portugal the significant increase in banks' NPLs co-existed with a sharp reduction in credit.

We investigate the effects of banks' NPLs on credit growth to NFC in the 2009-2018 period using data at the individual bank-firm relationship from the Portuguese Central Credit Register. Our sample is limited to NFCs with no overdue loans and the analysis focuses on the existing credit relationship (intensive margin of credit).

Against this background, we find that, when controlling for loan demand and several bank characteristics, there is no evidence that NPL ratios per se constrained bank loan supply to corporates in this period. Put differently, on average, a firm borrowing from two banks that only differ in the level of the NPL ratio did not observe a significant difference in the respective loan growth. This result holds for the crisis and the post crisis periods (2009-2015 and 2016-2018, respectively). It also holds independently of the size of the NFC, and for low and medium credit risk firms which account for about 80 percent of the sample. These findings support the main conclusion whereby the supply of credit to NFCs was not significantly affected by the high NPL ratios prevailing on the Portuguese banks' balance sheet over the sample period. Still we find a positive relation between NPLs and credit granted to performing NFCs with high credit risk, though with a weak statistical significance, which could reflect credit support to riskier firms, whose viability could have been difficult to assess, special in a period of challenging and less predictable macroeconomic circumstances.

Additionally, we find some evidence that other bank characteristics influenced the credit supply to NFC during this period. Namely, i) banks' voluntary capital buffer (i.e. difference between observed capital ratios and the respective minimum requirement) seem to be positively associated with credit supply during the crisis / NPL buildup period; ii) a negative relation between the recourse to the ECB funding and the NFC loan growth

is estimated,; and iii) we find a negative relation between the share of household credit and the NFC loan growth, potentially reflecting the impact of differences in banks' business models and risk appetite, especially given that our sample is dominated by a period of stress.

These conclusions are robust to different definitions of both dependent and explanatory variables and to alternative/additional bank-level and credit demand controls.

Finally, with the aim to obtain a more comprehensive view we look into the extensive margin and find that higher NPLs were associated with a lower propensity to initiate new credit relationships in the post crisis period (2016-2018).

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Appendix: Variables description

Type of variable	Variable	Notes	Source
Dependent variable	Bank loans granted to NFCs	Drawn and undrawn amount; end-of-period stock change; bank and firm specific	Central Credit Register data
Variable of interest	NPL ratio	Credit at risk over total credit; value observed in the beginning of the period; bank specific	Supervisory data (Credit at Risk Instruction)
	Coverage ratio	Impairments over credit at risk; value observed in the beginning of the period; bank specific	
Control variables at bank-level	Voluntary capital buffer	Considering the difference between observed capital ratios and the respective minimum requirement. The variable is the smallest of these differences, for each bank, at each point in time.	Supervisory data (FinRep and CoRep)
	ECB funding	ECB funding over total assets	
	Share of household credit	Loans to Households over total credit (proxy for the bank business model)	
	Return on assets (ROA)		
	Loan to deposits ratio		
	Tier 1 ratio		
Control variables at firm-level	Sales/Assets		Central Balance Sheet data
	EBITDA/Assets		
	Leverage ratio		
	Financial debt/Assets		
	Economic sector		
Other explored variables	Firm total loan exposure	Used to differentiate between retail and non-retail segments.	
	Weight of credit relationship	Weight of the loan exposure in total loans obtained by the firm in banking sector	
	Number of credit products	The number of credit products a firm has in a given bank	
	NFC Rating	Probability of default based on Banco de Portugal in-house Credit Assessment System (ICAS). Used to differentiate firms according to credit risk buckets.	

TABLE A.1. Variables