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## The role of non-performing loans for bank lending rates

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# Non-technical summary


## Research question

This paper investigates the channels through which the stock of non-performing loans (NPLs) of euro area banks affects lending rates on new loans. It focuses on effects that extend beyond losses linked to this stock that have already been taken over and are already incorporated into the capital position. In particular, the roles of net NPLs and loan loss reserves are disentangled, which is, however, complicated due to the high correlation between both variables. Furthermore, the role of funding costs as a potential link between the NPL stock and lending rates is considered.

## Contribution

The link between lending behavior and the NPL stock in the euro area has been previously investigated. This paper primarily adds to prior research by shedding more light on the channels through which a potential relationship is created between both variables.

## Results

There is no clear-cut relation between gross NPLs and lending rates. Splitting the gross NPL stock into net NPLs and loan loss reserves indicates that a high stock of NPLs is associated with higher lending rates, if it is not sufficiently covered by loan loss reserves. Although a high stock of NPLs entails higher funding costs, the latter variable seems to play only a minor role with regard to a potential link between NPL stocks and lending rates. Furthermore, results indicate that there is no strong link between the NPL stock and the interest rate pass-through.

# Nichttechnische Zusammenfassung

## Fragestellung

Das vorliegende Papier untersucht, über welche Wirkungskanäle der Bestand an notleidenden Krediten (NPLs) in den Büchern der Banken im Euroraum die Zinsen für neu vergebene Kredite beeinflusst. Der Fokus liegt dabei auf jenen Effekten, die über Verluste, die sich bereits durch die Bildung von Wertberichtigungen im Eigenkapital niedergeschlagen haben, hinausgehen. Speziell werden die Wirkungen des Netto-NPL- sowie des Wertberichtigungsbestandes separiert, was jedoch auf Grund der hohen Korrelation zwischen beiden Variablen schwierig ist. Außerdem wird die Rolle der Finanzierungskosten als mögliche Verbindung zwischen NPL-Bestand und Kreditzinsen untersucht.

## Beitrag

Der Zusammenhang zwischen dem Kreditvergabeverhalten und dem NPL-Bestand wurde für den Euroraum in der Vergangenheit bereits analysiert. Der Beitrag dieses Papieres besteht in erster Linie in der Untersuchung der Wirkungskanäle, über die sich ein möglicher Zusammenhang zwischen beiden Variablen erklären lässt.

## Ergebnisse

Es zeigt sich kein eindeutiger Zusammenhang zwischen dem Brutto-NPL-Bestand und Kreditzinsen. Die Aufspaltung der Brutto-Größe in den Netto-NPL- sowie den Wertberichtigungsbestand deutet darauf hin, dass ein hoher NPL-Bestand dann mit höheren Kreditzinsen einhergeht, wenn er nicht hinreichend durch Wertberichtigungen gedeckt ist. Obwohl ein hoher NPL-Bestand höhere bankseitige Finanzierungskosten nach sich zieht, spielen Letztere für den Zusammenhang zwischen NPL-Bestand und Kreditzinsen nur eine untergeordnete Rolle. Weiterhin deuten die Ergebnisse nicht auf einen starken Zusammenhang zwischen NPL-Bestand und der Zinsweitergabe hin.

BUNDESBANK DISCUSSION PAPER NO 52/2018

# The role of non-performing loans for bank lending rates[1]

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**Abstract**

Against the backdrop of a high stock of non-performing loans (NPLs) in several European countries, this paper investigates the role of NPLs for lending rates charged for newly granted loans in the euro area. More precisely, it looks for an effect that extends beyond losses caused by that stock which have already been incorporated into the banks' capital positions. The paper focuses on the question of which channels are responsible for such a potential effect. The results indicate that a higher stock of net NPLs is associated with higher lending rates, whereby there are indications that this relation tends to be offset by loan loss reserves. Although the NPL stock affects banks' idiosyncratic funding costs as well, the latter do not seem to constitute an important link between the stock of NPLs and lending behavior. Furthermore, NPLs do not strongly affect the banks' interest rate pass-through.

**Keywords:** Lending rates, non-performing loans, impaired loans, funding costs

**JEL classification:** G21; E43

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# 1 Introduction

The stock of non-performing loans (NPLs) in the euro area banking system has rapidly increased in the aftermath of the financial crisis. Although a decline has been observed as of late, the stock level still remains high. One conjecture in this context is that a high stock of NPLs held by banks might impair the transmission of monetary policy or the banking system's contribution to economic recovery (e.g. Aiyar, Bergthaler, Garrido, Ilyina, Jobst, Kang, Kovtun, Liu, Monaghan and Moretti, 2015; Praet, 2016; Council of the European Commission, 2017; Demertzis and Lehmann, 2017; European Commission, 2017). Arguably the most obvious way in which NPLs might affect the lending behavior of banks is through losses caused by loan loss reserves banks hold against the NPL stock. Raising these reserves leads – via the profit and loss statement – to a reduction in capital. However, if this was the only transmission channel, there should not be any impact of NPLs on lending behavior once the capital position is taken into account. This in turn would imply that a high stock of NPLs does not affect banks' lending behavior per se, but that capital is what matters.[2]

Against this backdrop, the present paper investigates the relation between the stock of NPLs and bank lending behavior in the euro area. More precisely, it assesses whether NPLs have an impact on lending rates once the actual capital position of banks is controlled for, and therefore whether this impact extends beyond losses already captured in bank capital. It focuses on how such a potential impact can be explained, although precisely pinning down the relevant channel(s) is difficult. To do so, gross NPLs are split into net NPLs and loan loss reserves in order to disentangle their effects on lending rates, which is, however, complicated due to the high correlation between both variables. Furthermore, the role of funding costs as a potential link between the NPL stock and lending rates is considered. Assessing the role of funding costs in this context is interesting, as it reveals whether a potential link between NPLs and lending rates is driven by higher risk premia investors' demand from banks with higher NPL stocks, which are subsequently passed on to borrowers. If that was the case, measures

[2] Empirical evidence indeed suggests that capital-restricted banks are more reluctant when it comes to granting new loans, although there seems to be some controversy surrounding how strong the impact is. See Peek and Rosengren (1997), Gambacorta and Mistrulli (2004), Watanabe (2007), Berrospide and Edge (2010), Michelangeli and Sette (2016) and Gambacorta and Shin (2018). Papers dealing with capital restrictions stemming from tighter regulatory requirements are Mésonnier and Monks (2015), Gropp, Mosk, Ongena and Wix (2016) and Kanngiesser, Martin, Maurin and Moccero (2017). A similar picture emerges when considering effects on lending rates, see Gambacorta and Mistrulli (2014), Burlon, Fantino, Nobili and Sene (2016) and Michelangeli and Sette (2016), although the results are not clear-cut in all cases, see Holton and Rodriguez d'Acri (2015).

potentially leading to a reduction of these risk premia – for instance, large-scale asset purchases by central banks – could weaken the link between NPLs and lending rates.

In order to tackle the research questions raised above, variation at the bank level using data referring to euro area banks is exploited. Macroeconomic factors are considered to be given, which implies that potential feedback effects of the NPL stock of single banks on macroeconomic variables or lending rates of other banks are neglected. Some caution is therefore warranted when drawing conclusions based on the results of this paper that go beyond how banks adjust their lending policies in comparison with their competitors given the macroeconomic conditions in a country.[3] On the other hand, effects of NPLs that manifest themselves in differences between lending policies of banks with a high NPL stock and those of banks with a low NPL stock can be more credibly detected, simply because macroeconomic conditions can be explicitly controlled for.[4] The benchmark regressions contain year-country fixed effects that absorb all variation between year-country cells. As bank-level fixed effects are included as well, identification results from variation around single bank or banking group-specific means over time that does not mirror year-country specific developments. A wide range of potential determinants of lending rates is thus implicitly controlled for. However, it is impossible to rule out that unobserved variation in bank-specific borrower risk or loan demand affects the results of the analysis. Although no data on borrower risk at the single bank level is available in the context of this analysis, the issue is addressed further below.

Amongst other sources, the present paper relies on bank-level data on lending rates (iMIR dataset) and balance sheet items (iBSI dataset) collected by the Eurosystem, which have already been used in other studies to investigate lending behavior in the euro area (e.g. Holton and Rodriguez d'Acri, 2015; Albertazzi, Nobili and Signoretti, 2016; Altavilla, Canova and Ciccarelli, 2016; Boeckx, de Sola Perea and Peersman, 2016; Camba-Mendez, Durré and Mongelli, 2016; Altavilla, Pagano and Simonelli, 2017; de Haan, Vermeulen and van der End, 2017; Holton and McCann, 2017). Some of these studies also focus on the impact of NPLs or loan loss reserves on lending behavior, in particular lending rates (Holton and Rodriguez d'Acri, 2015; Albertazzi et al., 2016; Altavilla et al., 2016; Holton and McCann, 2017) and report an effect on the

[3] Imagine, for instance, that the high NPL stock of some banks induces them to raise lending rates. Other banks with a low NPL stock might then experience an increase in loan demand (assuming that loan demand faced by one bank depends positively on lending rates set by other banks, inter alia) and increase their rates as well. What the analysis in this paper identifies are the remaining differences in lending rates between high and low-NPL banks, but not the effects of NPLs that also show up in lending rates of low-NPL banks.

[4] Of course, this only holds for the component of macroeconomic variables, which is the same for all banks operating in a given country.

level of lending rates when capital is taken into account (Albertazzi et al. 2016), on the pass-through of non-standard policy measures (Altavilla et al., 2016) and on the interest rate differential between small and large-scale loans (Holton and McCann, 2017), which is used as a proxy for the difference between lending rates charged on loans to SMEs and on loans to large enterprises.

The present paper adds to this research in particular by investigating the link between NPL stocks and lending behavior in more detail. Furthermore, contrary to the papers relying on iMIR and iBSI data mentioned above, the empirical analysis is conducted with data on a yearly rather than a monthly frequency. The motivation for using data of a lower frequency stems from the fact that information on NPLs and (regulatory) capital is only available on a yearly basis for most banks. The obvious drawback of this approach is that the monthly frequency of the iMIR and iBSI dataset is not fully exploited. The results of the empirical analysis indicate that there is a relatively robust positive association between net NPLs (the part of NPLs not covered by loan loss reserves) and lending rates when macroeconomic factors are captured via year-country fixed effects. Loan loss reserves tend to offset this positive association, with the result that there is no strong relation between gross NPLs and lending rates, although this offsetting effect is not observed in all specifications. Funding costs do not seem to be the main driver of the effects of NPLs on lending rates. These empirical results correspond to a situation in which banks adjust their lending behavior in light of further anticipated losses and "anticipated falls in capital" (Hernando and Villanueva, 2014) stemming from the stock of net NPLs. Furthermore, it seems that an increase in net NPLs leads to an increase in these anticipated losses in particular in situations where loan loss reserves are not immediately adjusted accordingly, which is plausible, as such a scenario implies that the realisation of losses is postponed. The findings are compatible with a situation where banks restrict lending by charging higher interest rates, but they are also consistent with "gambling for resurrection" behavior, which implies that banks with a high uncovered NPL stock switch to riskier borrowers as this allows higher credit risk spreads to be charged. The available data does not permit a clear distinction to be made in this context due to the lack of borrower-related information. A possible impact of NPLs on the extent to which banks pass changes in market rates onto their customers, which is particularly interesting from a monetary policy perspective, cannot be detected. However, even if the pass-through is not affected by the stock of NPLs, a higher mark-up charged by banks with high net NPL stocks might be problematic at the zero lower bound when a further expansionary stimulus cannot be easily achieved but lending rates are still considered to be too high from a monetary policy perspective.

## 2 Relevant literature

There are academic contributions which consider the impact of NPLs or loan loss reserves on lending rates and the interest rate pass-through while relying on the same euro area-wide bank-level dataset (iBSI / iMIR) as the empirical analysis in this paper. These contributions, however, do not consider net NPLs and loan loss reserves separately. The iBSI / iMIR data is merged with bank-level balance sheet data (taken from the iBSI dataset or from commercial databases, namely Bankscope and SNL). Using iBSI / iMIR data, Albertazzi et al. (2016) identify an impact of NPLs on lending rates, also after capital effects (Tier 1 ratio), bank-level fixed effects and month-country fixed effects are taken into account. The results suggest that this impact manifests in the form of a higher mark-up on lending rates, and is largely independent from the monetary policy stance, whereby the latter is measured via the MRO rate (to capture standard policy measures) and via the spread between a shadow rate and the MRO rate (to capture unconventional monetary policy measures). A higher stock of NPLs therefore seems to entail higher lending rates, while the responsiveness of lending rates to monetary policy measures remains rather unaffected. This holds for both standard and non-standard monetary policy measures. The authors report a low correlation between capital and NPLs in their sample; it thus appears that controlling for capital does not greatly affect the results with regard to NPLs. Altavilla et al. (2016) use iMIR data in a VAR model framework. The VAR model includes lending, deposit and bank bond rates (for those banks for which bond rates are available) along with several macroeconomic variables. The VAR is estimated separately for each bank, meaning that bank-specific responses to monetary policy shocks are obtained. It turns out that impulse responses calculated for a sample of banks with a high NPL stock by the end of 2007 do not systematically differ from those calculated for a sample of banks with a low NPL stock when standard policy measures are considered. The reaction is more pronounced for high NPL banks compared with low NPL banks in the case of non-standard measures. Holton and Rodriguez d'Acri (2015) focus on the role of bank-specific variables such as the capital ratio and loan loss provisions on the interest rate pass-through in a single panel error correction framework that includes bank fixed effects. In order to examine this, the authors interact right-hand side lending and market rate variables one by one with different bank-level variables. No clear picture emerges with regard to the impact of loan loss provisions on the interest rate pass-through.

Other papers indicate that NPLs might affect a bank's lending policy after controlling for bank capital, using more granular loan data or industry bank-level data, which also allows controlling for borrower side effects but is restricted to a single country. In their seminal paper, Jiménez, Ongena, Peydró and Saurina (2012) use Spanish credit register data in order to identify the balance sheet channel of monetary policy. The data not only contains information on granted loans but also on rejected loan applications. This setting enables the authors to analyse the determinants of whether a loan is granted or not, controlling for all potential borrower side effects via firm-month or even loan fixed effects. While the authors focus on the existence of a balance sheet channel of monetary policy (captured by the coefficient related to interaction terms for the change in money market rates on the one hand and bank capital or bank liquidity on the other hand), the estimation also includes the doubtful loans ratio as a control variable. In some, but not all benchmark specifications the authors report a negative impact of this control variable on the probability of a loan being granted, while the capital ratio is controlled for. Burlon et al. (2016) assess the role of NPLs ("bad loans") and capital for credit rationing using loan-level data from the Italian credit register. The authors estimate the prevalence of credit rationing by simultaneously estimating a demand, a supply and a loan margin function on the single loan level. In order to disentangle supply and demand, exclusion restrictions (defining variables that affect either demand or supply exclusively) are used. The benchmark results indicate that the loan margin – calculated as the difference between the interest rate on loans and EONIA – increases with a higher share of bad loans while controlling for Tier 1 capital, which itself has a negative impact on the loan margin. At the same time, credit supply is negatively affected by the share of bad loans, again while controlling for Tier 1 capital, which has a positive effect. Another important contribution comes from Hernando and Villanueva (2014). The authors use Spanish data on the banking industry level in order to assess the impact of current and anticipated changes in bank capital on lending growth. The authors argue that an increase in the NPL ratio is a suitable indicator for anticipated falls in bank capital but not for instantaneous falls due to peculiarities in Spanish regulation linked to the system of "dynamic provisioning". Both the growth of bank capital and that of NPLs between 2008 and 2009 are instrumented by the exposure to real estate development directly before the beginning of the housing boom (1995-1997) and the interaction of this variable with the average change in house prices in the provinces in which the bank operates. The instrument variable regressions reveal a negative impact of the change in NPLs on lending growth, while the change in Tier 1 capital has a positive impact. On the other hand, based on Italian credit register data, Accornero, Alessandri, Carpinelli and Sorrentino (2017) find that the impact of the NPL stock on lending growth vanishes as soon as borrower characteristics are properly taken into account by means of time-borrower fixed effects. What the authors identify is a negative impact of the exogenous emergence of new NPLs on lending growth, whereby provisions and changes in NPL ratios triggered by the asset quality review in 2014 are used as a source of exogenous variation. The authors argue that such an NPL shock is similar to an exogenous shock to capitalization, liquidity or profitability. Their findings imply that the stocks of NPLs have no effects on bank lending that extend beyond losses connected to this stock that have already been taken over and are already captured in bank capital.

Taken together, the insights of the research discussed above suggest that NPLs might indeed have an impact on bank lending policies even if bank capital is accounted for, although empirical results do not unanimously point in that direction. Rather, studies based on the iMIR dataset for the whole euro area suggest that this impact takes the form of a mark-up on market rates that are closely connected to the monetary policy stance, whereas – at least in the case of standard monetary policy measures – the NPL stock does not seem to have a strong influence on the responsiveness of lending rates to monetary policy measures.

Turning to the impact of NPLs on banks' funding costs, Babihuga and Spaltro (2014) fail to find an impact of loan loss provisions on marginal unsecured wholesale funding costs of banks in the euro area. The latter are calculated as the sum of the five-year CDS and the three-month LIBOR, according to the method suggested by Button, Pezzini and Rossiter (2010). The estimated error correction model captures both short and long-term effects. However, higher loan loss provisions are connected with higher funding costs in the US, the UK and in the Nordic countries. Galiay and Maurin (2015) look at actual bank bond coupon rates paid by EU banks. They include flows of provisions as well as loan loss reserves into the construction of a micro factor. This factor affects coupon rates in some, but not all specifications.

The pass-through of bank-specific costs of market funding to lending rates in the euro area is assessed by Camba-Mendez et al. (2016), employing iMIR data along with yield-to-maturity data for highly liquid bonds. The results suggest that higher costs of market funding imply a decline in bond issuance (measured as the probability to issue bonds in a given month), which in turn leads to higher lending and deposit rates. Taken together, higher bond rates imply higher lending rates. In the theoretical model, which Camba-Mendez et al. (2016) use as the basis of their empirical investigation, the cost of bond financing is considered to be exogenous and determines the amount of bonds issued, which affects lending and deposit rates. Harimohan, McLeay and Young (2016) use bank-level data for the UK to investigate whether idiosyncratic changes in the costs of market funding are passed through to lending and deposit rates in a different way than a general change in market rates that affects the funding costs of all banks. They find that while a change in the costs of market funding that affects all banks similarly – captured by a change in swap rates – is passed through completely in the long run, the pass-through is weaker in the case of an idiosyncratic change in funding costs – captured by bank-specific CDS premia or unsecured bank bond spreads. The authors explain this finding with the impact of competition, which leads to a loss in market share once a bank tries to pass idiosyncratic increases in funding costs on to their customers or creates an opportunity to increase the spread between lending rates and funding costs in the case of an idiosyncratic decline. According to their theoretical model, the authors assume that costs or market funding are exogenously given from the single bank's perspective (banks are price takers in this market), whereas lending and deposit rates are set by the bank (under certain conditions) independently.

Summarizing the evidence of the papers on bank-specific funding costs and their pass-through, bank-specific characteristics are unsurprisingly an important determinant of bank-specific risk premia. However, there is no clear indication of how important NPLs are in this context. Furthermore, the literature suggests that costs of market funding can in general be considered to be exogenous from the single bank's point of view, whereas deposit rates are endogenous in the sense that banks possess a certain market power for this funding source and can thus use the deposit rate as a strategic variable in order to maximize utility or profits. This is in line with the ideas of Button et al. (2010), according to which the treasury acts like a "bank in a bank" (Cadamagnani, Harimohan and Tangri, 2015), providing funds to the lending unit at a rate equal to the cost of market funding and remunerating deposits provided by the deposit unit with the same rate. Consequently, the marginal cost of the lending unit which is relevant for setting lending rates is equal to the cost of market funding.[5]

# 3 Data and descriptive analyses

The empirical analysis in this paper relies on three principal data sources: the iBSI / iMIR dataset collected by the Eurosystem, data from the commercial data sources Bankscope (BS) and SNL[6] as well as data from the CSDB, which is also collected by the Eurosystem.

The iBSI / iMIR dataset contains individual bank-level information on lending and deposit rates and new business volumes (iMIR) as well as flows and stocks of loans

[5] See also Freixas and Rochet (2008, p. 79) for the irrelevance of deposit rates to lending rates under certain conditions with regard to the bank's cost function.

[6] Bankscope and SNL recently changed their names to "ORBIS Bank Focus" and "S&P Global Market Intelligence" respectively. In what follows, the data sources are still referred to as "BS" and "SNL", as the main part of the data was retrieved before the names were changed.

(iBSI) of around 250 euro area banks, which include head institutions, subsidiaries and branches. These banks and branches constitute a sub-sample of all euro area banks that report MIR data to their respective national central banks. The iBSI / iMIR data is available on a monthly basis from July 2007 onwards. They are (like the BSI and MIR dataset) based on the concept of unconsolidated balance sheets, which implies that loans granted by subsidiaries are not assigned to their respective parent institutions. Furthermore, loans granted by foreign branches are not assigned either. Data collection therefore follows the "host principle", according to which only offices within the respective national territory should report (European Central Bank and European Banking Authority, 2012). Banks are supposed to take into account all deposits and loans that have been received from or granted to customers resident in the euro area when calculating lending rates and volumes. This implies that the average interest rate on loans reported by a German bank, for instance, is not necessarily exclusively based on loans to German customers, but also on loans to customers resident in other euro area countries. However, on account of the host principle it seems plausible to assume that the volume of loans to the latter group of customers will be rather small. The focus of the present paper is on lending rates for loans to non-financial corporations (NFCs). However, lending rates on loans for house purchase and the growth of both NFC loans and loans for house purchase derived from the iBSI dataset are considered as well.

BS and SNL constitute commercial data sources that are fed from publicly available bank reports. These data sources contain information on regulatory capital, RWAs, the stock of NPLs,[7] the stock of loan loss reserves and on a multitude of further balance sheet and profit and loss positions. It is widely known that NPL definitions have differed between countries and over time, which could potentially restrict the comparability of NPL data between banks.[8] This issue will be addressed in Section 5.5. Furthermore, it is important to note that BS and SNL data refer mainly to consolidated

[7] The NPL variable selected for this analysis might refer to "impaired loans" for some banks, and for other banks may also contain "potential problem loans" that are still performing but show signs of deteriorating borrower quality. Furthermore, it must be noted that BS and SNL provide information on the stock of gross NPLs and the stock of loan loss reserves. In what follows, the stock of net NPLs will be calculated as the difference between the former and the latter. The stock of net NPLs calculated this way might underestimate the actual stock, as not all loan loss reserves are held against NPLs (thus making the amount deducted from gross NPLs to determine net NPLs too high). On the other hand, the inclusion of "potential problem loans" might bias the stock of net NPLs upwards. All in all, the coverage ratio (loan loss reserves divided by stock of gross NPLs) for the banks included in the sample underlying the empirical investigations in this paper is largely in line with supervisory data. The European Banking Authority (2016) reports the coverage ratio of NPLs based on specific loan loss reserves (i.e. only those reserves explicitly assigned to NPLs) for the period between 2014 and 2016 to be around 43% for the entire European Union, whereas the coverage ratio for sampled banks amounts to 46%.

[8] A harmonized definition was introduced on the European level in 2015. Before this harmonization, definitions differed across European countries (see for example Barisitz, 2013). This implies that the definition of NPLs varies over time as well as over countries.

balance sheets (although information referring to unconsolidated balance sheets is available for several banks) and to the highest level of consolidation, whereas iBSI / iMIR data refer to single banks (which might themselves be part of a banking group).[9] Given this data structure, iBSI / iMIR data are merged to BS and SNL data stemming from the consolidated balance sheet of the banking group that the respective single bank captured in the iBSI / iMIR dataset belongs to. Thus the data structure is such that several iBSI / iMIR single banks might belong to the same BS / SNL banking group.[10] The underlying assumption is that the characteristics of an entire banking group have a bearing on the lending decisions of the single bank. De Haas and van Lelyveld (2010) provide evidence in favour of this assumption. Table 1 gives more information on the number of head banks and subsidiaries / branches in the sample taken from iMIR data used for the benchmark regressions, in which the lending rate for loans to NFCs serves as a dependent variable, as well as data on the group parents from BS / SNL. The table also shows how many banks and banking groups from vulnerable countries (i.e. countries that were hit particularly hard by the sovereign debt crisis: CY, ES, GR, IE, IT, PT and SI) and non-vulnerable countries (the remaining countries) are included in the sample. Annex I explains in more detail how BS and SNL data have been brought together.

The third dataset employed in this paper is the Centralised Securities Database (CSDB) of the Eurosystem. This database has recorded information on all securities that are either issued or held by euro area entities or that are denominated in euro on a monthly basis since April 2009. The CSDB data is used to track the evolution of market funding costs on the bank level. Therefore, information on the coupons and yields to maturity (YTMs) for debt instruments without embedded options and with a fixed interest rate and a fixed maturity is collected on a monthly basis. Then the spread over the OIS rate, whose reference period is closest to the original or residual maturity, is calculated for each instrument for each month. This spread is consolidated on the bank-year level over all available bonds. Two different spreads are calculated: the first spread is based on YTMs of all bonds for which information on YTMs is available at a certain point in time (YTM spread). This spread can be understood as a measure of how costly funding

[9] "Banking group" is used throughout this paper to refer to what would be called a "Bankkonzern" in German, not to a "Bankengruppe", which refers to a certain type of banks.

[10] Strictly speaking, not all BS / SNL units necessarily belong to banking groups. The BS / SNL datasets also contain information on single banks that are independent and do not form part of a banking group. However, for the sake of simplicity, BS / SNL units are referred to as "banking groups" in the following. The data structure is similar to that of Mésonnier and Monks (2015). For non-independent single banks, it was verified that the single bank was part of the respective banking group over the entire sample period. If it became part of the banking group after the beginning of the sample period, the observations referring to the part of the sample period in which it was actually not part of the banking group yet were removed.

was in a given month – relative to the risk-free rate – if the bank issued a bond with the same characteristics as those for which the YTM is observed (YTM funding costs). The second spread is based on funding costs in a certain month based on the coupons of bonds that were actually issued in this month (actual funding cost spread or AFC spread). Both the AFC and the YTM spread are computed based on bonds of all maturities and are calculated as an average over all maturities (YTM spread, AFC spread) or are normalized to capture the funding costs for bonds with a maturity from 1-5 years (YTM_spread_1-5, AFC_spread_1-5). They are calculated at the parent company level and are subsequently merged to the respective banking group. More information on the calculation of the AFC and YTM spreads can be found in Annex II. The YTM spread is available for more observations, as the AFC spread can only be observed if bonds are actually issued.

As can be seen from Table 1, the analysis is based on yearly data. Yearly values from the iMIR dataset are aggregates of the monthly values of the respective year, weighted with new lending volumes. Lower frequency data is used on account of the present paper's focus on the impact of NPLs on lending rates. For many banks, information on NPLs is available on an annual frequency only. The dataset covers the period from 2010 to 2017. The number of observations in Table 1 refers to those observations that are effectively included in the estimations described in the next section. As some of the estimations require up to two lags of the dependent variable, observations from 2008 and 2009 drop out of the sample (the first full year for which iBSI / iMIR data is available is 2008).

Table 2 explains the main single bank and banking group variables used in the benchmark regressions, while Table 3 displays the number of observations and of imputed values (imputed according to the methodologies described in Annexes I and II), means and standard deviations (for all countries as well as for non-vulnerable and vulnerable countries separately). As can be seen from Table 3, lending rates are on average higher in vulnerable countries, compared with non-vulnerable countries. The same is true for the NPL ratio, whereas the Tier 1 ratio, the liquidity ratio and the ROA are higher in non-vulnerable countries. Funding costs are higher in vulnerable countries as well. Interestingly, the difference is less pronounced for the AFC spread than for the YTM spread, which might indicate that banks in vulnerable countries were more successful in the timing of their bond issuances (average actual funding costs are below average hypothetical funding costs captured by the YTM spread; the opposite is true for banks in non-vulnerable countries). This in turn could primarily be the consequence of banks in vulnerable countries drastically reducing their bond issuances during the sovereign debt crisis when YTM spreads in those countries skyrocketed. The high number of imputed values for the liquidity ratio is mainly due to the fact that this variable is available in BS but not in SNL for several banks in non-vulnerable countries. The high number of imputed values for the YTM spread and in particular for the AFC spread_1_5 variable indicates that for many observations, these spreads are only available for maturities outside the 1-5 year bucket and thus have to be normalized to this maturity,[11] and are then counted as imputed values.

**Table 1: Number of observations for the benchmark regressions**

| | ***Single Banks (IMIR units)*** | | | | | ***Banking Groups*** | | |
|---|---|---|---|---|---|---|---|---|
| | **Total** | Parent Com-panies | Sub-sidiaries / Bran-ches | Non-vulner-able* | Vulner-able** | **Total** | Non-vulner-able*** | Vul-nerable |
| 2010 | **78** | 46 | 32 | 47 | 31 | **55** | 33 | 22 |
| 2011 | **99** | 51 | 48 | 62 | 37 | **61** | 37 | 24 |
| 2012 | **93** | 52 | 41 | 55 | 38 | **60** | 35 | 25 |
| 2013 | **115** | 61 | 54 | 69 | 46 | **72** | 44 | 28 |
| 2014 | **114** | 59 | 55 | 70 | 44 | **70** | 43 | 27 |
| 2015 | **119** | 59 | 60 | 71 | 48 | **70** | 42 | 28 |
| 2016 | **119** | 57 | 62 | 75 | 44 | **67** | 43 | 24 |
| 2017 | **102** | 50 | 52 | 70 | 32 | **59** | 43 | 16 |
| Cross-Sections (N) | **143** | 72 | 71 | 87 | 56 | **83** | 49 | 34 |
| Total observations (sum 2010-2016) | **839** | 435 | 404 | 519 | 320 | **514** | 320 | 194 |

*Non-vulnerable countries include: AT, BE, DE, EE, FI, FR, LT, LU, LV, MT, NL and SK;
**Vulnerable countries include: CY, ES, GR, IE, IT, PT and SI
*** Non-vulnerable countries plus DK, GB and SE

Outlier values were set to missing, whereby first differences of variables have been considered to define outliers. This is due to the fact that the effect of outliers in levels will be largely eliminated in the estimations described below owing to the usage of fixed effects (which is asymptotically equivalent to the usage of first differences). An outlier is defined as a value in the first difference of the respective variable which is below twice the value of the first percentile or above twice the value of the 99th percentile of the distribution of the difference.

[11] See Annex II for a description of this methodology.

**Table 2: Description of banking variables in the benchmark regressions**

| Variable Name | Data Source / Level of data collection | Description |
|---|---|---|
| Lending-Rate | IMIR / Sinlge Bank | Average lending rate for loans to NFCs (excluding overdrafts) |
| Gross_NPL_TA (-1) | SNL, BS / Banking Group | Gross NPLs or impaired loans / Total assets in % (1 Lag) |
| Net_NPL_TA (-1) | SNL, BS / Banking Group | (Gross NPLs or impaired loans - loan loss reserves) / total assets in % (1 Lag) |
| LL_Res_TA (-1) | SNL, BS / Banking Group | Loan loss reserves / total assets in % (1 Lag) |
| Tier1_Ratio (-1) | SNL, BS / Banking Group | Regulatory Tier 1 capital over risk weighted assets in % (1 Lag) |
| Liq_Ratio (-1) | SNL, BS / Banking Group | Liquid assets (cash, loans to banks, securities) over liabilities in % (1 Lag) |
| ROA (-1) | SNL, BS / Banking Group | Return on assets in % (1 Lag) |
| YTM_Spread | CSDB / Banking Group | Spread of yield to maturity over corresponding OIS swap rate in PP |
| YTM_Spread_1_5 | CSDB / Banking Group | Spread of yield to maturity over corresponding OIS swap rate in PP, bonds with residual maturity of 1-5 years. |
| AFC_Spread | CSDB / Banking Group | Spread of actual funding costs over corresponding OIS swap rate in PP |
| AFC_Spread_1_5 | CSDB / Banking Group | Spread of actual funding costs over corresponding OIS swap rate in PP, bonds with original maturity of 1-5 years. |

**Table 3: Basic descriptive statistics of variables in the benchmark regressions**

| | *N_Obs all* | *N_Obs all Imp** | *Mean all* | *Mean NV*** | *Mean V**** | *SD**** all* | *SD NV* | *SD V* |
|---|---|---|---|---|---|---|---|---|
| Lending-Rate (NFCs) | 839 | 0 | 2.57 | 2.22 | 3.13 | 1.22 | 0.91 | 1.42 |
| Gross_NPL_TA (-1) | 514 | 16 | 5.85 | 2.93 | 10.37 | 6.97 | 3.08 | 8.06 |
| Net_NPL_TA (-1) | 514 | 19 | 3.49 | 1.79 | 5.90 | 4.51 | 2.40 | 5.18 |
| LL_Res_TA (-1) | 514 | 4 | 2.36 | 1.14 | 4.48 | 2.72 | 0.98 | 3.17 |
| Tier1_Ratio (-1) | 514 | 4 | 12.26 | 13.28 | 10.91 | 3.68 | 3.54 | 2.40 |
| Liq_Ratio (-1) | 514 | 84 | 33.97 | 38.90 | 28.64 | 14.17 | 14.41 | 9.30 |
| ROA (-1) | 514 | 0 | 0.05 | 0.28 | -0.30 | 0.95 | 0.31 | 1.29 |
| YTM_Spread_1_5 | 514 | 84 | 1.71 | 1.02 | 2.57 | 1.58 | 0.64 | 1.80 |
| AFC_Spread_1_5 | 411 | 252 | 1.69 | 1.40 | 2.04 | 1.29 | 1.22 | 1.24 |

*N_Obs all Imp gives the number of values that have been imputed according to the methodology described in Annexes I and II included in the number of total observations
** NV stands for Non-vulnerable countries, including the non euro-area countries;
*** V stands for Vulnerable Countries
****SD stands for Standard Deviation

Figure 1 gives a first impression of the relation between the lending rate for loans to NFCs and the stock of gross NPLs. It shows the mean lending rate per year for banks with an NPL stock below and for banks with an NPL stock above the sample median in the respective year. The figure suggests that a higher stock of NPLs is generally linked to higher lending rates. However, this difference becomes only visible after 2010 and has been narrowing in recent years. In a similar vein, Figure 2 looks at the relation between the YTM spread or the AFC spread (for bonds with a residual maturity of 1-5 years) and the NPL stock. A higher stock of NPLs is connected with higher funding costs. This relation is more pronounced for the YTM spread than for the AFC spread, which is supposedly due to the fact that for several high-NPL banks, values can be observed for the YTM spread but not for the AFC spread.

Both figures suggest that NPLs became relevant for the pricing of loans and funding costs with the onset of the sovereign debt crisis. However, it should be kept in mind that neither of the figures control for other bank-specific or macroeconomic factors that might be correlated to the NPL stock and that drive funding costs and lending rates at the same time. Macroeconomic factors in particular, such as sovereign spreads, might have been important during the sovereign debt crisis in this context, and will be taken into account in the econometric analysis which is described in the next section.

**Figure 1: Lending rates and gross NPLs**

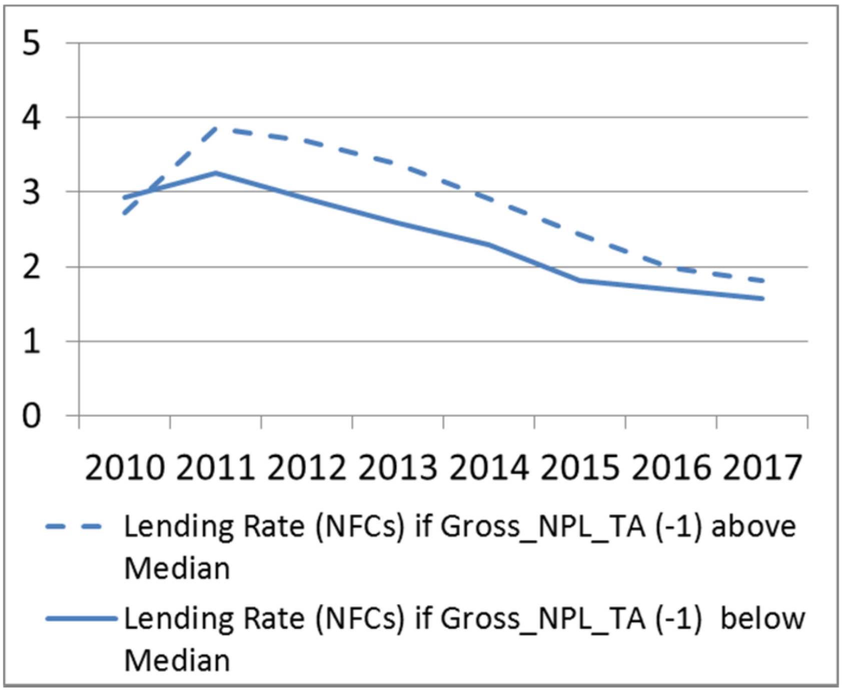
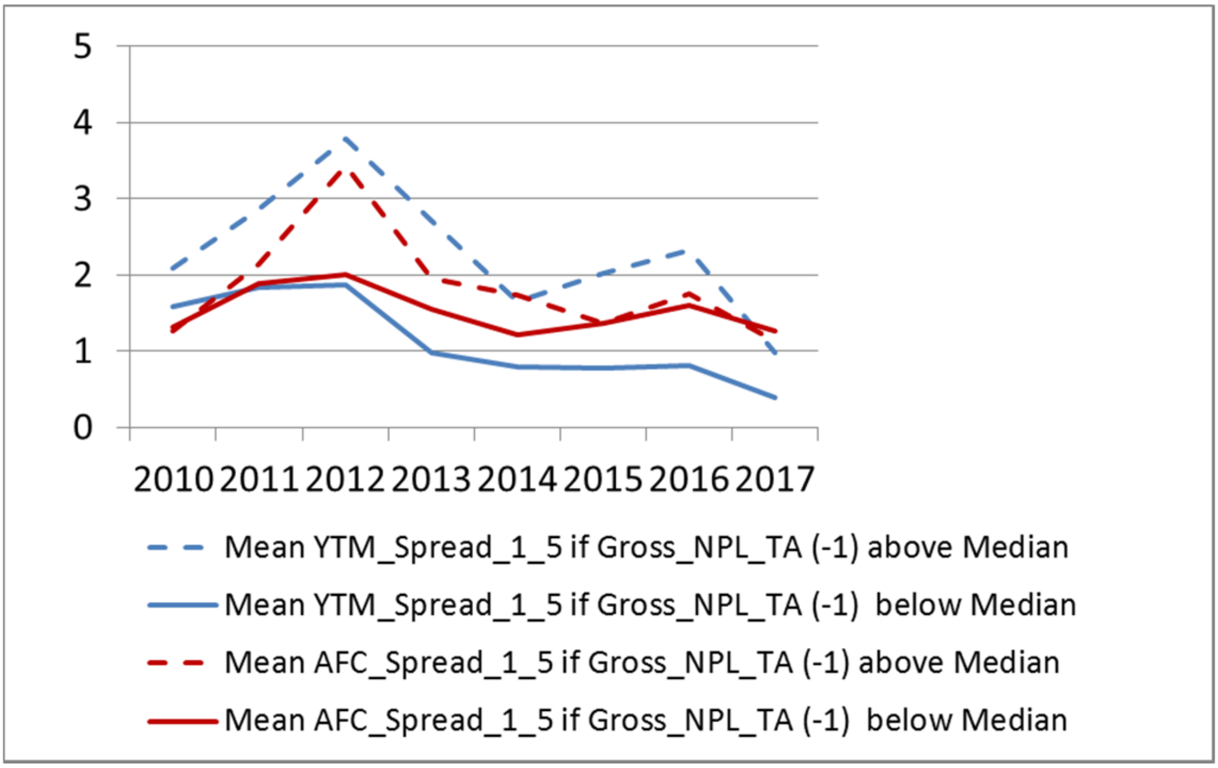



**Figure 2: YTM and AFC spreads and gross NPLs**



# 4 Empirical approach

The empirical approach essentially consists of the estimation of models based on three different equations, which are described in detail below. Estimations based on the first equation are meant to assess whether there is any relation between lending rates and NPLs. Funding costs are not considered at this stage yet. Estimations based on the second equation are intended to reveal whether NPLs affect funding costs. This is a prerequisite for funding costs being a driver of a potential relation between lending rates and NPLs. Finally, estimations based on the third equation show whether explicitly controlling for funding costs affects the coefficient describing the relation between lending rates and NPLs. If this relation was substantially weakened by the inclusion of funding costs and there was an impact of funding costs on lending rates at the same time, it could be concluded that funding costs are the main link between lending rates and NPLs.

Accordingly, two different dependent variables are used throughout the analysis. The lending rate for newly granted loans to NFCs (in further estimations, loans for house purchase and loan growth are considered as well) serves as dependent variable for models based on the first and third equations. The second dependent variable is costs of market funding captured via the YTM spread or the AFC spread, which is used in models based on the second equation.

Models with the lending rate as dependent variable are estimated on the single bank level and include single bank fixed effects, whereas models with the YTM spread are estimated on the banking group ("Bankkonzern") level and include banking group fixed effects. Furthermore, year-country fixed effects are included. These can be understood as a control for all country-specific and time-invariant (over the course of a year) macroeconomic effects that might drive loan demand (see also Albertazzi et al., 2016; Holton and McCann, 2017) or bank funding costs. Models in which the year-country fixed effects are replaced by a set of macroeconomic variables, along with pure year fixed effects, are estimated as well. Although the focus of the analysis is not on the effects of those macroeconomic variables, and year-country fixed effects implicitly capture all those effects, estimating this model still seems useful. The reason behind this is that year-country fixed effects soak up a lot of degrees of freedom, and tests for instrument validity within the SysGMM framework tend to deliver unreliable results in this situation (see below). A more parsimonious model employing year fixed effects and a set of macroeconomic variables is thus better suited to testing instrument validity.[12]

In the estimated models, therefore, identification results from variation around single bank or banking group-specific means over time that does not mirror year-country specific developments. However, it is impossible to rule out that unobserved variations in borrower side credit risk or loan demand, which do not necessarily vary at just the country level, affects the results of the analysis. The issue of credit risk is addressed in the discussion of robustness in Section 5.5.

In the first equation, the lending rate serves as dependent variable. Year-country fixed effects or macroeconomic variables refer to the country in which the respective single bank is operating, which is not necessarily the same as the home country of the respective banking group. In order to account for differences in average interest fixation periods for new loans in the sample, the average interest rate fixation period is included in levels together with higher degree polynomials as the effect might be non-linear. To account for the fact that several single banks might be assigned to the same banking group, the errors are clustered at the banking group level. Taken all together, the first equation is:

$$LR_{i,t} = \alpha_i + \partial_1 LR_{t-1} + \boldsymbol{\beta_1}'\boldsymbol{NPL\_Int_{j,t-1}} + \boldsymbol{\gamma_1}'\boldsymbol{x_{j,t-1}} + \boldsymbol{\tau_1 m_{c(i),t}} + \boldsymbol{\theta_1}'\boldsymbol{irf_{i,t}} + \varepsilon_{i,t} \quad (1)$$

Here, *LR* is the lending rate for new loans to non-financial corporations (alternatively loans for house purchase or loan growth). The vector ***NPL_Int*** contains the variable(s) of interest, either the variable Gross_NPL_TA or the variables Net_NPL_TA and LL_Res_TA. Splitting the NPL variable into net NPLs and loan loss reserves is meant to reveal further information on the channels through which NPLs affect bank lending. However, it must be stressed that disentangling the effects of net NPLs and loan loss reserves is complicated by the fact that both variables are highly correlated. Besides the NPL variable(s) in levels, ***NPL_Int*** also contains interactions of the NPL variable(s) with the medium term risk-free market rate (1-year OIS rate). This captures a segment of the term structure that should be more relevant for bank loans than a rate that more directly captures monetary policy decisions like EONIA. Hence, the pass-through of

[12] As the same set of instruments is used in models with year-country fixed effects and those with year fixed effects and macroeconomic variables, it seems reasonable to assume that any results of the instrument validity test obtained through the latter will also be informative with regard to instrument validity for the former.

monetary policy actions to risk-free market rates like the 1-year OIS rate is considered to be given and not explicitly modelled.

The vector $\boldsymbol{x}$ includes further control variables (most importantly the Tier 1 ratio), $\boldsymbol{m}$ is a vector including either year-country fixed effects or time fixed effects and a set of macroeconomic variables (the set of macroeconomic variables comprises: GDP growth, unemployment rate, inflation, year-to-year change of the national stock index and spread of the 10-year government bond rate over 10-year OIS rate; all in percent). Finally, ***irf*** is a vector containing the average interest rate fixation[13] in levels, squared and cubed, and $\varepsilon$ is the error term, which is clustered on the level of the respective banking group. Furthermore, *i* is a single bank indicator, *j* a banking group indicator, *t* captures the year and *c(i)* stands for the home country of single bank *i*. The parameters $\alpha$ and $\delta_1$ as well as those included in $\boldsymbol{\beta_1}$, $\boldsymbol{\gamma_1}$, $\boldsymbol{\tau_1}$ and $\boldsymbol{\theta_1}$ are to be estimated, whereby $\alpha_i$ is the bank fixed effect.

The second equation is on the banking group level and can be written in a similar fashion as Equation (1), as follows:

$$MFCS_{j,t} = \alpha_j + \partial_2 MFCS_{j,t-1} + \boldsymbol{\beta_2}'\boldsymbol{NPL_{j,t-1}} + \boldsymbol{\gamma_2}'\boldsymbol{x_{j,t-1}} + \boldsymbol{\tau_2 m_{c(j),t}} + \boldsymbol{\theta_2}'\boldsymbol{mat_{j,t}} + \varepsilon_{j,t} \quad (2)$$

*MFCS* stands for the market funding cost spread, which is either the YTM spread or the AFC spread, and the vector ***NPL*** contains the levels of the NPL variables but no interactions with other market rates (hence ***NPL*** is in fact a scalar if gross NPLs are considered). The vector ***mat*** contains the residual maturity in levels, squared and cubed. As the maturity can directly be controlled for, the actual funding costs instead of those normalized to bonds with a maturity from 1-5 years are used in this equation. All remaining variables and indices are defined as in Equation (1) (note that bank fixed effects and time-country fixed effects or macroeconomic variables now refer to the home country of the banking group *j*).

[13] The interest fixation period cannot be inferred exactly from the iMIR data. Its approximation is based on information on new business volumes in different interest rate fixation period ranges – up to 1 year, 1-5 years, over 5 years – and on assumptions on the average fixation period within each range. Here, averages of 0.25 years (3 months), 3 years and 10 years are assumed. These estimates are arguably rather ad hoc, but are supported by data available from 2010 onwards, which contain information on the volumes in more granular ranges – up to 3 months, 3 months - 1 year, 1-3 years, 3-5 years, 5-10 years, over 10 years. On the euro area level, the volume is much higher in the range up to 3 months compared with the 3 month - 1 year range, whereas volumes are rather similar in the 1-3 years range and the 3-5 years range as well as in the 5-10 years and the over 10 years range.

To figure out the extent to which a potential impact of NPLs on the lending rate spread runs through the market, a funding cost variable (either the YTM spread or the AFC spread) is added to Equation (1) as the explanatory variable which leads to Equation (3). In this equation, the normalized spread capturing funding costs for bonds with a maturity from 1-5 years is used in order to ensure that the funding cost variable is comparable over all banks:

$$LR_{i,t} = \alpha_{3,i} + \partial_3 LR_{t-1} + \boldsymbol{\beta_3}'\boldsymbol{NPL\_Int_{j,t-1}} + \rho MFCS\_1\_5_{j,t} + \boldsymbol{\gamma_3}'\boldsymbol{x_{j,t-1}} + \boldsymbol{\tau_3 m_{c(i),t}} + \boldsymbol{\theta_3}'\boldsymbol{irf_{i,t}} + \varepsilon_{i,t} \quad (3)$$

Note that the market funding cost spread is not lagged in this equation. This is due to the fact that Equations (1) and (2) imply that NPLs affect both lending rates as well as market funding costs. The effect of NPLs on lending rates through the YTM spread or the AFC spread is therefore captured by the contemporaneous value of this variable. As discussed in Section 2, it seems valid to consider costs of market funding to be exogenous with regard to lending rates. The extent to which the funding costs capture the impact of NPLs on lending rates is assessed by comparing $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_3}$.

Equations (1), (2) and (3) are estimated using both an ordinary fixed effects estimator (FE) and – due to the potential dynamic panel bias – the system GMM (SysGMM) estimator based on Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). In the system GMM estimator, all banking group-specific variables (i.e. those included in ***NPL*** / ***NPL_Int*** and ***x***) are instrumented. Although potential endogeneity concerns with regard to the banking group-specific variables are already taken into account by considering the lags of those variables in Equations (1)-(3), these variables are still not necessarily strictly exogenous and are potentially correlated with bank-specific fixed effects; hence instrumenting them might still be warranted. The fact that the dependent variable is on the single bank level whereas the bank-specific variables are on the banking group level in Equations (1) and (3) only mitigates endogeneity concerns to a limited extent as in many cases, either the single bank and the banking group are the same or the single bank constitutes an important part of the banking group. However, the system GMM estimators are known to be very sensitive to the model specification (in particular the number and definition of instruments); thus estimating standard fixed effects models still has its merits.

# 5 Results

## 5.1 Benchmark results

Table 4 shows the results of estimating Equation (1). The results in the left panel refer to specifications with year-country fixed effects. They deliver some signs for a positive association between the stock of gross NPLs and higher lending rates, whereby this relation is statistically significant in the FE specification only. The coefficients related to the interaction between the NPL variable and the OIS rate indicate that there is no statistically significant impact of gross NPLs on the extent to which market rates are passed through to lending rates. When the NPL variable is split into net NPLs and loan loss reserves, it turns out that the former drive the positive impact of gross NPLs and lending rates in the FE specification, although the respective coefficient is not statistically significant. For the SysGMM specification, results indicate a positive impact of net NPLs and a negative impact of loan loss reserves on lending rates. Assuming that an increase in the gross NPL variable by 1 pp implies an increase in the net NPL variable by 0.58 pp and an increase in the loan loss reserve variable by 0.42 pp – which is the average relation observed in the sample – the effect through the net NPL variable and the loan loss reserve variable roughly cancel out each other. Again, no evidence of an impact of NPLs on the pass-through from market to lending rates can be found. The p-value for the Hansen statistic highlights the difficulty that emerges when year-country fixed effects are included: the number of instruments (which includes the year-county fixed effects that instrument themselves) is high, which leads to an upward bias in the p-value (Roodman, 2009). In fact, the value 1.0 clearly indicates that the Hansen statistic should not be trusted. Furthermore, it should be noted that the correlation between net NPLs and loan loss reserves is high (the correlation coefficient is around 0.85). In such a case, the impact of both variables might be unstable and reversed if the sample were to be slightly altered. Against this background, Annex III (Figure 3 and Figure 4) documents how the coefficients related to net NPLs and loan loss reserves vary if some banking groups are randomly removed from the sample. The results of this exercise indicate that signs of pronounced instability (such as sign reversals) can be only observed in a very few cases.

By and large, the results from the specifications with year-country fixed effects tentatively confirm the findings of other studies based on iMIR data discussed in Section 2, according to which a high stock of NPLs entails a higher mark-up for the lending rates, whereas the interest rate pass-through seems rather unaffected. Beyond that, the SysGMM specification indicates that this higher mark-up occurs only when net NPLs rise in isolation, with loan loss reserves remaining largely unchanged.

The picture changes when time-country fixed effects are replaced by (pure) time fixed effects and a set of macroeconomic variables, as indicated by the results in the right panel of Table 4. The significant relations detected in the left panel vanish and the results of the FE specification even suggest a negative relation between gross NPLs and lending rates, as well as an attenuation of the pass-through from market to lending rates as gross NPLs increase. Furthermore, in the SysGMM specifications the Tier 1 ratio is found to be negatively related to lending rates. Although it seems preferable to control for macroeconomic factors via year-country fixed effects, the specifications with macroeconomic variables still have their merits, especially when used to assess instrument validity when SysGMM is applied. As can be seen from the table, the number of instruments is drastically reduced. Thus the Hansen statistic is more trustworthy. It does not reject the null of valid instruments, which also renders the results of the SysGMM in the left panel more reliable.

Next, the relation between NPLs and funding costs is assessed as described by Equation (2). The estimations of Equation (2) are run at the banking group level. The results in Table 5 suggest a positive relation between gross NPLs on the YTM spread. Contrary to the case of Equation (1), when splitting gross NPLs into net NPLs and loan loss reserves, it turns out that the latter, not the former, seem to be the main driving force behind this relation. This is the opposite of the result found for Equation (1). Investors therefore seem to be less concerned with potential future losses stemming from the net NPL stock than with the losses that have already been taken over. This outcome is in line with a situation where investors consider those losses to be an indicator of management quality, if they assume at the same time that management quality has a significant impact on future earnings and solvency. Furthermore, Annex III (Figure 5, Figure 6, Figure 7 and Figure 8) reveals that the results in Table 5 with regard to net NPLs and loan loss reserves are relatively robust to alterations of the sample. The coefficients related to the remaining banking group specific variables are not significantly different from zero.[14] The results barely depend on whether year-country fixed effects of pure year fixed effects along with macroeconomic variables are used.[15]

[14] The negative impact of bank profitability (measured via the ROA) is on the edge of being significant at the 10% level in some estimations.

[15] Contrary to Equation (1), the sample size is larger in the case of Equation (2) when macroeconomic variables along with year fixed effects instead of year-country fixed effects are included in the model. In the case of year-country fixed effects, year-country cells are only kept if at least two observations fall into that cell, which is not the case when macroeconomic variables are used. Thus the sample size can also increase when macroeconomic variables are used, namely if the effect of including observations from

The Hansen test is again not reliable for the specifications with year-country fixed effects and cannot reject the null of valid instruments in the specifications with macroeconomic variables.

**Table 4: Impact of NPLs on lending rates (Equation 1)**

**Dependent variable: Lending rate (loans to NFCs)**

| | **FE** | **Sys GMM** | **FE** | **Sys GMM** | **FE** | **Sys GMM** | **FE** | **Sys GMM** |
|---|---|---|---|---|---|---|---|---|
| Lending-Rate (-1) | 0.351 *** | 0.704 *** | 0.349 *** | 0.749 *** | 0.493 *** | 0.861 *** | 0.492 *** | 0.811 *** |
| **Gross_NPL_TA (-1)** | **0.020** ** | **0.015** | | | **-0.002** | **-0.033** ** | | |
| **Gross_NPL_TA(-1)*OIS** | **-0.004** | **0.024** | | | **-0.011** | **-0.023** * | | |
| **Net_NPL_TA (-1)** | | | **0.026** | **0.121** ** | | | **-0.008** | **-0.012** |
| **LL_Reserves_TA (-1)** | | | **0.000** | **-0.137** * | | | **0.017** | **-0.021** |
| **Net_NPL_TA (-1)*OIS** | | | **0.004** | **-0.007** | | | **-0.022** | **-0.015** |
| **LL_Reserves_TA (-1)*OIS** | | | **-0.042** | **-0.044** | | | **0.031** | **-0.006** |
| Tier1_Ratio (-1) | -0.005 | 0.011 | -0.004 | 0.008 | -0.010 | -0.027 * | -0.011 | -0.028 * |
| Liq_Ratio (-1) | 0.001 | -0.015 ** | 0.000 | -0.018 * | -0.005 | -0.022 ** | -0.003 | -0.018 ** |
| ROA (-1) | 0.003 | -0.012 | -0.002 | -0.048 | 0.067 * | 0.004 | 0.072 * | 0.036 |
| YTM_Spread_1_5 | | | | | | | | |
| GDP_growth | | | | | -0.003 | 0.013 | -0.003 | 0.014 |
| Unemployment Rate | | | | | 0.011 | -0.012 * | 0.011 | -0.009 |
| Inflation | | | | | 0.059 | 0.036 | 0.053 | 0.051 |
| Change_Stock_Index | | | | | 0.003 | -0.002 | 0.003 | -0.003 |
| GovBond_Spread | | | | | 0.159 *** | 0.101 *** | 0.161 *** | 0.104 *** |
| Number of Observations | 826 | 826 | 826 | 826 | 821 | 821 | 821 | 821 |
| Number of Cross Sections | 143 | 143 | 143 | 143 | 138 | 138 | 138 | 138 |
| Number of Instruments | | 148 | | 158 | | 46 | | 56 |
| P_Hansen | | 1.0000 | | 1.0000 | | 0.1808 | | 0.1648 |
| P_AR2 | | 0.1871 | | 0.1310 | | 0.1422 | | 0.1233 |
| *Year fixed effects* | *no* | *no* | *no* | *no* | *yes* | *yes* | *yes* | *yes* |
| *Year*Country fixed effects* | *yes* | *yes* | *yes* | *yes* | *no* | *no* | *no* | *no* |
| *Controls for IR-Fixation* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* |

***SysGMM: All banking group specific variables instrumented,***
***instruments collapsed, only lags 2-5 used as instruments;***
***Standard errors clustered on banking group (j) level;***
****** ***, ** and * indicate statistical significance at the 1%, 5%, and 10% level.***

year country cells with only one observation outweighs the effect of excluding observations with missing values for macroeconomic variables.

**Table 5: Impact of NPLs on YTM spread (Equation 2)**

**Dependent variable: YTM spread**

| | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
|---|---|---|---|---|---|---|---|---|
| YTM_Spread (-1) | 0.181 ** | 0.668 *** | 0.170 ** | 0.616 *** | 0.127 * | 0.409 *** | 0.100 * | 0.364 *** |
| **Gross_NPL_TA (-1)** | **0.088** *** | **0.067** *** | | | **0.086** *** | **0.068** *** | | |
| **Net_NPL_TA (-1)** | | | **0.033** | **0.006** | | | **-0.037** | **0.001** |
| **LL_Reserves_TA (-1)** | | | **0.153** ** | **0.109** | | | **0.233** *** | **0.153** ** |
| Tier1_Ratio (-1) | -0.009 | 0.020 | -0.010 | 0.021 | -0.023 | 0.013 | -0.019 | 0.014 |
| Liq_Ratio (-1) | 0.007 | -0.003 | 0.005 | -0.004 | 0.005 | 0.015 | 0.002 | 0.010 |
| ROA (-1) | -0.111 | -0.085 | -0.108 | -0.096 | -0.078 | -0.060 | -0.064 | -0.064 |
| | | | | | | | | |
| GDP_growth | | | | | -0.021 | -0.036 | -0.028 | -0.020 |
| Unemployment Rate | | | | | 0.097 ** | -0.008 | 0.107 ** | -0.008 |
| Inflation | | | | | 0.114 | 0.175 ** | 0.106 | 0.200 ** |
| Change_Stock_Index | | | | | -0.014 *** | -0.013 ** | -0.015 *** | -0.015 *** |
| GovBond_Spread | | | | | 0.435 *** | 0.298 *** | 0.428 *** | 0.320 *** |
| Number of Observations | 446 | 446 | 446 | 446 | 474 | 474 | 474 | 474 |
| Number of Cross Sections | 76 | 76 | 76 | 76 | 80 | 80 | 80 | 80 |
| Number of Instruments | | 98 | | 103 | | 40 | | 45 |
| P_Hansen | | 1.0000 | | 1.0000 | | 0.4904 | | 0.3483 |
| P_AR2 | | 0.4445 | | 0.4864 | | 0.7258 | | 0.6193 |
| | | | | | | | | |
| *Year fixed effects* | *no* | *no* | *no* | *no* | *yes* | *yes* | *yes* | *yes* |
| *Year*Country fixed effects* | *yes* | *yes* | *yes* | *yes* | *no* | *no* | *no* | *no* |
| *Controls for Maturity* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* |

***SysGMM: All banking group specific variables instrumented, instruments collapsed, only lags 2-5 used as instruments;***
***Estimations based on data from 2010-2017;***
*******, ** and * indicate statistical significance at the 1%, 5%, and 10% level; assessment of significance based on robust standard errors.****

Estimating Equation (2) with the AFC spread instead of the YTM spread as dependent variable yields the results shown in Table 6. The AFC spread can be calculated further back in time than the YTM spread (see Annex II for details), thus the sample period is from 2008 to 2017. At the same time, the number of cross-sectional observations is smaller compared with that of the estimations in Table 5. This is because the AFC spread is not observable for a bank that does not issue bonds in a certain year; however, the YTM spread might still be observed if that bank has bonds outstanding that were issued in previous years. In this context, it is important to stress that banks that drop out of the sample this way are, in particular, those with high NPL ratios. However, this does not seem to explain why the relation between NPLs and the AFC spread in Table 6 is weaker than the relation between NPLs and the YTM spread in Table 5: if the estimations shown in Table 5 and Table 6 are repeated based on the sample of observations for which both the YTM and the AFC spread are available, the relation between NPLs and the YTM spread remains considerably stronger than the relation between NPLs and the AFC spread. Table 6 furthermore suggests that bank profitability plays quite an important role for the AFC spread.

Taken together, results based on the YTM spread indicate a pronounced relation between NPLs and funding costs, whereas this relation weakens and turns insignificant in most specifications when the YTM spread is replaced by the AFC spread. Although high YTM spreads do not necessarily imply higher actual funding costs for a bank, they might still reflect higher actual funding costs for other funding sources like deposits, because banks that abstain from issuing bonds would have to attract more funding in other markets by offering more attractive conditions (see Camba-Mendez et al., 2016). Thus it is hard to say whether the AFC spread or the YTM spread is a more important determinant for loan rates, and both variables will be used in the estimation of Equation (3).

Table 7 shows the results of estimating Equation (3) with the YTM spread as funding cost indicator. As can be seen from the table, including the YTM spread variable does not change the results much with regard to NPLs. Again, the results in Annex III (Figure 9 and Figure 10) suggest that the results are relatively robust to alterations of the sample for the specifications with year-country fixed effects. It can therefore be concluded that the impact of NPLs on lending rates does not primarily result from higher funding costs. The impact of the YTM spread on lending rates is small and not statistically significant. This implies that the pass-through of the bank's idiosyncratic funding cost component (the component that affects all banks in a country is captured by the year-country fixed effects or the macroeconomic variables) to lending rates is very limited. The pass-through of risk premia of the sovereign – which is an important constituent of banks' funding costs, according to the results in Table 5 – is stronger than that of bank-specific premia.[16] This is in line with the findings of Harimohan et al. (2016) for the UK who find that the pass-through of changes in banks' CDS premia to

[16] At this point it must be kept in mind that for some single banks in the sample, the home country of the single bank itself and the banking group it belongs to do not match. This is the case for around 30% of the single bank observations. For those observations it is misleading to think of the sovereign spread as a component of the funding costs of the banking group. However, the overall picture does not change if only the single banks for which the home country matches that of the banking group they belong to are included in the estimation sample. On the other hand, if the sovereign spread referring to the banking groups' home country instead of the sovereign spread referring to the single banks' home country is used, its effect remains significant in the FE estimations but turns insignificant in the SysGMM estimations. This might indicate that the sovereign spread is not only an important driver of lending rates because it affects the banking groups' funding costs, but also because it affects the returns of potential investments other than loans.

lending rates is more complete when the change in CDS premia occurs for all banks. Consequently, the extent to which banks' lending rates are affected by their marginal funding costs (which are, according to Button et al., 2011 the banks' market funding costs) depends, inter alia, on the extent to which their marginal funding costs are driven by idiosyncratic factors.

## Table 6: Impact of NPLs on AFC spread (Equation 2)

**Dependent variable: AFC spread**

| | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
|---|---|---|---|---|---|---|---|---|
| AFC_Spread (-1) | 0.106 | 0.325 *** | 0.107 | 0.313 *** | 0.135 | 0.439 ** | 0.137 | 0.379 ** |
| **Gross_NPL_TA (-1)** | **0.048** * | **0.043** | | | **0.020** | **0.074** | | |
| **Net_NPL_TA (-1)** | | | **0.066** | **0.019** | | | **0.094** | **0.194** ** |
| **LL_Reserves_TA (-1)** | | | **0.018** | **0.033** | | | **-0.122** | **-0.241** * |
| Tier1_Ratio (-1) | -0.036 * | 0.045 | -0.035 * | 0.051 * | -0.022 | 0.003 | -0.020 | -0.009 |
| Liq_Ratio (-1) | 0.004 | 0.001 | 0.005 | 0.002 | 0.003 | -0.004 | 0.006 | -0.008 |
| ROA (-1) | -0.174 * | -0.275 *** | -0.178 * | -0.275 ** | -0.210 | -0.249 | -0.234 * | -0.276 * |
| GDP_growth | | | | | -0.070 ** | -0.044 | -0.060 | -0.047 |
| Unemployment Rate | | | | | 0.173 *** | 0.025 | 0.174 *** | 0.070 ** |
| Inflation | | | | | 0.162 | 0.100 | 0.164 | 0.122 |
| Change_Stock_Index | | | | | 0.003 | 0.002 | 0.004 | 0.005 |
| GovBond_Spread | | | | | 0.027 | 0.104 | 0.025 | 0.088 |
| Number of Observations | 453 | 453 | 453 | 453 | 479 | 479 | 479 | 479 |
| Number of Cross Sections | 60 | 60 | 60 | 60 | 64 | 64 | 64 | 64 |
| Number of Instruments | | 113 | | 118 | | 43 | | 48 |
| P_Hansen | | 1.0000 | | 1.0000 | | 0.0920 | | 0.1643 |
| P_AR2 | | 0.1468 | | 0.1519 | | 0.1187 | | 0.1714 |
| *Year fixed effects* | *no* | *no* | *no* | *no* | *yes* | *yes* | *yes* | *yes* |
| *Year*Country fixed effects* | *yes* | *yes* | *yes* | *yes* | *no* | *no* | *no* | *no* |
| *Controls for Maturity* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* |

***SysGMM: All banking group specific variables instrumented, instruments collapsed, only lags 2-5 used as instruments;***
***Estimations based on data from 2008-2017;***
******, ** and * indicate statistical significance at the 1%, 5%, and 10% level; assessment of significance based on robust standard errors.***

Table 8 shows the results of replacing the YTM spread by the AFC spread. As can be seen, there are some considerable changes in the result. In particular, the specifications with year-country fixed effects provide no more indications that net NPLs are related to higher lending rates. However, these changes are not primarily driven by the inclusion of the AFC spread variable, but by the altered sample, the size of which declines. As mentioned above, this decline is first and foremost caused by high-NPL banks. Removing these banks from the sample produces results similar to those in Table 8, also when the YTM spread is used as a funding cost proxy.

**Table 7: Impact of NPLs on lending rates, controlling for the YTM spread (Equation 3)**

**Dependent variable: Lending rate (loans to NFCs)**

| | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
|---|---|---|---|---|---|---|---|---|
| Lending-Rate (-1) | 0.351 *** | 0.626 *** | 0.348 *** | 0.648 *** | 0.494 *** | 0.800 *** | 0.493 *** | 0.754 *** |
| **Gross_NPL_TA (-1)** | **0.019** * | **0.011** | | | **-0.002** | **-0.028** ** | | |
| **Gross_NPL_TA(-1)*OIS** | **-0.003** | **0.009** | | | **-0.011** | **-0.020** | | |
| **Net_NPL_TA (-1)** | | | **0.026** | **0.110** ** | | | **-0.008** | **-0.025** |
| **LL_Reserves_TA (-1)** | | | **-0.004** | **-0.117** * | | | **0.017** | **0.008** |
| **Net_NPL_TA (-1)*OIS** | | | **0.006** | **-0.008** | | | **-0.022** | **-0.013** |
| **LL_Reserves_TA (-1)*OIS** | | | **-0.044** | **-0.045** | | | **0.030** | **0.011** |
| Tier1_Ratio (-1) | -0.006 | 0.010 | -0.005 | 0.006 | -0.010 | -0.019 | -0.011 | -0.019 |
| Liq_Ratio (-1) | 0.002 | -0.007 | 0.000 | -0.007 | -0.004 | -0.018 ** | -0.002 | -0.014 * |
| ROA (-1) | 0.008 | -0.038 | 0.003 | -0.062 | 0.068 * | -0.002 | 0.072 * | 0.026 |
| YTM_Spread_1_5 | 0.021 | 0.020 | 0.024 | 0.025 | 0.007 | 0.019 | 0.005 | 0.010 |
| GDP_growth | | | | | -0.003 | 0.012 | -0.003 | 0.015 |
| Unemployment Rate | | | | | 0.010 | -0.010 | 0.010 | -0.008 |
| Inflation | | | | | 0.058 | 0.017 | 0.052 | 0.022 |
| Change_Stock_Index | | | | | 0.003 | -0.002 | 0.003 | -0.003 |
| GovBond_Spread | | | | | 0.158 *** | 0.113 *** | 0.160 *** | 0.121 *** |
| Number of Observations | 826 | 826 | 826 | 826 | 821 | 821 | 821 | 821 |
| Number of Cross Sections | 143 | 143 | 143 | 143 | 138 | 138 | 138 | 138 |
| Number of Instruments | | 149 | | 159 | | 47 | | 57 |
| P_Hansen | | 1.0000 | | 1.0000 | | 0.1248 | | 0.1426 |
| P_AR2 | | 0.1900 | | 0.1129 | | 0.1352 | | 0.1250 |
| *Year fixed effects* | *no* | *no* | *no* | *no* | *yes* | *yes* | *yes* | *yes* |
| *Year*Country fixed effects* | *yes* | *yes* | *yes* | *yes* | *no* | *no* | *no* | *no* |
| *Controls for IR-Fixation* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* |

***SysGMM: All banking group specific variables except YTM spread instrumented, instruments collapsed, only lags 2-5 used as instruments;***
***Standard errors clustered on banking group (j) level;***
******, ** and * indicate statistical significance at the 1%, 5%, and 10% level.***

To sum up, the results presented in this section are somewhat ambiguous with regard to the relation between lending rates and NPLs. Results of estimating specifications with year-country fixed effects point to a positive relation between lending rates and net NPLs, while loan loss reserves tend to offset this positive relationship. When a set of macroeconomic variables is used instead, the results point to a negative relation – if any

– between lending rates and net NPLs. However, as specifications with year-country fixed effects capture all macroeconomic factors, they can be considered to be superior. Furthermore, it should be kept in mind that net NPLs and loan loss reserves are highly correlated, and results that include both variables might therefore change if additional observations are added.[17] The costs of market funding – captured by the spread of bond returns over a risk-free rate – only have a minor impact on the relation between lending rates and NPLs, although NPLs seem to affect funding costs. Yet the impact of the bank-specific funding costs on lending rates is too small for the former to be the main link between NPLs and lending rates.

Taken together, estimations with year-country fixed effects deliver a picture consistent with a situation where further expected losses stemming from NPLs make banks more reluctant to grant new loans. Of course, it cannot be ruled out that the relation between net NPLs and lending rates in fact mirrors borrower-related risk (a robustness check presented in Section 5.5 further deals with this issue). At the same time, the stock of NPLs could affect the risk tolerance of banks and could be relevant for their lending policies on account of an "institutional memory", a term coined by Berger and Udell (2004). According to the institutional memory hypothesis, dealing with a huge amount of problem loans maximizes the skills of loan officers, which then results in stricter lending policies (hence the stricter lending policies of banks with a high NPL stock are not the consequence of actual or expected losses). However, both explanations are difficult to reconcile with a situation in which only net NPLs are related to stricter lending policies, and loan loss reserves even tend to offset this relation.

[17] In a previous version of this paper (entitled "The role of non-performing loans in the transmission of monetary policy"), which was based on data up to 2016, the positive relation between net NPLs and lending rates was more robust than in this present version that also includes data from 2017.

**Table 8: Impact of NPLs on lending rates, controlling for the AFC spread (Equation 3)**

**Dependent variable: Lending rate (loans to NFCs)**

| | **FE** | **Sys GMM** | **FE** | **Sys GMM** | **FE** | **Sys GMM** | **FE** | **Sys GMM** |
|---|---|---|---|---|---|---|---|---|
| Lending-Rate (-1) | 0.364 *** | 0.595 *** | 0.364 *** | 0.590 *** | 0.487 *** | 0.754 *** | 0.489 *** | 0.743 *** |
| **Gross_NPL_TA (-1)** | **0.037** *** | **0.026** | | | **0.001** | **-0.019** | | |
| **Gross_NPL_TA(-1)*OIS** | **-0.005** | **0.009** | | | **-0.021** ** | **-0.005** | | |
| **Net_NPL_TA (-1)** | | | **0.022** | **0.034** | | | **-0.022** | **0.006** |
| **LL_Reserves_TA (-1)** | | | **0.057** | **0.019** | | | **0.045** | **-0.054** |
| **Net_NPL_TA (-1)*OIS** | | | **0.001** | **-0.009** | | | **-0.030** * | **-0.019** |
| **LL_Reserves_TA (-1)*OIS** | | | **-0.010** | **0.028** | | | **0.031** | **-0.002** |
| Tier1_Ratio (-1) | 0.002 | 0.014 | 0.002 | 0.015 | 0.007 | -0.002 | 0.004 | -0.002 |
| Liq_Ratio (-1) | 0.003 | -0.005 | 0.002 | -0.005 | -0.004 | -0.016 | -0.002 | -0.015 |
| ROA (-1) | -0.002 | -0.047 | 0.002 | -0.058 | 0.052 | -0.028 | 0.063 | -0.031 |
| AFC_Spread_1_5 | 0.029 | -0.017 | 0.030 | -0.018 | -0.021 | -0.004 | -0.020 | -0.006 |
| GDP_growth | | | | | 0.005 | 0.032 ** | 0.004 | 0.029 ** |
| Unemployment Rate | | | | | 0.016 | 0.001 | 0.017 | 0.002 |
| Inflation | | | | | 0.078 | 0.054 | 0.068 | 0.060 |
| Change_Stock_Index | | | | | 0.002 | -0.005 * | 0.002 | -0.005 |
| GovBond_Spread | | | | | 0.159 ** | 0.116 ** | 0.160 ** | 0.119 ** |
| Number of Observations | 714 | 714 | 714 | 714 | 710 | 710 | 710 | 710 |
| Number of Cross Sections | 130 | 130 | 130 | 130 | 125 | 125 | 125 | 125 |
| Number of Instruments | | 141 | | 151 | | 47 | | 57 |
| P_Hansen | | 1.0000 | | 1.0000 | | 0.1981 | | 0.139 |
| P_AR2 | | 0.1445 | | 0.1463 | | 0.1861 | | 0.1540 |
| *Year fixed effects* | *no* | *no* | *no* | *no* | *yes* | *yes* | *yes* | *yes* |
| *Year*Country fixed effects* | *yes* | *yes* | *yes* | *yes* | *no* | *no* | *no* | *no* |
| *Controls for IR-Fixation* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* |

***SysGMM: All banking group specific variables except AFC spread instrumented, instruments collapsed, only lags 2-5 used as instruments;***
***Standard errors clustered on banking group (j) level;***
*******, ** and * indicate statistical significance at the 1%, 5%, and 10% level.****

## 5.2 Differentiating according to loan size

This subsection sheds more light on whether the relations between lending rates and NPLs described above differ depending on whether small-scale loans (volume up to €1 million) or large-scale loans (volume above €1 million) are considered. The iMIR dataset contains information on lending rates for both categories. The estimations are based on Equation (3) with the YTM spread as funding cost indicator. As discussed above, the inclusion of the funding cost variable does not alter the estimation results much. However, it seems reasonable to take the funding costs into account in order to rule out any omitted variable problems; using Equation (3) as the starting point for robustness checks thus seems preferable to using Equation (1). The variant with the YTM spread is chosen, as using the AFC spread entails a sample selection bias that affects the results considerably (see Section 5.1).

Table 9 shows the results when only lending rates for small-scale loans (volume up to €1 million) and large-scale loans (volume above €1 million) are considered consecutively. The results indicate that there is no strong relationship between gross NPLs and lending rates for these loan subcategories. There is in turn a positive relation between net NPLs and lending rates, which tends to be offset by a negative relation between loan loss reserves and lending rates and which is more robust for large-scale loans. The latter finding is somewhat surprising, as Holton and McCann (2017) find that the spread between small and large-scale loans increases with rising NPL levels. Given this finding, one would have expected rates for small-scale loans to be more sensitive to the NPL stock.

**Table 9: Results for estimation of Equation (3) with alternative dependent variables**

| Modell | Gross_NPL_ TA (-1) | Gross_NPL_ TA(-1)*OIS | Net_NPL _ TA (-1) | LL_Res_ TA (-1) | Net_NPL_ TA(-1)*OIS | LL_Res_ TA(-1)*OIS |
|---|---|---|---|---|---|---|
| **Only loans with volume < €1 million** | | | | | | |
| **Year*country FE** | | | | | **N= 773** | |
| FE | 0.008 | 0.002 | 0.016 | 0.002 | -0.005 | 0.019 |
| SysGMM | 0.014 | 0.008 | 0.109 ** | -0.121 * | -0.022 | -0.047 |
| **Macro Variables** | | | | | **N= 769** | |
| FE | -0.013 | -0.017 ** | -0.020 | 0.008 | -0.026 | 0.022 |
| SysGMM | -0.032 ** | -0.017 | -0.064 | 0.055 | 0.004 | 0.006 |
| **Only loans with volume > €1 million** | | | | | | |
| **Year*country FE** | | | | | **N= 715** | |
| FE | 0.015 | -0.001 | 0.056 *** | -0.050 * | -0.007 | -0.039 |
| SysGMM | 0.011 | 0.015 | 0.096 * | -0.116 * | 0.014 | -0.061 |
| **Macro Variables** | | | | | **N= 723** | |
| FE | 0.001 | -0.009 | 0.032 * | -0.030 | -0.037 ** | 0.041 |
| SysGMM | -0.024 | -0.008 | 0.026 | -0.073 | -0.008 | -0.022 |

## 5.3 Loans for house purchase

Table 10 shows the results of estimating Equation (3) when the rates for loans to NFCs are replaced by rates for loans for house purchase. Contrary to when lending rates for loans to NFCs are being considered, there is no evidence for a positive impact of gross NPLs in the FE specifications with year-country fixed effects. The evidence for a positive relation between net NPLs and lending rates in the SysGMM specification remains, whereby there is also some evidence that a higher stock of loan loss reserves dampens the interest rates pass-through. No evidence for a relation between NPLs and lending rates emerges for the specifications with a set of macroeconomic variables in the right panel of the table.

**Table 10: Impact of NPLs on lending rates for loans for house purchase, controlling for the YTM spread (Equation 3)**

**Dependent variable: Lending rate (loans for house purchase)**

| | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM | FE | Sys GMM |
|---|---|---|---|---|---|---|---|---|
| Lending-Rate (-1) | 0.386 *** | 0.607 *** | 0.383 *** | 0.648 *** | 0.446 *** | 0.657 *** | 0.445 *** | 0.613 *** |
| **Gross_NPL_TA (-1)** | **0.008** | **0.002** | | | **-0.007** | **-0.005** | | |
| **Gross_NPL_TA(-1)*OIS** | **-0.008** | **-0.024** | | | **-0.003** | **-0.001** | | |
| **Net_NPL_TA (-1)** | | | **0.006** | **0.089** ** | | | **-0.001** | **0.059** |
| **LL_Reserves_TA (-1)** | | | **0.005** | **-0.115** ** | | | **-0.009** | **-0.075** |
| **Net_NPL_TA (-1)*OIS** | | | **-0.003** | **-0.028** | | | **-0.011** | **-0.027** |
| **LL_Reserves_TA (-1)*OIS** | | | **-0.026** | **-0.107** * | | | **0.017** | **0.014** |
| Tier1_Ratio (-1) | 0.000 | 0.014 | 0.001 | 0.013 | 0.013 | -0.001 | 0.013 | -0.004 |
| Liq_Ratio (-1) | 0.003 | 0.007 | 0.002 | 0.003 | 0.002 | 0.003 | 0.003 | 0.006 |
| ROA (-1) | 0.046 | 0.001 | 0.045 | -0.012 | 0.034 | -0.013 | 0.034 | 0.003 |
| YTM_Spread_1_5 | 0.019 | 0.031 | 0.019 | 0.029 | 0.001 | 0.026 | 0.001 | 0.026 |
| GDP_growth | | | | | 0.010 | 0.026 *** | 0.009 | 0.015 |
| Unemployment Rate | | | | | 0.075 *** | 0.007 | 0.074 *** | 0.011 ** |
| Inflation | | | | | 0.195 *** | 0.137 *** | 0.193 *** | 0.159 *** |
| Change_Stock_Index | | | | | 0.000 | -0.002 | 0.000 | -0.001 |
| GovBond_Spread | | | | | 0.048 | 0.071 *** | 0.048 | 0.060 ** |
| Number of Observations | 697 | 697 | 697 | 697 | 696 | 696 | 696 | 696 |
| Number of Cross Sections | 117 | 117 | 117 | 117 | 114 | 114 | 114 | 114 |
| Number of Instruments | | 146 | | 156 | | 47 | | 57 |
| P_Hansen | | 1.0000 | | 1.0000 | | 0.0571 | | 0.1475 |
| P_AR2 | | 0.1684 | | 0.1147 | | 0.1422 | | 0.5106 |
| *Year fixed effects* | *no* | *no* | *no* | *no* | *yes* | *yes* | *yes* | *yes* |
| *Year*Country fixed effects* | *yes* | *yes* | *yes* | *yes* | *no* | *no* | *no* | *no* |
| *Controls for IR-Fixation* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* | *yes* |

***SysGMM: All banking group specific variables except YTM spread instrumented, instruments collapsed, only lags 2-5 used as instruments;***
***Standard errors clustered on banking group (j) level;***
****, ** and * indicate statistical significance at the 1%, 5%, and 10% level.***

## 5.4 Loan growth

Instead of lending rates, the effect of NPLs on loan growth can be assessed. If banks do indeed react to a high stock of net NPLs by restricting loan supply, this effect should also be visible when looking at quantities rather than prices. Table 11 shows the results of estimating Equation (3) when lending rates are replaced by loan growth[18] for both loans to NFCs and loans for house purchase. In the case of loans to NFCs, the lagged endogenous variable is never significant,[19] thus it is removed from the estimations. The equation is hence estimated with standard fixed effects (FE). In the case of loans for house purchase, the lagged endogenous variable has explanatory power, so it is kept in the model and the SysGMM approach is employed.

As can be seen from the table, higher net NPLs do indeed seem to be accompanied by lower NFC loan growth, whereby this effect again tends to be offset by loan loss reserves.[20] This finding is what would be expected if anticipated further losses from net NPLs do in fact make banks more reluctant to grant new loans. Similarly to the results for the investigation of lending rates, this outcome only occurs if macroeconomic factors are captured via year-country fixed effects, and no significant relation between net NPLs and loan growth is observed when macroeconomic variables and year fixed effects are used instead. Furthermore, such a significant relation cannot be detected in the case of loans for house purchase.

[18] The latter is calculated as the sum of monthly flows in the respective year divided by the stock in December of the previous year.
[19] This holds for FE estimations as well as for SysGMM estimations.
[20] However, the statistically significant relation between net NPLs and NFC loan growth disappears when a lagged value of NFC loan growth is added and the SysGMM approach is used.

**Table 11: Results for estimations of Equation (3) with loan growth as dependent variable**

**Dependent variable: Loan Growth**

| | Loans to NFCs | | | | Loans for house purchase | | | |
|---|---|---|---|---|---|---|---|---|
| | FE | FE | FE | FE | Sys GMM | Sys GMM | Sys GMM | Sys GMM |
| Loan Growth (-1) | | | | | 0.378 *** | 0.329 *** | 0.400 *** | 0.352 *** |
| **Gross_NPL_TA (-1)** | **-0.424** | **-0.365** | | | **0.197** | **0.055** | | |
| **Gross_NPL_TA(-1)*OIS** | **-0.229** | **-0.082** | | | **-0.502** | **-0.208** | | |
| **Net_NPL_TA (-1)** | | | **-1.385** *** | **-0.905** | | | **0.366** | **0.102** |
| **LL_Reserves_TA (-1)** | | | **1.136** * | **0.819** | | | **-0.549** | **-0.494** |
| **Net_NPL_TA (-1)*OIS** | | | **-0.102** | **-0.280** | | | **0.290** | **0.880** |
| **LL_Reserves_TA (-1)*OIS** | | | **0.709** | **1.285** | | | **-1.649** * | **-2.315** * |
| Tier1_Ratio (-1) | 0.015 | 0.018 | -0.017 | -0.010 | 0.412 | 0.027 | 0.540 | 0.035 |
| Liq_Ratio (-1) | 0.418 *** | 0.273 * | 0.461 *** | 0.344 ** | -0.034 | -0.029 | -0.052 | -0.040 |
| ROA (-1) | 0.088 | -0.076 | 0.344 | 0.142 | 1.235 | 0.895 | 0.477 | 0.277 |
| YTM_Spread_1_5 | 0.306 | -0.233 | 0.183 | -0.331 | -0.477 | -0.558 | -0.129 | -0.298 |
| GDP_growth | | -0.030 | | -0.047 | | -0.470 | | -0.489 |
| Unemployment Rate | | -0.598 * | | -0.566 * | | 0.171 | | 0.231 |
| Inflation | | -0.865 | | -1.122 | | 0.960 | | 1.071 |
| Change_Stock_Index | | -0.030 | | -0.038 | | 0.052 | | 0.065 |
| GovBond_Spread | | -0.064 | | -0.020 | | -0.226 | | -0.393 |
| Number of Observations | 891 | 881 | 891 | 881 | 793 | 789 | 793 | 789 |
| Number of Cross Sections | 142 | 137 | 142 | 137 | 135 | 130 | 135 | 130 |
| Number of Instruments | | | | | 144 | 44 | 154 | 54 |
| P_Hansen | | | | | 1.0000 | 0.7072 | 1.0000 | 0.7128 |
| P_AR2 | | | | | 0.1325 | 0.5403 | 0.1224 | 0.5188 |
| *Year fixed effects* | *no* | *yes* | *no* | *yes* | *no* | *yes* | *no* | *yes* |
| *Year*Country fixed effects* | *yes* | *no* | *yes* | *no* | *yes* | *no* | *yes* | *no* |

***SysGMM: All banking group specific variables except YTM spread instrumented, instruments collapsed, only lags 2-5 used as instruments;***
***Standard errors clustered on banking group (j) level;***
*******, ** and * indicate statistical significance at the 1%, 5%, and 10% level.****

## 5.5 Robustness

This section presents the results of some alternative specifications of the estimations discussed in Section 5, as well as results based on restricted samples. The alternative specifications are again all based on Equation (3) with the YTM spread as funding cost indicator. Table 12 shows the results of estimating several variations of Equation (3).

The first panel restates the results from the benchmark model in the previous section for convenience. The structure of the table is the same as in subsection 5.2.

The first robustness check takes a more direct measure of credit risk faced by the respective iMIR single bank *i* into account in order to figure out the extent to which the relation between NPLs and lending rates is driven by the time-varying riskiness of the borrowers the bank is lending to. For this reason, the loan loss provisions (lagged by one period like all the other banking group-specific variables) from the profit and loss statement on the level of the single bank *i* are added to the estimation. This variable is meant to capture the time-varying component of the credit risk of the bank borrowers which is not captured by bank fixed effects. The inclusion of this variable entails a reduction in sample size, as the additional variable is not available for all single banks (in fact, it is never available when the iMIR single bank *i* is a foreign branch). Despite the smaller sample, the results are qualitatively similar to those from the benchmark specification. This indicates that time-varying credit risk is not the main driver of the positive relation between net NPLs and lending rates, which is suggested by the results of the specifications with year-country fixed effects. However, the positive relation between gross NPLs and lending rates, which can be detected in the benchmark estimations for the FE specifications with year-country fixed effects, weakens somewhat and is no longer statistically significant.

Next, the dependent variable is altered. Instead of the lending rate as reported by the banks, the spread over an OIS rate is used. The maturity the OIS rate refers to is bank-specific and is selected according to the average interest rate fixation period of the newly granted loans to NFCs in the respective year. Again, the results are largely unchanged, with the exception that SysGMM specifications indicate some associations between NPLs and the speed of the interest rate pass-through. Another variation consists of replacing the RWA-based regulatory Tier 1 ratio by the leverage ratio, calculated as equity according to the balance sheet divided by total assets. Again, as can be seen from Table 12, the results do not change much. Next, the deposit rate[21] of single bank *i* is added as an explanatory variable. As described in Section 2, there are good reasons to focus on the costs of market funding as funding cost proxy; however, it could still be argued that including deposit rates is warranted as deposits constitute an important source of funding for most sampled banks. As information on deposit rates is taken from the iMIR dataset, it is measured on the level of the single bank *i*, not on the

[21] The deposit rate considered is a volume-weighted average of rates on overnight deposits and rates on deposits with an agreed maturity of up to one year. Both deposits held by households and by NFCs are taken into account.

level of the banking group $j$. The inclusion of deposit rates does not markedly alter the results with regard to the relation between NPLs and lending rates.

Table 12 also shows the results of estimating Equation (3) when the sample is restricted to observations that fulfil certain criteria. The second panel shows the results produced when the sample is restricted to banks for which the banking group $j$ is located either in Cyprus, Greece, Italy, Portugal or Spain. All these countries were severely hit by the sovereign debt crisis and exhibited negative or only slightly positive average GDP growth over the sample period. The rationale behind this approach is that the development of NPL stocks in these countries is likely to be dominated by flows generated by performing loans that became non-performing, and to a lesser extent, by other factors such as write-off policies. As can be seen from the results in Table 12, in the specifications with year-country fixed effects, the coefficient related to the gross NPL and net NPL variables tends to become more positive and the offsetting impact of loan loss reserves gets weaker. However, caution is warranted as the sample size shrinks considerably.

The next panel of the table displays the results that are generated when the sample is restricted to single banks that operate in the country which is also the home country of the banking group they belong to.[22] In this case, one might argue that year-country fixed effects not only capture macroeconomic factors (including loan demand), but also differences in NPL definitions between countries and over time as the respective country refers simultaneously to the home country of the single bank $i$ and the home country of the banking group $j$, which constitutes the level on which NPLs are measured. Besides the stronger impact of net NPLs and the impact of loan loss reserves on the speed of the interest rate pass-through in the FE specification with year-country fixed effects, the results are largely in line with those of the benchmark model.

By and large, the robustness checks indicate that the results from the benchmark model shown in the previous section are relatively robust with regard to the relation between net NPLs and lending rates: there is a positive and mostly significant relation between both variables when year-country fixed effects are used. This relation vanishes when time-country fixed effects are replaced by macroeconomic variables and time fixed effects. By contrast, the relation between gross NPLs and lending rates is not clear-cut. Furthermore, the interaction between gross NPLs and the OIS rate barely seems to be relevant.

[22] This criterion is obviously also met for independent single banks that do not belong to a banking group.

**Table 12: Results for estimations of Equation (3) with alternative specifications and samples**

| Modell | Gross_NPL_ TA (-1) | Gross_NPL_ TA(-1)*OIS | Net_NPL _ TA (-1) | LL_Res_ TA (-1) | Net_NPL_ TA(-1)*OIS | LL_Res_ TA(-1)*OIS |
|---|---|---|---|---|---|---|
| **Benchmark** | | | | | | |
| | **Year*country FE** | | | | **N= 826** | |
| FE | 0.019 * | -0.003 | 0.026 | -0.004 | 0.006 | -0.044 |
| SysGMM | 0.011 | 0.009 | 0.110 ** | -0.117 * | -0.008 | -0.045 |
| | **Macro Variables** | | | | **N= 821** | |
| FE | -0.002 | -0.011 | -0.008 | 0.017 | -0.022 | 0.030 |
| SysGMM | -0.028 ** | -0.020 | -0.025 | 0.008 | -0.013 | 0.011 |
| **Including Provisions over Gross Loans for i** | | | | | | |
| | **Year*country FE** | | | | **N= 623** | |
| FE | 0.015 | 0.011 | 0.031 * | -0.028 | 0.050 *** | -0.093 * |
| SysGMM | 0.021 | 0.004 | 0.097 *** | -0.092 * | 0.027 | -0.095 |
| | **Macro Variables** | | | | **N= 637** | |
| FE | -0.005 | -0.013 | 0.000 | 0.004 | -0.042 | 0.062 |
| SysGMM | -0.025 * | -0.027 | 0.018 | -0.050 | -0.014 | -0.018 |
| **Loan rate spread over relevant OIS-swap rate** | | | | | | |
| | **Year*country FE** | | | | **N= 824** | |
| FE | 0.018 * | -0.006 | 0.022 | -0.002 | 0.005 | -0.054 |
| SysGMM | 0.033 *** | 0.025 | 0.081 ** | -0.033 | -0.047 ** | 0.133 ** |
| | **Macro Variables** | | | | **N= 819** | |
| FE | -0.002 | -0.007 | -0.016 | 0.030 | -0.016 | 0.036 |
| SysGMM | 0.017 * | 0.023 ** | 0.032 | -0.004 | -0.039 | 0.128 * |
| **Leverage Ratio** | | | | | | |
| | **Year*country FE** | | | | **N= 847** | |
| FE | 0.018 * | -0.002 | 0.022 | 0.001 | 0.006 | -0.039 |
| SysGMM | 0.024 | 0.028 | 0.135 ** | -0.130 * | -0.023 | -0.004 |
| | **Macro Variables** | | | | **N= 841** | |
| FE | -0.001 | -0.011 | -0.010 | 0.023 | -0.023 | 0.036 |
| SysGMM | -0.019 | -0.010 | -0.004 | 0.004 | -0.023 | 0.042 |
| **Including Deposit rate (i)** | | | | | | |
| | **Year*country FE** | | | | **N= 825** | |
| FE | 0.012 | 0.002 | 0.030 * | -0.018 | 0.001 | -0.023 |
| SysGMM | 0.033 ** | 0.027 | 0.124 ** | -0.103 | -0.021 | 0.034 |
| | **Macro Variables** | | | | **N= 819** | |
| FE | -0.001 | 0.000 | 0.000 | 0.009 | -0.028 | 0.044 |
| SysGMM | -0.012 | -0.006 | -0.003 | 0.016 | -0.025 | 0.057 |

**Table 12 continued**

| Modell | Gross_NPL_ TA (-1) | Gross_NPL_ TA(-1)*OIS | Net_NPL _ TA (-1) | LL_Res_ TA (-1) | Net_NPL_ TA(-1)*OIS | LL_Res_ TA(-1)*OIS |
|---|---|---|---|---|---|---|
| **Only weak growth country** | | | | | | |
| | | **Year*country FE** | | | **N= 267** | |
| FE | 0.042 | 0.035 | 0.068 ** | 0.013 | 0.074 | -0.022 |
| SysGMM | 0.052 | 0.090 | 0.114 * | -0.017 | 0.023 | 0.158 |
| | | **Macro Variables** | | | **N= 296** | |
| FE | 0.011 | 0.000 | 0.009 | 0.019 | 0.033 | -0.047 |
| SysGMM | -0.004 | -0.022 | -0.029 | 0.049 | -0.006 | -0.004 |
| **Only if i and j from same country** | | | | | | |
| | | **Year*country FE** | | | **N= 562** | |
| FE | 0.015 | -0.002 | 0.040 *** | -0.037 | 0.010 | -0.077 * |
| SysGMM | 0.014 | 0.030 | 0.108 ** | -0.106 * | 0.027 | -0.074 |
| | | **Macro Variables** | | | **N= 598** | |
| FE | 0.000 | 0.000 | 0.018 | -0.018 | -0.026 | 0.029 |
| SysGMM | -0.024 * | -0.013 | 0.008 | -0.027 | -0.007 | 0.017 |

# 6 Conclusion

The present paper attempts to shed more light on the relation between the stock of non-performing loans of a bank and the lending rates it charges for newly-granted loans. The results indicate that the relation between the gross NPL stock and lending rates is not clear-cut. Splitting the gross NPL stock into net NPLs and loan loss reserves reveals a positive relation between net NPLs and lending rates in specifications which implicitly control for all macroeconomic determinants by means of year-country fixed effects. This positive relation is, however, largely offset by a negative relation between loan loss reserves and lending rates. It must be kept in mind that net NPLs and loan loss reserves are highly correlated, which might render the results of the estimations in which both variables serve as regressors rather unstable if new observations are added, although they do not seem to be overly sensitive to variations within the present sample. The pass-through of market rates to lending rates does not seem to be strongly affected by NPLs.

The positive relation between net NPLs and lending does not seem to be caused by higher idiosyncratic funding costs. In fact, a high stock of NPLs seems to entail higher funding costs, but the impact of bank-specific funding costs on lending rates is too weak for funding costs to be the main channel through which net NPLs affect lending rates.

As in all estimations throughout the paper the banks' capital ratios are controlled for, the NPL variable(s) capture effects beyond losses already caused by the creation of loan loss reserves and already incorporated into banks' capital. The finding that there seems to be a positive relation between lending rates and net NPLs, but not between lending rates and loan loss reserves, is compatible with net NPLs being a source of anticipated future losses. If banks consider a high stock of net NPLs to potentially pose a hindrance to the build-up of capital in future, NPLs might have the same impact on lending policies as actual capital shortages. Although a relation between (actually reported) bank capital and lending can barely be found in the present paper, other studies have found capital shortages – either caused by low capital or by tightening regulatory requirements – to entail cuts in bank lending. The positive relation between lending rates and net NPLs may therefore be thought of as a leftward shift of the credit supply curve. An alternative interpretation is that banks shift the composition of their borrower portfolio towards riskier borrowers who can be charged higher risk premia and "gamble for resurrection".

To sum up, the results suggest that on the single bank level, net NPLs lead to a higher mark-up over market rates (at least in situations in which the overall coverage of NPLs with loan loss reserves is particularly low), but do not alter the sensitivity of lending rates to market rates (the evidence is rather weak, at least). It could therefore be argued that the drop in lending rates induced by an expansionary monetary policy measure is of the same magnitude for a bank with a high net NPL stock and a bank with a low net NPL stock. However, due to the higher mark-up, the lending rate of the high NPL stock bank will be higher. Such a mark-up might be problematic at the zero lower bound when a further expansionary stimulus cannot be easily achieved, but lending rates are still too high from a monetary policy perspective. Of course, when drawing conclusions with regard to monetary policy from the present results, it must be kept in mind that the analysis is focused on the single bank level and takes macroeconomic conditions on the country level as given. It is thus implicitly assumed that the impact of NPLs held by a particular bank will be reflected in the lending rates of that particular bank only. Potential spillovers of the NPL stock of one bank to macroeconomic aggregates are neglected, but might be important for the overall effect of NPLs, which is ultimately what matters for monetary policy.

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# Annex I: Bankscope (BS) and SNL data

Balance sheet information is taken from two different sources: Bankscope (BS) (ORBIS Bank Focus since 2017) and SNL (now S&P Global Market Intelligence). After merging the different data sources, there are slightly more observations with information for all variables if SNL data is used compared with when BS data is used. Thus, where available, SNL data is employed.[23]

Values for similar balance sheet items for the same bank and the same period are not necessarily identical in BS and SNL. This is due to the fact that exact definitions of the item might differ between both data sources (e.g. impaired loans vs. non-performing loans or ignoring vs. taking into account floors in the calculation of RWAs). For observations for which information is missing in SNL but is available in BS, the following procedure is applied for each variable:

- If information in SNL is missing in one year, but is available in BS and available in SNL in the previous and in the following year, the SNL value is calculated as:

  $$SNL_t = SNL_{t-1} + (SNL_{t+1} - SNL_{t-1}) * \frac{BS_t - BS_{t-1}}{BS_{t+1} - BS_{t-1}}$$

  It is thus assumed that the change from *t-1* to *t* in the SNL value is equal to the change from *t-1* to *t+1* times the ratio of the change in the BS value observed from *t-1* to *t* over the change from *t-1* to *t+1*.
- If information in SNL is missing for at least one year, but there is information from both sources BS and SNL for at least four different years, the SNL values for years for which only BS values are available are imputed using the forecast of a single regression of the SNL variable on a constant and the BS variable

[23] Before merging SNL and BS data, BS and ORBIS data were merged following the same procedure described below for SNL and BS data, with BS data taking the "role" of SNL data and ORBIS data taking the "role" of BS data.

using exclusively observations for the respective banking group, if the $R^2$ of this regression is above 95%.

- If information is available in BS but not in SNL for at least 10 observations for banking groups from a single country, and at the same time there are at least 20 observations for which information from both sources is available for banking groups from this country, the SNL variable is regressed on a constant and the BS variable using exclusively observations from the respective country and the SNL values are forecasted based on the regression results for observations, for which only the BS value is available. If the $R^2$ of the regression is above 70%, the SNL values are deleted entirely and replaced by the forecasted values for banking groups from the respective country, for which there are more observations in BS than in SNL. This procedure ensures that the dynamics of the variable over time on the banking group level are only driven by either the SNL or the BS values. However, to ensure some consistency over different banking groups, it seems advisable not to use the "raw" BS values (although systematic differences between banking groups would be eliminated by the usage of fixed effects in the econometric specifications).

# Annex II: Calculation of the AFC and YTM spreads based on CSDB data

In order to preserve some degree of homogeneity, not all debt instruments for which the CSDB provides information are used to calculate the AFC (actual funding cost) and YTM (yield to maturity) spreads. More specifically, the underlying sample is restricted to straight bonds, euro medium-term notes, certificates of deposit and euro commercial paper, and excludes convertible bonds and bonds with warrants attached. Furthermore, it is restricted to instruments with a fixed or zero interest rate and with a fixed maturity. Instruments that are explicitly labelled as secured or as being guaranteed by the government are also excluded. However, instruments for which this information is missing are retained; hence it cannot be ruled out that some secured or government-guaranteed instruments remain in the sample.

The YTM spread for a certain month is calculated for every instrument that meets the above-mentioned criteria. First, the spread between the YTM and the OIS rate referring to the duration in years closest to the residual maturity of the instrument is computed.

This is done for all instruments for which the YTM, based on the actual market price, is available for the respective month. Instruments with an exceptionally low or high spread (lower than -500 bps or higher than 1500 bps) are removed from the sample. Subsequently, spreads are aggregated at the bank level by computing averages weighted by the outstanding amount. The YTM spread is exclusively based on those instruments for which actual market prices have been observed. The AFC spread for a certain month is calculated for every instrument that meets the above-mentioned criteria and was issued in the respective month. On the instrument level, the spread is computed as the difference between the coupon and the OIS rate referring to the duration in years closest to the original maturity of the instrument. Instruments with an exceptionally low or high spread (lower than -500 bps or higher than 1500 bps) are again removed from the sample. Then the spreads are aggregated on the bank level by computing averages weighted by the issued amount.

The first month for which CSDB data is available is 2009m4. A lot of YTM information in this month refers to 2009m3, so this is the first month for which the YTM spread is available for most of the banks. The AFC spread in turn is also available for earlier periods as it is linked to the issue date of the instrument, which might be prior to 2009m3 as the CSDB covers all instruments outstanding at the month of data collection.

The impact of the risk-free yield curve is eliminated by considering spreads instead of coupons and YTMs. However, it is likely that the spread over a risk-free rate will also depend on the maturity of the instrument. Thus the spreads are calculated separately for each point in time for instruments from three different maturity buckets (residual maturity for the YTM spread, original maturity for the AFC spread): up to 1 year, 1-5 years and over 5 years. These buckets correspond to the interest rate fixation periods for which data is available in the iMIR dataset. The spread referring to the 1-5 year bucket is used in the subsequent analysis as most observations are available for this bucket in the CSDB data. In the case of banks for which there are no instruments in the 1-5 year bucket in a given month, but there are in other buckets, the 1-5 year spread is computed as follows for both YTM and AFC:

- The average difference in the spread between the 1-5 year bucket and the 5+ year bucket and the 1 year bucket is calculated at the bank level for banks for which spreads in both buckets are available.
- The average differences are calculated separately for different time periods and for each time period separately for vulnerable and non-vulnerable countries. The time periods are:

    - 2009m3-2010m12
    - 2011m1-2012m12
    - 2013m1-2017m12
- Subsequently, for all banks for which only spreads in the 5+ and / or the 1 year bucket are available in a certain month, the 1-5 year spread is computed as the sum of the observed 5+ or 1 year spread and the average difference computed based on all banks for which spreads in both buckets are observed.

Finally, both the AFC and the YTM spreads for the 1-5 year are aggregated on a yearly basis by calculating the unweighted average over all months for which observations are available.

## Annex III: Stability of estimated coefficients related to net NPLs and loan loss reserve variables

In order to check the stability of the coefficients related to the net NPL variable and the loan loss reserves variable, the estimations for which the results are presented in Section 5 have been repeated with altering samples. Altering samples is achieved by randomly picking 10 banking groups and subsequently removing all observations referring to single banks that are part of one of those 10 banking groups. In this way, 1,000 different samples are generated for each specification, on the basis of which the estimation is then conducted. The 1,000 different estimators for both variables are depicted in kernel density plots below for the FE and SysGMM specifications.

The outputs are each depicted in two separate graphs: the left graph displays the density of coefficients referring to the net NPL and loan loss reserve variable in levels. The right graph shows the density of the differences between both coefficients for each sample alteration. The left graph depicting both densities allows conclusions to be drawn on whether the respective coefficient remains systematically above / below zero when the underlying sample is altered and, hence, whether possible significant results stated in the main text are confirmed. The right graph facilitates conclusions on whether the coefficient referring to one variable lies systematically above / below the coefficient referring to the other variable.

## Equation (1):

**Figure 3: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE (time*country FE, related to Table 4, left panel)**

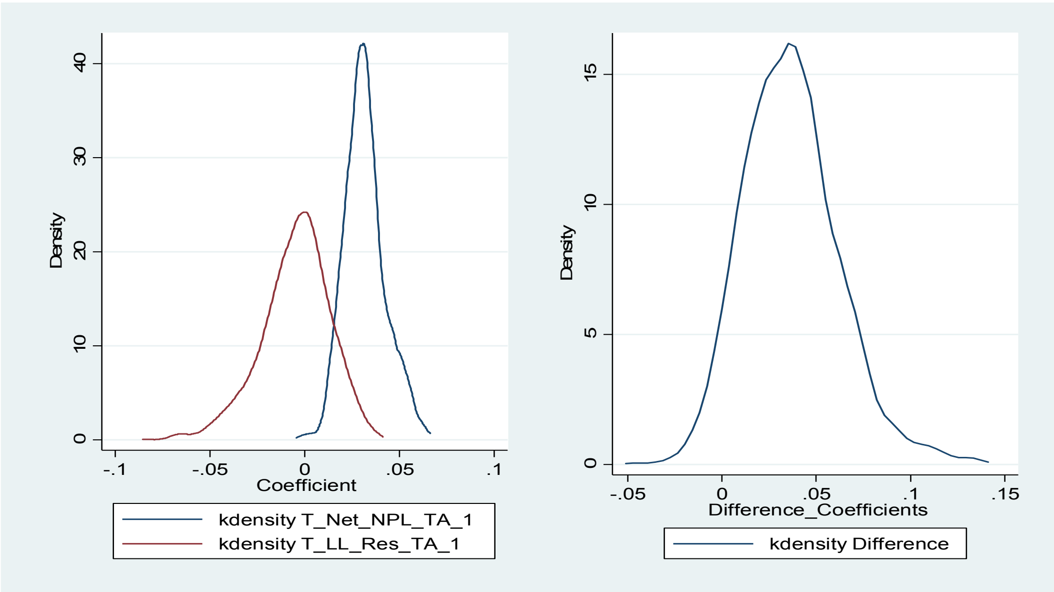
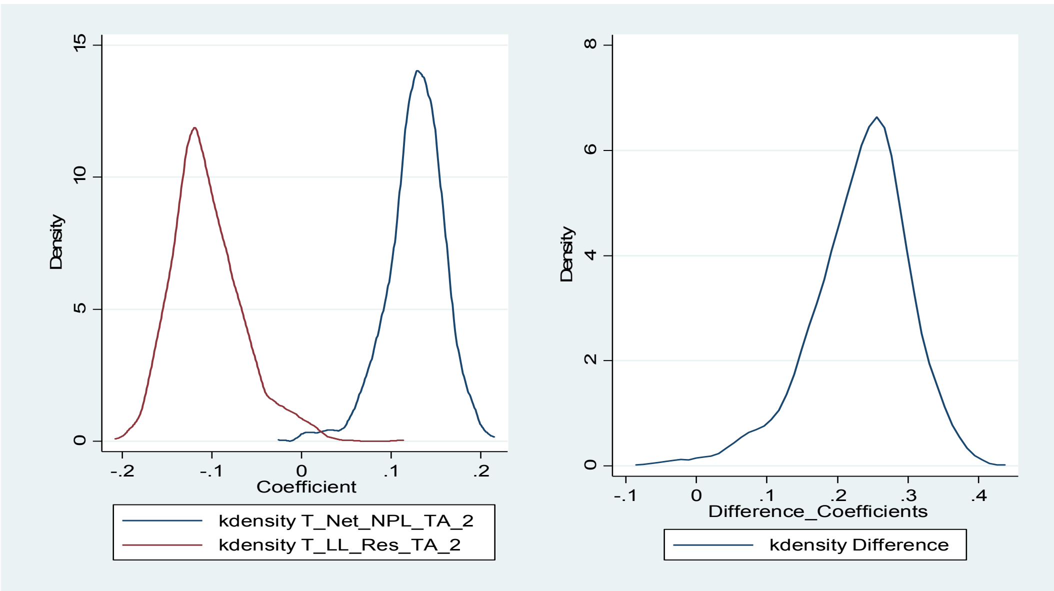



**Figure 4: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM (time*country FE, related to Table 4, left panel)**



**Equation (2):**

**Figure 5: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE with YTM spread as dependent variable (time*country FE, related to Table 5, left panel)**

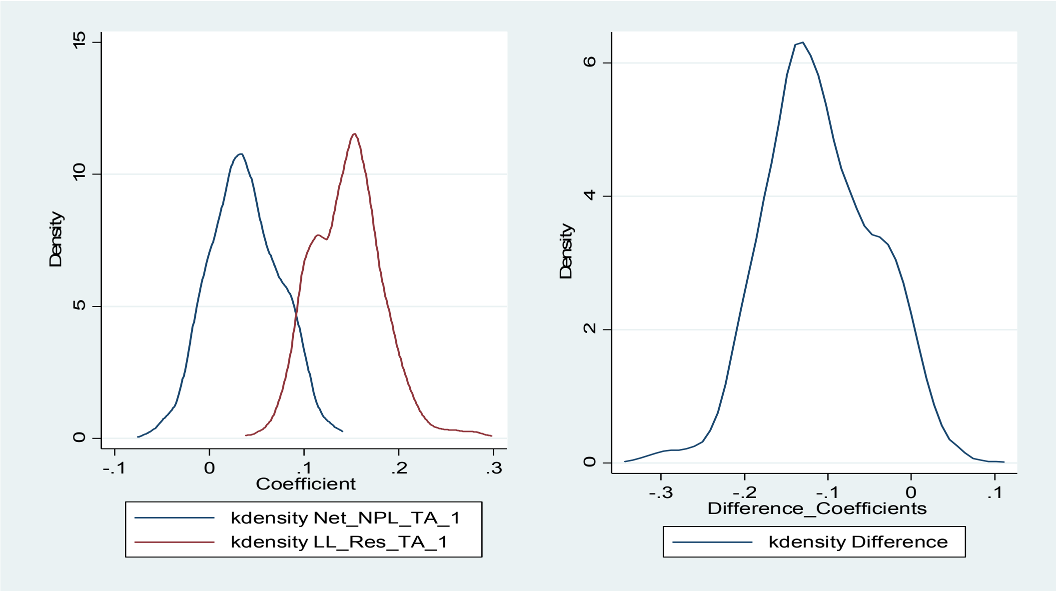



**Figure 6: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM with YTM spread as dependent variable (time*country FE, related to Table 5, left panel)**

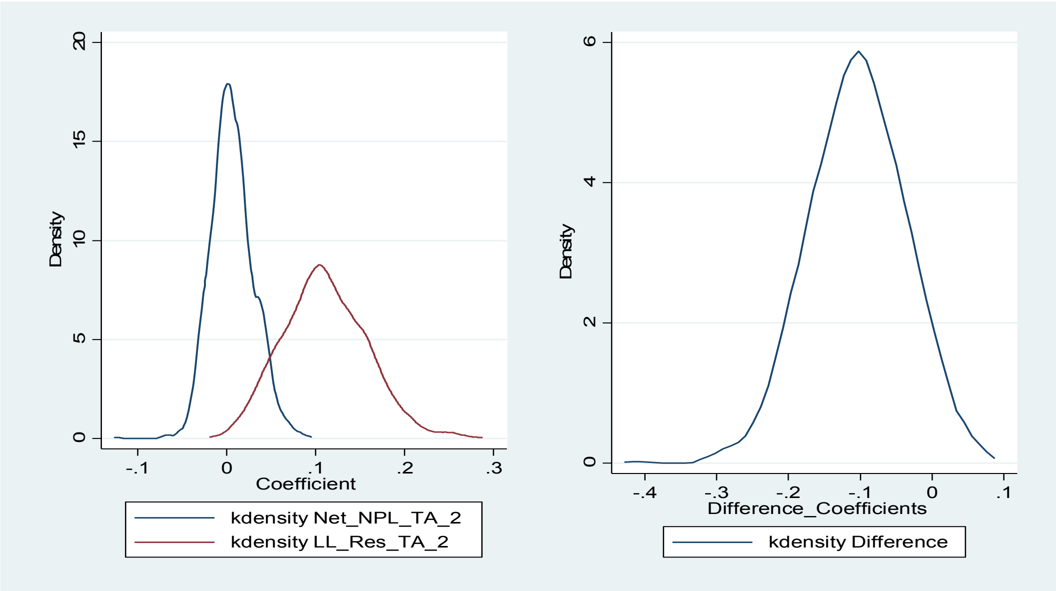


**Figure 7: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE with YTM spread as dependent variable (macroeconomic variables, related to Table 5, right panel)**

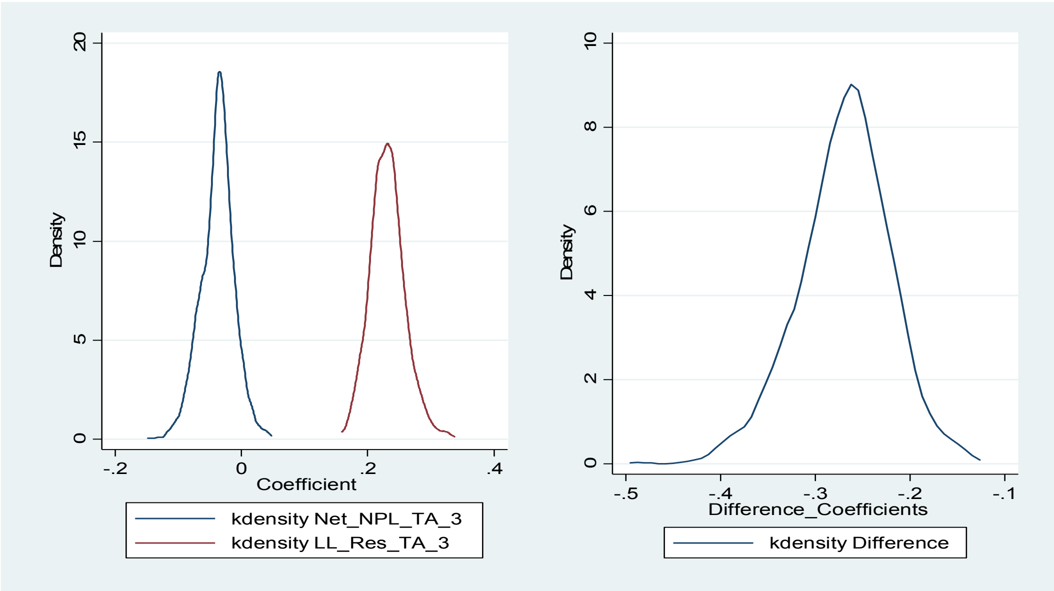
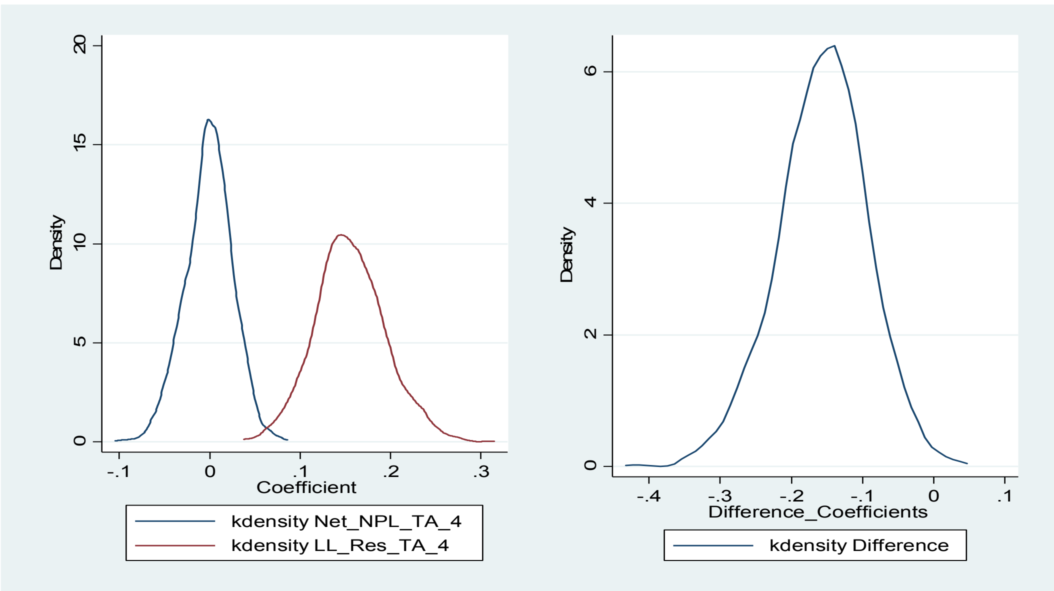



**Figure 8: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM with YTM spread as dependent variable (macroeconomic variables, related to Table 5, right panel)**



## Equation (3):

**Figure 9: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE (time*country FE, related to Table 7, left panel)**

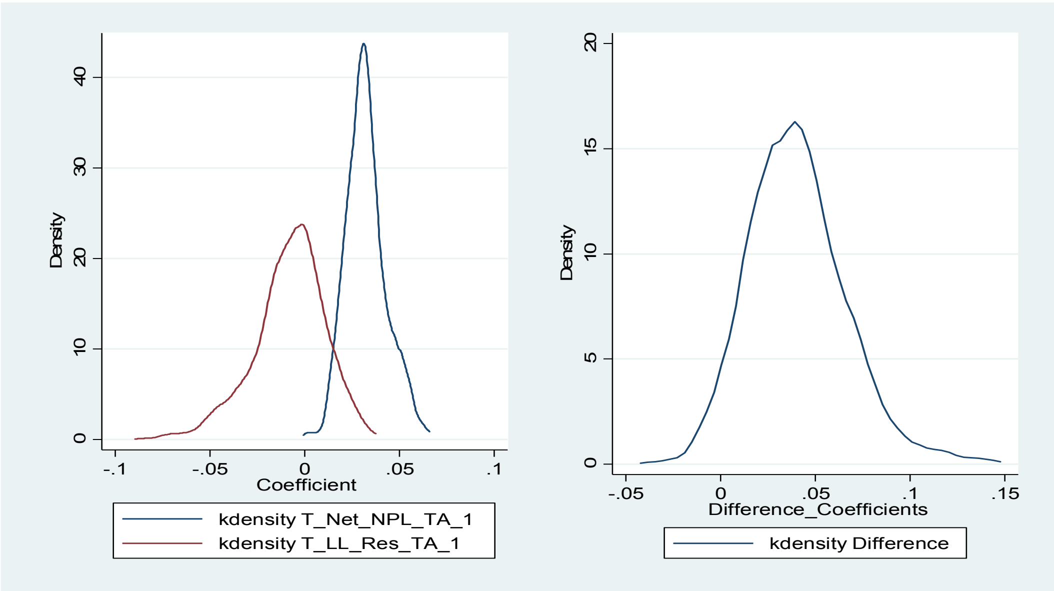



**Figure 10: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM (time*country FE, related to Table 7, left panel)**