The role of non-performing loans in the transmission of monetary policy[1]

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Abstract

Against the backdrop of a strong increase in the stock of non-performing loans in the several European countries, this paper investigates the role of non-performing loans (NPLs) for lending rates charged for newly granted loans in the euro area. More precisely, it looks for an effect that goes beyond losses linked to that stock that are already incorporated in the banks' capital positions. Furthermore, this paper considers the importance of funding costs as a potential link between the NPL stock and lending rates. The results indicate that a higher stock of net NPLs comes along with higher lending rates. Although the NPL stock also affects banks' idiosyncratic funding costs, the latter do not seem to constitute the main link between the NPL stock and lending rates. The strength of the pass-through from market rates to lending rates barely seems to be affected by the stock of NPLs.

Keywords: Lending rates, non-performing loans, funding costs, interest rate pass-through

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1 Introduction

The stock of non-performing loans (NPLs) in the euro-area banking system has rapidly increased since the financial crisis. 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 (eg 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). The rise of the NPL stock occurred in the context of two major crises: the financial crisis that peaked in 2008 and 2009 and the sovereign debt crisis that roughly stretched from 2010 to 2012. At the same time, the Eurosystem cut policy rates (with the exception of a short intermezzo in 2011 when the MRO-rate was slightly increased) to unprecedented low levels and implemented a number of non-standard policy measures. It was widely perceived that – at least for some time – the transmission of those monetary policy measures to bank lending rates did not go smoothly in all countries of the euro area (ECB, 2013). Against this backdrop, the present paper aims at assessing the impact of NPLs on the pricing of loans by banks and their role in the transmission of monetary policy.

Arguably the most obvious way in which NPLs might affect the lending behaviour 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 channel, there should not be any impact of NPLs on lending behaviour once the capital position is taken into account. In this case, a high NPL stock should not constitute a problem if capitalization was sufficient and reducing the stock would not be vital from a monetary policy perspective. Empirical results in several papers suggest that NPLs indeed affect lending behaviour apart from the drain on bank capital that banks disclose as there remains an effect of NPLs after taking capital into account (see Peek and Rosengren, 1997; Jiménez, Ongena, Peydró and Saurina, 2012; Hernando and Villanueva, 2014; Albertazzi, Nobili and Signoretti, 2016; Burlon, Fantino, Nobili and Sene, 2016), although at least one contribution (Accornero, Alessandri, Carpinelli and Sorrentino, 2017) reaches a different conclusion.

The present paper sheds more light on how this impact of NPLs on lending behaviour in the euro area – in particular lending rates – can be explained, although precisely pinning down the relevant channel(s) is difficult. There are several potential channels through which NPLs might affect the lending behaviour of a bank.

First, a bank might adjust its lending behaviour in case of a high stock of NPLs, if it expects further losses from this stock in the future, which are not yet incorporated in the amount of capital it discloses. Hence, NPLs might be considered an indicator for "anticipated falls in capital" (Hernando and Villanueva, 2014). In this case, *net* NPLs (gross NPL net of loan loss reserves) should be relevant, as they signal the amount of loans which will potentially not or only partly be paid back and for which no reserves have been set aside yet. A condition for this channel to be relevant is an impact of capital on lending decisions. Otherwise, falls in capital, whether disclosed or only anticipated, would be irrelevant. Empirical evidence suggests that capital restricted banks might be more reluctant when it comes to granting new loans when considering quantity effects, although there seems to be some controversy on how strong the impact is (see Peek and Rosengren, 1997; Gambacorta and Mistrulli, 2004; Watanabe, 2007; Berrospide and Edge, 2010; Gambacorta and Shin, 2016; Michelangeli and Sette, 2016; papers dealing with capital restrictions stemming from tighter regulatory requirements are Mésonnier and Monks, 2015; Gropp, Mosk, Ongena and Wix, 2016; Kanngiesser, Martin, Maurin, Moccero, 2017). A similar picture emerges when considering price effects (Gambacorta and Mistrulli, 2014; Burlon, Fantino, Nobili and Sene 2016; Michelangeli and Sette, 2016), although the results are not clear-cut in all cases (Holton and Rodriguez d'Acri, 2015). In general, actual as well as anticipated falls in capital should influence lending behaviour if capital constraints are binding or banks expect them to become binding in the future. In such a situation, banks should be more reluctant to grant new loans, especially if they are constrained or reluctant in raising new equity (which would only leave deleveraging as an option to improve the capital position). On the other hand, it is also possible that banks engage in "gambling for resurrection" and shift the composition of their loan portfolio towards riskier borrowers. Such a behaviour might also entail higher lending rates which however were not the result of credit supply restrictions but of the higher average risk of the loan portfolio which in turn is reflected in higher risk premia.

Second, a further channel through which *net* NPLs can affect lending behaviour runs through the funding cost of banks. If investors consider a high stock of net NPLs as an indicator for future losses and falls in bank capital, they should demand higher risk premia when providing funds to the respective bank. Those risk premia should most likely become visible in the cost of market funding, as retail-depositors are generally protected by a deposit insurance scheme. Higher funding costs would affect lending behaviour if they were a least partly passed-through to borrowers.

Third, a high stock of NPLs might be perceived as a bad signal by investors with regard to the quality of the bank's management and hence also to future bank profitability. This in turn might induce investors to demand higher risk premia. Note, that in this context not only net NPLs but also loan loss reserves should be relevant, whereby it is not clear per se, whether the former or the latter is more important.

Fourth, the stock of NPLs or loan loss reserves might affect the risk tolerance of banks and might be relevant due to an "institutional memory", a term coined by Berger and Udell (2004). According to the institutional memory hypothesis, banks ease lending policies the more the longer their last credit bust dates back. Hence, banks should be comparatively strict if they are in the midst of such a bust. Again, not only net NPLs, but also loan loss reserves and hence gross NPLs should be relevant. Berger and Udell (2004) focus on loan loss reserves in their empirical investigation.

Finally, it has to be kept in mind that a positive relationship between bank lending rates and the stock of NPLs might also be driven by time variant credit risk or other characteristics of the pool of borrowers the respective bank is granting loans to (Accornero et al., 2017).[3] If credit risk for this pool of borrowers increases at some point in time, one would expect an increase in NPLs and reserves and at the same time an increase in lending rates if the increase in credit risk is properly reflected in the lending rate charged by the bank.

Overall, the first and second channel work exclusively through the stock of *net* NPLs, whereas the third and fourth channel can work through both, net NPLs and loan loss reserves. The first two channels, in which only net NPLs are relevant, describe situations in which a potential effect of the NPL stock should vanish once the NPLs are removed from the bank balance sheets – assuming all other influencing factors are held constant. The third and fourth channel describe situations, in which those effects are not likely to vanish in such a case.

From a monetary policy perspective, the question which of those channels is at work is important in order to evaluate the NPL problem and potential desirable remedies. If NPLs affect lending rates in a way as described by the first channel – i.e. banks restrict their lending or gamble for resurrection due to anticipated further losses stemming from the net NPL stock – it might be desirable to urge banks to take these anticipated losses right away and to immediately rebuild their capital position if necessary and possible – this might be referred to as "cleaning up banks' balance sheets". It has to be kept in mind that cleaning up banks' balance sheets is not a task of monetary policy. However, if the impact of the anticipated falls in capital runs primarily through higher funding

[3] Systematic differences in the riskiness of the borrower pool that are time invariant can be captured by bank fixed effects. Likewise, variations of the riskiness of borrowers at the country level can be captured by time-country fixed effects.

costs as described in the second channel, it could be weakened through a decline in risk premia triggered by large scale assets purchases – a monetary policy tool. On the other hand, if a high stock of NPLs is considered as an indicator of bad management by investors (third channel) or if the “institutional memory” was at work (fourth channel), there would be no remedy to weaken the impact of NPLs on lending rates immediately. The impact of a credit bust on the “institutional memory” would rather automatically recede as time passes by. Finally, if higher lending rates charged by banks with a higher stock of NPLs simply mirrored the fact that these banks mainly deal with customers that are particularly risky at a given point in time, the lending rate surcharge would even be desirable, as it simply implies that banks price creditor risk adequately.

In order to figure out, which of the above mentioned channels of NPLs’ impact on lending rates is relevant, the present paper exploits variation on the bank-level using data referring to euro-area banks. 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. Hence, caution is warranted when drawing conclusions based on the results of this paper that go beyond how banks set lending rates in comparison to their competitors given macroeconomic conditions in a country. Imagine for instance that the high NPL stock of some banks induces them to raise lending rates. Other banks, with a low NPL stock then might experience an increase in loan demand (assuming that loan demand faced by one bank depends inter alia positively on lending rates set by other banks) and increase their rates as well. What the analysis in this paper can identify 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.

On the other hand, effects of NPLs that show up in differences between lending rates 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] Amongst others, the present paper relies on bank-level data on lending rates (IMIR-dataset) and balance sheet items (IBSI-dataset) collected by the Eurosystem, which has already been used in other studies to investigate the interest rate pass-through and the determinants of lending rates in the euro area (Holton and Rodriguez d’Acri, 2015; Albertazzi, Nobili and Signoretti, 2016; Altavilla, Canova and Ciccarelli, 2016a; Altavilla, Pagano and Simonelli, 2016b; Camba-Mendez, Durré and Mongelli, 2016; de Haan, Vermeulen and van der End, 2016; Holton and McCann,

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

2016). Some of these studies also focus on the impact of NPLs or loan loss reserves on lending rates (Holton and Rodriguez d'Acri, 2015; Albertazzi et al., 2016; Altavilla et al., 2016a; Holton and McCann, 2016) and report an effect on the 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., 2016a) and on the interest rate differential between small- and large scale loans (Holton and McCann, 2016), which is used as a proxy for the difference between lending rates charged on loans to SMEs and on loans to large enterprises. Taking those studies into account, there remain the following contributions of the present paper:

1) It assesses, whether the potential impact of NPLs on lending rates is driven at least to some extent by higher funding costs of banks with a high NPL stock which are then passed on to their customers.

2) It attempts to disentangle the effects of net NPLs and loan loss reserves by splitting up gross NPLs into those two variables and considering them jointly. This should give some indications which of the above-described channels might be relevant.

3) It investigates whether a relation between NPLs and lending rates – controlling for capital – can be found if yearly data is used. The motivation in using data of a lower frequency stems from the fact, that information on NPLs and (regulatory) capital are only available on a yearly frequency for most banks. The obvious drawback of this approach is that the monthly frequency of the IMIR dataset is not fully exploited.

The results indicate that there is a relatively robust positive association between net NPLs and lending rates. Loan loss reserves tend to offset this positive association according to the results of some specifications, when an average ratio of loan loss reserves over gross NPLs (coverage ratio) is preserved. Hence, results are ambiguous with regard to the question whether an increase in net NPLs affects lending rates notwithstanding the development of loan loss reserves or only in cases in which the parallel increase in loan loss reserves is insufficient. Funding costs do not seem to be the main driver of the effects of NPLs on lending rates. These empirical results are in line with the first channel described above, according to which banks adjust their lending behaviour in the light of further anticipated losses stemming from the stock of net NPLs. It is however unclear, whether an increase in net NPLs leads to an increase in these anticipated losses in general or only in cases in which loan loss reserves are not adjusted accordingly. This result is compatible with a situation in which banks restrict lending by charging higher interest rates but also with a gambling for resurrection behaviour which implies that banks with a high net NPL stock switch to riskier borrowers which allow for charging higher credit risk spreads. The available data does not allow for a clear distinction in this context due to the lack of borrower related information.

2 Relevant Literature

There are contributions which consider the impact of NPLs or loan loss reserves on lending rates and the interest rate pass-through relying on the same euro area wide bank-level data set (IBSI / IMIR) as the empirical analysis in this paper. These contributions however do no 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 data, namely Bankscope and SNL). Using IBSI / IMIR data, Albertazzi et al. (2016) find an impact of NPLs on lending rates, also after capital (Tier1 ratio), bank fixed effects and month-country fixed effects are taken into account. The results suggest that this impact comes in the form of a higher markup 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). Hence, a higher stock of NPLs 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, thus controlling for capital does not affect the results with regard to NPLs much. Altavilla et al. (2016a) 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, hence 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 to low NPL banks in the case of non-standard measures. Holton and Rodriguez d'Acri (2015) focus on the role of bank-specific variables – the capital ratio and loan loss provisions being two of them – on the interest rate pass-through in a single panel error correction framework that includes bank fixed effects. In order to do so, 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- 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 in all benchmark specifications the authors report a negative impact of this control variable on the probability of granting a loan, 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, 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 exclusively demand or supply, 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 bank-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 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 of NPLs between 2008 and 2009 are instrumented via the exposure to real estate development right 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 the bank operates in. 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 et al. (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 find 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 there are no effects of the NPL stock on bank lending that go beyond losses connected to this stock that have already been taken and are already captured in the capital level.

Taken together, the insights of the research discussed above suggest that there might indeed be an impact of NPLs on bank lending in general and on lending rates in particular even if bank capital is accounted for, although empirical results do not unanimously point in that direction. Studies based on the IMIR-dataset for the whole euro area rather suggest that this impact takes the form of a markup on 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 suggest by Button, Pezzini and Rossiter (2010). The estimated error correction model captures both, short- and long-term effects. However, higher loan loss provisions come along 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 in all specifications.

The pass-through of bank-specific costs of market funding on 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 underpinning for 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 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 by 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 to the 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 its pass-through, bank-specific characteristics are unsurprisingly an important determinant of bank-specific risk premia, however there is no clear evidence, how important NPLs are in this context. Furthermore, the literature suggests that costs or 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 hence use the deposit rate as a strategic variable in order to maximise utility or profits. This is in line with the idea of Button et al. (2010), according to which the treasury acts like a "bank in a bank" (Cadamagnani, Harimohan and Tangri, 2015) and provides funds to the lending unit at a rate equal to the cost of market funding and remunerates deposits provided by the deposit unit with the same rate. The consequence is that 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 IMIR-data collected by the Eurosystem, data from the commercial data sources Bankscope (BS) /

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

ORBIS Bank Focus[6] and SNL as well as data from the CSDB, which is also collected by the Eurosystem.

The IMIR / IBSI-dataset contains individual bank-level information on lending and deposit rates and volumes (IMIR) and on balance sheet items (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- and BSI-data to their respective national central banks. The IMIR- / IBSI- data are available at a monthly frequency from July 2007 onwards. They are (like the MIR- and BSI-datasets) 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. Thus, data collection follows the “host principle”, according to which only offices within the respective national territory should report (European Central Bank and European Banking Authority, 2012). In the context of the (I)MIR-data, banks are supposed to take all deposits and loans that have been granted to or from customers resident in the euro area into account. This implies that for instance the average interest rate on loans reported by a German bank is not necessarily exclusively based on loans to German customers but also on loans to customers resident in other euro-area countries. However, due to the “host principle” it seems plausible to assume that the volume of loans to the latter group of customers should be rather small. The present paper focuses on interest rates on loans to non-financial corporations (NFCs) and new lending business.

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 important to note that BS- and SNL-data refer mainly to consolidated balance sheets (although information referring to unconsolidated

[6] Bankscope changed its name to „ORBIS Bank Focus“ by the beginning of 2017. In what follows, the data source is still referred to as “BS”, as the main part of the data was retrieved before 2017.

[7] It has to 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 systematically underestimates the actual stock as not all loan loss reserves are held against NPLs (and thus the amount deducted from gross NPLs to determine net NPLs is too high). However, this bias seems to be small as only a small share of loan loss reserves is held against performing loans. The European Banking Authority (2016) reports the coverage ratio of NPLs based on specific loan loss reserves (hence 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 in the sample underlying empirical investigations in this paper based on all loan loss reserves is only slightly higher for this time period at 46 %. Furthermore one might argue that general reserves that have not been assigned to a specific loan yet might also be considered as a reserve against losses stemming from NPLs.

balance sheets is available for several banks) and to the highest level of consolidation, whereas IMIR- and IBSI-data refer to single banks (which might themselves be part of a banking group). Given this data structure, IMIR-data are merged to BS- and SNL-data stemming from the consolidated balance sheet of the banking group the respective single bank captured in the IMIR-dataset belongs to. Thus, the data structure is such that several IMIR single banks might belong to the same BS / SNL banking group.[8] The underlying assumption is that characteristics of the entire banking groups are relevant for 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 further analysis as well as on the group parents from BS / SNL. It also shows how many banks and banking group from vulnerable countries (CY, ES, GR, IE, IT, PT and SI) and non-vulnerable countries (all other 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 contains 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 are collected on a monthly basis. Then, for each instrument for each month, the spread over the OIS-rate, whose reference period is closest to the original or residual maturity, is calculated. 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 – relative to the risk-free rate – funding at a given month was 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 AFC- and YTM spread are computed based on bonds of all

[8] 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, in what follows BS / SNL units are referred to as "banking groups". The data structure is similar to the one in 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.

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. As the YTM spread is available for more observations, it is used in the benchmark regressions, whereas the AFC-spread is employed in robustness checks.

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. The reason for using lower frequency data is the focus of the present paper 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 2016. 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 from the sample (the first full year, for which IMIR-data is available is 2008).

Table 1: Number of observations

	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	**81**	45	36	48	33	**57**	35	22
2011	**99**	52	47	60	39	**65**	40	25
2012	**115**	62	53	66	49	**73**	45	28
2013	**121**	64	57	73	48	**77**	49	28
2014	**123**	63	60	79	44	**75**	50	25
2015	**127**	65	62	80	47	**76**	50	26
2016	**119**	60	59	77	42	**69**	48	21
Cross-Sections (N)	**145**	76	69	91	54	**90**	58	32
Total observations (sum 2010-2016)	**785**	411	374	483	302	**492**	317	175

*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

Table 2 explains the main variables used in the benchmark regressions, Table 3 displays number of observations and of imputed values (imputed according to the methodologies described in the 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 compared to 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. 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. 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 due to the usage of fixed effects of first differences. An outlier is defined as a value in the first difference of the respective variable below twice the value of the first percentile or above twice the value of the 99th percentile of the distribution of the difference.

Table 2: Description of variables in benchmark regressions

Variable Name	Data Source / Level of data collection	Description
Rate_all_NFC	IMIR / Sinlge Bank	Average interest rate charged by the bank for loans to NFCs (excluding overdrafts)
Gross_NPL_TA (-1)	SNL, BS / Banking Group	Gross NPLs / Total assets in % (1 Lag)
Net_NPL_TA (-1)	SNL, BS / Banking Group	(Gross NPLs - 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

	N_Obs all	*N_Obs all Imp**	*Mean all*	*Mean NV***	*Mean V****	*SD**** all*	*SD NV*	*SD V*
Rate_all_NFC	785	0	2.56	2.18	3.17	1.16	0.77	1.39
Gross_NPL_TA (-1)	492	13	5.48	2.89	10.17	6.35	3.01	7.21
Net_NPL_TA (-1)	492	16	3.30	1.77	5.89	4.24	2.43	4.75
LL_Res_TA (-1)	492	4	2.18	1.12	4.28	2.36	0.84	2.74
Tier1_Ratio (-1)	492	4	12.12	13.07	10.72	4.02	3.75	2.41
Liq_Ratio (-1)	492	97	34.24	38.81	27.99	14.11	14.18	9.28
ROA (-1)	492	27	0.05	0.25	-0.33	0.86	0.29	1.24
YTM_Spread	492	0	1.87	1.24	2.80	1.49	0.74	1.59
YTM_Spread_1_5	492	70	1.80	1.12	2.82	1.61	0.73	1.80

*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 on the relation between the lending-rate spread 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 in general is linked to higher lending rates. However, this difference becomes only visible after 2010. In a similar vein, Figure 2 looks at the relation between the YTM spread (for bonds with a residual maturity of 1-5 years) and the NPL stock. Again, there seems to be a relation between both variables in the sense that a higher stock of NPLs comes along with higher funding costs. Again, the difference is smallest in 2010.

Both figures suggest that NPLs became relevant for the pricing of loans and funding costs with the start of the sovereign debt crisis. However, it should be kept in mind that both figures do not control for other bank-specific or macroeconomic factors that might be correlated to the NPL stock and at the same time drive funding costs and lending rates. Particularly macroeconomic factors, 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

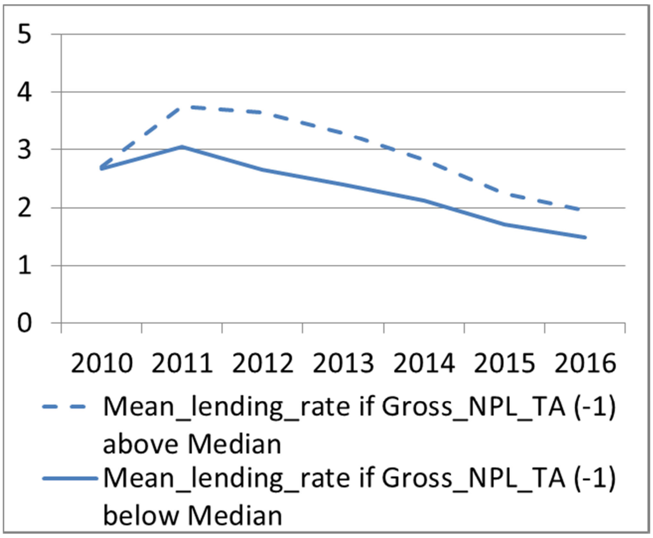
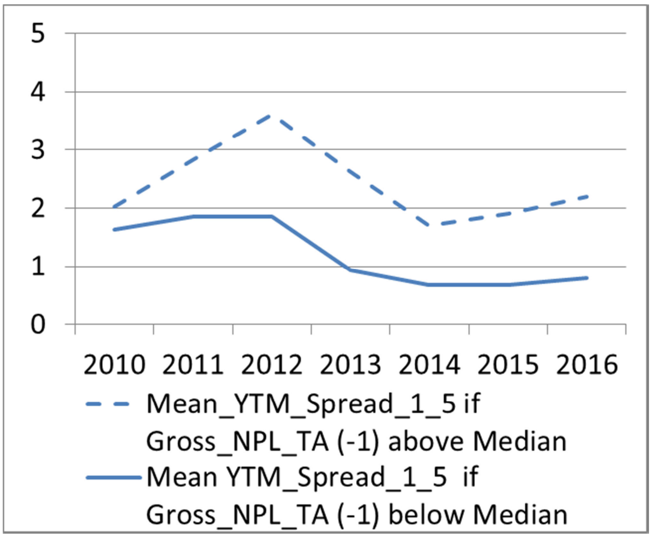


Figure 2: YTM spreads and gross NPLs



4 Empirical Approach

The empirical approach basically 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 a relation between lending rates and NPLs at all. Funding costs are not considered at this stage as the question whether they drive a potential impact is not yet addressed. Estimations based on the second equation are supposed 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, one could conclude 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 serves as dependent variable for models based on the first and third equation. In principle, NPLs can be supposed to affect lending rates in all loan categories. The reason for focusing on one particular category is to ensure a certain homogeneity of the loans the lending rates refer to. Furthermore, capital requirements for NFC loans tend to be higher than for the other principal loan category – loans to private households for house purchases. Hence, if the stock of NPLs is relevant for lending decisions because it is an indicator for future losses and potential capital shortages, the effect is more likely to show up in lending rates on loans to NFCs. The second dependent variable is the YTM 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 level and include banking group fixed effects. Furthermore, year-country fixed effects are included in some models. Those can be understood as a control for all country specific and time invariant (over the course of a year) macroeconomic effects that might drive credit demand (see also Albertazzi et al., 2016; Holton and McCann, 2016) or bank funding costs. Models in which the year-country fixed effects are replaced by a set of macroeconomic variables, along with pure time 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 warranted. The reason is that year-country fixed effects soak up a lot of degrees of freedom and that tests for model specification tend to deliver unreliable results in this situation (see below).

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 identical with 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. Taking all together, the first equation is:

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

Here, *LR* is the lending rate for new loans to non-financial corporations Rate_all_NFC. 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 up the NPL variable in net NPLs and loan loss reserves is meant to reveal further information with regard to which of the channels described in Section 1 might be relevant. However, it has to 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 a 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 monetary policy actions to longer term risk-free rates like the 1-year OIS-rate is considered to be given and not explicitly modelled.

The vector ***x*** includes further control variables (most importantly the Tier 1 ratio), ***m*** is a vector including either year-country fixed effects or time fixed effects and a set of macroeconomic variables. Finally ***irf*** is a vector containing the average interest rate fixation[9] in levels, squared and cubed[10] and ε is the error term, which is clustered on the

[9] 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 on, which contains 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 month compared to 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 year range.

[10] The intention to use squared and cubed terms is to control for all potential effects of the interest rate fixation, including non-linear ones. It seems warranted to properly control for these effects as the interest rate fixation is very heterogenous over the sample and is at the same time likely to heavily influence lending rates.

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 α and δ_1 as well as those included in $\boldsymbol{\beta_1}$, $\boldsymbol{\gamma_1}$, $\boldsymbol{\tau_1}$ and $\boldsymbol{\theta_1}$ are to be estimated, thereby α_1 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:

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

YTMS stands for the YTM spread, the vector ***NPL*** contains – contrary to ***NPL_Int*** – no interactions of the NPL variable(s) 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).

To figure out to what extent a potential impact of NPLs on the lending-rate spread runs through the YTM spread, the YTM spread is added to Equation (1) as 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 between all banks:

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

Note that the YTM 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 AFC- or YTM spreads with a lag. Hence, the effect of NPLs on lending rates through the AFC- or YTM spread is 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 an ordinary fixed effects estimator. In one version, the dependent lagged variable is omitted (FE_1) in the other version it is included (FE_2) as stated in Equations (1), (2) and (3). Including the lagged dependent variable is preferable, but excluding it still has its merits as it allows assessing how sensitive the empirical results react on dynamics of the dependent variable. Furthermore, due to the potential dynamic panel bias, the equations are estimated using the system-GMM estimator based on Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). Two versions of the system-GMM estimator are considered (in what follows: SysGMM1 and SysGMM2): a first version in which only the lagged endogenous variable is instrumented and a second version in which 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 very limited extent as in many cases either single bank and banking group are the same or the single bank constitutes an important part of the banking group. However, as the system-GMM estimators are known to be very sensitive to the model specification (for instance the number and definition of instruments), estimating standard fixed effects models still has its merits.

5 Results

5.1 Benchmark results

Table 4 shows the results of estimating Equation (1) with the gross NPL variable. The results in the left panel suggest that a higher stock of gross NPLs is associated with higher lending rates in all estimations in which year-country fixed effects are used. For the SysGMM_2 specification, the interaction term furthermore indicates that a higher stock of NPLs is associated with a more pronounced pass-through of changes in the 1-year OIS-rate to lending rates. The coefficients related to all remaining banking-group specific variables are insignificant. The p-value for the Hansen statistic points at 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.[11] By and large these results 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 markup for the lending rates, whereas the interest rate pass through seems rather unaffected.

In order to better assess the instrument validity in the system-GMM estimations, all estimations are repeated replacing year-country fixed effects by time fixed effects and a set of macroeconomic variables. As can be seen from the results in the right panel of Table 4, this strongly reduces the number of instruments. The sample size somewhat decreases due to the fact, that government bond spreads are not available for all countries in all years. The relation between gross NPLs and lending rates practically disappears for this specification and turns even significantly negative for the SysGMM_2 estimation. The Hansen test rejects the Null of valid instruments for specification SysGMM_1 but not for SysGMM_2. This might be due to a violation of the assumption of independence between banking-group specific variables and single-bank fixed effects.[12]

[11] This pronounced bias seems surprising, given that the number of cross sections still exceeds the number of instruments. However, it should be kept in mind that the sample is unbalanced, the number of cross sections, for which observations are available for every year, is only 64. Instruments have been collapsed and reduced to four lags in SysGMM_2 in order to reduce the number of instruments.

[12] However, if difference GMM is used which does not include the level equation and is based on the difference equation (in which single bank fixed effects vanish) only, the Hansen statistic does not improve.

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

Dependent variable: Lending rate (loans to NFCs)

	FE_1	**FE_2**	**Sys GMM_1**	**Sys GMM_2**	**FE_1**	**FE_2**	**Sys GMM_1**	**Sys GMM_2**
LendingRate (-1)		0.343 ***	0.536 ***	0.562 ***		0.429 ***	0.553 ***	0.812 ***
Gross_NPL_TA (-1)	**0.037 *****	**0.026 *****	**0.035 *****	**0.038 *****	**0.009**	**-0.002**	**0.009**	**-0.030 ****
Gross_NPL_TA(-1)*OIS	**-0.013**	**-0.008**	**0.009**	**0.036 ***	**-0.006**	**-0.012**	**0.000**	**-0.017**
Tier1_Ratio (-1)	-0.003	-0.004	0.002	0.012	0.005	-0.001	-0.015 *	-0.033 **
Liq_Ratio (-1)	0.010	0.008	0.001	-0.005	-0.005	-0.004	-0.004 **	-0.022 ***
ROA (-1)	-0.005	-0.012	0.009	-0.010	-0.019	-0.029	-0.021	-0.065
GDP_growth					0.045 ***	0.021 **	0.003	0.001
Unemployment Rate					0.101 ***	0.046 *	0.020 ***	0.004
GovBond_Spread					0.114 ***	0.104 ***	0.079 ***	0.048 ***
Inflation					0.070	0.123 **	0.138 ***	0.128 ***
# Observations	778	778	778	778	725	725	725	725
# Cross Sectional Units	145	145	145	145	132	132	132	132
# Instruments			119	136			54	44
P_Hansen			1.0000	1.0000			0.0362	0.1849
P_AR2			0.8208	0.8988			0.8325	0.925
Year FE	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*
*Year*Country FE*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*
Controls for IR-Fixation	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

SysGMM_1: Only LendingRate(-1) instrumented, instruments collapsed
SysGMM_2: All banking-group specific variables instrumented,
instruments collapsed, only lags 2-5 used as instruments
Standard errors clustered on banking group (j) level

Table 5 shows the results for the estimation of Equation (1) when gross NPLs are split into net NPLs and loan loss reserves. The results in the left panel indicate that the positive relation between gross NPLs and lending rates which has been found in Table 4 when year-country fixed effects are used is driven by net NPLs and not by loan loss reserves. In the case of SysGMM_2, results even indicate that a higher stock of loan loss reserves comes along with lower lending rates. However, it should be noted that the correlation between net NPLs and reserves is high (the correlation coefficient is around 0.80). In such a case, the impact of both variables might be unstable and change reverse if the sample is slightly altered. Against this background, Annex III 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 are shown for models FE_2 and SysGMM_2 (for the sake of facility of inspection, the results for FE_1 and SysGMM_1 are not shown, however they are in line with the findings for FE_2 and

SysGMM_2) and indicate no pronounced instability (such as abrupt reversals of signs of coefficients). The speed of the pass-through of OIS-rates to lending rates does not seem to be affected by net NPLs or loan loss reserves according to the results for three of the four models. Only in SysGMM_1 the respective coefficients are statistically significant, indicating that Net NPLs weaken the pass-through down, whereas loan loss reserves intensify it.

Considering the models that replace year-country fixed effects by year fixed effects and macroeconomic variables in the right panel, it turns out that the positive relation between net NPLs and lending rates prevails for models FE_1, FE_2 and SysGMM_1. However, contrary to the results in the left panel, results suggest that higher loan loss reserves come along with lower lending rates. This pattern is different for SysGMM_2, here the coefficient related to net NPLs – which is the highest of all models in the left panel – drops to a value close to zero. Furthermore, the coefficient referring to the interaction of net NPLs and OIS-rate is significantly negative also for FE_2. Again, results do not seem to be overly sensitive to alterations of the underlying sample (cf. Annex III).

Overall, there seems to be a rather stable positive relation between net NPLs and lending rates, whereas the relation between loan loss reserves and lending rates is not clear-cut. What is striking is the fact that in four out of eight cases (Sys_GMM2 with country-year fixed effects; FE_1, FE_2 and Sys_GMM1 with macroeconomic variables) the point estimate for the coefficient relating to the loan loss reserves variable is of a similar magnitude as the coefficient relating to the net NPL variable but with a reversed sign (although not significantly different from zero in all cases). This implies that the effect of both variables on lending rates offsets each other if both variables increase (the same holds of course for a decrease) by roughly the same amount. This is indeed the case for a bank that sees its stock of gross NPLs increasing and covers roughly half of that increase by loan loss reserves. Given that the average coverage ratio (ratio of loan loss reserves over gross NPLs) for the sample is around 45 %, this is close to what an average bank would do. Consequently, when considering gross NPLs (cf. Table 4) no significant impact can be detected cases (with the exception of Sys_GMM2 with country-year fixed effects).

The picture described above by and large prevails, if the effects of the net NPL and loan loss reserves level variables and their respective interactions with the OIS-rate are combined (this is done by fixing the OIS-rate at its sample mean). The results of this exercise are shown graphically in Annex VI.

Table 5: Impact of net NPLs and loan loss reserves on lending rates (Equation 1)

Dependent variable: Lending rate (loans to NFCs)

	FE_1	FE_2	Sys GMM_1	Sys GMM_2	FE_1	FE_2	Sys GMM_1	Sys GMM_2
Lending-Rate (-1)		0.340 ***	0.526 ***	0.606 ***		0.424 ***	0.537 ***	0.761 ***
Net_NPL_TA (-1)	**0.070** ***	**0.051** ***	**0.058** ***	**0.158** ***	**0.063** **	**0.044** *	**0.040** **	**0.025**
LL_Res_TA (-1)	**-0.017**	**-0.010**	**0.003**	**-0.145** *	**-0.060**	**-0.062** *	**-0.035**	**-0.082**
Net_NPL_TA(-1)*OIS	**-0.017**	**-0.014**	**-0.031** **	**-0.026**	**-0.044**	**-0.040** *	**-0.053** ***	**0.000**
LL_Res_TA(-1)*OIS	**-0.039**	**-0.011**	**0.101** **	**0.029**	**0.057**	**0.029**	**0.100** **	**-0.054**
Tier1_Ratio (-1)	-0.002	-0.004	0.002	0.011	0.004	-0.001	-0.016 **	-0.036 **
Liq_Ratio (-1)	0.008	0.007	0.002	-0.007	-0.004	-0.004	-0.004 *	-0.017 ***
ROA (-1)	-0.014	-0.016	0.005	-0.044	-0.025	-0.035	-0.027	-0.064
GDP_growth					0.046 ***	0.022 **	0.001	-0.001
Unemployment Rate					0.101 ***	0.046 *	0.023 ***	0.009
GovBond_Spread					0.119 ***	0.108 ***	0.078 ***	0.045 **
Inflation					0.069	0.122 **	0.136 ***	0.151 ***
# Observations	778	778	778	778	725	725	725	725
# Cross Sectional Units	145	145	145	145	132	132	132	132
# Instruments			121	146			56	54
P_Hansen			1.0000	1.0000			0.0336	0.2491
P_AR2			0.8391	0.8604			0.8158	0.8335
Year FE	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*
*Year*Country FE*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*
Controls for IR-Fixation	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

SysGMM_1: Only LendingRate(-1) instrumented, instruments collapsed
SysGMM_2: All banking-group specific variables instrumented,
instruments collapsed, only lags 2-5 used as instruments
Standard errors clustered on banking group (j) level
*******, ** and * indicates statistical significance at the 1%-, 5%-, and 10%-level****

Next, the relation between NPLs and funding costs is assessed as described by Equation (2). As outlined in the introduction, it is possible that a high stock of NPLs is perceived by investors' as a signal of future losses or for a bad bank management. The estimations of Equation (2) are run on the banking-group level. In order to increase the size of the sample, additional banking groups, which are not in the baseline sample described in Section 3, have been included. This is possible, as information from banks, which are not part of the IMIR / IBSI can be used as well.[13]

The results in Table 6 suggest a positive relation between gross NPLs on the YTM spread. The coefficients related to the remaining banking-group specific variables are not significantly different from zero, with the exception of the liquidity variable. Higher liquidity seems to come along with higher funding costs, which is somewhat at odds

[13] The results of the estimation based on a sample restricted to IMIR / IBSI banks are shown in Section 6 that assesses the robustness of the estimates.

with what one would in general expect as more liquid banks should be less risky from a bank creditor's perspective. However, this results might be driven by assets like sovereign bonds, which are considered to be liquid according to the definition used here, but might have also been considered as a source of risk by investors especially during the sovereign debt crisis. Contrary to the case of Equation (1), the results barely depend on whether year-country fixed effects of pure year fixed effects along with macroeconomic variables are used.[14] The Hansen test cannot reject the Null of valid instruments for both System-GMM regressions for the models with year fixed effects and macroeconomic variables. When year-country fixed effects are used, the bias of the statistic discussed above prevails.

[14] Contrary to the case of 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 into 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 year country cells with only one observation outweighs the effect of excluding observations with missing values for macroeconomic variables.

Table 6: Impact of gross NPLs on YTM spread (Equation 2)

Dependent variable: Yield-to-maturity (YTM)_Spread

	FE_1	FE_2	Sys GMM_1	Sys GMM_2	FE_1	FE_2	Sys GMM_1	Sys GMM_2
YTM-Spread (-1)		0.269 ***	0.904 ***	0.808 ***		0.240 ***	0.669 ***	0.624 ***
Gross_NPL_TA (-1)	**0.094** ***	**0.087** ***	**0.023** **	**0.057** ***	**0.075** **	**0.071** **	**0.021** **	**0.050** ***
Tier1_Ratio (-1)	0.007	0.003	0.002	0.016	-0.007	-0.012	-0.002	-0.026
Liq_Ratio (-1)	0.022 *	0.020 **	0.004 **	0.001	0.010	0.011	0.002	0.023
ROA (-1)	-0.076	-0.050	-0.004	-0.058	-0.086	-0.064	-0.061	-0.014
GDP_growth					-0.071 **	-0.059 **	-0.001	-0.023
Unemployment Rate					0.079	0.047	0.014	0.003
GovBond_Spread					0.269 ***	0.240 ***	0.112 **	0.156 **
Inflation					0.135	0.212 **	0.348 ***	0.343 ***
# Observations	603	603	603	603	613	613	613	613
# Cross Sectional Units	123	123	123	123	126	126	126	126
# Instruments			84	98			44	38
P_Hansen			1.0000	0.6133			0.1387	0.1263
P_AR2			0.7699	0.838			0.9879	0.9614
Year FE	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*
*Year*Country FE*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*
Controls for Maturity	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

SysGMM_1: Only YTM-Spread (-1) instrumented, instruments collapsed
SysGMM_2: All banking-group specific variables instrumented, instruments collapsed, only lags 2-5 used as instruments
Robust Standard errors
*******, ** and * indicates statistical significance at the 1%-, 5%-, and 10%-level****

Splitting gross NPLs into net NPLs and loan loss reserves in Table 7 reveals that the positive relation between NPLs and funding costs seems to be driven mainly by loan loss reserves, although the results are somewhat ambiguous for SysGMM_2 when year-country fixed effects are used. This is the opposite of what was found for Equation (1). Hence investors seem to be less concerned with potential future losses stemming from the net NPL stock but rather with the losses that have already been taken and might be an indicator for management quality. Furthermore, Annex IV reveals that the results in Table 7 for FE_2 and SysGMM_2 are relatively robust to alterations of the sample.

Table 7: Impact of net NPLs and loan loss reserves on YTM spread (Equation 2)

Dependent variable: Yield-to-maturity (YTM)_Spread

	FE_1	FE_2	Sys GMM_1	Sys GMM_2	FE_1	FE_2	Sys GMM_1	Sys GMM_2
YTM-Spread (-1)		0.257 ***	0.887 ***	0.789 ***		0.225 ***	0.672 ***	0.640 ***
Net_NPL_TA (-1)	**-0.015**	**-0.014**	**-0.004**	**0.044**	**-0.092** **	**-0.089** **	**-0.025**	**-0.015**
LL_Res_TA (-1)	**0.266** ***	**0.246** ***	**0.106** **	**0.080**	**0.328** ***	**0.314** ***	**0.133** ***	**0.153** *
Tier1_Ratio (-1)	0.001	-0.001	0.003	0.022	-0.010	-0.014	-0.001	-0.021
Liq_Ratio (-1)	0.015	0.014	0.003	-0.003	0.003	0.003	0.001	0.020
ROA (-1)	-0.074	-0.050	-0.001	-0.065	-0.074	-0.055	-0.042	-0.021
GDP_growth					-0.082 ***	-0.070 ***	0.001	-0.014
Unemployment Rate					0.086	0.056	0.002	-0.005
GovBond_Spread					0.286 ***	0.258 ***	0.113 **	0.158 **
Inflation					0.098	0.172 **	0.365 ***	0.374 ***
# Observations	603	603	603	603	613	613	613	613
# Cross Sectional Units	123	123	123	123	126	126	126	126
# Instruments			85	103			45	43
P_Hansen			1.0000	0.3470			0.1220	0.1217
P_AR2			0.751	0.8408			0.9989	0.916
Year FE	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*
*Year*Country FE*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*
Controls for Maturity	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

SysGMM_1: Only YTM-Spread (-1) instrumented, instruments collapsed
SysGMM_2: All banking-group specific variables instrumented,
instruments collapsed, only lags 2-5 used as instruments
Robust Standard errors
****** , ** and * indicates statistical significance at the 1%-, 5%-, and 10%-level***

Finally, Table 8 shows the results of estimating Equation (3). As can be seen from the table, including the YTM spread variable does not change the results with regard to NPLs much. Although the coefficients in the left panel referring to the system-GMM regressions are somewhat smaller compared to the corresponding estimation of Equation (1) without the YTM spread (see Table 4), one can conclude that the impact of NPLs on lending rates does not primarily run through higher funding costs. This is not surprising considering that the impact of the YTM spread on lending rates is small and not statistically significant in most cases. It is strongest for the system-GMM estimates along with year fixed effects and macroeconomic variables. 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 bank's funding costs according to the results in Table 6 and Table 7 – is stronger than that of bank-specific premia.[15] 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 lending rates is more complete when the change in CDS-premia occurs for all banks. The consequence is that the extent to which banks' lending rates are affected by their marginal funding costs (which are, according to Button et al., 2011 the banks' cost of market funding) depends inter alia on the extent to which their marginal funding costs are driven by idiosyncratic factors. However, it is possible that the impact of the sovereign spread on lending rates goes beyond its impact via the common component in banks' funding costs. Even if the sovereign spread did not affect the funding costs of banks at all, there might still be an impact on lending rates. One reason is that from the banks' perspective, higher sovereign spreads imply higher returns to investments other than loans.

[15] At this point it has to 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 coincide. This is the case for around 25 % of the single bank observations. For those observations it is misleading to think of the sovereign spread as a component of the funding costs. However, the effect of the sovereign spread also outweighs the effect of the YTM-spread in three out of four specifications (the effects are practically equal for Sys_GMM2) when the estimation is modified such that this interpretation seems legitimate: either by removing single banks from the sample that belong to a banking group that is not located in the same country or by using the sovereign spread on the level of the banking group country, not the single bank country.

Table 8: Impact of gross NPLs on lending rates, controlling for YTM_Spread (Equation 3)

Dependent variable: Lending rate (loans to NFCs)

	FE_1	FE_2	Sys GMM_1	Sys GMM_2	FE_1	FE_2	Sys GMM_1	Sys GMM_2
LendingRate (-1)		0.343 ***	0.540 ***	0.559 ***		0.433 ***	0.544 ***	0.772 ***
Gross_NPL_TA (-1)	**0.037 *****	**0.026 *****	**0.028 *****	**0.026 ****	**0.007**	**-0.003**	**0.004**	**-0.028 ***
Gross_NPL_TA(-1)*OIS	**-0.013**	**-0.007**	**0.005**	**0.020**	**-0.005**	**-0.011**	**0.001**	**-0.019**
Tier1_Ratio (-1)	-0.004	-0.005	-0.006	-0.010	0.005	-0.001	-0.014 *	-0.034 **
Liq_Ratio (-1)	0.010	0.008	0.001	-0.001	-0.004	-0.002	-0.003 *	-0.018 ***
ROA (-1)	-0.001	-0.008	-0.003	-0.012	-0.013	-0.022	-0.028	-0.057
YTM_Spread	0.017	0.014	0.031	0.025	0.036	0.047	0.064 **	0.040 *
GDP_growth					0.046 ***	0.022 **	0.008	0.003
Unemployment Rate					0.094 ***	0.036	0.014 **	0.001
GovBond_Spread					0.113 ***	0.102 ***	0.084 ***	0.060 ***
Inflation					0.062	0.112 **	0.101 ***	0.097 **
# Observations	778	778	778	778	725	725	725	725
# Cross Sectional Units	145	145	145	145	132	132	132	132
# Instruments			120	137			55	45
P_Hansen			1.0000	1.0000			0.0615	0.1359
P_AR2			0.7814	0.8029			0.8535	0.9234
Year FE	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*
*Year*Country FE*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*
Controls for IR-Fixation	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

SysGMM_1: Only LendingRate(-1) instrumented, instruments collapsed
SysGMM_2: 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 * indicates statistical significance at the 1%-, 5%-, and 10%-level****

The results of estimating Equation (3) when gross NPLs are split up into net NPLs and loan loss reserves are shown in Table 9. Again, the results do not change qualitatively compared to the corresponding estimation of Equation (1) (see Table 5). Only for SysGMM_2 some noticeable changes in the coefficients can be observed. According to Annex V (Figure 11 and Figure 14) the results in Table 9 for FE_2 and SysGMM_2 are robust to alterations of the sample. Figures

Table 9: Impact of net NPLs and loan loss reserves on lending rates, controlling for YTM spread (Equation 3)

Dependent variable: Lending rate (loans to NFCs)

	FE_1	FE_2	Sys GMM_1	Sys GMM_2	FE_1	FE_2	Sys GMM_1	Sys GMM_2
Lending-Rate (-1)		0.340 ***	0.532 ***	0.565 ***		0.427 ***	0.529 ***	0.740 ***
Net_NPL_TA (-1)	**0.071 *****	**0.051 *****	**0.054 *****	**0.099 ****	**0.062 ****	**0.042 ***	**0.034 ****	**-0.012**
LL_Res_TA (-1)	**-0.020**	**-0.012**	**-0.014**	**-0.075**	**-0.062**	**-0.064 ***	**-0.042 ***	**-0.037**
Net_NPL_TA(-1)*OIS	**-0.016**	**-0.014**	**-0.029 ****	**0.000**	**-0.043**	**-0.038 ***	**-0.046 ****	**0.004**
LL_Res_TA(-1)*OIS	**-0.039**	**-0.011**	**0.076 ***	**-0.004**	**0.056**	**0.028**	**0.089 ****	**-0.044**
Tier1_Ratio (-1)	-0.002	-0.004	-0.006	-0.008	0.005	-0.001	-0.015 **	-0.036 **
Liq_Ratio (-1)	0.009	0.008	0.002	0.000	-0.003	-0.002	-0.003	-0.014 **
ROA (-1)	-0.008	-0.012	-0.008	-0.029	-0.020	-0.028	-0.030	-0.061
YTM_Spread	0.020	0.017	0.038 *	0.028	0.035	0.046	0.069 ***	0.043 **
GDP_growth					0.046 ***	0.022 **	0.006	0.004
Unemployment Rate					0.094 ***	0.037	0.016 ***	0.004
GovBond_Spread					0.117 ***	0.106 ***	0.082 ***	0.060 ***
Inflation					0.061	0.112 **	0.099 **	0.108 ***
# Observations	778	778	778	778	725	725	725	725
# Cross Sectional Units	145	145	145	145	132	132	132	132
# Instruments			122	147			57	55
P_Hansen			1.0000	1.0000			0.0537	0.2374
P_AR2			0.7746	0.7369			0.8285	0.8725
Year FE	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*	*Yes*
*Year*Country FE*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*
Controls for IR-Fixation	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

SysGMM_1: Only LendingRate(-1) instrumented, instruments collapsed
SysGMM_2: 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 * indicates 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 gross NPLs. When year-country fixed effects are used there is a relatively robust positive relation between both variables. When macroeconomic effects are captured by a set of macroeconomic variables instead, this relation disappears. Splitting gross NPLs into net NPLs and loan loss reserves reveals a rather robust positive relationship between net NPLs and lending rates. The effect of loan loss reserves in turn varies over the different specifications. Whereas some results indicate a negligible effect, others suggest that loan loss reserves offset the impact of net NPLs as long as the coverage ratio is kept close to the sample average. Anyway, it should be kept in mind that net NPLs and loan loss reserves are highly correlated and results that include both variables might hence change if additional observations are added, although they prove robust to alterations of the sample the analyses in this paper are based on. 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. However, the impact of funding costs on lending rates is too small for funding costs to be the main link between NPLs and lending rates.

5.2 Sub-categories of NFC-loans

This subsection sheds more light on whether the relations between lending rates and NPLs described above differ if lending rates referring to different loan sub-categories are used. The estimations are based on Equation (3). As discussed above, the inclusion of the funding cost variable does not alter the estimation results much. However, taking the funding costs into account seems reasonable in order to avoid any omitted variable problem, hence using Equation (3) as the starting point for robustness checks seems preferable to using Equation (1).

Table 10 shows the results when only lending rates for small-scale loans (volume up to 1 Mio Euros), large-scale loans (volume above 1 Mio Euros), loans with short interest fixation (up to one year) and with long interest fixation (above one year) are considered consecutively. The table displays the estimators for the coefficients referring to the gross NPL variable, for their interaction with the OIS-rate as well as the estimators from the model in which the NPL variable is split, namely the coefficients referring to net NPLs, reserves and their interactions with the OIS-rate. Furthermore, the table displays the results for all four different models (FE_1, FE_2, SysGMM_1 and SysGMM_2) for both, the specifications with year-country fixed effects and those with year fixed effects along with macroeconomic variables. As can be seen from the first two panels, the association between gross NPLs and lending rates is rather similar for small- and large-scale loans. This is somewhat surprising, as Holton and McCann (2016) find that the spread between small- and large-scale loans to increase with rising NPL-levels. Given this finding, one would have expected rates for small-scale loans to be more sensitive to the NPL stock. The effect of net NPLs is even more pronounced in the case of large-scale loans. This is also true for loan loss reserves with the reversed sign.

The third and fourth panels of Table 10 show the results of estimating Equation (3) for loans with short and long interest rate fixation. For the former type of loans, the market rate for the calculation of the interaction terms has been adjusted to the shorter fixation: the 3-month OIS-rate instead of the 1-year rate is used. The relation between gross NPLs and lending rates is stronger for loans with longer interest rate fixation when year-country fixed effects are used. It is practically zero for both loan types when year-country fixed effects are replaced by year fixed effects and macroeconomic variables. The positive effect of net NPLs on lending rates, which has been documented in the benchmark regressions, completely vanishes. Especially in the case of loans with longer fixations, the positive effect of gross NPLs is captured by loans loss reserves when the gross NPL variable is split. Thus, a positive association between net NPLs and lending rates can be found for lending rates pooled over all interest rate fixations, but this effect vanishes when different fixation periods are considered separately. These results cast some doubt on how well the effect of net NPLs and loan loss reserves, which are highly correlated, can be disentangled.

Table 10: Results for estimation of Equation (3) with alternative dependent variables

Only loans with volume < 1 Mio. Euro

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
Year*country FE					**N= 778**	
FE_1	0.024 **	-0.013	0.017	0.029	-0.006	-0.031
FE_2	0.016 *	-0.014	0.014	0.012	-0.006	-0.043
SysGMM_1	0.026 ***	-0.003	0.042 ***	-0.005	-0.012	0.002
SysGMM_2	0.011	0.019	0.049	-0.028	0.015	-0.006
Macro variables					**N= 725**	
FE_1	0.004	-0.015	0.019	-0.003	-0.042	0.057
FE_2	-0.010	-0.022 **	0.015	-0.042	-0.039 **	0.005
SysGMM_1	0.009	0.001	0.030	-0.027	-0.023 *	0.040
SysGMM_2	-0.043 **	-0.024	-0.013	-0.041	-0.005	-0.030

Only loans with volume > 1 Mio. Euro

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
Year*country FE					**N= 778**	
FE_1	0.020 **	-0.014	0.078 ***	-0.070 *	-0.026	-0.036
FE_2	0.018 **	-0.008	0.064 ***	-0.050	-0.024	-0.003
SysGMM_1	0.024 ***	0.009	0.052 ***	-0.024	-0.020	0.063
SysGMM_2	0.020	0.022	0.103 **	-0.096	0.004	-0.025
Macro variables					**N= 725**	
FE_1	-0.008	-0.007	0.062 **	-0.098 **	-0.053 *	0.067
FE_2	-0.010	-0.011	0.045 *	-0.078 **	-0.051 **	0.059
SysGMM_1	0.000	0.000	0.035 **	-0.055 **	-0.044 *	0.079 *
SysGMM_2	-0.021	-0.009	0.002	-0.040	-0.003	-0.015

Only loans with interest rate fixation < 1 year (OIS rate 3M)

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
Year*country FE					**N= 772**	
FE_1	0.021 *	-0.019	0.003	0.049	-0.015	-0.011
FE_2	0.015 *	-0.020	0.001	0.037	-0.016	-0.019
SysGMM_1	0.025 ***	-0.007	0.041 **	-0.007	-0.020	0.005
SysGMM_2	0.027 *	0.028	0.064	-0.005	-0.011	0.076
Macro variables					**N= 719**	
FE_1	-0.002	-0.011	0.020	-0.009	-0.059 *	0.116
FE_2	-0.013	-0.021	0.015	-0.039	-0.058 **	0.063
SysGMM_1	0.004	0.003	0.028	-0.034	-0.040 **	0.080 **
SysGMM_2	-0.019	-0.003	0.040	-0.066	-0.051	0.096

Table 10 continued

Only loans with interest rate fixation > 1 year						
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
Year*country FE					**N= 657**	
FE_1	0.047 ***	-0.019	0.034	0.047	0.002	-0.084
FE_2	0.044 ***	-0.016	0.031	0.048	0.001	-0.066
SysGMM_1	0.030 **	-0.010	0.007	0.077 **	-0.020	0.035
SysGMM_2	0.035 *	-0.001	0.026	0.066	0.015	-0.017
Macro variables					**N= 631**	
FE_1	-0.002	-0.019	0.011	-0.004	-0.052	0.071
FE_2	-0.007	-0.014	0.007	-0.009	-0.051	0.081
SysGMM_1	0.018	0.006	0.019	0.034	-0.076 **	0.209 **
SysGMM_2	0.002	0.015	-0.064	0.136 *	-0.012	0.183

6 Robustness

This section presents 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). Furthermore, the section also contains some robustness checks for Equation (2). Table 11 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 to what extent the positive relation between NPLs and lending rates is driven by time varying riskiness of the borrowers the bank is lending to. For this reason the loan loss provisions (lagged by one period as 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). However, the results are qualitatively similar to those from the benchmark specification which indicates that time varying credit risk is not the main driver of the positive relation between NPLs and lending rates.

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. As can be seen, the alternative dependent variable leads to changes of the coefficients in the SysGMM_2 model with split NPL variable when year-country fixed effects are used. A part of the positive effect of the gross NPL variable is now captured by loan loss reserves instead of the net NPL variable. At the same time, the coefficient related to the interaction of reserves and the OIS-rate strongly increases. This finding points at a certain instability of the SysGMM_2 model.

The next three specifications consecutively replace total assets in the denominator of the NPL variable(s) and the reserves variable by risk weighted assets (RWA), the regulatory Tier 1 ratio by the leverage ratio (equity according to the balance sheet divided by total assets) and finally the YTM spread by the AFC-spread (see Annex II for a detailed explanation of the difference). In a nutshell, the SysGMM_2 model again delivers estimates for gross and net NPLs that differ in some cases considerably from the benchmark model. Furthermore, the relation between net NPLs and the lending rate according to the FE_2 model tends to be weaker when macroeconomic variables are used.

Table 12 shows the results of estimating Equation (3) when the sample is restricted to observations that fulfil certain criteria. The second panel shows the results 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 a negative average GDP growth over the sample period, with the exception of Spain where GDP ngrowth was slightly positive. 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 turned to non-performing and to a lesser extent by other factors like write-off policies. As can be seen from the results in Table 12, the coefficient related to the gross NPL and net NPL variables tends to become more positive in these estimations compared to the benchmark regression (shown again for convenience in the top panel of the table) and the offsetting effect of loan loss reserves gets less pronounced. However, caution is warranted as the sample size considerably shrinks.

The third panel of the table shows 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.[16] In this case one might argue that year-country fixed effects not only capture macroeconomic factors (including credit demand) but also NPL-definitions that differ between countries and over time as the respective country refers to the home country of the single bank *i* and at the same time also to the home country of the banking group *j*, which constitutes the level on which NPL are measured. It is well known that NPL-definitions differed strongly between different countries and also over time.[17] The results show that the coefficients related to gross NPLs in the fixed effects regressions are somewhat smaller compared to the benchmark model and not statistically significant any more, which might also be due to the smaller sample. The coefficients related to the net NPL variable are relatively similar to those resulting from the estimations of the benchmark model. Furthermore it is noteworthy that restricting the sample this way leads to the only instance (FE_1 and FE_2 and year-country fixed effects) when the coefficient related to the interaction between loan loss reserves and OIS-rate is significantly negative.

By and large, the robustness checks indicate that the results from the benchmark model shown in the previous section are relatively robust as the general pattern of the coefficients of interest is rather similar: there is a positive and significant relation between gross NPLs and lending rates when year-country fixed effects are used. This relation vanishes when time-country fixed effects are replaced by macroeconomic variables and time fixed effects. The interaction between gross NPLs and OIS-rate barely seems to be relevant. When gross NPLs are split into net NPLs and loan loss reserves, the relation between net NPLs and lending rates is positive and significant in the models with year-country fixed effects, there are however some exceptions in the case of SysGMM_2. In the case of macroeconomic variables and time fixed effects the picture is more mixed: in the benchmark regressions there is a positive and significant association between net NPLs and lending rates except in the case of SysGMM_2 whereas loan loss reserves seem to largely offset this positive association. This picture also emerges for some, but not for all alternative specifications. The interactions between net NPLs respectively loan loss reserves and OIS-rates deliver – as in the benchmark regressions – some tentative evidence for a weaker pass-through of market rates to lending rates coming along with a higher stock of net NPLs and a stronger pass-through coming along with a higher stock of loan loss reserves. This tentative evidence can also be found for some of the alternative specifications.

[16] This criterion is obviously also met for independent single banks that do not belong to a banking group.
[17] A harmonized definition on the European level was introduced 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.

Table 11: Results for estimations of Equation (3) with alternative specifications

Benchmark

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
Year*country FE					**N= 778**	
FE_1	0.037 ***	-0.013	0.071 ***	-0.020	-0.016	-0.039
FE_2	0.026 ***	-0.007	0.051 ***	-0.012	-0.014	-0.011
SysGMM_1	0.028 ***	0.005	0.054 ***	-0.014	-0.029 **	0.076 *
SysGMM_2	0.026 **	0.020	0.099 **	-0.075	0.000	-0.004
Macro variables					**N= 725**	
FE_1	0.007	-0.005	0.062 **	-0.062	-0.043	0.056
FE_2	-0.003	-0.011	0.042 *	-0.064 *	-0.038 *	0.028
SysGMM_1	0.004	0.001	0.034 **	-0.042 *	-0.046 **	0.089 **
SysGMM_2	-0.028 *	-0.019	-0.012	-0.037	0.004	-0.044

Including provisions over gross loans for i

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
Year*country FE					**N= 609**	
FE_1	0.033 **	-0.012	0.060 **	-0.021	-0.001	-0.067
FE_2	0.026 **	-0.003	0.047 **	-0.016	0.003	-0.041
SysGMM_1	0.033 ***	0.015	0.067 ***	-0.026	-0.014	0.063
SysGMM_2	0.021 *	0.021	0.082 *	-0.070	0.022	-0.043
Macro variables					**N= 575**	
FE_1	0.011	0.000	0.065 **	-0.054	-0.052	0.101
FE_2	-0.001	-0.009	0.044	-0.057	-0.046	0.060
SysGMM_1	0.008	0.005	0.040 **	-0.040 *	-0.049 *	0.102 *
SysGMM_2	-0.022	-0.018	-0.006	-0.027	0.021	-0.057

Loan rate spread over relevant OIS-swap rate

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
Year*country FE					**N= 778**	
FE_1	0.035 ***	-0.017	0.068 ***	-0.022	-0.019	-0.050
FE_2	0.025 ***	-0.011	0.051 ***	-0.018	-0.015	-0.026
SysGMM_1	0.018 ***	0.018	0.039 ***	-0.010	-0.034 ***	0.146 ***
SysGMM_2	0.031 ***	0.027 *	0.022	0.033	-0.017	0.130 **
Macro variables					**N= 725**	
FE_1	0.006	-0.008	0.061 **	-0.065	-0.044	0.047
FE_2	-0.004	-0.014	0.041 *	-0.065 *	-0.039 *	0.018
SysGMM_1	0.002	0.009	0.036 ***	-0.049 ***	-0.049 ***	0.117 ***
SysGMM_2	0.003	0.012	0.026	-0.045	-0.015	0.038

Table 11 continued

RWA as denomiator for NPL-variables						
Modell	Gross_NPL_ RWA (-1)	Gross_NPL_ RWA(-1)*OIS	Net_NPL_ RWA (-1)	LL_Res_ TA (-1)	Net_NPL_ TA(-1)*OIS	LL_Res_ TA(-1)*OIS
Year*country FE					**N= 774**	
FE_1	0.017 ***	-0.012	0.034 ***	-0.014	-0.008	-0.053
FE_2	0.010 **	-0.007	0.023 **	-0.010	-0.008	-0.026
SysGMM_1	0.010 ***	0.010	0.023 ***	-0.010	-0.018	0.071 *
SysGMM_2	0.008	0.024	0.020	-0.004	0.026	0.024
Macro variables					**N= 721**	
FE_1	0.004	-0.005	0.027 *	-0.024	-0.033	0.051
FE_2	-0.003	-0.012	0.014	-0.024	-0.030	0.021
SysGMM_1	0.001	0.001	0.014 **	-0.019 **	-0.038 *	0.079 *
SysGMM_2	-0.009	-0.012	0.002	-0.021	-0.011	-0.001

Leverage ratio						
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
Year*country FE					**N= 735**	
FE_1	0.035 ***	-0.023 *	0.058 ***	-0.005	-0.019	-0.057
FE_2	0.026 ***	-0.014 *	0.043 ***	-0.002	-0.014	-0.029
SysGMM_1	0.034 ***	0.009	0.057 ***	-0.001	-0.035 ***	0.105 ***
SysGMM_2	0.039 ***	0.028	0.093 *	-0.036	-0.016	0.067
Macro variables					**N= 692**	
FE_1	0.004	-0.018	0.036	-0.029	-0.052 *	0.054
FE_2	-0.006	-0.020 *	0.022	-0.039	-0.044 **	0.025
SysGMM_1	0.006	-0.003	0.028 *	-0.023	-0.055 ***	0.102 **
SysGMM_2	-0.015	-0.002	-0.003	-0.017	0.008	-0.013

AFC spread						
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
Year*country FE					**N= 681**	
FE_1	0.041 ***	-0.029 *	0.059 ***	0.017	-0.039 *	-0.008
FE_2	0.030 ***	-0.016	0.037 **	0.026	-0.026 *	0.014
SysGMM_1	0.040 ***	0.000	0.059 ***	0.013	-0.038 **	0.095 **
SysGMM_2	0.032 **	0.027	0.057	0.003	0.003	0.049
Macro variables					**N= 633**	
FE_1	0.009	-0.021	0.040 *	-0.021	-0.063 **	0.092
FE_2	-0.004	-0.023 **	0.020	-0.025	-0.055 ***	0.062
SysGMM_1	0.009	-0.017	0.031	-0.018	-0.071 ***	0.105 **
SysGMM_2	-0.017	-0.021	0.043	-0.122 ***	-0.042	-0.039

Table 12: Results for estimation of Equation (3) with restricted samples

Benchmark

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
Year*country FE					**N= 778**	
FE_1	0.037 ***	-0.013	0.071 ***	-0.020	-0.016	-0.039
FE_2	0.026 ***	-0.007	0.051 ***	-0.012	-0.014	-0.011
SysGMM_1	0.028 ***	0.005	0.054 ***	-0.014	-0.029 **	0.076 *
SysGMM_2	0.026 **	0.020	0.099 **	-0.075	0.000	-0.004
Macro variables					**N= 725**	
FE_1	0.007	-0.005	0.062 **	-0.062	-0.043	0.056
FE_2	-0.003	-0.011	0.042 *	-0.064 *	-0.038 *	0.028
SysGMM_1	0.004	0.001	0.034 **	-0.042 *	-0.046 **	0.089 **
SysGMM_2	-0.028 *	-0.019	-0.012	-0.037	0.004	-0.044

Only when banking group from weak growth country

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
Year*country FE					**N= 224**	
FE_1	0.067 **	0.030	0.139 ***	-0.024	0.055	-0.023
FE_2	0.058 **	0.028	0.124 ***	-0.023	0.062	-0.036
SysGMM_1	0.054 **	0.070 *	0.120 ***	-0.043	0.048	0.073
SysGMM_2	0.068	0.078	0.139 **	-0.017	0.004	0.164
Macro variables					**N= 243**	
FE_1	0.082 ***	0.054	0.138 ***	0.007	0.058	0.028
FE_2	0.063 **	0.035	0.108 ***	0.002	0.051	-0.006
SysGMM_1	0.001	-0.033	0.020	-0.029	-0.067	0.020
SysGMM_2	-0.001	-0.032	-0.039	0.032	-0.009	-0.089

Only if i and j from same country

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
Year*country FE					**N= 531**	
FE_1	0.027	-0.022	0.066 ***	-0.063	-0.001	-0.133 **
FE_2	0.021	-0.012	0.051 ***	-0.047	0.002	-0.093 **
SysGMM_1	0.034 ***	0.017	0.065 ***	-0.022	-0.014	0.076
SysGMM_2	0.033 *	0.034	0.121 ***	-0.094 *	0.025	-0.043
Macro variables					**N= 549**	
FE_1	-0.001	-0.002	0.068 **	-0.100 **	-0.037	0.035
FE_2	-0.006	-0.004	0.056 **	-0.096 **	-0.031	0.020
SysGMM_1	0.003	0.007	0.046 ***	-0.065 ***	-0.044	0.087 *
SysGMM_2	-0.023	-0.008	-0.009	-0.038	0.035	-0.078

Next, some robustness checks for Equation (2) are considered. The results are shown in Table 13. Again, the first panel shows the coefficients of the benchmark model from the previous section for convenience. The next panel displays coefficients of estimations in which the YTM spread is replaced by the AFC-spread, which measures the funding costs actually incurred by banks when issuing new bonds (see Annex II for a more detailed explanation). As can be seen, the positive relation between gross NPLs and funding costs largely prevails, with the exception of FE_1 and FE_2 when macroeconomic variables are used. However, splitting up gross NPLs into net NPLs and loan loss reserves reveals that this relation is driven by the former variable instead of the latter, hence the opposite of what is observed in the benchmark regression. Furthermore, the estimation of Equation (2) is repeated with a sample that is restricted to banking groups that also appear in the estimations of Equation (1) and Equation (3) as single banks, belonging to those banking groups, are part of the IMIR-sample (as described in Section 5, banking groups which are not in the baseline sample described in Section 3, have been included in the benchmark estimation). The third panel of Table 13 indicates that the relation between NPLs and funding costs does not change much when only IMIR banking groups are considered with the exception of the SysGMM_2 estimations, for which the relation between funding costs and loan loss reserves gets much stronger. Finally, the YTM spread is replaced by the YTM spread normalized for bonds with a maturity from 1-5 years (YTM_Spread_1_5) which is used as explanatory variable in Equation (3) and the controls for residual maturity are removed. The coefficients measuring the impact of gross NPLs on funding costs in the models with macroeconomic variables are smaller compared to the benchmark estimation and lose their statistical significance. However when gross NPLs are split the positive impact of loan loss reserves remains. To sum up, the robustness checks of Equation (2) suggest that there is indeed in impact of NPLs on funding costs, but that caution in warranted with regard to the question whether this impact is driven by net NPLs or loan loss reserves.

Table 13: Results for estimations of Equation (2) with alternative specifications

Modell	Gross_NPL_ TA (-1)	Net_NPL _ TA(-1)	LL_Res_ TA(-1)
Benchmark			
Year*country FE		**N= 603**	
FE_1	0.094 ***	-0.015	0.266 ***
FE_2	0.087 ***	-0.014	0.246 ***
SysGMM_1	0.023 **	-0.004	0.106 **
SysGMM_2	0.057 ***	0.044	0.080
Macro variables		**N= 613**	
FE_1	0.075 **	-0.092 **	0.328 ***
FE_2	0.071 **	-0.089 **	0.314 ***
SysGMM_1	0.021 **	-0.025	0.133 ***
SysGMM_2	0.050 ***	-0.015	0.153 *
AFC spread			
Year*country FE		**N= 413**	
FE_1	0.059 **	0.111 *	-0.037
FE_2	0.067 **	0.127 **	-0.042
SysGMM_1	0.031 ***	0.022 *	0.062
SysGMM_2	0.076 ***	0.079 *	0.043
Macro variables		**N= 481**	
FE_1	-0.040	0.013	-0.132
FE_2	-0.023	0.056	-0.161 *
SysGMM_1	0.039 ***	0.046 *	0.021
SysGMM_2	0.068 **	0.149 **	-0.087
Only IMIR banking groups			
Year*country FE		**N= 408**	
FE_1	0.111 ***	0.019	0.259 **
FE_2	0.108 ***	0.014	0.259 ***
SysGMM_1	0.052 ***	0.003	0.161 ***
SysGMM_2	0.094 ***	-0.028	0.281 **
Macro variables		**N= 426**	
FE_1	0.102 ***	-0.066	0.338 ***
FE_2	0.100 ***	-0.070	0.338 ***
SysGMM_1	0.048 ***	-0.021	0.182 ***
SysGMM_2	0.083 ***	-0.078	0.320 **

Table 13 continued

YTM spread_1_5 (no controls for residual maturity)			
Modell	Gross_NPL_ TA (-1)	Net_NPL _ TA(-1)	LL_Res_ TA(-1)
Year*country FE		**N= 603**	
FE_1	0.102 ***	0.013	0.244 ***
FE_2	0.095 ***	0.009	0.231 ***
SysGMM_1	0.020 *	-0.001	0.084 *
SysGMM_2	0.062 ***	0.052	0.087
Macro variables		**N= 613**	
FE_1	0.054	-0.093 *	0.277 ***
FE_2	0.049	-0.096 **	0.268 ***
SysGMM_1	0.017	-0.019	0.106 **
SysGMM_2	0.030	-0.031	0.138

7 Conclusion

The present paper tries 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 to non-financial corporations. The results indicate that the relation between the gross NPL stock and lending rates is somewhat ambiguous: it is positive in some but not in all specifications. Splitting up the gross NPL stock into net NPLs and loans loss reserves reveals that this ambiguity is mainly driven by loan loss reserves. They tend to offset the positive association between net NPLs and lending rates according to the results of some but not of all specifications for cases in which banks preserve an average coverage ratio. This offsetting effect is primarily found for specifications in which macroeconomic determinants are captured by several macroeconomic variables, whereas it is less pronounced when time-country fixed effects are used instead. It has to 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. If anything, results suggest that net NPLs tend to weaken this pass-through.

The relation between 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 being the main channel through which NPLs impact 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 in 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 as a potential future drag to the built-up of capital, 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. Hence one might think of the positive relation between lending rates and NPLs 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, results suggest that on the single bank-level net NPLs lead at least in situations in which the coverage ratio is particularly low to a higher markup over market rates but not alter the sensitivity of lending rates to market rates (the evidence is at least rather weak). Hence, one might argue 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 markup, the lending rate of the high NPL stock bank will be higher. Such a markup 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 has to be kept in mind that the analysis is focused on the single bank-level and takes macroeconomic conditions on the country level as given. Hence, it is implicitly assumed that the impact of NPLs held by a particular bank shows up in 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 finally what matters for monetary policy.

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Annex I: Bankscope (BS)- and SNL-data

Balance sheet information are taken from two different sources: from Bankscope (BS) (ORBIS Bank Focus since 2017) and from SNL. After merging the different data sources, there are slightly more observations with information for all variables if SNL-data is used compared to when BS-data is used. Thus, when available, SNL-data is employed.

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:

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

  Hence, it is 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 at least for four different years there is information from both sources BS and SNL: 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 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 are 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 completely deleted 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 as they 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 first differences or fixed effects in the econometric specifications).

Annex II: Calculation of the AFC- and YTM spread based on CSDB-data

In order to preserve some degree of homogeneity, not all debt instruments, for which the CSDB provides information, are used in order 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 kept, thus 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 BP or higher than 1500 BP) are removed from the sample. Subsequently, spreads are aggregated on 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 BP or higher than 1500 BP) 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. However, as only CSDB-data from 2010 to 2016 is used in the empirical analyses, the period covered by CSDB-data does not cause any restrictions.

The impact of the risk-free yield curve is eliminated by considering spreads instead of coupons and YTMs. However, it is likely, that also the spread over a risk-free rate depends on the maturity of the instrument as well. Thus, the spreads are calculated for each point in time separately 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. Those 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. For banks, for which there are no instruments in the 1-5 year bucket in a given month, but 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 on 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
- 2013m1-2016m12

- 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 AFC- and YTM spread for the 1-5 year are aggregated at 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 Equation (1).

In order to check the stability of the coefficients related to the net NPL variable and the loan loss reserves variable, the estimations whose 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, for each specification 100 different samples are generated, based on which the estimation is then conducted. The 100 different estimators for both variables are depicted in kernel density plots below for the FE_2 and SysGMM_2 specification.

The outputs consist of four separate graphs each: the first row refers to the density of coefficients referring to the net NPL and loan loss reserve variable. It shows both densities in the first graph (upper left) and the density for the differences between both coefficients in the second graph (upper right). The second row shows the density of coefficients referring to the interactions of the net NPL and loan loss reserve variable with the OIS swap rate.

Graphs on the left side depicting both densities allow conclusions on whether the respective coefficient remains systematically above / below zero when the underlying sample is altered and, hence, whether possible significant results displayed in the main text are confirmed. Graphs on the right-hand side allow conclusions on whether the coefficient referring to one variable lies systematically above / below the coefficient referring to the other variable.

Figure 3: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE_2 (Equation (1), time*country FE, related to Table 5, left panel)

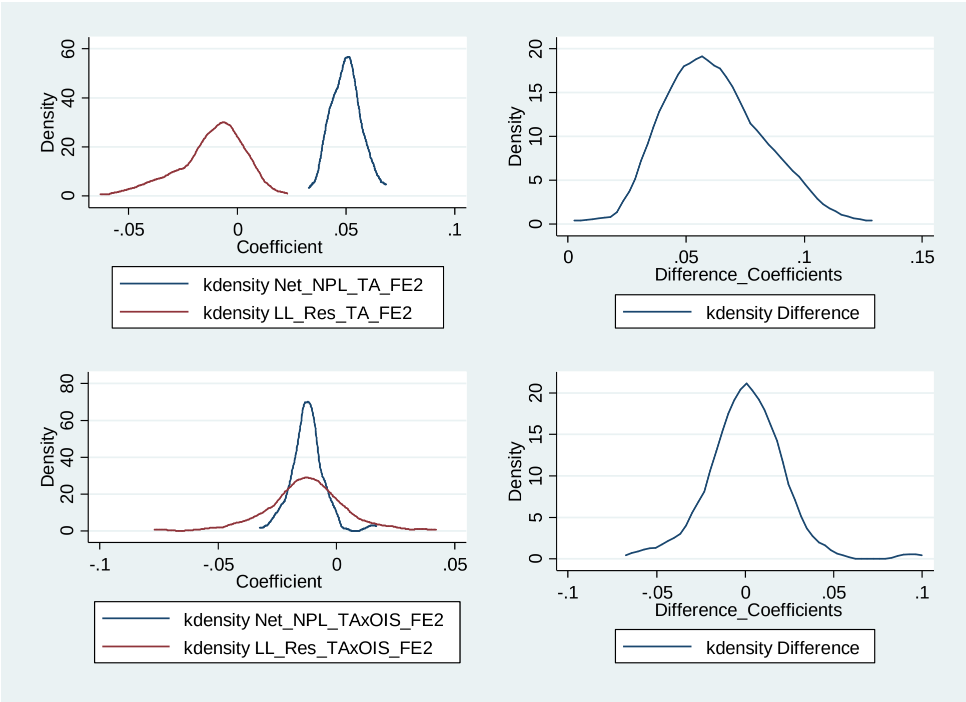


Figure 4: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM_2 (Equation (1), time*country FE, related to Table 5, left panel)

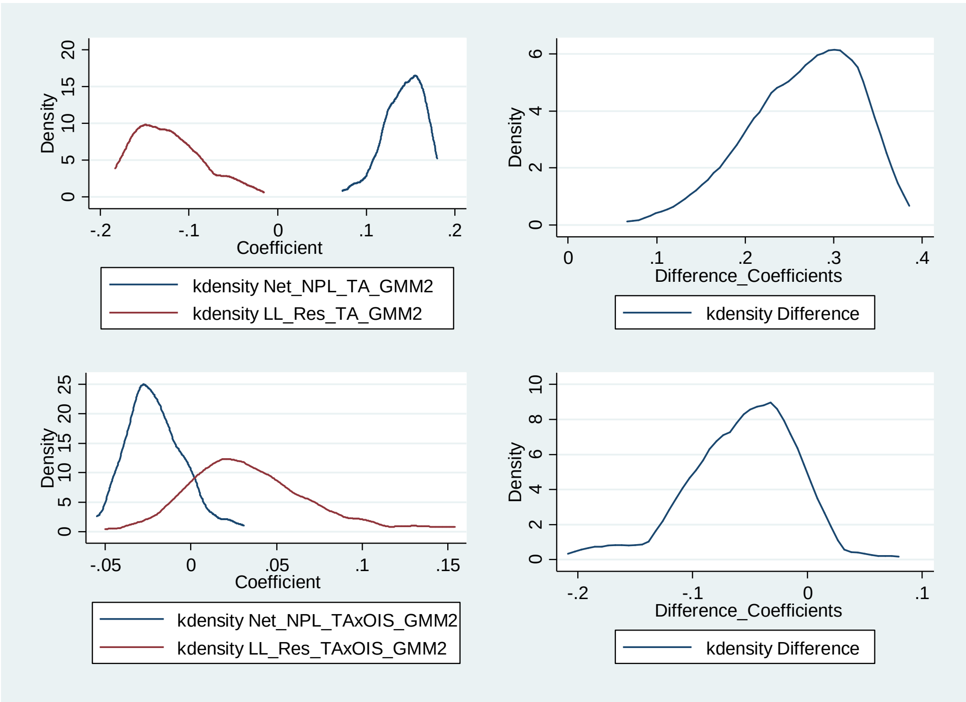


Figure 5: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE_2 (Equation (1), macroeconomic variables, related to Table 5, right panel)

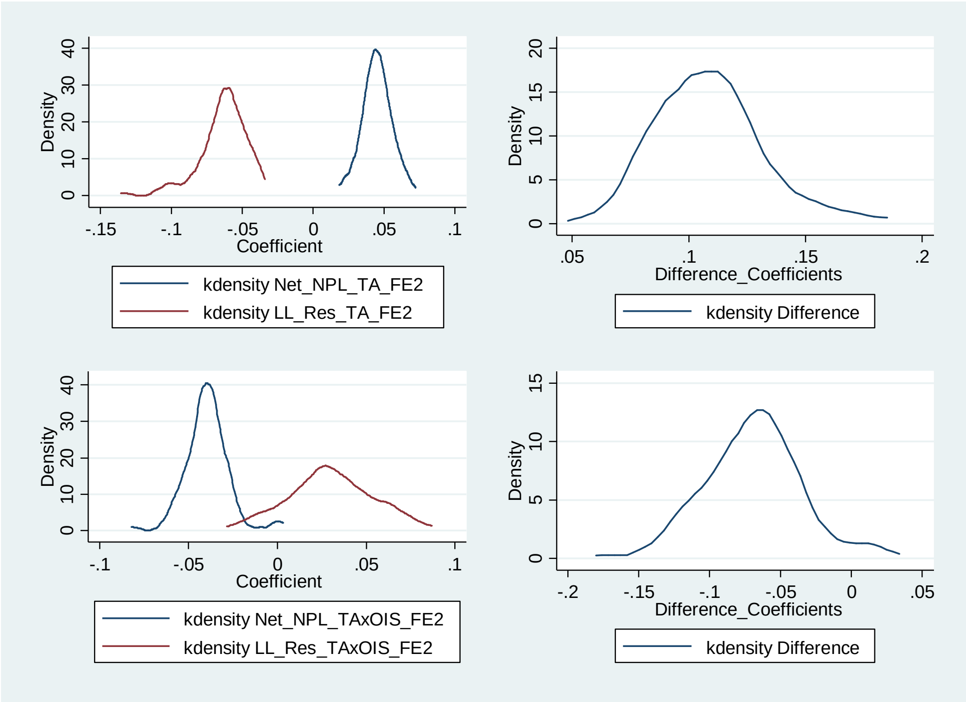
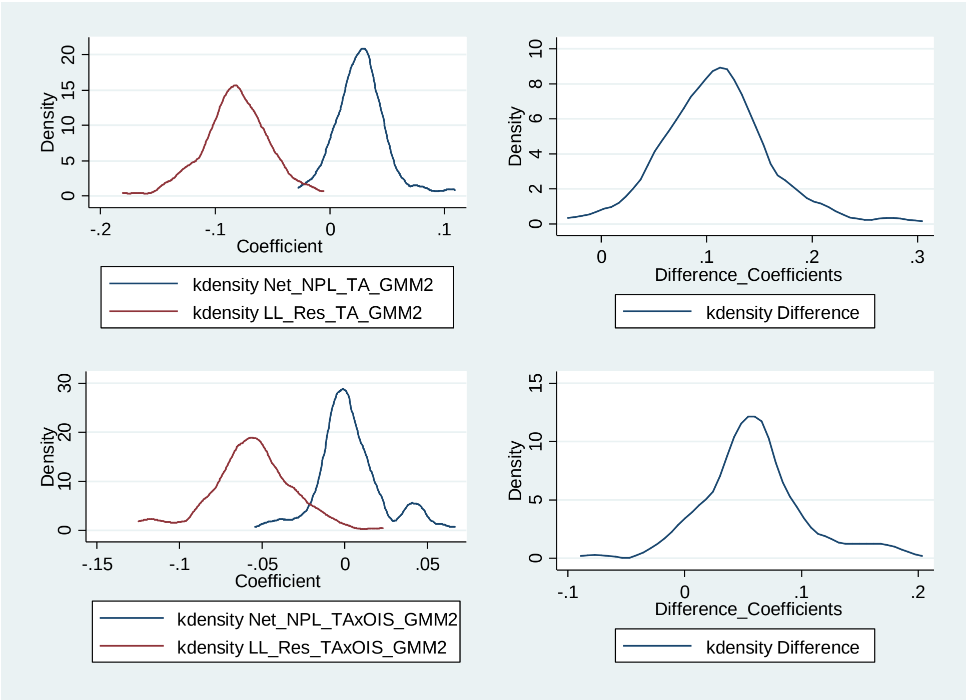


Figure 6: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM_2 (Equation (1), macroeconomic variables, related to Table 5, right panel)



Annex IV: Stability of estimated coefficients related to net NPLs and loan loss reserve variables in Equation (2).

In order to check the stability of the coefficients related to the net NPL variable and the loan loss reserves variable, the estimations whose results are presented in Section 5 have been repeated with altering samples. Altering samples is achieved by randomly picking 10 banking groups which are removed from the sample. In this way, for each specification 100 different samples are generated, based on which the estimation is then conducted. The 100 different estimators for both variables are depicted in kernel density plots below for the FE_2 and SysGMM_2 specification. The structure of the graphs is as in Annex III (however, there are no interaction terms to be estimated).

Figure 7: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE_2 (Equation (2), time*country FE, related to Table 7, left panel)

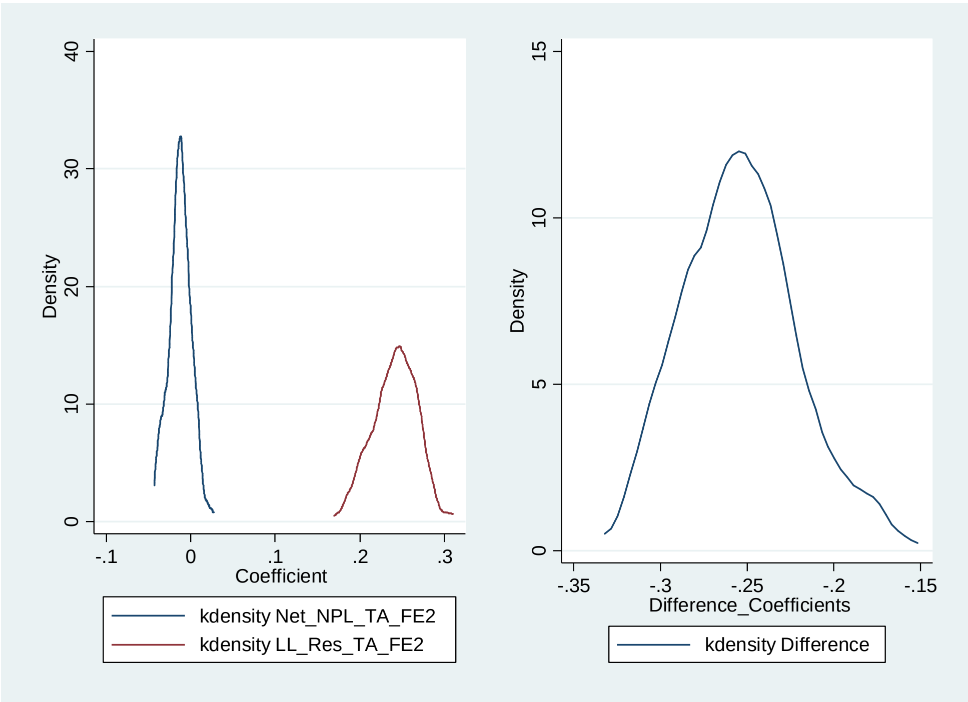


Figure 8: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM_2 (Equation (2), time*country FE, related to Table 7, left panel)

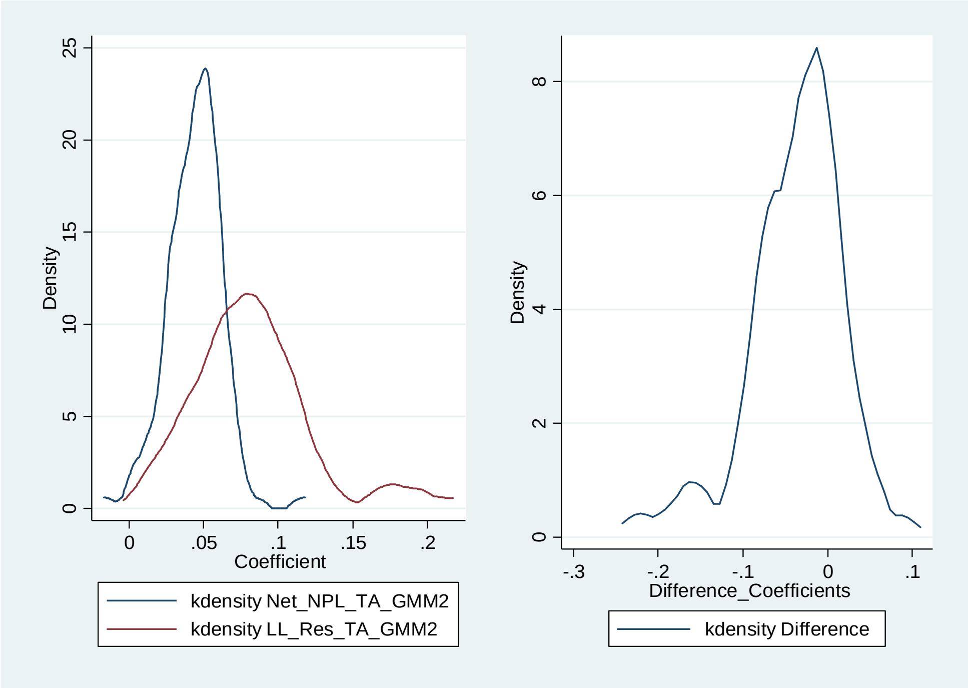


Figure 9: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE_2 (Equation (2), macroeconomic variables, related to Table 7, right panel)

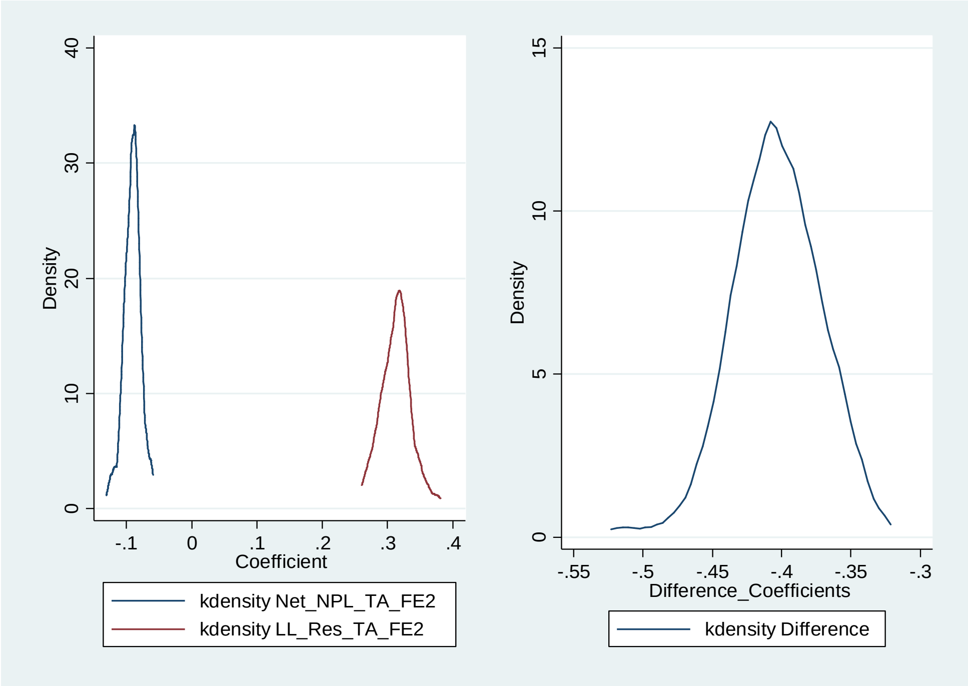
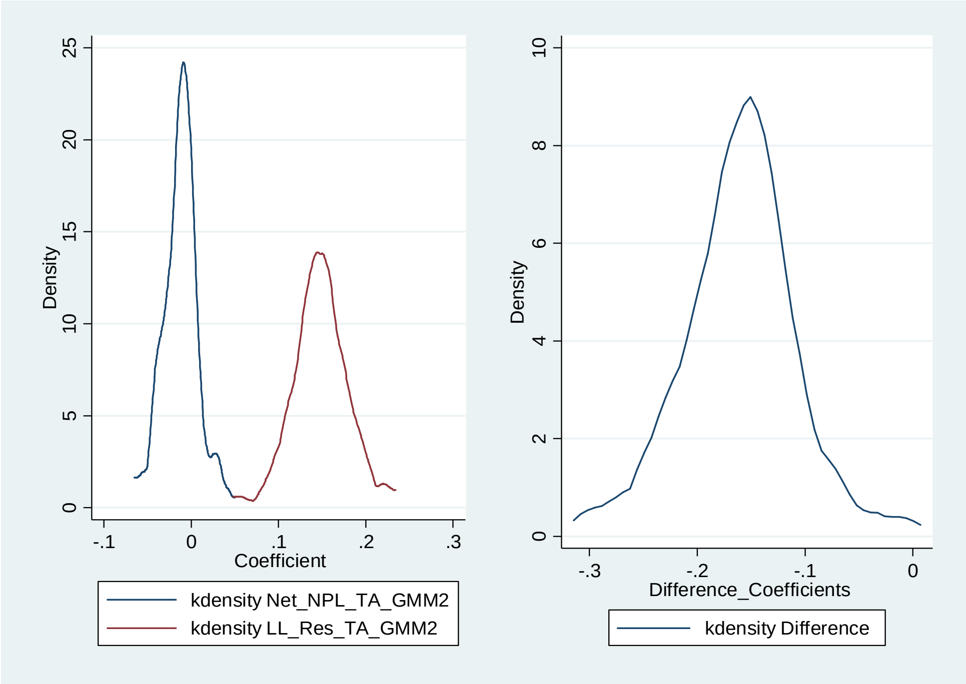


Figure 10: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM_2 (Equation (2), macroeconomic variables, related to Table 7, right panel)



Annex V: Stability of estimated coefficients related to net NPLs and loan loss reserve variables in Equation (3).

In order to check the stability of the coefficients related to the net NPL variable and the loan loss reserves variable, the estimations whose results are presented in Section 5 have been repeated with altering samples as described in Annex III for Equation (1)

Figure 11: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE_2 (Equation (3), time*country FE, related to Table 9, left panel)

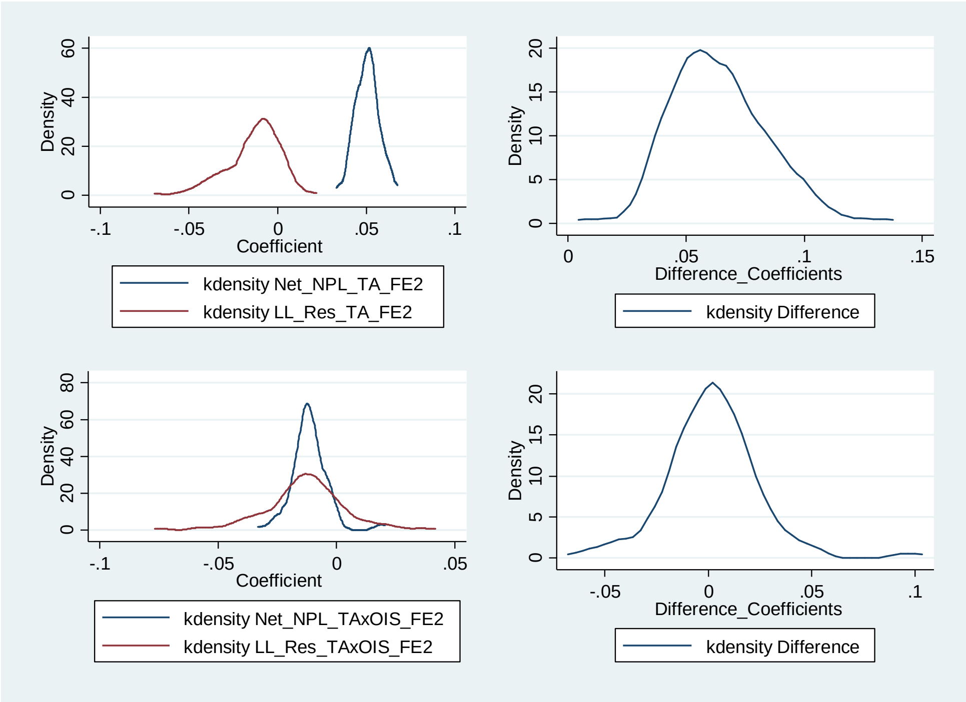


Figure 12: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM_2 (Equation (3), time*country FE, related to Table 9, left panel)

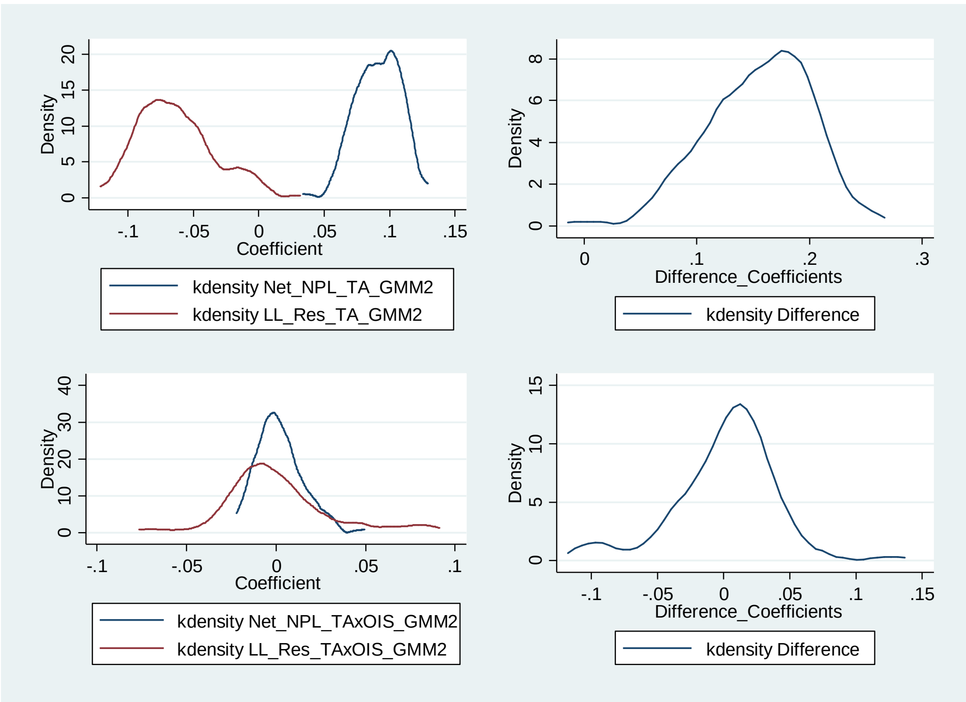


Figure 13: Stability of estimated coefficients related to net NPLs and loan loss reserves for FE_2 (Equation (3), macroeconomic variables, related to Table 9, right panel)

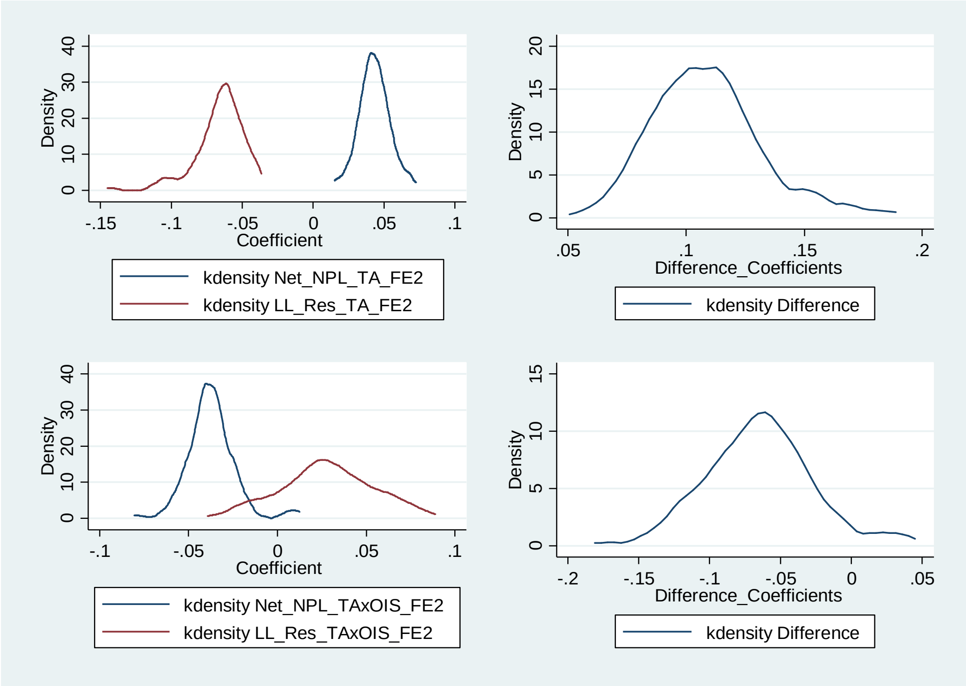
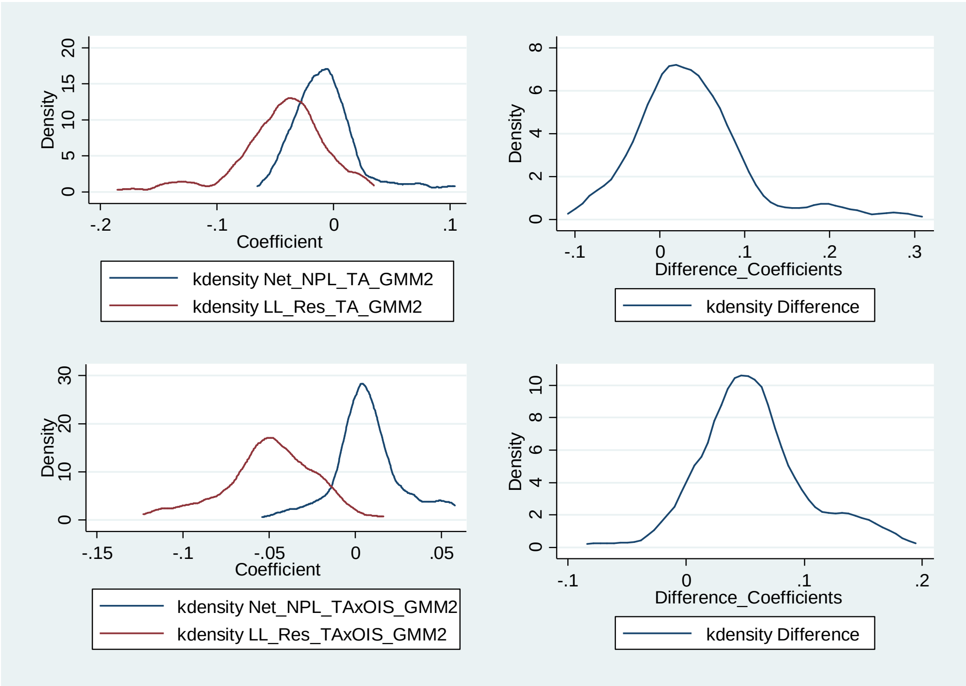


Figure 14: Stability of estimated coefficients related to net NPLs and loan loss reserves for SysGMM_2 (Equation (3), macroeconomic variables, related to Table 9, right panel)



Annex VI: Total effects of NPL-variables

The figures below graphically depict the overall impact of gross NPLs, net NPLs and loan loss reserves which result from combining the effects from the respective level variable and the interaction of the respective variable with the OIS-rate on lending rates. The figures show point estimates as well as 95 %-confidence intervals. They are based on the results displayed in Table 4 (gross NPLs) and Table 5 (net NPLs and loan loss reserves). In all cases, an increase of gross NPLs (as a share of total assets) of 2 percentage points (equal to the average increase on the banking group level between the beginning and the end of the sample), a coverage ratio of 45 % and an OIS-rate of roughly 20 basis points (both equal to sample mean) are assumed. This implies increases of net NPLs by (1-0.45) * 2 PP and of loan loss reserves by 0.45 * 2 PP.

Figure 15: Total effects of gross NPLs (based on results displayed in Table 4)

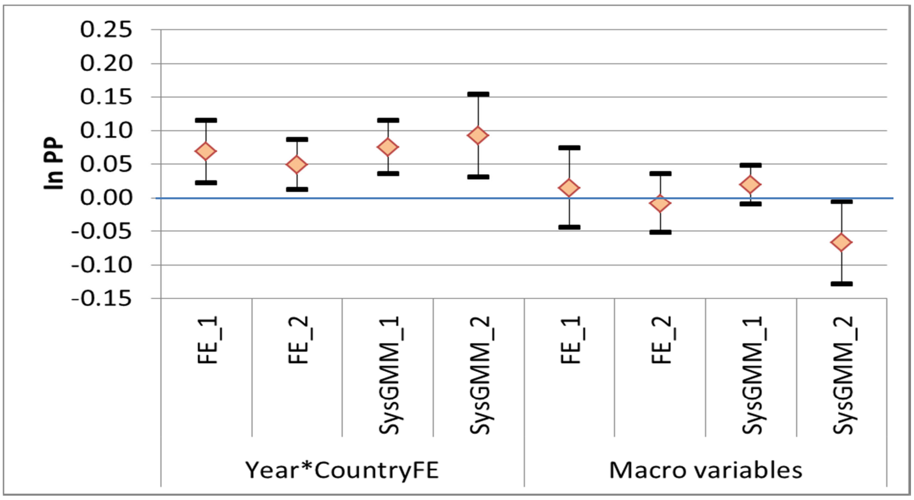


Figure 16: Total effects of net NPLs (based on results displayed in Table 5)

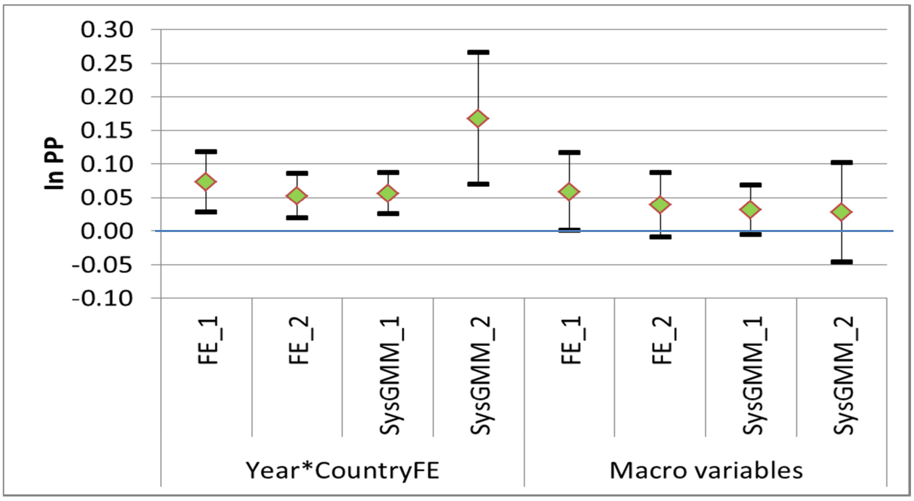


Figure 17: Total effects of loan loss reserves (based on results displayed in Table 5)

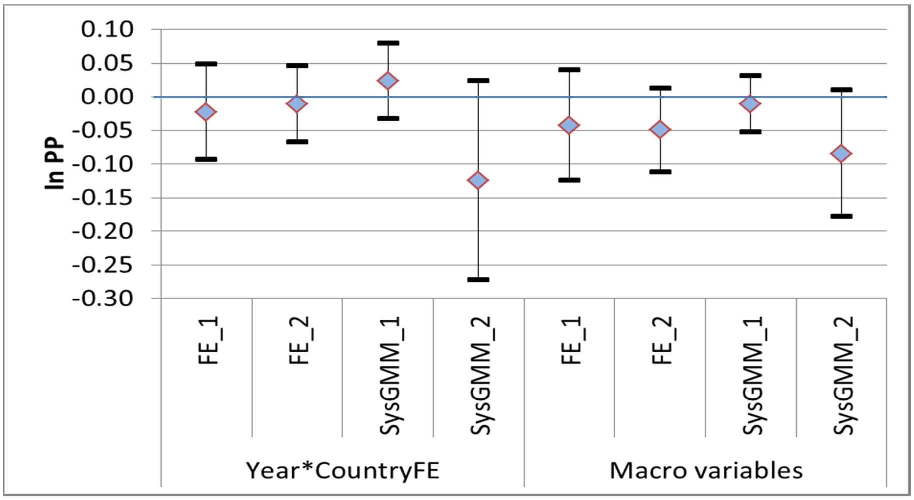


Figure 18: Total effects of net NPLs and loan loss reserves (based on results displayed in Table 5)