The effects of capital and provisioning requirements on bank lending and sales of non-performing loans: A theoretical and empirical assessment

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We develop a partial-equilibrium framework for studying banks' interest rate setting and sales of NPLs through a prism of two policy instruments, i.e. capital and provisioning requirements. We formally show that the effectiveness of policy instruments depends on the cost of banks' capital financing. We verify the model on the example of 13 euro-zone countries between 2005 and 2014. Our results suggest that (i) capital requirements are an important driver of banks' lending rates and provisioning requirements of sales of NPLs, (ii) NPLs, and unprovisioned NPLs in particular, seem to be a drag on effective monetary policy transmission and (iii) the quality of legislative and regulatory frameworks matter for an effective monetary policy and functioning of a distressed debt market. This study has direct implications for policy makers engaged in a clean-up process of banks' balance sheets to eventually unlock lending in the euro area.
JEL: E43, E58, G21, G28
Keywords: capital requirements, provisioning, non-performing loans, banking

The recent economic slowdown made a large portion of the European corporate sector insolvent, causing many of the corporate and retail loans non-performing. Consequently, loan-originating banks suffered from both deterioration of profitability as well as increases of funding costs due to higher riskiness of their portfolios. High levels of non-performing loans (NPLs) can be a drag on proper functioning of the banking sector and effective monetary policy transmission and they may make banks more reluctant to engage in new lending projects (European Central Bank, 2015). Recent studies suggest that clean-up of banks' (and also corporates') balance sheets are a necessary condition for more solid and sustained economic recovery in the euro area (European Central Bank, 2014; Bergthaler et al., 2015; Jassaud and Kang, 2015; International Monetary Fund, 2015).

The current economic environment of low growth discourages banks from addressing their distressed assets problem. The IMF estimates that write-off rates of the euro area banks remain low by international standards (6.2 percent), and are less than a quarter of that in the United States, despite the euro areas high stock

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of distressed debt. Limited capital buffers and low profitability (owing to weak loan demand and compressed interest margins) constrain banks capacity to clean up their balance sheets, especially in countries where impaired assets are high and the debt service capacity of borrowers remains low. Legislative bottlenecks and accounting rules may further delay timely loss recognition. Also the lack of a well-functioning market for distressed assets, and costly enforcement and foreclosure procedures, complicate the disposal of impaired assets. High restructuring costs have so far reduced banks incentives to comprehensively tackle distressed assets and resolve disruptions to debt servicing in an economically meaningful way.

The European Central Bank (ECB) and Iinternational Monetary Fund (IMF) stress that given the current level of impaired assets, their timely resolution is crucial to unlock lending in Europe (European Central Bank, 2014; International Monetary Fund, 2015). Currently, credit growth remains particularly slow in countries where banks report a high level of NPLs, insolvency procedures are weak, and the effectiveness of enforcement is low. The IMF delivers empirical evidence that euro-area banks with higher NPLs ratios in the years 2012 and 2013 have been lending less than banks with average (stable) asset quality operating in the same country under the same demand conditions (International Monetary Fund, 2015). Similarly, as a result of increased risk profiles in countries with high levels of NPLs the lending spreads tend to be higher, however it is likely that the exact disproportion of lending spreads is additionally affected by other country-specific characteristics, including solvency of the sovereign, political stability and overall risk profiles.

Euro-zone member states as well as the area-wide authorities have taken a number of steps to support the corporate and banking sectors, including improvements in the domestic regulatory frameworks, strengthening of the financial supervision and recent plans to develop the Capital Markets Union (CMU). These efforts are however not sufficient in the face of embarrassingly high levels of NPLs, limited write-offs and ever-greening practices. The IMF stresses that supervisors should push towards swift loss recognitions and prompt foreclosure non-viable debt. In this respect the country-wide rules should include *inter alia* conservative application of accounting standards and collateral valuation, higher provisioning levels, stronger capital requirements and prudential oversight.

Having pointed this out, the goal of this paper is therefore twofold. Firstly, we build a theoretical partial-equilibrium model which studies the banks' decision-making processes through a prism of interest rate setting and sales of NPLs. We pay close attention to two policy instruments which can potentially play a role in alleviating the bottlenecks of balance sheets' clean-ups, i.e. capital and provisioning requirements. Secondly, we verify the theoretical predictions empirically on the sample of 13 euro-zone countries between 2005 and 2014.

There is a broad literature on the role of capital requirements and banks' performance, especially in the view of the forthcoming implementation of Basel III.

For instance, in the euro area the estimated impact of 1 pp increase in capital requirement ranges from 14.3 bp (Slovik and Cournede, 2011) to 18.8 bp (Sutorova and Teply, 2013) increases in banks' lending rates. Our results also confirm that banks transmit extra capital charges into the lending rates, however, to a smaller extent of around 5 bp. We find evidence that NPLs, and in particular unprovisioned NPLs, are a significant driver of banks' lending spreads. Those results support the view that NPLs are a drag on monetary policy transmission in the euro area and therefore remain a priority policy area to restore bank lending (European Investment Bank, 2014; Bergthaler et al., 2015).

The role of provisioning requirements on bank lending is not yet fully explored. Bouvatier and Lepetit (2012) study the dependence of lending rates on provisioning requirements, showing that backward-looking provisioning systems are characterized by more pro-cyclical business cycle. On the contrary the authors show that forward-looking provisioning systems do not suffer from this drawback. Our research extends the framework proposed by Bouvatier and Lepetit (2012) by allowing banks to sell their non-performing exposure.[1] As it is shown later, our results are independent on the nature of provisioning system chosen.

To our best knowledge, this is the first attempt to formally quantify the effectiveness of policy actions in facilitating the sales of NPLs and therefore supporting the functioning of the distressed debt market. Our theoretical as well as empirical findings support the effectiveness of provisioning in promoting sales of non-performing exposure. We also find evidence that the performance of the distressed debt market largely depends on the resolving insolvency environment, confirming observation of Bergthaler et al. (2015).

The remainder of the paper is organized as follows. Section I describes the theoretical framework. Section II comprises the empirical investigation which is additionally supported by robustness checks in Section III. Finally, Section IV concludes.

I. Theoretical framework

We develop a partial equilibrium model where banks are allowed to sell a fraction of their non-performing loans' portfolio. Our methodology is similar to the framework proposed by Bouvatier and Lepetit (2012) but we introduce a market for non-performing assets. The demand-side of this market consists of companies with resolution technology which is superior to banks' technology. Therefore we assume that for any NPL which is bought from banks they can incur profits by either restructuring or liquidating the bad debt.

We assume that in the economy there is a number N of banks, operating in the monopolistically competitive environment. Each bank is initially endowed with equity capital $K_{i,t}$ and risk-free securities $S_{i,t}$. Banks are active in their

[1] Although in practice there are subtle differences between the definitions of non-performing loans and non-performing exposure, to streamline the text throughout the text we treat those as synonyms.

fields of specialization, denoted by i. Each bank performs intermediation activity between depositors and borrowers by collecting deposits and giving long-term flexible-rate loans. In each period t each bank collects $D_{i,t}$ of deposits and gives specialized loans in the amount of $L_{i,t}$. We assume that within the economy there is a fully-fledged deposit insurance scheme to mitigate the risk of sudden deposits' withdrawal. Banks compete on the loan rate so that the amount of loans given by a bank depends on the relative attractiveness of the loan rate on the background of other banks.

The deposit and loan contracts are signed at the beginning of each period. Loans are granted at the interest rate of $r_{i,t}$ which are paid to the bank at the beginning of the next period. The borrowers' ability to pay the interest depends on the exogeneous business cycle. In times of prosperity a larger fraction of borrowers can finance their liabilities, benefiting the banks. On the other hand, in times of economic slowdown, borrowers' income is reduced being a drag on the debt's repayment and causing cash-flow mismatch in banks. The proportion to which banks' loans are non-performing in each period is denoted by $\theta_t \in [0,1]$. Banks hold reserves against the potential losses in the amount of $LLR_{i,t}$, which evolves according to the standard law of motion

$$LLR_{i,t} = LLR_{i,t-1} + LLP_{i,t-1}, \tag{1}$$

where $LLP_{i,t-1}$ denotes the new provisions taken in the previous period. The bank's balance sheet constraint implies that

$$L_{i,t} + S_{i,t} = D_{i,t} + K_{i,t} + LLR_{i,t}. \tag{2}$$

The regulator imposes the economy-wide provisioning rules for banks' bad assets in the amount of $h_0 \geq 0$ of the non-performing exposure. The exact amount of provisions depends on the on the quality of bad assets, which we denote by their standardized market price $x_{i,t} \in [0,1]$. We introduce the quality of assets in the provisioning rules for two reasons. Firstly, this complies with the International Financial Reporting Standard (IFRS) on the value of provisions, which should be booked at the "probability-weighted expected value" (see for instance International Accounting Standard 37 (European Commission, 2009)). Secondly, many domestic provisioning systems take into account quality of bad assets explicitly. For instance, in Croatia loans which are 90 days past due are provisioned at 10% level whereas loans which are one year after deliquency are provisioned at 20% or 30% levels, depending on whether the collateral was activated. We book the provisioning as coming from the bank's equity base.[2]

Since provisioning of bad assets reduces banks' profits, banks can decide to sell a fraction $\alpha_{i,t} \in [0,1]$ of NPLs on the secondary market. Sold NPLs have

[2]We do this for transparency reasons as loan loss provisions are booked in the banks' income statements. Bouvatier and Lepetit (2012) assume that the provisioning reduces the value of banks' loan portfolio. Nevertheless, this booking assumption does not influence our theoretical investigation.

similar interpretation to the write-offs with the exception that banks receive extra liquidity from selling the NPLs. To keep the model simple, we therefore do not include the write-offs explicitly but their responsiveness to policy instruments is the same as for sales of the NPLs. The provisioning rules apply to the remaining non-performing exposure only. Bad assets are sold at price $x_{i,t}$, depending on the NPL's market conditions. We can formally rewrite the amount of provisions in period t as

$$LLP_{i,t} = h_0 \theta_t (1 - \alpha_{i,t})(1 - x_{i,t}) L_{i,t}. \tag{3}$$

Since the provisioning rule includes explicitly the quality of assets and therefore focuses on potential losses, parameter h_0 is allowed to be above 1. In fact, Eq. (3) represents a backward-looking provisioning environment as described by Bouvatier and Lepetit (2012). We consider such a setting as it allows capturing the dynamics of the NPL market explicitly without the need to assume any steady-state equilibrium of the NPLs in banks' balance sheets. Our theoretical and empirical analyses fully hold, however, for the forward-looking system as well, substituting the time-dependent NPL formation in Eq. (3) by its steady-state equivalent.

In our environment banks are conservative, i.e. the sold non-performing exposure is invested in the risk-free assets, together with banking capital and loan loss reserves. This makes the risk-free securities equal

$$S_{i,t} = LLR_{i,t} + K_{i,t} + \alpha_{i,t} \theta_t x_{i,t} L_{i,t}. \tag{4}$$

This assumption assures that capital and loan loss reserves are fully liquid and can therefore absorb any possible losses. It can be however a source of limited banks' profitability, which we discuss in detail later.

The demand for the NPLs is given exogeneously by companies which are more effective in restructuring or enforcing liquidation of troubled debt. Similarly to Henzel et al. (2008) we assume that the inverse demand function is of the form

$$x_{i,t} = \left(\frac{\alpha_{i,t}}{\alpha_t} \right)^{-1/u} \left(\frac{L_{i,t}}{L_t} \right)^{-1/u} x_t, \tag{5}$$

where x_t, α_t and L_t represent the average area-wide variables and $u > 1$ is a measure of market power.[3]

Similarly, each bank faces a regulatory capital requirement in the amount of $k_0 \in [0, 1]$ on the risky assets. We distinguish between two types of risky assets, i.e. performing loans and non-performing loans. Performing loans have a standardized weight of 1 and non-performing loans have a weight of $W \geq 1$. Risk-free securities

[3]By market power we mean the degree of substitutability between the financial securities. The higher the substitutability, explicitly captured by u, the lower the market power of a bank.

have a zero weight. Accordingly, we can represent the capital constraint as

$$K_{i,t} \geq k_0 \left[(1-\theta_{i,t})L_{i,t} + W(1-\alpha_{i,t})\theta_t L_{i,t}\right]. \tag{6}$$

To close the model we assume that the demand for loans is given exogeneously, similarly to Henzel et al. (2008), as

$$L_{i,t} = \left(\frac{r_{i,t}^L}{r_t^L}\right)^{-\zeta} L_t, \tag{7}$$

where ζ is again a measure of bank's market power (similar to the market power in the NPL market) and r_t^L represents the average economy-wide interest rate on loans.

The objective of each bank is to maximize the expected discounted flow of dividends by selecting optimal interest rates and deciding how many NPLs to sell to the market. Formally, the optimization problem of an individual bank becomes

$$\max_{r_{i,t}^L,\alpha_{i,t}} \mathrm{E}_t \sum_{t=0}^{\infty} \beta^t \Delta_{i,t}, \tag{8}$$

where β is the discount factor and

$$\Delta_{i,t} = r_{i,t}^L(1-\theta_t)L_{i,t} + r_t^M S_{i,t} - r_{i,t}^M D_{i,t} - LLP_{i,t} + K_{i,t} - K_{i,t+1}, \tag{9}$$

with r_t^M being the market interest rate paid on debt. Each bank operates under the balance-sheet constraints given by Eqs. (2), (1), (3), (4), (5), (6) and (7).

A. *Optimal banks' behaviour*

We solve the model with a constant discount factor β as well as the time-varying discount factor $\beta_t = 1/(1+r_t^M)$, however, for clarity reasons below we present the derivation for the former only.[4] In symmetric equilibrium, the first-order conditions imply the following optimal $r_{i,t}^L$ and $\alpha_{i,t}$ equalities

$$\begin{aligned} r_{i,t}^L(1-\theta_t) = \frac{\zeta}{(\zeta-1)} \big[& k_0\lambda_{i,t}(1+\theta_t(W-1)) + r_t^M \\ & + h_0\theta_t(1-x_t)(1-\beta r_{t+1}^M)\big], \end{aligned} \tag{10}$$

[4]The inference on the time-dependent discount is the same as with the constant one except for the condition on the capital requirement. As it is described below, the banks' behaviour depends on the shadow price of capital, which in the case of a constant discount factor is $\lambda_{i,t} = \max[0, (1-\beta)/\beta - r_t^M]$ and in the time-varying discount factor it is $\lambda_{i,t} = \max[0, r_{t-1}^M - r_t^M]$. The details on derivations can be found in Appendix.

$$\alpha_{i,t} = \frac{h_0 x_t (1-\beta r^M_{t+1})}{u\left(Wk_0\lambda_{i,t} + h_0\left(1-\frac{u-1}{u}x_t\right)\left(1-\beta r^M_{t+1}\right)\right)}, \tag{11}$$

where $\lambda_{i,t} \geq 0$ is a Lagrange multiplier associated with capital constraint (Eq. 6).

The right-hand side of Eq. (10) represent the marginal returns on performing loans. It is therefore scaled by the non-performing exposure $1/(1-\theta_t)$ and a mark-up on the marginal lending costs $\zeta/(1-\zeta)$. The marginal cost of lending depends then on three main components, i.e. the risk-adjusted cost of capital associated with the capital requirement $(k_0\lambda_{i,t}(1+\theta_t(W-1)))$, the cost of debt (r^M_t) and the extra cost of net debt associated with changes in the loan loss reserves $(h_0\theta_t(1-x_t)(1-\beta r^M_{t+1}))$.

The fraction of sold NPLs depends on the trade-off between the marginal net gains from selling the non-performing exposure $(h_0 x_t(1-\beta r^M_{t+1}))$ and marginal benefits of keeping it in house. Those include two main factors. Firstly, extra capital kept against the risk-weighted NPLs (in form of capital, i.e. $Wk_0\lambda_{i,t}$) is allocated in the risk-free securities at a positive interest. Secondly, limiting the sale of NPLs drives up their market price which decreases the realized losses on the bad debt kept on the balance sheets $(h_0(1-(u-1)/ux_t)(1-\beta r^M_{t+1}))$. The profitability of this channel depends on the market power of a bank. Should a bank be a price taker in the NPL market, i.e. $u \to \infty$, it would sell non of the non-performing exposure at the desired price. On the other side, if a bank admire some degree of market power, i.e. $u < \infty$, it would sell NPLs up to the point where marginal benefits of the transaction are equal to the marginal costs.

Parameter $\lambda_{i,t}$ represents a shadow price of breaching the capital constraint and can be viewed as a carry of risk-free securities or their net returns.[5] In the model, each bank obtains capital at the cost of the last-period promised shareholders' income. Therefore, the cost of capital or/and provisions is $(1/\beta)-1$ or r^M_{t-1} in the constant and time-varying discount factor environments, respectively. Since capital is reinvested in the risk-free securities at the rate r^M_t, if the revenues from today's securities exceed the costs of financing them, a bank is generating risk-free profit from any unit of capital. The capital constraint is non-binding therefore as in the equilibrium banks could relatively cheaply attract new capital. Consequently, extra capital or provisioning requirements are indeed welcomed by banks as a source of income and any losses can be offset by rebalancing the funding structure, i.e. keeping more retained capital or collect new capital. Nevertheless, if carry of risk-free securities is negative, capital is expensive and a bank is at the capital constraint. It has to either find extra revenues from assets or/and reshuffle its assets' composition not to breach the regulatory capital requirement.

[5]Carry describes the difference between profits from assets and costs of financing. If profits are higher (lower) than costs we say that an instrument has a positive (negative) carry (Jassaud and Kang, 2015).

This indeed creates incentives to increase the rates on loans or/and to sell non-performing exposure.

In the model it is not the level of interest rates *per se* but its relation to the economic environment and its dynamics which drive the banks' behaviour. The optimal solution implies that the effectiveness of the various policy instruments depends on the cost of banking capital, or the carry of risk-free securities. If capital is expensive banks are at the minimum capital constraint. Any policy which operates in relation to the capital constraint will therefore be effective as banks incentives are aligned to those of a policy maker. Should capital be cheap, banks will hold capital at the equilibrium levels above the minimum capital requirement so that this policy-intervention channel will be switched off until capital becomes expensive again. Interestingly, if banks run perfectly matched books (in a sense that carry of risk-free securities is zero), the aforementioned policies are ineffective either.

Let us consider the effects of capital and provisioning requirements on bank interest-rate setting and sales of non-performing exposure. In an environment when capital is expensive, any increase in regulatory requirements bank will compensate by either demanding higher retail interest rates or more sales of NPLs. Nevertheless, should capital be cheap increments in any of the two policy instruments will result in larger capital and provisioning holdings, without any direct effect on retail interest rates or NPL market.

This observation leads to a conclusion that the effectiveness of changes in policy is asymmetric and heavily depends on the interest-rate environment, or to put it differently, on the cost of capital financing. Table 1 depicts influence of the main policy and macroeconomic variables on interest rate setting and sale of NPLs, implied by Eqs. (10) and (11).[6]

Capital requirements and risk weight have simillar effects for the lending rates and sales of non-performing exposure. When capital is costly, and therefore banks prefer to stay at the capital requirement, any increases in the regulatory requirements are transmitted to the lending rates. The effect on sales of NPLs is negative as the income from sold NPLs is reinvested in the risk-free securities and therefore if capital is expensive it will generate additional losses to a bank. Therefore, to avoid those losses in equilibrium the cost of extra capital requirement is offset by lower sales of NPLs. This effect largely depends on the ability of banks to reinvest the liquidity from sold NPLs into higher-yield instruments. Should a bank be able to exploit this possibility, the effects of capital requirements on sales of NPLs will be parallel to the effect on lending rates. In environments of low cost of capital, capital requirements are not transmitted to either lending rates of sales of NPLs.

Provisioning requirements always positively impact the lending rates, as they in fact increase cost of banks' funding. In case of sales NPLs, provisioning requirements will only be effective if capital is expensive. In a low-cost-of-capital

[6]We look at the marginal effects of changes in the variables of interest on the interest rates and sales of NPLs.

TABLE 1—MODEL-IMPLIED EFFECTS OF CHANGES IN THE POLICY AND MACROECONOMIC VARIABLES ON BANKS' INTEREST RATES AND SALE OF NON-PERFORMING EXPOSURE.

	lending rates ($r^L_{i,t}$)		sale of NPLs ($\alpha_{i,t}$)	
	high cost	low cost	high cost	low cost
capital req. (k_0)	+	0	-	0
risk weight (W)	+	0	-	0
provisioning req. (h_0)	+	+	+	0
amount of NPL (θ_t)	+	+	0*	0*
price of NPLs (x_t)	-	-	+	+
rates today (r^M_t)	+	+	0*	0*
rates tomorrow ($\mathrm{E}r^M_{t+1}$)	-	-	-	0
loan market comp. (ζ)	-	-	0*	0*
NPL market comp. (u)	0*	0*	-	-

Notes: Symbol + means that an increase in the policy or macroeconomic variable is associated with an increase in the response variable (a positive effect). Symbol - means that an increase in the policy or macroeconomic variable is associated with a decrease in the response variable (a negative effect). Symbol 0 indicates no effect. Columns "high cost" describe the effects under high cost of capital, i.e. in the low or falling interest rate environment. Columns "low cost" describe the effects under low cost of capital, i.e. in the high or rising interest rate environment. * marks that a variable is not present in the optimal solution.

scenario, provisioning requirements do not impact the sales of NPLs, as argued above.

NPLs themselves seem to be transmitted to the lending rates, being in line with the vast literature on the topic (European Investment Bank, 2014; European Central Bank, 2015). They do not show any impact on sales of NPLs signaling that in equilibrium the behaviour of banks does not depend of the absolute amount of bad assets. Of course, the underlying assumption is that bank's NPLs are homogeneous and valued at the same market price. Should portfolio structure of NPLs be more complex, it can also impact the banks' decision-making process. This is however outside the scope of this paper and we leave it for further consideration.

Market price of NPLs, a proxy for NPLs' quality, has a negative effect on lending rates and positive on sales of NPLs, independent on the cost of capital. This makes clear sense as the better the quality of assets, the better condition of banks' balance sheets and eventually lower funding costs which are transmitted in equilibrium to the lending rates. Also, the higher the quality of NPLs the smaller the incurred losses on their sales so that banks would be willing to engage in more transactions.

Today's debt interest rates, i.e. the market interest rates, are directly transmitted to the banks' lending rates, being in line with both theoretical and empirical literature (Woodford, 2003; European Central Bank, 2015). The sales of NPLs are however independent on the market interest rates. The debt interest rates tomorrow have the opposite effect. They have always a negative impact on the lending rates and, in case of high cost of capital, also a negative effect on sales on NPLs. This is the result of banks' dynamic optimization process and discounting of future cash flows. If the interest rates are expected to be higher in the next period, in equilibrium banks will benefit from charging lower lending rates today as they will be compensated by higher rates tomorrow. Similarly, since the cash flows from sold NPLs is reinvested at the debt interest rate, if tomorrow's rates are expected to be higher than today's, banks will be willing to postpone the sales of NPLs to the next period as it yield higher discounted income.

Substitutability within the loans' and NPLs' markets have always negative effects on lending rates and sales of non-performing exposure, respectively. This indeed stems out from a bank's market power and the ability to dictate the market price. A bank will exploit the possibility of charging higher lending rates to customers as well as selling more NPLs at a higher price.

II. Empirical investigation

We verify the effects of the main policy and macroeconomic variables on the banks' behaviour, implied by the theoretical framework (see Table 1), in an empirical exercise. In particular we estimate the structural equations, characterizing banks' interest rate setting and sales of non-performing exposure.

Three caveats of the analysis have to be pointed out. Firstly, the data availability makes us to group the capital-related variables, i.e. the capital requirement and risk weight. Therefore in the empirical investigation we assume $W = 1$. Both variables are captured in the regulatory capital adequacy ratios so that we view them as being complementary. Similarly, both variables have the same effects on the dependent variables.

The second caveat includes the future interest rates' dynamics in both equations. Since the interest rates are showed to be an autoregressive process (Woodford, 2003), it can bring the reverse causality problem to the estimation procedures. We therefore exclude this variable from the empirical regressions.[7]

The last caveat concerns the banks' market-power. In the theoretical assessment Bouvatier and Lepetit (2012) calculate those unobservables from the steady-state equalities. Similarly we consider those parameters bank-specific and include them in the bank fixed effects.

Eqs. (10) and (11) do not have canonical functional representations. Therefore, we rely on functional approximations of the marginal effects of individual variables. Consequently, we estimate them in the first differences which also accounts for possible nonstationarity bias.[8]

We treat the dynamics of sovereign bond yields as a proxy for cost of capital

[7]We confirm the findings with the specifications which include the next-period's interest rates in the rational expectations setting. For clarity of exposition we do not present the results here, however, they are available upon request.

[8]All the variables are panel-stationary in the first differences according to the Fisher test for panels at the standard significance levels.

financing. Although one would perfectly apply more straightforward measures of cost of capital, this one seems to be the most consistent with the proposed theoretical framework. As a possible direction for future studies, one could think of alternative indicators of the cost of capital, including the returns on equity (RoE) or dividend payments.

To account for possible nonlinear effects resulting from the evolution of the relative cost of capital, we add an interaction term with $I(ENV_{ct})$ to each independent variable which has a different marginal effect in a low- and high-cost-of-capital environments (see Table 1). Variable ENV_{ct} can be either $HIGH_{ct}$ in a high or $RISING_{ct}$ in a rising interest-rate environment. Therefore, the interacting term $I(ENV_{ct})$ is a dummy which takes value 1 if the debt interest rates are above the country's average (constant discount factor seting) or are rising (time-varying discount factor setting).

The functionals of marginal effects of any of the independent variables in the RHS of Eq. (10) are linear. Therefore, in the empirical investigation we use a functional approximation of Eq. (10) of the form

$$\begin{aligned}\Delta RATE_{ict} = &\beta_0 + \beta_{k0}\Delta CAP\_RATIO_{ict} + \beta_{k0_{HR}}\Delta CAP\_RATIO_{ict} * I(ENV_{ct}) \\ &+ \beta_{h0}\Delta LLR_{ict} + \beta_{\theta}\Delta NPL_{ict} + \beta_x \Delta RI\_RATE_{ct} + \beta_r \Delta YIELD_{ct} \\ &+ \mu_i + \gamma_{ct} + \varepsilon_{ict}.\end{aligned} \tag{12}$$

We denote by $RATE_{ict}$ the interest rates individual banks charge on the new loans, CAP_RATIO_{ict} is the total capital ratio, LLR_{ict} are the loan-loss reserves, NPL_{ict} is the fraction on non-performing exposure to gross loans, RI_RATE_{ct} is the economy-wide recovery rate of non-performing assets (a proxy for price of NPLs following Laryea (2010)) and $YIELD_{ct}$ is the yield on 5-year general government bonds. Indices i, c and t correspond to the bank, country and time dimensions, respectively, and Δ is the first-difference operator. In the regressions we correct for bank-specific (μ_i) and country-year fixed effects (γ_{ct}). Component ε_{ict} denotes the standard error term.

We carry out a similar linear experiment and estimate the responsiveness of the sales of the non-performing exposure as a function of model-implied exogenous factors. The basic equation has the form

$$\begin{aligned}\Delta SALE_{ict} = &\beta_0 + \beta_{h0}\Delta LLR_{ict} + \beta_{h0_{HR}}\Delta LLR_{ict} * I(ENV_{ct}) \\ &+ \beta_{k0}\Delta CAP\_RATIO_{ict} + \beta_{k0_{HR}}\Delta CAP\_RATIO_{ict} * I(ENV_{ct}) \\ &+ \Delta RI\_RATE_{ct} + \mu_i + \gamma_{ct} + \varepsilon_{ict}.\end{aligned} \tag{13}$$

The variable specification is parallel to Eq. (12) with the exemption of variable $SALE_{ict}$ which denotes the empirical representation of model variable $\alpha_{i,t}$, i.e. the fraction of NPLs which are sold by bank i in country c in period t. Also, we add the interaction terms $I(ENV_{ct})$ to the loan-loss reserves, as indicated by

Table 1.

It should be pointed out that Eq. (11) has nonlinear functionals for the marginal effects of each of the independent variables which purely linear model could miss. To at least partially account for those, we carry out a simple functional exercise on Eq. (11). We begin by an observation that in a low/falling interest rate environment ($\lambda_{i,t} > 0$) and under the assumption of banks' low market power ($u \to 1$) and high average recovery rates ($x_t \to 1$), Eq. (11) can be expressed as a logit function.[9] Therefore, as a model extension, we assume that the empirical effects of independent variables possibly affect the sales of the non-performing portfolio through the logit functional. This leads us to a logit-extension of Eq. (13)

$$\Pr(SALE_{ict} > SALE_{ict-1}) = \frac{\exp(z_{ict})}{1 + \exp(z_{ict})}, \tag{14}$$

where

$$\begin{aligned} z_{ict} &= \beta_{h0}\Delta \ln LLR_{ict} + \beta_{h0_{HR}}\Delta \ln LLR_{ict} * I(ENV_{ct}) \\ &+ \beta_{k0}\Delta \ln CAP\_RATIO_{ict} + \beta_{k0_{HR}}\Delta \ln CAP\_RATIO_{ict} * I(ENV_{ct}) \\ &+ \beta_{\mathbf{CN}}\mathbf{CN_{ct}} + \mu_i + \gamma_t + \varepsilon_{ict}. \end{aligned} \tag{15}$$

Due to non-concavity of the likelihood function, Eq. (15) does not include the country-time fixed effects. In order to account for possible country-and-time-specific influence, we add a set of control variables $\mathbf{CN_{ct}}$. Those include the GDP growth, changes in unemployment and inflation, changes in public debt-to-GDP ratio as well as changes in enforcing contracts and resolving insolvency indices.

A. Data

We focus on a panel of banks from the euro area in years 2005-2014. Together we collect the data for 1492 banks from 13 euro-zone member states, including Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia.

As bank-specific variables we include the capital ratio, loan-loss reserves and proportion on non-performing loans. To limit the possible bias resulting from the model-implied capital specification we run the analysis on two types of capital ratios, i.e. total capital ratio (CAP_RATIO) and Tier 1 capital ratio (T1_RATIO). The latter includes equity capital (without the revaluation reserves) whereas the former comprises Tier 1 capital plus undisclosed reserves, revaluation reserves, subordinated debt, hybrid instruments and general provisions.[10] Both ratios are taken with respect to the risk-weighted assets. Loan-loss reserves are taken with

[9] Under the assumptions, Eq. (11) becomes $\alpha_{i,t} = 1/\left(1 + \exp\left(\ln\left(k_0\lambda_{i,t}\right) - \ln\left(h0(1 - \beta r^M_{t+1})\right)\right)\right)$.

[10] General provisions can partly incorporate loan loss reserves and therefore possibly causing identification problems. Our main results are confirmed with both capital ratios as shown in Section III.

respect to gross non-performing exposure and non-performing loans are expressed as a share of gross loans. The data comes from the Bankscope.

We approximate the price of NPLs by the country-wide recovery rate on non-performing assets. This is a recommended proxy for valuation of bad assets when there is no readily-available market data (Laryea, 2010). The data comes from the World Bank Doing Business.

Similarly, we approximate the debt interest rates by the 5-year yield on general government bonds in particular countries. The time series come from Bloomberg. For additional country-specific control variables we use in the logit specification we include GDP growth, unemployment, inflation, public debt-to-GDP ratio as well as enforcing contract and resolving insolvency indices. The last two variables aim at capturing the country-specific regulatory and legislative frameworks which can affect the NPL resolution (Bergthaler et al., 2015). The time series are downloaded from the ECB and the World Bank.

Additionally, since there is no available data for banks' retail interest rate setting or the fraction of sold NPLs, we approximate those two variables in the following ways. We spread the bank-specific retail interest rates around the country mean on the basis of the amount of new gross loans granted by individual banks using the standard normal distribution. This transformation assumes that banks who grant more loans have superior technology or information with respect to banks which grant less loans, which allows to offer lower interest rates, or to put it differently, to transmit the monetary policy more efficiently. We additionally impose a restriction that the lending rates cannot be smaller than the banks' cost of interbank liquidity, which we approximate by EONIA rate.[11] The average country-specific interest rate is the rate on loans up to 1-year maturity and up to EUR 1 million granted to non-financial corporates (new businesses) in a given year and comes from the ECB.[12] The benefit of focusing on smaller loans is that Small and Medium-sized Enterprises (SMEs) mostly rely on this type of funding so that the analysis brings an additional insight on the mostly troubled companies in the euro area (European Central Bank, 2015).

To approximate the share of sold NPLs we apply the motion equation of bad assets. The NPLs in any given period should be equal the NPLs in the previous period plus the new NPLs coming from the business cycle fluctuations minus the write-offs and the sold NPLs. We assume that the NPLs which become performing again are included in the business cycle and are otherwise marginal. Bouvatier and Lepetit (2012) suggest that the proportion of bad assets follows an exogenous business cycle as $\theta_0 \left(GDP_t/GDP^*\right)^{-\omega}$, with θ_0 being the stead-state fraction on bad assets, ω is the elasticity parameter and GDP^* is the potential GDP. If we scale it by the proportion of loans in total assets (to represent all the variables

[11]We confirm the results with 3-month EURIBOR rates.

[12]We carry out robustness checks on different types of maturity and size structures. The results indicate that longer-maturity and larger loans are less responsive to changes in exogenous variables but the qualitative results are the same. Therefore, we report here the most-responsive results but the other specifications are available upon request.

in terms of gross loans), one can rewrite the amount of sold NPLs in any given period t as

$$(16) \qquad SALE_{i,t} = 1 - \frac{NPL_{i,t+1} - \theta_0 \left(\frac{GDP_{i,t+1}}{GDP_i^*}\right)^{-\omega} \frac{A_{i,t+1}}{L_{i,t+1}} + WO_{i,t}}{NPL_{i,t}},$$

where $A_{i,t}$ denotes total assets, $L_{i,t}$ is the amount of gross loans and $WO_{i,t}$ is the fraction of loans that have been written off. Since the data on write-offs are not available for the majority of banks, we approximate it by average charge-offs in the sample in a given year.[13] We take θ_0 as a country-wide average of non-performing exposure of gross loans and calculate parameter ω on the basis of the dynamic panel specification of the form

$$(17) \qquad NPL_{i,t} = \rho_0 + \rho_1 NPL_{i,t-1} + \rho_2 \hat{y}_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t},$$

where $\hat{y}_{c,t}$ are the log-deviations of GDP with respect to the potential output in country of bank i and year t. (We calculate the potential output from the Hodrick-Prescott filter (for details see for instance Fincke and Wolski (2015).) The error term consists of bank-specific fixed effects μ_i, time effects γ_t and idiosyncratic noise $\varepsilon_{i,t}$. To estimate Eq. (17) we apply the two-step Arellano-Bond estimator (Arellano and Bond, 1991) with second lags of the dependent variable as instruments. [14] We then calculate $\omega = \rho_2/(1-\rho_1)$ as being equal to 0.734 (for a similar procedure see also Bouvatier and Lepetit (2012)).

To limit possible bias from our $\alpha_{i,t}$ approximation, we standardize the values to a unit-interval. Before turning to empirical analysis, we winsorize all the variables at 2 per cent level. Data description together with basic summary statistics are presented in Table 2.

[13]Since this assumption can be seen as strict, we run additional robustness checks by using the available data on bank-specific charge-offs, country-specific charge-offs and by excluding charge-offs from Eq. (16). The specification with individual charge-offs suffers from small sample problem nevertheless many of the main findings are to a large extent confirmed, especially in the logit specification. The two other specifications fully confirm our main results so that we do not report those estimates in the paper but they are available upon request.

[14]The validity of instruments is confirmed by the Sargan test, with the p-value of 0.257 for the null hypothesis of validity of overidentifying restrictions.

TABLE 2—DESCRIPTION AND SUMMARY STATISTICS OF THE DATA

Variable	Description	Source†	Unit‡	Obs	Banks	Mean	Std. Dev.	Min	Max
	Bank-specific variables								
RATE	Banks' lending interest rate	own	pp	5141	1492	4.23	1.76	1.31	9.37
SALE	Fraction of sold NPLs	own	pp	3839	930	6.63	16.69	0	100
CAP_RATIO	Total capital ratio	BS	pp	5141	1492	16.64	5.90	9.00	35.50
T1_RATIO	Tier 1 capital ratio	BS	pp	5111	1482	14.69	6.21	6.40	36.39
LLR	Fraction of Loan Loss Reserves to NPLs	BS	pp	5141	1492	46.08	26.66	8.46	189.11
NPL	Fraction of NPLs to gross loans	BS	pp	5141	1492	7.67	5.79	0.35	26.83
ASSETS	Total assets	BS	tn	5141	1492	18.10	51.40	0.04	225.00
GLOANS	Total gross loans	BS	tn	5141	1492	9.88	26.40	0.02	111.00
	Country- and area-wide variables								
WO	Average charge-offs in the euro area to gross loans	BS	pp	5141	—	0.0032	0.0010	0.0012	0.0041
RI_RATE	Resolving insolvency index: recovery rate	WB	pp	5141	—	65.89	10.34	44.90	86.30
YIELD_5	Yield on 5-year government bonds	BG	pp	5141	—	3.00	1.65	0.01	6.15
GDP	Gross domestic product at constant prices	IMF	tn	5141	—	1.59	0.60	0.02	2.52
UNEMP	Unemployment rate	ECB	pp	5141	—	8.07	2.52	4.98	14.24
INFL	Overall inflation	ECB	pp	5141	—	2.06	0.91	0.21	3.49
DEBT	Debt to GDP ratio	ECB	pp	5141	—	104.24	22.31	39.63	135.20
EC_DTF	Enforcing contracts index: distance to frontier	WB	0/100	5141	—	53.11	16.71	38.21	82.50
RI_DTF	Resolving insolvency index: distance to frontier	WB	0/100	5141	—	70.97	11.24	43.98	96.55

Notes: Table describes all the variables used in the empirical analysis to either estimate the model or calculate model-related variables, as described in the text. Data cover annual observations from 2005 until 2014. † sources: ECB denotes the European Central Bank, BG denotes Bloomberg, BS denotes Bankscope, IMF denotes the International Monetary Fund, own denotes authors' calculations and WB denotes World Bank. ‡ units: pp denotes percentage points, tn denotes trillions of EUR and 0/100 represents a scale from 0 to 100. The data were winsorized at 2 per cent level.

The constructed variables satisfy the basic stylized facts implied by the model and observed in the reality. The span of lending rates is from 1.31 to 9.37 per cent, which reflects well the heterogeneity in investment projects. The fraction of sold NPLs also fall in a reasonable interval. Preliminary IMF estimates approximate the size of distressed market in the euro area at the level of around 6.9 per cent of NPLs in 2013. Given that our sample does not cover all of the Member States and taking into account all the data limitations, the level of 6.63 per cent closely corresponds to the empirical estimates. Similarly, 90 per cent of all the banks in the sample sell less than 16 per cent, and 95 per cent less than 33.31 per cent of their NPL portfolio. This suggest that the distribution of sales is highly skewed towards keeping the NPLs in house, confirming the small size of the distressed debt market in the euro area (Jassaud and Kang, 2015).

Our sample corresponds to the average euro-area provisioning levels, making it somehow representative on the sample of selected countries (Bergthaler et al., 2015). The levels or NPLs are however below the euro-area averages, as revealed by the recent ECB's comprehensive assessment (European Central Bank, 2014). This is mostly due to the fact that our sample does not cover Cyprus, which suffers most from the NPL problem and many troubled-economies banks do not reveal the true figures of their non-performing portfolios. Nevertheless, the in-sample cross-country distribution follows closely the ECB's results.

Distributions of banks' assets and gross loans are positively skewed, with mass mostly concentrated in the left part of the distribution. This feature is consisted with empirical patterns (Ghossoub and Reed, 2015).

Country-specific variables remain euro-area representative as well, even though the sample comprises only 13 of the member states. If expressed as a fraction of non-performing exposure the write-offs average to 6.7 per cent, against the 6.2 per cent in the whole euro area. The both nominal and real variables closely follow the euro-zone business cycle in years 2005-2014 and include cross-country euro-area heterogeneities (between core and periphery).

Also the World Bank indicators shed light on cross-country disparities in terms of legislative and regulatory frameworks. The average recovery rate in the sample is about 66 per cent, meaning that from each euro of loan, on average, 66 cent are recoverable upon liquidation if the loan is non-performing. Due to weak contract enforceability and poor foreclosure and bankruptcy laws, the lowest recovery rates are observed in economies like Greece, France or Slovakia. The highest recovery ones can be found in Finland, Netherlands, Belgium and Ireland. Those patterns also apply to the enforcing contracts and resolving insolvency indices.

B. Results

The results for three model specifications from Eqs. (12), (13) and (15), including constant and time-varying discount factors as well as two fixed-effects specifications (i.e. year and country-year), are presented in Tables 3, 4 and 5, respectively.

Looking at interest rate setting (Table 3), capital requirements seem to be a significant driver of the banks' lending rates. For each 1 pp increase in total capital, the interest rates jump by approximately 5 bp. The proportion of non-performing loans also significantly affects banks' lending rates, however, the magnitude is about half of the impact from capital requirements. Controlling for country-year fixed effects, one can observe also that the economy-wide recovery rates have larger influence on banks' interest rate setting, both in terms of statistical significance and magnitude. For each 1 pp increase in the recovery rate, banks decrease the lending rate by 6 bp in the constant discount factor setting and by 6.3 bp when considering the time-varying specification. The most important driver of the bank lending rates are the economy wide interest rates, here expressed as yields on 5-year government bonds. The transmission is slightly larger than one-to-one, and highly significant. Those effects are however only visible if controlled for country-year fixed effects, suggesting strong crisis effects which mitigate the influence. Interestingly, provisioning rules are not a significant driver of the banks' lending rates.

The effects of capital requirements estimated in the model are somehow smaller in magnitude than the ones reported in other studies. For instance, on the example of the euro area Sutorova and Teply (2013) find that 1 pp increase in capital requirements leads to 18.8 bp increase in lending rates, and Slovik and Cournede (2011) finds that this effect is 14.3 bp. This can reflect the view that banks with higher capital levels do not necessarily tend to transmit the capital costs to the lending spreads on corporate loans (Chun, Kim and Ko, 2012; Mattes, Steffen and Wahrenburg, 2013). For instance, for the US Mattes, Steffen and Wahrenburg (2013) find that higher lending spreads are a result of exogenous events and Chun, Kim and Ko (2012) report that in some of the euro-area countries, like Germany or the Netherlands, the capital requirement transmission is weaker and depends on banks' business models. Similarly, Bridges et al. (2012) report large cross-bank heterogeneity in adjustments to new capital environment on the example of the UK, both in terms of magnitude and timing of the effects, which we do not cover in our framework.

When it comes to the sales of the NPLs, the provisioning rules and recovery rates on insolvent projects seem to be major driving forces. The results for the former are consistent in both model specifications (Tables 4 and 5). The results from the linear model suggest that 1 pp increase in provisioning rules increase the sales of NPLs ranging from 8.6 to 13.6 bp. In the logit model the relation ranges from 81.5 to 90.8 bp. The effects of provisioning are always non-significant in low-cost-of-capital environment, as predicted by the model.

Capital requirements do not seem to affect the sales of NPLs with an exception of the rising interest rate environment in the logit model. This can reflect the fact that interest rate dynamics do not necessarily have to capture well the actual cost of banks' capital. In a situation when the capital constraint is binding and carry of securities is positive, banks will be able to decrease the lending rates in

Table 3—Results for the banks' interest rate setting

	(1)	(2)	(3)	(4)
ΔCAP_RATIO_{ict}	0.050***	0.046**	0.051***	0.051**
	(0.015)	(0.017)	(0.016)	(0.017)
$\Delta CAP\_RATIO_{ict} * I(HIGH_{ct})$	-0.010	-0.018		
	(0.023)	(0.021)		
$\Delta CAP\_RATIO_{ict} * I(RISING_{ct})$			-0.016	-0.040
			(0.016)	(0.025)
ΔLLR_{ict}	-0.001	-0.000	-0.001	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)
ΔNPL_{ict}	0.025*	0.026**	0.025*	0.026**
	(0.012)	(0.011)	(0.012)	(0.011)
ΔRI_RATE_{ct}	-0.045	-0.060***	-0.046	-0.063***
	(0.029)	(0.003)	(0.029)	(0.003)
$\Delta YIELD_{ct}$	0.085*	1.348***	0.086*	1.358***
	(0.042)	(0.014)	(0.042)	(0.020)
Const	-3.044***	1.456***	-3.047***	1.612***
	(0.323)	(0.007)	(0.325)	(0.012)
Observations	5,141	5,141	5,141	5,141
R-squared	0.384	0.440	0.384	0.440
Number of bank_id	1,492	1,492	1,492	1,492
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	No	Yes	No
Country*Time FE	No	Yes	No	Yes

Notes: This table reports estimates for the linear panel model described in Eq. (12), which explains the changes in interest rates on loans granted by a bank i as a function of capital ratio, provisioning, NPL rates, recovery rate on insolvent projects and debt interest rates. Interaction term $I(HIGH_{ct})$ takes value 1 if the interest rates in country c and period t were above the country median (constant discount factor setting), and interaction term $I(RISING_{ct})$ takes value 1 if the interest rates in country c and period t were rising with respect to the previous period (time-varying discount factor setting). Fixed effects are either included ("Yes"), excluded ("No") or spanned by another set of effects ("—"). For each independent variable the first row shows the coefficient and the second row lists the robust standard error which is corrected for clustering at the country level. Corresponding statistical significance levels are adjacent to the coefficients: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$. The dataset comprises annual observations from 2005 until 2014 and includes following countries: Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia. Variable $YIELD$ is taken as yield on 5-year government bonds. The description of individual variables can be found in Table 2.

equilibrium as the associated losses will be compensated by extra income from risk-free securities which capital is invested into. There is also a possibility that the country-specific controls do not capture all of the effects of the domestic business cycle, however, the results are largely robust to different specifications of the set of control variables. We view this phenomenon as being an interesting topic for further investigation.

The general results from this exercise point to different effects of capital and provisioning requirements on banks' behaviour. The former have an important transmission effect on banks' lending rates, with no significant effect on sales of NPLs. On the contrary, provisioning rules do not seem to be transmitted to the bank lending but are motivating banks to sell the non-performing exposure. This result can have important policy implications. In particular, given that some of the euro-zone countries suffer from high NPLs exposures, policy makers can be tempted to make banks to sell or write bad debt off by increasing provisioning requirements. The empirical findings suggest that increased provisioning levels do not affect bank lending rates directly, as predicted by the theoretical model.

III. Robustness

As a robustness check, we carry out the analysis on Tier 1 capital ratio, instead of total capital ratio used in Section II. As one of the components total capital ratio includes general provisions, which partly can overlap with the loan loss provisions and therefore be colinear with other explanatory variables. The detailed results are depicted in Appendix in Tables B1, B2 and B3.

It can be observed that changing the capital variable to Tier 1 ratio does not impact the results on interest rate setting. The statistical significance of the coefficients is preserved and their magnitude remains largely intact. Only the influence of the recovery rates decreased in magnitude by about a half suggesting that 1 pp increase in the recovery rates decreased the banks' lending rates by around 6 bp, on average, compared to 12.5 bp estimated using the total capital ratio.

The robustness results of sales of NPLs also preserve the statistical significance of coefficients in the linear setting. The magnitude of impact of provisioning is also preserved, however, the impact of recovery rates is much larger. Controlling for country-time fixed effects, the coefficients increased from around 0.3 to around 2, suggesting an even more important impact of legislative framework on the effectiveness of sales of non-performing exposure.

The impact of provisioning in the logit-model specification is similar to the one predicted with total capital ratio. The impact of capital itself changes however. In the time-varying discount factor setting, increase in the Tier 1 ratio lead to larger sales of NPLs. Although controlling for country-wide variables it diminishes both in magnitude and statistical significance, it can be contradicting the theoretical predictions (see Table 1). An explanation can come from the assumption of the theoretical model that sold NPLs are invested in the risk-free assets which would

Table 4—Results for the banks' sales of non-performing exposure (linear model)

	(1)	(2)	(3)	(4)
ΔCAP_RATIO_{ict}	0.137	0.127	0.237	0.227
	(0.148)	(0.144)	(0.180)	(0.168)
$\Delta CAP\_RATIO_{ict} * I(HIGH_{ct})$	-0.064	0.076		
	(0.184)	(0.144)		
$\Delta CAP\_RATIO_{ict} * I(RISING_{ct})$			-0.038	-0.096
			(0.080)	(0.073)
ΔLLR_{ict}	0.045	0.086*	0.098*	0.136**
	(0.051)	(0.040)	(0.054)	(0.053)
$\Delta LLR_{ict} * I(HIGH_{ct})$	0.068	0.020		
	(0.088)	(0.077)		
$\Delta LLR_{ict} * I(RISING_{ct})$			-0.369	-0.143
			(0.418)	(0.188)
ΔRI_RATE_{ct}	-1.356**	0.327***	-1.368**	0.272***
	(0.457)	(0.044)	(0.450)	(0.066)
Const	16.274**	3.929***	16.283**	3.217***
	(6.535)	(0.095)	(6.618)	(0.221)
Observations	3,839	3,839	3,839	3,839
R-squared	0.084	0.349	0.084	0.352
Number of bank_id	930	930	930	930
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Country*Time FE	No	Yes	No	Yes

Notes: This table reports estimates for the linear panel model described in Eq. (13), which explains the changes in sales of non-performing exposure by a bank i as a function of capital ratio, provisioning and recovery rate on insolvent projects. Interaction term $I(HIGH_{ct})$ takes value 1 if the interest rates in country c and period t were above the country median (constant discount factor setting), and interaction term $I(RISING_{ct})$ takes value 1 if the interest rates in country c and period t were rising with respect to the previous period (time-varying discount factor setting). Fixed effects are either included ("Yes"), excluded ("No") or spanned by another set of effects ("—"). For each independent variable the first row shows the coefficient and the second row lists the robust standard error which is corrected for clustering at the country level. Corresponding statistical significance levels are adjacent to the coefficients: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.The dataset comprises annual observations from 2005 until 2014 and includes following countries: Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia. The description of individual variables can be found in Table 2.

TABLE 5—RESULTS FOR THE BANKS' SALES OF NON-PERFORMING EXPOSURE (LOGIT MODEL)

	(1)	(2)	(3)	(4)
$\Delta \ln CAP\_RATIO_{ict}$	0.832	0.577	1.108	0.892
	(0.750)	(0.536)	(0.759)	(0.643)
$\Delta \ln CAP\_RATIO_{ict} * I(HIGH_{ct})$	-0.959	-0.604		
	(0.949)	(0.796)		
$\Delta \ln CAP\_RATIO_{ict} * I(RISING_{ct})$			-2.454**	-1.969**
			(1.067)	(0.807)
$\Delta \ln LLR_{ict}$	0.862**	0.908**	0.905**	0.815**
	(0.355)	(0.400)	(0.385)	(0.388)
$\Delta \ln LLR_{ict} * I(HIGH_{ct})$	0.217	0.112		
	(0.187)	(0.251)		
$\Delta \ln LLR_{ict} * I(RISING_{ct})$			0.259	0.468
			(0.353)	(0.386)
Observations	4,118	4,118	4,118	4,118
R-squared	0.469	0.512	0.471	0.514
Number of banks	647	647	647	647
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Addtional controls	No	Yes	No	Yes

Notes: This table reports estimates for the logit panel model described in Eq. (15), which explains the probability of an increase in sales of non-performing exposure by a bank i as a function of capital ratio and provisioning. Interaction term $I(HIGH_{ct})$ takes value 1 if the interest rates in country c and period t were above the country median (constant discount factor setting), and interaction term $I(RISING_{ct})$ takes value 1 if the interest rates in country c and period t were rising with respect to the previous period (time-varying discount factor setting). Fixed effects are either included ("Yes") or excluded ("No"). Additional control variables include GDP growth, changes in unemployment and inflation, changes in public debt-to-GDP ratio as well as changes in enforcing contracts and resolving insolvency indices. For each independent variable the first row shows the coefficient and the second row lists the robust standard error which is corrected for clustering at the country level. Corresponding statistical significance levels are adjacent to the coefficients: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.The dataset comprises annual observations from 2005 until 2014 and includes following countries: Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia. The description of individual variables can be found in Table 2.

still generate losses to the bank if its capital financing is expensive. In practice, however, sold NPLs can be invested in higher-interest instruments, including debt certificates, or can be used to underwrite new loans. For simplicity reasons we don't consider such possibilities in the theoretical investigation. But indeed should a bank be able to reinvest the cash flows from sold NPLs into more profitable investments, increases in capital requirements can make banks sell more of their non-performing exposure. Tier 1 ratio is closer to the capital requirement so that it can capture this effect better than total capital ratio which can possibly explain the differences in the coefficients of both variables.

A. *The role of NPLs*

We also carry out two additional checks on the exact role of NPLs. NPLs themselves are widely present in the literature as their influence on bank lending is detrimental (European Central Bank, 2015). High levels of NPLs can affect both banks' profitability and financing costs, being therefore a drag on banking activity in especially weak euro-zone banking sector (Bergthaler et al., 2015). The impact of NPLs can be however reduced by sufficient provisioning. Indeed, if banks have sufficient provisioning levels against their non-performing exposure, NPLs should not affect banks' behaviour from the risk perspective.

We therefore check if the effects of net NPLs, i.e. the unprovisioned NPLs, on banks' interest rate setting (Eq. (12)). We approximate net NPLs as a fraction $(1 - LLR_{ict})$ of NPLs which is not provisioned for. If banks have provisions above 100% we treat that as zero net NPL exposure. The results are presented in Table 6.

One can observe, that compared to gross NPLs, the impact of net NPLs on banks' lending rates almost doubles. This indeed suggests that unprovisioned NPLs are more detrimental to banks' lending conditions. The influence of other variables in terms of magnitude and statistical significance is largely preserved.

Also, we test the robustness of the price at which NPLs are sold to the market. Instead of assuming that their price is equal the economy-wide recovery rate, we consider that the NPLs are sold at their full net value. The results are presented in Table 7.

It can be quickly observed that although positive, the coefficient of NET_NPL_{ict} is not statistically significant in any of the settings. Interestingly, however, the impact of provisioning requirements in country-fixed effects settings (Columns (2) and (4)) has slightly increased.

Economy-wide recovery rates are not only proxies for the price of NPLs (Laryea, 2010) but they also convey the information about the legislative and regulatory environments, like for instance foreclosure and bankruptcy frameworks. Those are indeed of crucial importance to the functioning of distressed debt markets (Bergthaler et al., 2015). Our study confirms that observation and points to a very significant influence of resolving insolvency frameworks on banks' willingness to sell their NPLs to the market.

Table 6—The effects of net NPLs on the banks' interest rate setting

	(1)	(2)	(3)	(4)
ΔCAP_RATIO_{ict}	0.050***	0.046**	0.051**	0.051**
	(0.016)	(0.017)	(0.017)	(0.017)
$\Delta CAP\_RATIO_{ict} * I(HIGH_{ct})$	-0.008	-0.016		
	(0.023)	(0.021)		
$\Delta CAP\_RATIO_{ict} * I(RISING_{ct})$			-0.015	-0.039
			(0.016)	(0.025)
ΔLLR_{ict}	0.000	0.001	0.000	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
ΔNET_NPL_{ict}	0.045***	0.045***	0.045***	0.045***
	(0.011)	(0.010)	(0.011)	(0.010)
ΔRI_RATE_{ct}	-0.044	-0.058***	-0.045	-0.060***
	(0.028)	(0.003)	(0.029)	(0.003)
$\Delta YIELD_{ct}$	0.085*	1.355***	0.085*	1.366***
	(0.041)	(0.014)	(0.041)	(0.012)
Const	-3.039***	1.507***	-3.042***	1.430***
	(0.313)	(0.007)	(0.314)	(0.016)
Observations	5,141	5,141	5,141	5,141
R-squared	0.385	0.441	0.385	0.441
Number of bank_id	1,492	1,492	1,492	1,492
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	No	Yes	No
Country*Time FE	No	Yes	No	Yes

Notes: This table reports estimates for the linear panel model described in Eq. (12), which explains the changes in interest rates on loans granted by a bank i as a function of capital ratio, provisioning, net NPL rates, recovery rate on insolvent projects and debt interest rates. Interaction term $I(HIGH_{ct})$ takes value 1 if the interest rates in country c and period t were above the country median (constant discount factor setting), and interaction term $I(RISING_{ct})$ takes value 1 if the interest rates in country c and period t were rising with respect to the previous period (time-varying discount factor setting). Fixed effects are either included ("Yes"), excluded ("No") or spanned by another set of effects ("—"). For each independent variable the first row shows the coefficient and the second row lists the robust standard error which is corrected for clustering at the country level. Corresponding statistical significance levels are adjacent to the coefficients: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$. The dataset comprises annual observations from 2005 until 2014 and includes following countries: Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia. Variable $YIELD$ is taken as yield on 5-year government bonds. The description of individual variables can be found in Table 2.

TABLE 7—RESULTS FOR THE BANKS' SALES OF NON-PERFORMING EXPOSURE WITH NET NPLS AS RECOVERY VALUE FOR NON-PERFORMING EXPOSURE (LINEAR MODEL)

	(1)	(2)	(3)	(4)
ΔCAP_RATIO_{ict}	0.213	0.148	0.284	0.246
	(0.164)	(0.143)	(0.189)	(0.170)
$\Delta CAP\_RATIO_{ict} * I(HIGH_{ct})$	-0.137	0.075		
	(0.217)	(0.144)		
$\Delta CAP\_RATIO_{ict} * I(RISING_{ct})$			-0.415	-0.144
			(0.440)	(0.185)
ΔLLR_{ict}	0.047	0.101*	0.100	0.148**
	(0.058)	(0.047)	(0.060)	(0.058)
$\Delta LLR_{ict} * I(HIGH_{ct})$	0.075	0.021		
	(0.092)	(0.076)		
$\Delta LLR_{ict} * I(RISING_{ct})$			-0.029	-0.091
			(0.084)	(0.073)
ΔNET_NPL_{ict}	0.140	0.332	0.117	0.305
	(0.139)	(0.237)	(0.140)	(0.228)
Const	14.995*	-3.934	15.041*	-1.394
	(7.444)	(2.798)	(7.548)	(3.047)
Observations	3,839	3,839	3,839	3,839
R-squared	0.067	0.351	0.066	0.354
Number of bank_id	930	930	930	930
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Country*Time FE	No	Yes	No	Yes

Notes: This table reports estimates for the linear panel model described in Eq. (13), which explains the changes in sales of non-performing exposure by a bank i as a function of capital ratio, provisioning and recovery rate (here approximated by net NPLs). Interaction term $I(HIGH_{ct})$ takes value 1 if the interest rates in country c and period t were above the country median (constant discount factor setting), and interaction term $I(RISING_{ct})$ takes value 1 if the interest rates in country c and period t were rising with respect to the previous period (time-varying discount factor setting). Fixed effects are either included ("Yes"), excluded ("No") or spanned by another set of effects ("—"). For each independent variable the first row shows the coefficient and the second row lists the robust standard error which is corrected for clustering at the country level. Corresponding statistical significance levels are adjacent to the coefficients: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.The dataset comprises annual observations from 2005 until 2014 and includes following countries: Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia. The description of individual variables can be found in Table 2.

IV. Conclusions

This research provides a theoretical model of the effects of capital and provisioning requirements on bank lending decisions and sales of non-performing exposure. It is one of the first attempts to formally represent the links between those regulatory requirements and banks' performance and then verify the theoretical predictions empirically.

In the paper we develop a theoretical partial-equilibrium banking model where banks are intermediaries between depositors and production companies. They underwrite loans at an internally determined lending rate. In each period a fraction of underwritten loans is deemed as non-performing and banks can decide to sell them to the market. Banks decision-making process stems out from the maximization of the expected discounted flow dividends to the shareholders.

Theoretical investigation reveals that the effectiveness of policy-instruments depends on the cost of banks' capital financing. Model-implied results suggest capital and provisioning requirements will be transmitted to the lending rates and sales of NPLs if banks find capital expensive. In such an environment banks offset the regulatory costs by either extra revenues from loans or less non-performing assets. Should capital be cheap for banks, the effectiveness of policy mechanisms is limited.

Empirical results largely support the theoretical predictions. We consider a sample of 1492 banks from 13 euro-area member states in years 2005-2014. As a proxy for the cost of capital we take the interest rate environment in a given country. We confirm that in times when capital financing was cheap, capital and provisioning requirements were ineffective. In times when capital was relatively expensive, we find that capital requirements were an important driver for banks' lending rates and provisioning requirements were positively influencing sales of NPLs. We confirm also a significant detrimental effect from NPLs on banks' lending rates (European Central Bank, 2015). Our analysis shows that unprovisioned NPLs are a larger drag on lending rates than the gross NPLs, supporting the necessity of sufficient provisioning in the NPL-hit countries (Bergthaler et al., 2015). The effects of unprovisioned (or net) NPLs are almost twice the magnitude of gross NPLs. We find also evidence that economy-wide recovery rates, which also convey the legislative and regulatory frameworks, seem to be an important factor on both banks' lending rates and sales of NPLs.

This study raises interesting questions which deserve further exploration. A straightforward extension of this analysis includes verification of the findings on more granular and detailed data sets. Similarly, our sample does not comprise the severely NPL-hit countries, including Cyprus for instance, which are likely to suffer more than our estimates suggest. Further investigation is therefore needed to fully understand the nature of the phenomenon.

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Technical appendix

Given the constraints each bank is facing, the Lagrangian of the maximization problem of an individual bank becomes

(A1)

$$\mathcal{L}\left(r^M_{i,t}, \alpha_{i,t}\right) = \mathrm{E}_t \sum_{t=0}^{\infty} \beta^t \left[\Delta_{i,t} - \lambda_{i,t}\left(k_0\left((1-\theta_{i,t})L_{i,t} + W(1-\alpha_{i,t})\theta_t L_{i,t}\right) - K_{i,t}\right)\right],$$

where

$$\Delta_{i,t} = r^L_{i,t}(1-\theta_t)L_{i,t} + r^M_t S_{i,t} - r^M_{i,t} D_{i,t} - LLP_{i,t} + K_{i,t} - K_{i,t+1}, \tag{A2}$$

$$L_{i,t} + S_{i,t} = D_{i,t} + K_{i,t} + LLR_{i,t}, \tag{A3}$$

$$S_{i,t} = LLR_{i,t} + K_{i,t} + \alpha_{i,t}\theta_t x_{i,t} L_{i,t}, \tag{A4}$$

$$LLR_{i,t} = LLR_{i,t-1} + LLP_{i,t-1}, \tag{A5}$$

$$LLP_{i,t} = h_0\theta_t(1-\alpha_{i,t})(1-x_{i,t})L_{i,t}, \tag{A6}$$

$$x_{i,t} = \left(\frac{\alpha_{i,t}}{\alpha_t}\right)^{-1/u} \left(\frac{L_{i,t}}{L_t}\right)^{-1/u} x_t, \tag{A7}$$

$$L_{i,t} = \left(\frac{r^L_{i,t}}{r^L_t}\right)^{-\zeta} L_t. \tag{A8}$$

The Kuhn-Tucker conditions imply that in any period t

$$\begin{gathered}
\partial\mathcal{L}\left(r^M_{i,t}, \alpha_{i,t}\right)/\partial r^M_{i,t} = 0, \\
\partial\mathcal{L}\left(r^M_{i,t}, \alpha_{i,t}\right)/\partial \alpha_{i,t} = 0, \\
\lambda_{i,t} \geq 0 \\
k_0\left((1-\theta_{i,t})L_{i,t} + W(1-\alpha_{i,t})\theta_t L_{i,t}\right) \leq K_{i,t}, \\
\lambda_{i,t}\left(k_0\left((1-\theta_{i,t})L_{i,t} + W(1-\alpha_{i,t})\theta_t L_{i,t}\right) - K_{i,t}\right) = 0.
\end{gathered} \tag{A9}$$

Solving for Eq. (A9), one can verify that the optimal solution to the banks' maximization problem, under the constant discount factor β, yields

$$r^L_{i,t} = \begin{cases}
\dfrac{\zeta}{(\zeta-1)(1-\theta_t)}\left[k_0/\beta - k_0 + (1-k_0)r^M_t \right. & \\
\quad + \theta_t(W-1)(k_0/\beta - k_0(1+r^M_t)) & \text{if } r^M_t < \frac{1-\beta}{\beta}, \\
\quad \left. + h_0\theta_t(1-x_t)(1-\beta r^M_{t+1})\right] & \\
\dfrac{\zeta}{(\zeta-1)(1-\theta_t)}\left[r^M_t \right. & \text{if } r^M_t \geq \frac{1-\beta}{\beta}, \\
\quad \left. + h_0\theta_t(1-x_t)(1-\beta r^M_{t+1})\right] &
\end{cases} \tag{A10}$$

$$\alpha_{i,t} = \begin{cases}
\dfrac{h_0 x_t(1-\beta r^M_{t+1})}{u\left(Wk_0\left(\frac{1-\beta}{\beta} - r^M_t\right) + h_0\left(1 - \frac{u-1}{u}x_t\right)\left(1-\beta r^M_{t+1}\right)\right)} & \text{if } r^M_t < \frac{1-\beta}{\beta}, \\
x_t/(u - x_t(u-1)) & \text{if } r^M_t \geq \frac{1-\beta}{\beta},
\end{cases} \tag{A11}$$

and under the time-varying discount factor $\beta_t = (1/1 + r^M_t)$ the optimal solutions become

$$
r^L_{i,t} = \begin{cases} \dfrac{\zeta}{(\zeta-1)(1-\theta_t)} \Big[k_0 \left(r^M_{t-1} - r^M_t \right) + r^M_t \\ \quad + \theta_t (W-1) k_0 \left(r^M_{t-1} - r^M_t \right) & \text{if } r^M_t < r^M_{t-1}, \\ \quad + h_0 \theta_t (1-x_t) \left(1 - \dfrac{r^M_{t+1}}{1+r^M_t} \right) \Big] \\ \dfrac{\zeta}{(\zeta-1)(1-\theta_t)} \Big[r^M_t \\ \quad + h_0 \theta_t (1-x_t) \left(1 - \dfrac{r^M_{t+1}}{1+r^M_t} \right) \Big] & \text{if } r^M_t \geq r^M_{t-1}, \end{cases} \tag{A12}
$$

$$
\alpha_{i,t} = \begin{cases} \dfrac{h_0 x_t \left(1 + r^M_t - r^M_{t+1} \right)}{u \left(W k_0 \left(r^M_{t-1} - r^M_t \right) + h_0 \left(1 - \frac{u-1}{u} x_t \right) \left(1 - \frac{r^M_{t+1}}{1+r^M_t} \right) \right)} & \text{if } r^M_t < r^M_{t-1}, \\ x_t / (u - x_t(u-1)) & \text{if } r^M_t \geq r^M_{t-1}. \end{cases} \tag{A13}
$$

Online appendix (additional results)

Table B1—Results for the banks' interest rate setting with Tier 1 capital ratio

	(1)	(2)	(3)	(4)
$\Delta TIER1\_RATIO_{ict}$	0.044***	0.051**	0.041***	0.049**
	(0.013)	(0.019)	(0.012)	(0.018)
$\Delta TIER1\_RATIO_{ict} * I(HIGH_{ct})$	-0.003	-0.027		
	(0.020)	(0.020)		
$\Delta TIER1\_RATIO_{ict} * I(RISING_{ct})$			0.005	-0.033
			(0.020)	(0.024)
ΔLLR_{ict}	-0.001	-0.000	-0.001	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)
ΔNPL_{ict}	0.024**	0.025**	0.024**	0.026**
	(0.010)	(0.012)	(0.010)	(0.011)
ΔRI_RATE_{ct}	-0.035	-0.125***	-0.034	-0.125***
	(0.030)	(0.002)	(0.030)	(0.002)
$\Delta YIELD_{ct}$	0.098*	1.315***	0.097*	1.322***
	(0.049)	(0.017)	(0.049)	(0.022)
Const	-2.967***	1.198***	-2.966***	1.209***
	(0.308)	(0.007)	(0.309)	(0.007)
Observations	5,082	5,082	5,082	5,082
R-squared	0.380	0.437	0.380	0.437
Number of bank_id	1,482	1,482	1,482	1,482
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	No	Yes	No
Country*Time FE	No	Yes	No	Yes

Notes: This table reports estimates for the linear panel model described in Eq. (12), which explains the changes in interest rates on loans granted by a bank i as a function of capital ratio (here Tier 1 capital ratio), provisioning, NPL rates, recovery rate on insolvent projects and debt interest rates. Interaction term $I(HIGH_{ct})$ takes value 1 if the interest rates in country c and period t were above the country median (constant discount factor setting), and interaction term $I(RISING_{ct})$ takes value 1 if the interest rates in country c and period t were rising with respect to the previous period (time-varying discount factor setting). Fixed effects are either included ("Yes"), excluded ("No") or spanned by another set of effects ("—"). For each independent variable the first row shows the coefficient and the second row lists the robust standard error which is corrected for clustering at the country level. Corresponding statistical significance levels are adjacent to the coefficients: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$. The dataset comprises annual observations from 2005 until 2014 and includes following countries: Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia. Variable $YIELD$ is taken as yield on 5-year government bonds. The description of individual variables can be found in Table 2.

TABLE B2—RESULTS FOR THE BANKS' SALES OF NON-PERFORMING EXPOSURE WITH TIER 1 CAPITAL RATIO (LINEAR MODEL)

	(1)	(2)	(3)	(4)
$\Delta TIER1\_RATIO_{ict}$	0.170	0.170	0.230	0.204
	(0.149)	(0.127)	(0.151)	(0.125)
$\Delta TIER1\_RATIO_{ict} * I(HIGH_{ct})$	-0.133	0.020		
	(0.225)	(0.124)		
$\Delta TIER1\_RATIO_{ict} * I(RISING_{ct})$			-0.366	-0.050
			(0.451)	(0.137)
ΔLLR_{ict}	0.044	0.080*	0.093*	0.130**
	(0.047)	(0.041)	(0.052)	(0.054)
$\Delta LLR_{ict} * I(HIGH_{ct})$	0.066	0.026		
	(0.085)	(0.080)		
$\Delta LLR_{ict} * I(RISING_{ct})$			-0.030	-0.086
			(0.078)	(0.074)
ΔRI_RATE_{ct}	-1.469**	2.023***	-1.485**	1.890***
	(0.497)	(0.111)	(0.490)	(0.145)
Const	16.761**	-8.620***	16.763**	-7.251***
	(6.500)	(1.051)	(6.559)	(0.674)
Observations	3,784	3,784	3,784	3,784
R-squared	0.088	0.345	0.087	0.347
Number of bank_id	889	889	889	889
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Country*Time FE	No	Yes	No	Yes

Notes: This table reports estimates for the linear panel model described in Eq. (13), which explains the changes in sales of non-performing exposure by a bank i as a function of capital ratio (here Tier 1 capital ratio), provisioning and recovery rate on insolvent projects. Interaction term $I(HIGH_{ct})$ takes value 1 if the interest rates in country c and period t were above the country median (constant discount factor setting), and interaction term $I(RISING_{ct})$ takes value 1 if the interest rates in country c and period t were rising with respect to the previous period (time-varying discount factor setting). Fixed effects are either included ("Yes"), excluded ("No") or spanned by another set of effects ("—"). For each independent variable the first row shows the coefficient and the second row lists the robust standard error which is corrected for clustering at the country level. Corresponding statistical significance levels are adjacent to the coefficients: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.The dataset comprises annual observations from 2005 until 2014 and includes following countries: Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia. The description of individual variables can be found in Table 2.

Table B3—Results for the banks' sales of non-performing exposure with Tier 1 capital ratio (logit model)

	(1)	(2)	(3)	(4)
$\Delta \ln TIER1\_RATIO_{ict}$	1.241	1.022	1.381**	1.174*
	(0.782)	(0.674)	(0.672)	(0.688)
$\Delta \ln TIER1\_RATIO_{ict} * I(HIGH_{ct})$	-1.568	-1.314		
	(0.993)	(0.831)		
$\Delta \ln TIER1\_RATIO_{ict} * I(RISING_{ct})$			-3.343***	-2.792***
			(1.055)	(0.873)
$\Delta \ln LLR_{ict}$	0.879**	0.892**	0.909**	0.782**
	(0.371)	(0.403)	(0.400)	(0.382)
$\Delta \ln LLR_{ict} * I(HIGH_{ct})$	0.204	0.116		
	(0.218)	(0.275)		
$\Delta \ln LLR_{ict} * I(RISING_{ct})$			0.328	0.556
			(0.365)	(0.366)
Observations	4,089	4,089	4,089	4,089
R-squared	0.474	0.520	0.480	0.525
Number of banks	640	640	640	640
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Additional controls	No	Yes	No	Yes

Notes: This table reports estimates for the logit panel model described in Eq. (15), which explains the probability of an increase in sales of non-performing exposure by a bank i as a function of capital ratio (here Tier 1 ratio) and provisioning. Interaction term $I(HIGH_{ct})$ takes value 1 if the interest rates in country c and period t were above the country median (constant discount factor setting), and interaction term $I(RISING_{ct})$ takes value 1 if the interest rates in country c and period t were rising with respect to the previous period (time-varying discount factor setting). Fixed effects are either included (”Yes”) or excluded (”No”). Additional control variables include GDP growth, changes in unemployment and inflation, changes in public debt-to-GDP ratio as well as changes in enforcing contracts and resolving insolvency indices. For each independent variable the first row shows the coefficient and the second row lists the robust standard error which is corrected for clustering at the country level. Corresponding statistical significance levels are adjacent to the coefficients: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.The dataset comprises annual observations from 2005 until 2014 and includes following countries: Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Slovenia and Slovakia. The description of individual variables can be found in Table 2.