

BIS Working Papers No 611

The effects of tax on bank liability structure

by Leonardo Gambacorta, Giacomo Ricotti, Suresh Sundaresan and Zhenyu Wang

Monetary and Economic Department

February 2017

JEL classification: G21, G32, G38, H25

Keywords: bank liability structure, corporate tax, leverage

BIS Working Papers are written by members of the Monetary and Economic Department of the Bank for International Settlements, and from time to time by other economists, and are published by the Bank. The papers are on subjects of topical interest and are technical in character. The views expressed in them are those of their authors and not necessarily the views of the BIS.

This publication is available on the BIS website (www.bis.org).

© *Bank for International Settlements 2017. All rights reserved. Brief excerpts may be reproduced or translated provided the source is stated.*

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

The effects of tax on bank liability structure

by Leonardo Gambacorta,^{*} Giacomo Ricotti,[†] Suresh Sundaresan[‡] and Zhenyu Wang[§]

Abstract

This paper examines the effects of taxation on the liability structure of banks. We derive testable predictions from a dynamic model of optimal bank liability structure that incorporates bank runs, regulatory closure and endogenous default. Using the supervisory data provided by the Bank of Italy, we empirically test these predictions by exploiting exogenous variations of the Italian tax rates on productive activities (IRAP) across regions and over time (especially since the global financial crisis). We show that banks endogenously respond to a reduction in tax rates by reducing non-deposit liabilities more than deposits in addition to lowering leverage. The response on the asset side depends on the financial strength of the bank: well-capitalized banks respond to a reduction in tax rates by increasing their assets, but poorly-capitalized banks respond by cleaning up their balance sheet.

JEL Classification: G21, G32, G38, H25.

Keywords: bank liability structure, corporate tax, leverage.

Contents

1. Introduction	2
2. A Model of Bank Liability Structure	5
2.1 Bank Liabilities and Valuation	5
2.2 Optimal Liability Structure and Comparative Statistics	8
3. Description of the IRAP Rates and Data	11
4. Empirical Results	15
4.1 Exogeneity of IRAP Rate Changes	15
4.2 Effects of IRAP Rate Change on Leverage	16
4.3 Tax Effects on Bank Liability Structure	19
4.4 Tax Effects on the Credit Portfolio of Bank Assets	21
4.5 Differential Effects on Poorly Capitalized Banks	22
5. Conclusions	25
Appendix	26
References	33
Tables and figures	35

^{*} Bank for International Settlements and CEPR.

[†] Bank of Italy, Tax Directorate.

[‡] Columbia University, Graduate School of Business.

[§] Indiana University, Kelley School of Business.

1 Introduction¹

What are the determinants of the leverage and liability structure of banks? The literature has argued that the factors that determine banks' leverage and liability structure are potentially distinct from the determinants of the leverage and liability structure of non-financial institutions. Diamond and Rajan (2000), for example, theorize that the optimal bank capital structure is a trade off between the effects on liquidity creation, the costs of bank distress, and the ability to force borrower repayment. They also stress that FDIC deposit insurance and regulatory capital requirements play a special role in bank leverage and liability structure. Gropp and Heider (2010) examine, from an empirical perspective, the cross-sectional determinants of leverage and find that the same factors that determine the leverage of non-financial firms also determine the leverage of banks, except bank capital ratios are close to the regulatory minimum.

While the special features of banks make them choose **higher** leverage than non-financial firms, taxes play an important role in bank leverage when debt and equity are treated differently in taxation. The recent literature has started paying attention to the relation between taxes and bank leverage. Schepens (2016) shows that a reduction in tax discrimination between debt and equity funding leads to better-capitalized banks. Schepens (2016) exploits an exogenous variation in the tax treatment of debt and equity created by the introduction of a tax shield for equity and shows that reducing the difference in the tax treatment of debt and equity increases bank capital ratios. This result is in line with Célérier et al. (2016) on the effects of tax reforms in Europe. Along similar lines, Bond et al. (2016) investigate the effects of tax on the capital structure of banks by employing exogenous regional and time variation in the rate of IRAP (Imposta regionale sulle attività produttive) and data on Italian mutual banks (credit cooperative banks, or CCBs). They show that changes in the IRAP rate affect leverage and the effect is larger for smaller or slow-growing banks. Moreover, they show that banks constrained by regulatory capital do not change their leverage when tax rates change².

The literature, however, has not explored how exogenous variations in tax treatment affect banks' liability structure and how such a tax change could influence the cost of non-equity funding and banks' investment decisions. Our paper fills this gap and provides a comprehensive analysis of how tax changes modify the composition of bank funding, separating the effects on equity from those on forms of subordinated debt, such as bonds, and deposits, which are

¹This paper has benefitted from helpful suggestions by Darrell Duffie, Florian Heider, and two **anonymous** reviewers at the Bank of Italy. We thank the audience for comments at the 4th BIS Research Network Meeting on "Financial Intermediation and Macroeconomic Stability." Stefano Schiaffi and Roberto Felici provided excellent research assistance. The views expressed in this paper are those of the authors only and do not reflect the views of the Bank of Italy or the views of the Bank for International Settlements.

²For an analysis of the link between taxation and debt in the case of banks see, amongst others, Heckemeyer and de Mooij (2013) and Keen (2011).

typically insured. Bank liability structure is important because bank funding costs depend on both leverage and liability structure. A novelty of our paper is that we match our findings using testable predictions derived from a theoretical model. In particular, we derive implications of how tax changes affect banks' liability structure and how such modifications in bank funding are then transmitted to banks' assets, distinguishing their different degree of liquidity and risk.

We follow Bond et al. (2016) and use the Italian CCBs and IRAP as a laboratory. The exogenous variation in the tax treatment of CCBs allows us to exploit the variations in the tax exposure of such banks across regions and over time. The largest variations have happened since the global financial crisis. To discipline our econometric analysis, we use the theoretical predictions of a slightly modified version of Sundaresan and Wang (2014) to examine the optimal response of banks to changes in tax rates along the following four dimensions. First, we study how banks adjust their optimal leverage, although this question has already been examined in the literature. Second, we explore how exogenous variations in tax rates change the mix of deposit and non-deposit liabilities. Third, we investigate how the credit spreads of bank debt liabilities **respond** to exogenous variations in tax rates. Finally, we study how banks adjust their loan and investment portfolios in response to changes in tax rates.

The Italian IRAP presents an ideal laboratory to study as its changes generate exogenous time-series and regional variations in tax rates that this study employs to **identify** the effect of taxes on the capital structure of banks. Exogeneity in tax changes is motivated by the fact that the IRAP rate is a regional surcharge adopted to finance regional health care expenditure. These changes in IRAP are unrelated to bank balance sheet conditions and are decided autonomously by the (local or national) government. It is conceivable that some of these changes in the health care deficit could be correlated with the economic situation in a region, and this could affect the demand for bank loans and deposits. We address this issue in detail in Section 4.1 of the paper, where we describe the tax rate changes in our sample period and show that they are unrelated to the financial health of the banking sector. To further address the potential issue of exogeneity, we run regressions with macroeconomic regional controls.

The underlying theory that we **rely** on recognizes the tax advantages brought by both deposits and non-deposits liabilities, while equity does not bring any tax advantage. Banks in our theoretical setting are also cognizant of the fact that deposits provide liquidity services and hence are cheaper compared to non-deposit liabilities. By virtue of deposit insurance, deposits are sticky in the sense that they remain with the bank until the bank is closed by the regulators. The model, based on these economic underpinnings, determines sharp predictions on the data. A key implication of the model that we are interested in **testing** is whether banks increase their equity base in response to a reduction in the corporate rate. A related prediction from our theoretical analysis is whether banks reduce non-deposit funding more than deposit funding,

in response to a tax cut, as predicted by our model. The increased capitalization benefits credit spreads, which lowers the total non-equity cost of funding. All these effects could also have positive effects on banks' credit portfolios. Finally, we investigate which component of banks' portfolios is affected most in response to a change in tax rate, i.e., securities or loans, and in the latter case what the total effect on the quality of credit (performing vs. non-performing loans) is.

We find the following empirical results about bank liability structure. Consistent with the empirical evidence presented by Bond et al. (2016) and Schepens (2016) and the predictions of Sundaresan and Wang (2014), we find that banks reduce their leverage in response to a reduction in tax rates. Specifically, we find that a reduction in the IRAP rate by one percentage point leads to an increase of about 0.15 percentage points in the ratio of tangible equity to total assets. Second, we find that banks reduce their deposit liabilities less relative to non-deposit liabilities in response to a reduction in tax rates. In this context, we find that a reduction of one percentage point in the IRAP tax rate tends to cause a reduction of more than 0.39 percentage points in the ratio of bonds to total assets. The change in the tax rate, however, has a much smaller effect on the deposit-to-asset ratio. Third, the credit spreads of bank liabilities fall in response to an exogenous reduction in tax rates as predicted by the theory.

Our empirical results on how banks adjust the asset side of their balance sheets in response to an exogenous reduction in the tax rate are more sophisticated. We find that a reduction of one percentage point in the IRAP tax rate leads to an increase of around 0.83 percentage points in the bank credit-to-asset ratio if we do not control for bank risk and regional economic conditions. If we control for bank risk and economic conditions, the effect is reduced to 0.54 percentage points. The effects are heterogeneous across banks, depending on the financial strength of the banks. Strong banks use the reduction in tax rates to increase their assets, notably the investment portfolio. Weak banks, however, use the change in tax rates to clean up their balance sheets. Specifically, a reduction of one percentage point in the IRAP tax rate is associated with an increase of 0.45 percentage points in the ratio of securities to total assets, while the increase in the ratio of loans to assets is only slightly smaller at 0.4 percentage points and is not statistically significant. On the contrary, banks reduce the ratio of bad loans to total assets by 0.12 percentage points. This last result seems to indicate that banks (especially those that are close to minimum capital requirements) use the capital base to clean up their balance sheets by recognizing losses or to reallocate assets from risky to safe ones. This evidence of reallocation of assets is consistent with Schepens (2016).

We organize the paper as follows. Section 2 describes the model and its key predictions. Section 3 describes the institutional features of the tax, and its variations over time and regions. It also describes the data used in the analysis. Section 4 contains our main empirical results.

In Section 5 we conclude. In the appendix, we provide more background information about the banks in our data set. The appendix also contains all the proofs of propositions developed in Section 2.

2 A Model of Bank Liability Structure

2.1 Bank Liabilities and Valuation

Our model of liability structure in a bank follows Sundaresan and Wang (2014) but is modified to be more consistent with the bank regulation in Italy and to highlight the role of tax. In our model, a bank owns a portfolio of assets such as loans that generate cash flows. The cash flows are the source of the bank's reported earnings, which subtract the operations costs and interest expenses, and earnings are subject to tax. The cash flow of the asset portfolio is risky, and we assume that it follows a geometric Brownian motion with volatility σ . Denote the tax rate by τ . To focus on the effects of tax on banks' liability structure, we do not explicitly model the tax rate faced by investors.³ One may interpret τ as the difference between tax rate faced by the bank and tax rate faced by investors.

Given the assumption on the cash flows of the assets, the before-tax value of the assets \tilde{V} should also follow a geometric Brownian motion with volatility σ . Let δ be the rate of cash flows,⁴ the instantaneous before-tax cash flow is $\delta\tilde{V}$. The cash flows are part of the determinants of the growth rate of the assets. Larger cash flows mean slower accumulation or smaller reinvestment in assets. The after-tax cash flow of the assets is $(1 - \tau)\delta\tilde{V}$. If a bank owns the assets and finances entirely by equity, the value of the bank is simply $V = (1 - \tau)\tilde{V}$, and the after-tax dividend is δV . We refer to the all-equity bank value V as the asset value because it is the fair value for which the bank is willing to sell the assets. In the risk-neutral measure, the stochastic process of the asset value is then $dV = (r - \delta)Vdt + \sigma VdW$, where W is a Wiener process and r is the risk-free interest rate.

The bank takes deposits, which function as a source of funding. The bank uses deposits to make loans to individuals and businesses. As required by regulation, the bank purchases deposit insurance and pays a premium to an insurance organization. Deposits in Italian Banks are insured up to 100,000 euros for each individual account. The organizations that offer compulsory deposit insurance in Italy are Fondo di Garanzia dei Depositanti del Credito Co-

³By contrast, Goldstein et al. (2001) explicitly model different tax rates faced by corporations, bond investors, and equity investors.

⁴We define cash flows of assets as the cash distributed out from the assets to pay for the liabilities and equity holders, excluding the cash reinvested back into the assets. So, a higher rate of cash flow is associated with a lower rate of asset growth.

operative (FGD) and Fondo Interbancario di Tutela dei Depositi (FITD). The FGD insures the deposits held with credit cooperative banks while the FITD insures the deposits held with the other banks. Let I be the total deposit premium the bank pays to the insurance organization. Since insured deposits are safe, the fair market interest rate on deposits should be the risk-free rate r if there are no other costs or benefits associated with the deposits.

A major benefit of deposits to the bank is that it functions as a source of income. The bank provides account services to depositors so that it earns fees and interest discounts. The income from service fees and interest discounts from deposits is assumed to be ηD , proportional to deposits D , where η is the rate of account service income. In the literature, account services are sometimes called liquidity services, and the associated income is sometimes called liquidity premium. The bank's net liability to depositors is $C_D = (r - \eta)D$ after taking the income into account, where we assume $r \geq \eta$. We refer to D/V as deposit-to-asset ratio or simply deposit ratio.

Besides taking deposits, the bank also finances its assets by borrowing in the bond market. Bonds function as additional sources of funding. The bank has to pay a premium for credit risk because bonds are not insured and because the claim of bondholders is ranked lower than the claim of depositors if the bank is liquidated. The credit premium depends on the risk of the bond and thus depends on the liability structure. Therefore, we determine the credit premium by the market price of the bond for the given liability structure. Let s be the credit risk premium on the bond, the liability of bond is $C_B = (r + s)B$, where B is the par value of the bond. We refer to B/V as bond-to-asset ratio or simply bond ratio.

The bank's total debt is the sum of deposits and bond: $D + B$. The bank's leverage can be measured by $(D + B)/V$, which is the leverage ratio. Alternatively, bank's leverage is reflected by its tangible equity, which is defined by $T = V - (D + B)$. Tangible equity is also the book value of equity. The tangible equity ratio is $T/V = 1 - (D + B)/V$, which measures how well a bank is capitalized. A lower tangible equity ratio means a higher leverage.

The equity holders of the bank garner all the residual value and earnings of the bank after paying the contractual obligations associated with deposits and bonds. Since bank earnings do not include expenses on interests and insurance premium, the total after-tax liability of deposits and bonds is $(1 - \tau)(I + C_D + C_B)$. Then, $\delta V - (1 - \tau)(I + C_D + C_B)$ is the flow of dividend to equity holders. Equities of the Italian CCBs are privately owned, not traded in the market. Therefore, the value of equity, denoted by E , should be viewed as the economic value of all the dividend to be earned by the owner of the bank, although the value is not observable in the market.

Regulators close the bank for liquidation if its total capital ratio, which is $(V - D)/V$, falls to or below a threshold β . This implies that the bank is closed when its asset value drops to

V_a , where $V_a = D/(1 - \beta)$. Liquidation is costly because of the liquidation discount and legal expenses. If bank's assets are valued at V_a at the time of liquidation, the liquidation value is $(1 - \alpha)V_a$, where $\alpha \in (0, 1)$ measures the dead-weight losses in liquidation. If the bank is in liquidated, depositors are paid full because the insurance organization covers any shortfall. If there is more money left than the deposits after liquidation, it will be paid to bond holders. Thus, the loss function of the insurance organization is $[D - (1 - \alpha)V_a]^+$ at the time of bank liquidation, where $[x]^+$ equals x if $x > 0$ or 0 otherwise.

If the bank, which is owned by equity holders, chooses to default the obligation on liability, the bank is also closed for liquidation. The optimal point to default should maximize equity value. So, equity holders should fulfill the bank's obligation on liability until the equity value reaches zero. This is the endogenous default boundary. Let V_d be the asset value at which endogenous default happens, the liquidation value of assets is $(1 - \alpha)V_b$. It pays for depositors' claim first, and then the residual value pays for bond holder's claim. Since the bank is closed for liquidation when its asset value falls to the regulatory closure boundary or the endogenous default boundary, the asset value at bank closure is $V_b = \max\{V_a, V_d\}$. Thus, bond holders' recovery value is $[(1 - \alpha)V_b - D]^+$.

The bank's total economic value, denoted by F , is the sum of deposits, bond value, and equity value. That is, $F = D + B + E$. Since the economic value of equity E can be different from the tangible value of equity $V - (D + B)$, the bank value F can be different from the asset value V . The difference results from the benefits of financing through deposits and bond. The difference, $F - V$, is the bank's charter value. We can also view F/V as the bank's (gross) economic return on assets.

The value of the bank is depends on the bank's liability structure (I, C_D, C_B) . Sundaresan and Wang (2014) derive the closed-form formula for each part of the bank value under the assumptions in the model described above. Given a liability structure (I, C_D, C_B) , the deposits, the bond, the equity and the bank are priced by

$$D = C_D/(r - \eta) \quad (1)$$

$$B = (1 - P_b)C_B/r + P_b[(1 - \alpha)V_b - D]^+ \quad (2)$$

$$E = V - (1 - \tau)(1 - P_b)(I + C_D + C_B)/r - P_bV_b \quad (3)$$

$$F = V - P_b \min\{\alpha V_b, V_b - D\} + (1 - P_b)[C_D\eta/(r - \eta) + \tau(I + C_D + C_B) - I]/r, \quad (4)$$

respectively. In the above pricing functions, $P_b = [V_b/V]^\lambda$ is the state price of bank closure, and λ is a positive number given by

$$\lambda = \frac{1}{\sigma} \left\{ \left[\left(\frac{r - \delta}{\sigma} - \frac{\sigma}{2} \right)^2 + 2r \right]^{1/2} + \frac{r - \delta}{\sigma} - \frac{\sigma}{2} \right\}. \quad (5)$$

The bank closure boundary in the pricing functions is $V_b = \max\{V_a, V_d\}$, where the regulatory

closure boundary V_a and the endogenous default boundary are give by

$$V_a = C_D / [(r - \eta)(1 - \beta)] \quad (6)$$

$$V_d = (1 - \tau)[\lambda / (1 + \lambda)](I + C_D + C_B) / r. \quad (7)$$

In the above bank valuation, it is assumed that the deposit insurance premium I is exogenously set by the insurance organization. In practice, insurance organizations levy insurance premium based on the total deposits in the bank. Let ρ be the assessment rate, the insurance premium is $I_\rho = \rho D$. The insurance organization may use a single assessment rate ρ for all banks. For example, the Federal Deposit Insurance Corporation (FDIC) in the U.S. used to apply a uniform assessment rate for banks before starting to incorporate banks' Camels ratings in 2006. The FGD and FITD use a single assessment rate for deposit insurance of Italian banks. If an insurance organization uses a single fixed assessment rate, it should generally be smaller than the income a bank generates by serving deposits. Otherwise, the insured banks see no benefit in the business of serving deposits. Therefore, we assume $\rho < \eta$ if the assessment rate is a constant determined exogenously.

Theoretically, the assessment rate should depend on the risk exposed by the deposits in the bank. According to Sundaresan and Wang (2014), the fair assessment rate should be

$$\rho_a = r(1 - \beta)^{-1}[\alpha - \beta]^+ P_a / (1 - P_a), \quad (8)$$

where $P_a = [V_a / V]^\lambda$, which is the state price of regulatory closure. The insurance premium is then $I_a = \rho_a D$. By equation (8), the fair premium is positive if $\alpha > \beta$, which is the interesting case. Otherwise, the fair premium should be zero because the regulators close the bank when it has enough assets to cover deposit claims after liquidation. The asset risk and the liability structure of the bank affect the fair assessment rate through the state price P_a . Even when an insurance organization applies a variable assessment rate, it may not charge the fair premium. Duffie et al. (2003) show that the FDIC insurance subsidizes the banks. Then, the premium actually paid by the bank is $I_\omega = (1 - \omega)\rho_a D$, where $\omega \in [0, 1)$ represents a subsidy.

2.2 Optimal Liability Structure and Comparative Statistics

Whether the insurance premium is endogenous ($I_\omega = (1 - \omega)\rho_a D$) or exogenous ($I_\rho = \rho D$), it depends on the liability structure (C_D, C_B), given other parameters in our model, because $D = C_D / (r - \eta)$. The bank should choose a liability structure (C_D, C_B) to maximize the bank value F . Notice that maximization of bank value F is equivalent to maximization of the bank's (gross) return on assets F/V .

For the endogenous deposit insurance I_ω , Sundaresan and Wang (2014) derive the following closed-form solution of the optimal liability structure. Suppose the insurance premium is

$I_\omega = (1 - \omega)\rho_a D$, where $\omega \in [0, 1]$ and ρ_a is defined by equation (8). The optimal liability structure (C_D^*, C_B^*) is given by

$$C_D^*/V = \pi^{1/\lambda}(1 - \beta)(r - \eta) \quad (9)$$

$$C_B^*/V = \pi^{1/\lambda} \left[\frac{(1 + \lambda)r}{(1 - \tau)\lambda} - (1 - \beta)(r - \eta) - (1 - \omega)(\alpha - \beta) \frac{\pi}{1 - \pi} \right], \quad (10)$$

where π is the state price of bank closure, given by

$$\pi = \frac{1}{1 + \lambda} \cdot \frac{\eta(1 - \tau)\lambda(1 - \beta) + r\tau(1 + \lambda)}{r(1 - \tau)\lambda[(1 - \omega)(\alpha - \beta) + \omega\beta] + \eta(1 - \tau)\lambda(1 - \beta) + r\tau(1 + \lambda)}. \quad (11)$$

The state price π in the optimal liability structure is an elementary function of the exogenous parameters, which are r , σ , δ , τ , η , α , β , and ω . Substituting equations (9) and (10) into equations (1)–(4) and setting $P_b = \pi$, we obtain analytical solutions, which we omit to save space, for the deposit ratio D^*/V , the bond ratio B^*/V , and the tangible equity ratio T^*/V in the optimal liability structure. These financial ratios are often observable.

For the exogenous assessment rate, the optimal liability structure is slightly different from those derived by Sundaresan and Wang (2014). We derive the optimal structure in Appendix A.1 and provide the solution in the following proposition.

Proposition 1 *Suppose the insurance premium is $I_\rho = \rho D$, where $\rho \in (0, \eta)$ is an exogenous assessment rate. The optimal liability structure (C_D^*, C_B^*) is given by*

$$C_D^*/V = \pi^{1/\lambda}(1 - \beta)(r - \eta) \quad (12)$$

$$C_B^*/V = \pi^{1/\lambda} \left[\frac{r(1 + \lambda)}{(1 - \tau)\lambda} - (1 - \beta)(r - \eta + \rho) \right], \quad (13)$$

where π is the state price of bank closure, given by

$$\pi = \frac{1}{1 + \lambda} \cdot \frac{(1 - \tau)\lambda(1 - \beta)(\eta - \rho) + \tau(1 + \lambda)r}{(1 - \tau)\lambda\beta r + (1 - \tau)\lambda(1 - \beta)(\eta - \rho) + \tau(1 + \lambda)r}. \quad (14)$$

Again, the state price π in the optimal liability structure is an elementary function of the exogenous parameters.

Substituting equations (12) and (13) into equations (1)–(4) and setting $P_b = \pi$, we obtain analytical solutions for the deposit ratio D^*/V and the bond ratio B^*/V in the optimal liability structure for the exogenous assessment rate. We also obtain the credit spread s^* , which is $s^* = C_B^*/B^* - r$. The optimal tangible equity ratio T^*/V also has a closed-form formula. The formulas of these financial ratios are provided in the following proposition and used for deriving the comparative static analysis of tax rate changes.

Proposition 2 *Suppose the insurance premium is $I_\rho = \rho D$, where $\rho \in (0, \eta)$ is the exogenous*

assessment rate. The financial ratios in the optimal liability structure are

$$D^*/V = \pi^{1/\lambda}(1 - \beta) \quad (15)$$

$$B^*/V = (1 - \pi)\pi^{1/\lambda} \left(\frac{1 + \lambda}{\lambda} \cdot \frac{1}{1 - \tau} - (1 - \beta) \frac{r - \eta + \rho}{r} \right) \quad (16)$$

$$s^* = r\pi/(1 - \pi) \quad (17)$$

$$T^*/V = 1 - \pi^{1/\lambda}(1 - \beta) - (1 - \pi)\pi^{1/\lambda} \left(\frac{1 + \lambda}{\lambda} \cdot \frac{1}{1 - \tau} - (1 - \beta) \frac{r - \eta + \rho}{r} \right). \quad (18)$$

The optimal financial ratios depend on all the parameters except α . The ratios are **independent** of α because of the fixed assessment rate in deposit insurance. In the optimal liability structure, the bank is closed when asset value reaches $V_a^* = D^*/(1 - \beta)$. The deadweight loss at bank closure is supposed to be αV_a^* . Since β is smaller than α , the recovered value after liquidation is smaller than deposits: $(1 - \alpha)V_a^* = D^*(1 - \alpha)/(1 - \beta) < D^*$. Thus, the bond value is wiped out at bank closure. However, the further loss, $D^* - (1 - \alpha)V_a^*$, is shouldered by depositors only up to the premium ρD^* , despite α . Therefore, the deadweight loss to the bank is floored by the insurance organization, which shoulders the deadweight loss beyond the insurance premium. This is a welfare transfer (subsidy) to the bank and causes bank value to be **independent** of α .

The focus in this paper is the effects of tax rate changes on banks' choice of liability structure. Using the closed-form solutions in Proposition 1, we can derive the following effects of tax changes.

Proposition 3 Suppose the insurance premium is $I_\rho = \rho D$, where $\rho \in (0, \eta)$ is an exogenous assessment rate. The marginal effects of tax rate τ on the optimal financial ratios of the banks are:

$$\frac{\partial(B^*/V)}{\partial \tau} > \frac{\partial(D^*/V)}{\partial \tau} > 0, \quad \frac{\partial(T^*/V)}{\partial \tau} < 0, \quad \frac{\partial s^*}{\partial \tau} > 0. \quad (19)$$

This proof of the proposition is provided in Appendix A.2.

The first chain of inequalities in (19) implies that both the optimal deposit ratio D^*/V and optimal bond ratio B^*/V decrease if the tax rate τ is lowered. They also imply that the optimal bond ratio B^*/V decreases more than the optimal deposit ratio D^*/V . It follows that an increase in the optimal tangible equity ratio T^*/V is associated with a cut in the tax rate, as expressed in the next inequality. Reducing leverage should **lower** credit spread on the bond; this is the last inequality in (19), which implies that the credit spread s^* in the optimal liability structure is narrower if the tax rate is lower. Therefore, a **lower** tax rate is associated with a **lower** funding cost for the bank that optimally chooses its liability structure. Each of those effects implied by Proposition 3 is an implication that is empirically testable. If we observe exogenous differences or exogenous changes in tax rates **faced** by different banks, we can empirically

examine whether the differences and changes in the financial ratios of banks are consistent with the predictions in Proposition 3.

In view of Proposition 2, the tax rate τ is only one of the many parameters that determine the financial ratios. The other parameters are asset volatility σ , cash flow rate δ , account service income rate η , liquidation cost α , capital requirement β , and market risk-free interest rate r . The first four, σ , δ , η , and α are most likely to be different in different banks and at different times. The formulas in Proposition 2 show that the optimal financial ratios depend on σ , δ , and η but are **independent** of α . We summarize the comparative statics of the first three parameters in the next proposition.

Proposition 4 *Suppose the insurance premium is $I_\rho = \rho D$, where $\rho \in (0, \eta)$ is an exogenous assessment rate. The marginal effects of changes in asset volatility σ , asset cash flow δ , and account service income η on the optimal financial ratios of the banks are*

$$\frac{\partial(B^*/V)}{\partial \sigma} < 0, \quad \frac{\partial(D^*/V)}{\partial \sigma} < 0, \quad \frac{\partial(T^*/V)}{\partial \sigma} > 0, \quad \frac{\partial s^*}{\partial \sigma} > 0, \quad (20)$$

$$\frac{\partial(B^*/V)}{\partial \delta} < 0, \quad \frac{\partial(D^*/V)}{\partial \delta} < 0, \quad \frac{\partial(T^*/V)}{\partial \delta} > 0, \quad \frac{\partial s^*}{\partial \delta} > 0, \quad (21)$$

$$\frac{\partial(D^*/V)}{\partial \eta} > 0, \quad \frac{\partial(B^*/V)}{\partial \eta} > 0, \quad \frac{\partial(T^*/V)}{\partial \eta} < 0, \quad \frac{\partial s^*}{\partial \eta} > 0. \quad (22)$$

The mathematical proof of this proposition can be found in Appendix A.3. Tests of these effects are challenging because we do not directly observe these parameters and because changes in these parameters may be chosen by banks endogenously. By contrast, it is more reasonable to regard changes in tax rate as exogenous.

3 Description of the IRAP Rates and Data

In order to **assess** the effect of taxation on bank's liabilities structure, this paper follows the strategy used by Bond et al. (2016), based on data regarding an Italian tax, IRAP, and a specific typology of Italian banks, which are the CCBs.

The IRAP was introduced in 1998 to finance the national health system as a flat rate tax levied on the value added generated by all sectors of the Italian economy including the public administration. All types of business (corporations as well as un-incorporated businesses, partnerships, and sole traders) are subject to IRAP.

The basic IRAP tax rates established in 1998 were national, flat rates, which were 4.25% for the non-financial sector and 5.4% for the financial sector. The relatively **higher** IRAP rate for the financial sector was lowered gradually during the next ten years. It was cut to 5% in

2001, to 4.75% in 2002, and to 4.25% in 2003, as shown in Table 1. It reached its lowest level of 3.9% in 2008 when the tax base was broadened. This basic IRAP rate was kept at 3.9% for only three years until budget problems forced the government to increase the rate for the financial sector, but not for the non-financial sector, back to 4.65% in 2011.

For the financial sector, all regions maintained a uniform IRAP rate until 2002. Since then, each region was allowed to set its IRAP tax rate above or below the national basic rate. The deviation from the basic rate is limited within one percentage point until 2008 and 0.92 percentage points since then. Table 1 shows the evolution of the IRAP rate applied to banks across Italian regions during 2002–2011. Regional rates showed a wide heterogeneity due to regional surcharges. Because IRAP revenues are earmarked to finance health care expenditure, the Italian central government has also introduced automatic increases in the IRAP rates for the regions running a health care deficit. For instance, there has been a mandatory tax rate increase by one percentage point in 2006 for Abruzzo, Campania, and Liguria. All these changes generate exogenous time and regional variations in the IRAP tax rates, which is employed in this study to identify the effect of taxes on the capital structure of banks.

The IRAP levies tax by applying the tax rate on the tax base, which is the value added in a corporation. Nonfinancial firms and financial firms however calculate the value added differently. The tax base of a nonfinancial firm includes its profits, wages, and interest payments. The calculation of tax base does not discriminate between debt and equity financing: neither interest payments nor dividend payments are deductible from the tax base.⁵ Hence, IRAP is different from the corporate income tax, which is called IRES in Italy. This is not the case for financial firms. The tax base of a financial firm includes its profits and wages, unless loan loss and write-down were included during 2005–2012. Accordingly, banks can deduct interest expenses from the IRAP base. While IRAP and the corporate income tax share the deductibility of interest payments, IRAP is more suitable than IRES for our purpose of examining the effect of tax rates on capital structure because it varies across regions. By contrast, IRES is set at a uniform, national rate of 27.5% across all banks in Italy, and the variation over time is very small.

In our study, we focus on Italian cooperative credit banks (CCBs). These banks are restricted by law to operate only at the local level to support their local community. CCBs are typically small banks with very similar business models because of their geographical constraints. In contrast with the U.S. credit cooperatives, which are usually government-sponsored institutions designed to provide financing to specific industries, Italy's CCBs are private sector banks similar to credit unions but focusing on lending to small businesses and households rather than to consumers. At least half of CCBs' credit is granted to their own shareholders. The share-

⁵A small amount of interest (4%) is not deductible since 2009 (3% in 2008).

holders bear the same risks of commercial banks' shareholders: CCB can go bankrupt and in this case the shareholders lose their investment in equity. Mutual banks are subject to the same regulatory regime (and closure policies) as other banks and are under the supervision of the Bank of Italy.

CCBs have some important features that are particularly useful for the econometric identification of tax effects.

First, most commercial banks in Italy operate in more than one region and therefore are subject to different tax rates. The IRAP tax base is allocated proportionally for different tax rates according to the proportions of deposits in different regions. For commercial banks, therefore, it is difficult to analyze and identify the effects of the changes in the IRAP rate on the liability structure, because the overall IRAP rate is a weighted average rate calculated on the base of deposits in each region. Moreover, the analysis of changes in the corporate tax rate is further complicated for Italian, as well as for non-Italian, banking groups that operate in different jurisdictions and are subject to several tax regimes and to different taxes (corporate income taxes, bank levies, local business taxes, etc.). Instead, a CCB generally operates only in one region, so the changes in statutory IRAP rate, set by the region, apply to the whole tax base.

Second, the empirical analysis can more easily control for possible shifts in loan demand because such demand highly depends on the macroeconomic conditions at the regional level. Regional economic indicators in our analysis include the regional Gross Domestic Product (GDP), GDP per capita, and the employment ratio. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. All economic data are provided by ISTAT (Istituto Nazionale di Statistica).

Third, when the effects of taxes on leverage or riskiness are tested, it is worth remembering that taxes are generally computed at the individual level (even if a tax consolidation system applies, the consolidated tax base is equal to the sum of the tax bases of each companies belonging to a group), whilst the riskiness of a banking group is assessed on a consolidated basis. This implies that often equity is allocated between the banks belonging to the group without any correlation to the effective riskiness or the leverage of the single bank, because only the leverage and the supervisory ratio at group level are relevant for supervisory purposes. This means that any assessment of the relation between tax and leverage (or other financial statements ratio) made on sample composed (also) by banks belonging to groups can be biased by the equity policy decided by the parent bank. As CCBs are not allowed to be part of banking groups, this eliminates the complications arising from studying bigger banks, which are a part of a group.

Finally, despite the low tax rate, IRAP accounts for a relevant part of the tax burden of CCBs because their IRAP tax base is broader than the corporate income tax (IRES) for two reasons: i) until 2015 wages were not deductible from IRAP tax base (while they are deductible from IRES); ii) CCB must set aside at least 70% of profit in a reserve, unavailable for distribution, and this share of the profits is not subject to IRES, whilst they are subject to IRAP. In other words, in the period 1998–2011 the effective corporate tax rate for CCBs ranged from 0% (in the theoretical case that all profits are not distributed) to 11.11% (in case 70% of the profits are retained); on the other side the IRAP rate could reach in some region 5.56% and represent quantitatively at least half of the incidence of the IRES.

The characteristics of CCB to retain at least 70% of their profits in reserves does not have any effect on ROE and ROA or on the choice of mutual banks to increase the capital base through new equity issuance. Indeed in the period under investigation CCBs were more profitable than other banks. Taking into account the ROE and the ROA before tax (i.e., before the application of partial profit exemption provided by IRES tax rules for CCBs), CCBs' ROE was higher by 2.65 bps than one of the other Italian banks on an annual basis; in the same period, the ROA was higher by 0.39 bps. Furthermore, even though CCBs must set aside in the reserve 70% of the profits, they can decide how to use the remaining 30%. More institutional details on the functioning of CCBs are reported in Appendix A.4.

Our database includes 462 mutual banks operating in different regions of the Italian territory in the period 1999 to 2011 (see Table 2). The first panel of Table 2 compares the composition of assets of CCBs to that of Ltd banks in three different years: the beginning of our sample (1999), in the middle (2005) and at the end (2011). CCBs have a higher percentage of loans to Public Administration and other residents compared to non-CCBs. This remains true even after the recent financial crisis. CCBs also invest a greater share of their assets in government debt than in private sector securities; the reverse is true for non-CCBs. Moreover, CCBs hold almost no foreign assets. CCBs have been active in the securitization market.

The second panel of Table 2 describes the composition of the liability side. Due to their regulatory restrictions, CCBs are more conservative in their financing methods than non-CCBs. For example, CCBs are mostly funded by deposits received from residents while non-CCBs are financed through a non-negligible amount of deposits from abroad. The level of capitalization of CCBs is higher than other banks. For example, at the end of the sample the ratio of capital and reserves over total assets was 11.8%, around one percentage point higher than that of Ltd banks. Figure 1 reports the distribution of the leverage ratio among the CCBs in our sample. The cross sectional variation of capital ratios is quite high. In section 4 we will consider CCBs in the last decile of the distribution as poorly capitalized and we will check if such mutual banks could have had a different endogenous response to the changes in the IRAP rate.

4 Empirical Results

4.1 Exogeneity of IRAP Rate Changes

One possible **identification** limitation of **testing** whether changes in the tax rate does affect bank liability structure is that, in principle, the situation of the banking sector could also impact on fiscal decisions. That is we also have to consider whether financial stability objectives can also determine fiscal policy actions thereby biasing our estimations. We have considered this potential problem in a number of ways.

One first consideration is that CCBs are very small financial intermediaries and have limited systemic relevance. Therefore, it is very unlikely that changes in their specific banking conditions could alter fiscal decision on the IRAP rate, especially taking into account that the nature of this tax is to finance the national health system.

Decisions on changes in the IRAP rate are typically taken for reasons that are exogenous to the banking sector's state of health or to the regional cycle. In the period 1999–2011, there were 114 variations of the IRAP tax rate applied to the banking sector (39 increases and 75 decreases). Table 3 divides such variations in those decided by: i) the central government; ii) the regional government; iii) both. The analysis of such changes indicates that 96 out of 114 were exclusively due to a decision of the central government; in 5 cases we observed in the same year both a variation decided by the central government and a variation decided by the local government; only the remaining 13 variations were decided by the local government.

The 96 variations decided by the central government can be of two types:

- i) A compulsory and automatic variation in the IRAP rate caused by an health care deficit;
- ii) A modification of the basic tax rate due to a change in tax design or the need to increase the overall amount of tax revenues.

Modification of the IRAP rate under i) and ii) cannot be obviously linked, because of their nature, neither to changes in the state of health of the regional banking system nor to the dynamic of the regional economic cycle.

Finally, it is worth stressing that a variation of the tax rate does not imply an effect on the demand of credit by non-financial firms for two reasons. Firstly, both the national and the local government can decide to increase only the rate applied to the banking sector: as regards the period 1999–2011, 97 out of 114 tax rate variations applied only to banks. Secondly, the IRAP tax base rules for non-financial firms do not allow the deductibility of interest expense; in other words, there is not a IRAP debt-bias affecting non-financial firms, therefore a variation of the tax rate does not have any effect on the cost of debt funding and, consequently, on the credit demand of the non-financial firms.

To formally test for exogeneity of the IRAP rate, we regress the tax rate changes on banking health related variables and local macroeconomic conditions. In particular, we estimate the following model:

$$\Delta(\text{IRAP rate})_{rt} = \alpha \cdot B_{rt} + \beta \cdot Y_{rt} + \gamma \cdot (\text{IRAP GOV UP})_t \quad (23)$$

$$+ \delta \cdot (\text{IRAP GOV DOWN})_t + \theta_r + \epsilon_{rt} \quad (24)$$

where B_{rt} is a vector of variables that captures the state of health of the banking system in region r at time t (ROE, non-performing loans over total assets, leverage ratio) and Y_{rt} is a vector of macroeconomic variable (changes in GDP pro capita and regional employment). We also control for those variations in the IRAP rate that are decided by the central government by means of two dummy variables for increase (IRAP GOV UP) and decreases (IRAP GOV DOWN). We also include a complete set of regional fixed effects (θ_r) to control for the fact that enforcement may differ across regions.⁶

The results reported in the first column of Table 4 indicate that both banking health related variables and local macroeconomic conditions do not significantly affect changes in the IRAP rate. The above results do not change if we split the dummies to take into account the specific motivations of the change (see above points i) and ii)): either the automatic increase to finance the budget of the national health system or for tax design motivation (see second column of Table 4). The results are also robust to the introduction of lagged values of banking health related variables (third column of Table 4) and macroeconomic conditions (last column of Table 4).⁷ Very similar results (not reported for the sake of brevity) are obtained if one consider all banking system characteristics in first differences instead than in levels.

4.2 Effects of IRAP Rate Change on Leverage

We empirically examine the effects of changes in the IRAP rate on the liability structure of CCB banks. The effects we focus on are those listed in Proposition 3. The first hypothesis we test is

H1: A reduction in the tax rate leads to an increase in the tangible equity ratio of a bank.

For this hypothesis, we examine the relation between the change in tangible equity ratio and the change in the IRAP rate. If bank i operates in region j , we use $\Delta(\text{Equity/Total assets})_{ijt}$ to

⁶If we divide Italian regions between north (12 regions) and south (8 regions), we can see that 106 banks resident in the south were interested by 46 variations, and 356 banks resident in the north by 68 variations: again, the differences do not stem from differences in enforcement, but from the changes decided by the central government. If we consider only the variations decided by the local government, four were decided by southern regions and 14 by northern regions.

⁷Another way to mitigate endogeneity issues is the use of the dynamic Generalized Method of Moments (GMM) panel methodology. The pros and cons of such methodology are discussed in Annex A.5.

denote its change in tangible equity ratio from year $t - 1$ to year t and use $\Delta(\text{IRAP rate})_{jt-1}$ to denote the change in the IRAP rate from year $t - 2$ to year $t - 1$.⁸

We focus our analysis on an accounting measure of leverage instead than a market measure for two reasons. First, equity shares of mutual banks are not listed in exchanges and it is not possible to get market value for CCBs capitalization and asset value. Second, market value measure of leverage has been proved to be more volatile than accounting measures (Gambacorta and Shin, 2016) and could not reflect a bank's choice on its funding structure. For example, a change in the corporate tax rate ratio could be immediately discounted in the market value of a firm and causes a change in the market value of leverage even if the bank has not changed her equity vs debt policy mix.

To test hypothesis H1, we estimate the following regression:

$$y_{ijt} = \gamma \cdot \Delta(\text{IRAP rate})_{jt-1} + \phi \cdot X_{ijt-1} + \mu_i + \theta_t + \epsilon_{ijt}, \quad (25)$$

in which we use $\Delta(\text{Equity/Total assets})_{ijt}$ as the dependent variable y_{ijt} . The direct costs of remunerating shareholders and the risk profile of banks, which affect banks' optimal capital decisions, are controlled for by means of bank-specific characteristics. The control variables are lagged one period to mitigate possible endogeneity problems. These bank-specific characteristics are denoted by vector X_{ijt-1} in the regression. We include a complete set of year fixed effects (θ_t) and bank-fixed effects (μ_i). The inclusion of year fixed effects allows us to control for possible specific effects caused by the global financial crisis. Moreover, it is important to note that the inclusion of bank fixed effects allows us to interpret the coefficient estimates as variation within banks over time.⁹

In view of equation (18), the optimal tangible equity ratio is a function of σ , δ , η , β , r , and ρ . Parameters σ , δ , and η are bank characteristics, and changes of these parameters may cause a bank to adjust its liability structure, as theorized in Proposition 4. Since direct data on these parameters are not available, we have to use observable data that are believed to be related to these parameters. Since the volatility parameter σ measures the risk in bank assets, we use the change of the density function as a control variable. Because the density function is the ratio of the risk-weighted assets to the total assets, the change of the density function is denoted by $\Delta(\text{RWA/Total assets})_{it-1}$ for bank i in year $t - 1$.

⁸The same approach is followed by Hemmelgarn and Teichmann (2013) and Bond et al. (2016), who find that the lagged value of the IRAP rate is more informative than the current IRAP rate. The coefficient of the current IRAP rate is not statistical significant indicating that the impact of the IRAP rate on leverage is not immediate. When further lags of the tax rate are included in the regression, they are statistically insignificant. This suggests that changes in the IRAP rate take approximately one year to affect bank liability structure, but no longer than a year.

⁹The fixed effect approach has advantages and disadvantages, compared to the GMM test of dynamic econometric specification in Arellano and Bond (1991). We address this issue and check the robustness of our results in the GMM test in Appendix A.5.

The asset cash flow parameter δ affects both the growth of assets and the return on equity because the cash flows are taken out of assets accumulation or reinvestment and used for paying equity holders as well as other liabilities. We therefore include the change of bank's return on equity and asset growth rate as two additional control variables, which are denoted by ΔROE_{it-1} and $\Delta(\text{Assets growth})_{it-1}$ respectively. The parameter η measures the bank's profitability in serving deposits and should also affect the bank's return on equity. We proxy the service income parameter η using the volume of overdraft commissions and other fees on current accounts over total assets.¹⁰

The assets' riskiness (σ), the assets' cash flow (δ), and the account service income (η) may also depend on the economic environment in which a bank operates. It is arguable that the density function, ROE, assets' growth, and bank size may not provide complete control for the change of σ , δ , and η . Furthermore, it is even arguable that difference in regional economy may affect other bank characteristics that we have missed. For these reasons, we examine the robustness of our empirical results by controlling for the change of regional economic variables. The economic variables include the logarithm of the Gross Domestic Product (GDP), the regional GDP per capita, and the employment ratio. The regional GDP and GDP per capita are both deflated to 2005 value using the CPI. The employment ratio is defined as the total number of employed divided by the total population in each region.

The empirical results of econometric specification (25) are reported in Table 6. For the first column of the numerical results in the table, the regression does not control for bank risk or regional economy. The coefficient of the IRAP rate change is -0.1496 , which implies that a reduction of one percentage point in the IRAP rate leads to an increase of around 0.15 percentage points in the ratio of tangible equity to total assets. This effect is significant at 99 percent confidence, as indicated in the table. This result is consistent with the implication of our theory as stated in Proposition 3. This result is also consistent with Bond et al. (2016) and Schepens (2016), who show that banks with less tax benefits of debt tend to be better capitalized. The results are qualitatively very similar when we control for regional economy (second column of Table 6) and for the variation of bank risk (third column of Table 6).

¹⁰Empirical studies in the literature of bank lending channel also include bank size (measured by the logarithm of total assets) as control variable. Bank size controls for market power or for the capacity of banks to tap funds on the market (Kashyap and Stein, 1995, 2000; Kishan and Opiela, 2000). Notwithstanding the wide use of bank size in empirical specification, its non-stationary nature could potentially cause spurious correlation. For this reason, we do not include it in our baseline specification. Moreover, time-invariant difference in size among banks are already captured by the bank fixed effects. To check the robustness of the results, we have run regressions including bank size. The results (not reported for the sake of brevity but available from the authors upon request) remain the same qualitatively.

4.3 Tax Effects on Bank Liability Structure

While the increase in leverage associated with tax rate raise has been documented in the literature, there has been no empirical work on the structural adjustment of bank liabilities in response to tax rate changes. We examine how banks adjust their deposit and bond ratios when tax rate changes. Our theoretical model predicts a positive relation between each of these ratios and the tax rate, as shown in Proposition 3. The model also predicts that the adjustment of bond ratio is larger than the adjustment of deposit ratio. We therefore empirically test the following hypotheses:

- H2: A reduction in the tax rate leads to a reduction in the deposit ratio of a bank.
- H3: A reduction in the tax rate leads to a reduction in the bond ratio of a bank.
- H4: A reduction in the tax rate leads to greater reduction in bond ratio than in deposit ratio of a bank.

To test hypothesis H2, we replace the dependent variable y_{ijt} in regression (25) by the change in bank deposit ratio, which is denoted by $\Delta(\text{Deposits}/\text{Total assets})_{it}$. Similarly, we replace the dependent variable by change in bank bond ratio, which is denoted by $\Delta(\text{Bonds}/\text{Total assets})_{it}$, to test hypothesis H3. The estimated coefficient of the change in the IRAP rate in these two regressions also suggest the result of hypothesis H4, but for a formal statistical inference, we use the difference between the two changes,

$$y_{ijt} = [(\Delta\text{Bonds} - \Delta\text{Deposits})/\text{Total assets}]_{ijt}, \quad (26)$$

as the dependent variable in regression (25) and examine the coefficient of the change in the IRAP rate.

The empirical results of the above test are reported in Table 7. The coefficient of the IRAP rate change is significant at 95-percent confidence in the regression in which the change in the bond ratio is dependent variable. The estimate of the coefficient is about 0.39 if we do not control for bank risk or regional economy. The estimate is about 0.37, only slightly smaller if control for regional economy. It is above 0.39 after controlling for both bank risk and regional economy. Therefore, a reduction of one percentage point in the IRAP tax rate tends to cause a reduction of around 0.39 percentage points in the bond to total asset ratio. This effect of tax rate change is consistent with the prediction of our theoretical model.

The effect of tax rate change on deposit ratio is however much smaller. With the change of deposit ratio as the dependent variable, the estimated coefficient of the IRAP rate change is about 0.17 if we do not control for bank risk or regional economy. After controlling for regional

economy and bank risk, the estimate drops to 0.08. This estimate is not notably affected by the control for bank risk. Although the positive estimate indicates the association of decrease in deposit ratio with tax rate reduction and is consistent with our model's prediction, the estimate is insignificant statistically.

The difference in the estimates of the coefficient of IRAP rate change in the above tests with bond ratio and deposit ratio clearly suggests the differential effects of the tax rate change on banks' choice of the bond and deposits in the liability structure. When the tax rate is cut down, banks reduce bonds more than deposits because tax rate is relatively more important for bonds than for deposits. The reason is that deposits bring income through account services besides tax benefit. By contrast, bonds enjoy the tax benefit but do not generate additional incomes for the bank. In addition, the interest rate on bonds are higher than the interest on deposits, causing the effect of tax deduction of interest expenses on bonds larger than that on deposits. In particular, when running a regression with the y_{ijt} defined in (26) as the dependent variable and with the inclusion of the complete set of bank-specific controls, the estimated coefficient of the change in the IRAP rate is equal to 0.310 with a standard error of 0.155.

Since a cut in tax rate reduces bank leverage, it should be associated with lower premium for credit risk. This is another prediction of our model and expressed as the last inequality in Proposition 3. We do not directly observe the data of credit spread on the bonds of the banks in our sample, but we have the data of the weighted average cost of deposits and bonds, which we denote by $(\text{Cost of non-equity funding})_{it}$ for bank i in year t in our regressions. Since this cost excludes the funding cost of the bank owners, the funding cost of deposits and bonds can be viewed as a proxy of the credit spread. Therefore, we test the following hypothesis:

H5: A reduction in the tax rate leads to a narrowing of the cost of non-equity funding of a bank.

To test this hypothesis, we replace the dependent variable y_{ijt} in regression (25) by the change of the average non-equity funding cost. Obviously, the use of the average funding cost as proxy requires us to control for the risk-free interest rate. The inclusion of the year fixed effects serves as such control in our regressions.

The empirical results for the test of hypothesis H5 are reported in Table 8. The positive and significant coefficient of the IRAP rate change supports the hypothesis. Without controlling for bank risk and regional economy, the estimate of the coefficient is about 0.12. The estimate is slightly higher, which is about 0.13, after controlling for regional economy or controlling for both regional economy and bank risk. All these estimates are significant with 99-percent confidence. These results suggest that a reduction of one percentage point in the IRAP tax rate reduces the cost of non-equity funding by about 12–13 basis points. As the reduction of

the IRAP rate is also associated with an increase in bank capital, the results are in line with Gambacorta and Shin (2016) who find that better capitalized banks pay less on their non-equity funding. Berger and Bouwman (2013) provides also evidence that better capitalized banks have a greater capacity to absorb risk and hence have better access to wholesale funding markets.

4.4 Tax Effects on the Credit Portfolio of Bank Assets

In Proposition 3 and the empirical tests we have discussed so far, we focus on the change of financial ratios in the liability structure, but we ignore the potential adjustment a bank might make to the composition of assets in response to a tax rate change. Since a reduction in tax rates leaves a higher amount of after-tax earnings with the bank, a bank may choose to increase its lending. The increase in lending can be measured by the increase in total credit portfolio, for which data reported by banks are available. In this subsection, we investigate the effects of tax rate change on assets' composition by testing the following hypotheses:

H6: A reduction in tax rates lead to an increase in the total credit portfolio in the assets of the banks.

To test this hypothesis, we use the change in the ratio of credit portfolio value to the total assets as the dependent variable y_{ijt} in regression (25). The change of this ratio from year $t - 1$ to t in bank i , which is operated in region j , is denoted by $\Delta(\text{Credit/Total assets})_{ijt}$.

The empirical test of hypothesis H6 is displayed in Table 9. The results show that without controlling for bank risk and regional macro conditions, a reduction of one percentage point in the IRAP rate is associated with an increase of 0.83 percentage points in the ratio of bank credit to total asset ratio without controlling for bank risk and regional macro conditions. The effect is significant with 99 percent confidence. Controlling for regional economy, the impact of the tax rate change on the credit-to-asset ratio drops to around 0.51 percentage points and the confidence of significance drops to 95 percent. After controlling for both regional economy and bank risk, the impact of the tax rate on the credit-to-asset ratio goes to 0.54 and remains significant at 95 percent confidence.

The link between a decrease in the IRAP rate and an increase in equity and the credit portfolio is consistent with a recent study by the European Banking Authority (EBA, 2015) which finds substantial beneficial credit supply effects of greater bank capital in a cross-country study of European banks. Along similar lines Michelangeli and Sette (2016) use a novel micro dataset using web-based mortgage brokers to show that better capitalised banks lend more. More generally, in economic systems underpinned by relationship-based lending adequate bank capital allows financial intermediaries to shield firms from the effects of exogenous shocks (Bolton et

al. 2016; Gobbi and Sette; 2015). We further investigate the effects of IRAP rate change on various components of the total bank credit. Our data contain information of the three major categories in each bank's credit portfolio: government securities, performing loans, and bad loans. The categories are listed here in decreasing order of credit quality. This information allows us to construct the ratio of each category to the total assets and examine their changes:

$$\begin{aligned} &\Delta(\text{Security/Total assets})_{ijt} \\ &\Delta(\text{Performing loans/Total assets})_{ijt} \\ &\Delta(\text{Bad loans/Total assets})_{ijt} . \end{aligned}$$

We use each of the above variables as the dependent variable y_{ijt} in regression (25). We can include or exclude the control variables as we do in other regressions, but, to save space, we report only the results of the specification with all the control variables.

The empirical results presented in Table 10 shows that the effects of the tax rate change on the components of bank credit portfolio are heterogeneous. The estimated coefficient of the IRAP rate change is negative and significant for securities and for performing loans, but positive and significant for bad loans. Quantitatively, a reduction of one percentage point in the IRAP rate is associated with an increase of 0.45 percentage points in the ratio of securities to total assets and an increase of 0.4 percentage points in the ratio of loans to total assets. This result is in line with that found by Célérier et al. (2016) for the effects of changes in the allowance for corporate equity in Europe. On the contrary, banks's response to a reduction of one percentage point in the IRAP rate is to cut down the ratio of bad loans to total asset by 0.11 percentage points. The last result seems to indicate that banks, especially those that are close to minimum capital requirements, could use the tax savings to clean up their balance sheets and recognize losses or to reallocate assets from riskier to safer ones. This begs the question whether banks that barely meet the capital requirement behave differently from the other banks.

4.5 Differential Effects on Poorly Capitalized Banks

The behavior of banks with capital ratios that are close to the minimum capital requirement might be different from what is described by our theoretical model, which hypothesizes that banks choose financial ratios optimally in the given market, economic, and taxation environments and that they adjust financial ratios optimally in response to changes in the environments. These poorly capitalized banks may not have optimal liability structure in the first place, perhaps due to constraints or frictions that are not incorporated in our model, or they may not be able to response optimally as we modeled. As a result, these poorly capitalized banks may respond differently to the IRAP rate changes than the other well capitalized banks.

To account for the different behavior of the poorly capitalized banks, we divide the banks in our sample in each year into deciles according to the distribution of capital ratios. For convenience, the banks in the lowest capital-ratio decile are referred to as *poorly capitalized banks*, and the banks in the other deciles are referred to as *well capitalized banks*. We then introduce a dummy variable, named (Low capitalization dummy) $_{ijt}$, to indicate whether bank i of region j in year t is in the lowest capital-ratio decile. Adding this dummy variable and its interaction with the IRAP rate change, we consider the following regression:

$$\begin{aligned} y_{ijt} = & \gamma_0 \cdot \Delta(\text{IRAP rate})_{jt-1} \\ & + \gamma_1 \cdot \Delta(\text{IRAP rate})_{jt-1} \cdot (\text{Low capitalization dummy})_{ijt-1} \\ & + \gamma_2 \cdot (\text{Low capitalization dummy})_{ijt-1} + \phi \cdot X_{ijt-1} + \mu_i + \theta_t + \epsilon_{ijt}. \end{aligned} \quad (27)$$

We first use (Equity/Total assets) $_{ijt}$ as dependent variable y_{ijt} in regression (27) and report the results in the first column of Table 11, which shows the differential impact of the IRAP rate change on the liability structure of poorly capitalized bank. This regression tests hypothesis H1 while allowing for the possibility of heterogeneous reactions of banks depending on their level of capitalization. The estimated coefficients are around -0.1 for the IRAP rate change and around -0.2 for the interaction between the IRAP rate change and the dummy variable. Both coefficients are significant with 95 percent confidence. Therefore, a reduction of one percentage point in the IRAP rate change is associated with a larger increase in the equity-to-asset ratio of the poorly capitalized banks relative to the same ratio of the other banks (0.3 vs. 0.1 percentage points). It therefore appears that in response to a tax rate cut, capitally constrained banks de-lever more than those well capitalized banks. This result seems in contrast with Keen and De Mooij (2012) who employ a panel of over 14,000 commercial banks in 82 countries from 2001 to 2009 and find that banks with smaller equity buffers react by less to tax changes. However, they also find that small banks, such as CCBs, are noticeably more sensitive to tax.

We then examine the differential effects of the IRAP rate change on bonds and deposits in banks liability structure. For this examination, we replace the dependent variable y_{ijt} in regression (27) by the ratio of bonds to the total assets and then by the ratio of deposits to the total assets, as we have done in the tests of hypotheses H2, H3, and H4. The results of the regressions are reported in the second and third columns of Table 11. The coefficients of the IRAP rate change and its interaction with the dummy variable are both positive in each of the two columns. In the second column, which is for the effects on the bond-to-asset ratio, the two coefficients are around 0.4 and 0.1, each being larger than the corresponding coefficients in the third column, which is for the effects on the deposit-asset ratio. Therefore, the results are consistent with hypothesis H2, H3 and H4. This means that a cut of one percentage point in the IRAP tax rate is associated with a reduction of 0.5 percentage points in the bond-to-asset ratio for the poorly capitalized banks, while the associated reduction in the same ratio is

0.4 for the other banks. The effects on the deposit ratio are smaller, only about 0.2 percentage points for the poorly capitalized banks and 0.1 percentage points for the other banks. However, neither the effects on deposit-to-asset ratio nor the difference for the poorly capitalized banks are statistically significant.

In the last column of Table 11, we examine whether there are difference in the impact of the tax rate change on the funding cost in the liabilities. We use the cost of non-equity funding as the dependent variable y_{ijt} in regression (27) and test hypothesis H5. Interestingly, the coefficients of the IRAP rate change and its interaction with the dummy variable are both significant. The estimates of the coefficients suggest that a reduction of one percentage point in the IRAP tax rate leads to a drop of nearly 16 bps in the cost of non-equity funding in the poorly capitalized banks, comparing to a drop of 11 bps in the other banks.

Overall, the results displayed in Table 11 show that the IRAP rate change has a significant impact on both the tangible equity ratio and the cost of non-equity funding in the poorly capitalized banks but not on the deposit-to-asset and bond-to-asset ratios in these banks. If these banks do not adjust deposits and bonds significantly, the change of the tangible equity ratios and cost of non-equity funding must be due to changes in the assets. We therefore investigate effects of the IRAP rate change on the composition of assets and compare the effects in the poorly capitalized banks with the other banks.

The first column of Table 12 reports the results of the differential impacts on the credit portfolios of poorly capitalized banks and the other banks. The estimated coefficients suggest that a reduction of one percentage point in the IRAP tax rate is associated with an increase of around 0.77 percentage points in the credit-to-total ratio for the well capitalized banks. However, the poorly capitalized banks do not increase their proportion of credit portfolio in the assets.

The second column of Table 12 shows all banks increase the ratio of securities to total assets in response to an IRAP rate cut, but poorly capitalized banks increase the ratio by a larger amount. Since the securities held by these banks are government securities, raising this ratio cuts down the riskiness of the asset portfolio (actually they reduce by 0.2 percentage points, but the effect is not statistically significant).

The third column of Table 12 shows that the impact of the IRAP rate change on the ratio of performing loans to the total assets in the poorly capitalized banks is significantly different from the impact on the same ratio in the well capitalized banks. The coefficient of the IRAP rate change is around -0.63 , and the coefficient of the interaction variable is about 1.8. Both coefficients are significant with 99 percent confidence. These estimates indicate that the well capitalized banks increase the proportion of performing loans in their assets (by 0.6 percentage points) but the poorly capitalized banks decrease the proportion of performing loans (by 1.2

percentage points).

While our earlier results suggest that banks reduce the proportion of bad loans in their assets, the results in the last column of Table 12 show that the poorly capitalized banks make larger adjustment to the proportion of bad loans. The coefficient of the IRAP rate change's interaction with the dummy variable is positive and significant with 90 percent confidence.

Based on these results, we infer that if the tax rate was cut down, banks, especially those banks with low capital ratios, will clean up their balance sheet by writing off bad loans and acquire more (government) securities, which carry low risk weights and smaller regulatory capital charges. In other words, poorly capitalized banks seems to use the increase in equity to deleverage, shifting the asset composition towards less risky categories of assets. These adjustments improve the tangible equity ratios and trim the cost of non-equity funding. This result is in line with Brei et al. (2013) that examines whether the rescue measures adopted during the global financial crisis helped to sustain the supply of bank lending. Using a dataset covering large international banks headquartered in 14 major advanced economies for the period 1995–2010 they find that while stronger capitalization sustains loan growth in normal times, banks during a crisis can turn additional capital into greater lending only once their capitalization exceeds a critical threshold. This suggests that recapitalizations may not translate into greater credit supply until bank balance sheets are sufficiently strengthened.

5 Conclusions

Our paper offers new empirical results which support the theoretical predictions that exogenous changes in tax rates affect both the liability structure of banks as well as the credit spreads on bank liabilities. Our theoretical and empirical results for Italian taxes and banks support the empirical findings of Schepens (2016), who shows that Belgian bank leverage responds to exogenous tax rate changes, although our Italian data cover a very different sample period than the Belgian data. Most importantly, we provide both theoretical and empirical results on the effects of taxes on bank liability structure and bank funding costs. We also provide some evidence that the capitalization status of banks may play a role in how banks respond to variations in tax rates. In response to a drop in tax rate, more capitalized banks tend to increase their loan/investment portfolio, whereas less capitalized banks do not. Weaker banks tend to use the reduction in tax rates to spruce up their balance sheets. Collectively, our results stress the importance of fiscal policy on banks' liability structure, leverage, and loan portfolios.

Appendix

A.1 Derivation of Propositions 1 and 2

We introduce the following notions:

$$x = C_B/C_D, \quad c = C_D/(rV), \quad v_a = rV_a/C_D, \quad v_d = rV_d/C_D, \quad v_b = \max\{v_a, v_d\}. \quad (28)$$

Using the above notations, the state prices of the boundaries can be written as

$$P_a = [V_a/V]^\lambda = (v_a c)^\lambda \quad (29)$$

$$P_d = [V_d/V]^\lambda = (v_d c)^\lambda \quad (30)$$

$$P_b = [V_b/V]^\lambda = (v_b c)^\lambda. \quad (31)$$

It follows from equations (6) and (7) that

$$v_a = r/[(r - \eta)(1 - \beta)] \quad (32)$$

$$v_d = (1 - \tau)[\lambda/(1 + \lambda)][\rho/(r - \eta) + 1 + x]. \quad (33)$$

Let f be the bank's return on assets, i.e., $f = F/V$. Dividing equation (4) by V , using the notations in equations (28)–(31), and incorporating equations (32)–(33), the bank's return on assets can be written as

$$\begin{aligned} f(x, c) = & 1 - c(v_b c)^\lambda \min \left\{ \alpha v_b, v_b - \frac{r}{r - \eta} \right\} \\ & + c[1 - (v_b c)^\lambda] \left(\frac{\eta - (1 - \tau)\rho}{r - \eta} + \tau(1 + x) \right). \end{aligned} \quad (34)$$

Then, choosing (C_D, C_B) to maximize F in equation (4) is equivalent to choosing (x, c) to maximize $f(x, c)$ in equation (34). If (x^*, c^*) gives maximum value of f , then $C_D^* = c^* rV$ and $C_B^* = x^* C_D^*$ give the maximum value of F . In the rest of this proof, we derive (x^*, c^*) .

Keeping x fixed, the gross return on assets $f(x, c)$ is a continuously differentiable function in c . The partial derivative of f with respect to c is

$$\begin{aligned} f'_c(x, c) = & -(1 + \lambda)(v_b c)^\lambda \min \left\{ \alpha v_b, v_b - \frac{r}{r - \eta} \right\} \\ & + [1 - (1 + \lambda)(v_b c)^\lambda] \left(\frac{\eta - (1 - \tau)\rho}{r - \eta} + \tau(1 + x) \right). \end{aligned} \quad (35)$$

For each x , let c_x be the unique value of c such that $f'_c(x, c) = 0$. Imposing $f'_c(x, c_x) = 0$ in equation (35), we obtain

$$(v_b c_x)^\lambda = \frac{1}{1 + \lambda} \cdot \frac{[\eta - (1 - \tau)\rho]/(r - \eta) + \tau(1 + x)}{\min\{\alpha v_b, v_b - r/(r - \eta)\} + [\eta - (1 - \tau)\rho]/(r - \eta) + \tau(1 + x)}. \quad (36)$$

Keeping c fixed, the gross return on assets $f(x, c)$ is continuous but not continuously dif-

ferentiable because the function involves min and because v_b involves max. Whether v_b equals v_a or v_d depends on x . Let \hat{x} be the value of x such that $v_a = v_d$. It follows from equations (32) and (33) that

$$\hat{x} = \frac{1}{r - \eta} \left[\frac{(1 + \lambda)r}{\lambda(1 - \tau)(1 - \beta)} - \rho \right] - 1. \quad (37)$$

In function f expressed in equation (34), the term with $\min\{\alpha v_b, v_b - \eta/(r - \eta)\}$ depends on the comparison of αv_b and $v_b - r/(r - \eta)$. Let \tilde{x} be value of x such that $\alpha v_b = v_b - r/(r - \eta)$. It follows that

$$\tilde{x} = \frac{1}{r - \eta} \left[\frac{(1 + \lambda)r}{\lambda(1 - \tau)(1 - \alpha)} - \rho \right] - 1. \quad (38)$$

and that $\alpha v_b > v_b - r/(r - \eta)$ if and only if $x < \tilde{x}$. Because we assume $\alpha > \beta$, we have $\hat{x} < \tilde{x}$.

We examine $f(x, c)$ based on the range of x . First, consider the case of $x \in (0, \hat{x})$. In this case, $v_b = v_a$ and

$$f(x, c) = 1 - \frac{c(v_a c)^\lambda r \beta}{(r - \eta)(1 - \beta)} + c[1 - (v_a c)^\lambda] \left(\frac{\eta - (1 - \tau)\rho}{r - \eta} + \tau(1 + x) \right). \quad (39)$$

The partial derivative of f with respect to x is

$$f'_x(x, c) = c[1 - (v_a c)^\lambda] \tau, \quad (40)$$

which is always positive. Consequently, $f'_x(x, c_x) > 0$, which implies that $x \in (0, \hat{x})$ can never be optimal. In this case, bank can increase the return on assets by increasing x .

Next, consider the case of $x \in (\hat{x}, \tilde{x})$. In this case, $v_b = v_d$ and

$$\begin{aligned} f(x, c) = 1 - c(v_d c)^\lambda & \left[\left((1 - \tau) \frac{\lambda}{1 + \lambda} \rho - r \right) \frac{1}{r - \eta} + (1 - \tau) \frac{\lambda}{1 + \lambda} (1 + x) \right] \\ & + c[1 - (v_d c)^\lambda] \left(\frac{\eta - (1 - \tau)\rho}{r - \eta} + \tau(1 + x) \right). \end{aligned} \quad (41)$$

The partial derivative of f with respect to x is

$$\begin{aligned} f'_x(x, c) = & \left\{ \frac{\tau \rho}{r - \eta} + \tau(1 + x) - (v_d c)^\lambda \left(\frac{\tau \rho}{r - \eta} - \lambda + (\lambda + \tau)(1 + x) \right) \right\} \\ & \cdot \frac{c}{\rho/(r - \eta) + 1 + x}. \end{aligned} \quad (42)$$

The restriction of c_x in equation (36) becomes

$$(v_d c_x)^\lambda = \frac{\eta - (1 - \tau)\rho + \tau(r - \eta)(1 + x)}{(1 + \lambda)(\eta - r) - (1 - \tau)\rho + (\tau + \lambda)(r - \eta)(1 + x)}. \quad (43)$$

Imposing $f'_c(x, c_x) = 0$ and substituting equation (43) into equation (42), we obtain

$$f'_x(x, c_x) = - \frac{[1 - (v_d c_x)^\lambda](\eta - \rho) + r(v_d c_x)^\lambda}{\rho + (r - \eta)(1 + x)} \cdot c_x. \quad (44)$$

The above expression is always negative under the assumption of $\rho < \eta$. It follows that $x \in (\hat{x}, \tilde{x})$ can never be optimal because decreasing x will raise the value of f .

The last to consider is the case of $x \in [\tilde{x}, \infty)$. In this case, $v_b = v_d$ and

$$f(x, c) = 1 - c(v_d c)^\lambda \alpha \left(\frac{\rho}{r - \eta} + 1 + x \right) + c[1 - (v_d c)^\lambda] \left(\frac{\eta - (1 - \tau)\rho}{r - \eta} + \tau(1 + x) \right). \quad (45)$$

The partial derivative of f with respect to x is

$$f'_x(x, c) = \frac{c}{\rho + (r - \beta)(1 + x)} \cdot \{ \tau\rho + (r - \eta)\tau(1 + x) - (v_d c)^\lambda [(1 + \lambda)(\alpha + \tau)\rho + \lambda(\eta - \rho) + (r - \eta)(\alpha + \tau)(1 + x)] \}. \quad (46)$$

The restriction of c_x in equation (36) becomes

$$(v_d c_x)^\lambda = \frac{1}{1 + \lambda} \cdot \frac{\eta - (1 - \tau)\rho + \tau(r - \eta)(1 + x)}{\eta - (1 - \tau - \alpha)\rho + (\tau + \alpha)(r - \eta)(1 + x)}. \quad (47)$$

Imposing $f'_c(x, c_x) = 0$ and substituting equation (47) into equation (46), we obtain

$$f'_x(x, c_x) = - \frac{[1 - (v_d c_x)^\lambda](\eta - \rho)}{\rho + (r - \eta)(1 + x)} \cdot c_x. \quad (48)$$

The above expression is always negative under the assumption of $\rho < \eta$. It follows that $x \in [\tilde{x}, \infty)$ can never be optimal because decreasing x will raise the value of f .

In the above, we have shown that $f'_x(x, c_x) > 0$ for any $x \in (0, \hat{x})$ and $f'_x(x, c_x) < 0$ for any $x \in (\hat{x}, \infty)$. It follows that the optimal x^* is \hat{x} . In view of equation (37), we have

$$(r - \eta)(1 + x^*) = \frac{(1 + \lambda)r}{\lambda(1 - \tau)(1 - \beta)} - \rho. \quad (49)$$

Let $c^* = c_{x^*}$, $\pi = (v_a c^*)^\lambda$, and $v_b^* = (1 - \tau)[\lambda/(1 + \lambda)][\rho/(r - \eta) + 1 + x^*]$. Then, $v_b^* = v_a$ and $\pi = (v_b^* c^*)^\lambda$. It follows from equation (43) that

$$\pi = \frac{\eta - (1 - \tau)\rho + \tau(r - \eta)(1 + x^*)}{(1 + \lambda)(\eta - r) - (1 - \tau)\rho + (\tau + \lambda)(r - \eta)(1 + x^*)}. \quad (50)$$

Substitution of equation (49) into equation (50) gives formula (14). Then, $c^* = \pi^{1/\lambda}/v_a$ and $C_D^* = c^* r V$ give equation (12). Equation (13) follows from $C_B = x^* C_D^*$ and equation (49). These complete the proof of Proposition 1.

Equations (15)–(18) can be obtained by substituting equations (12) and (13) directly into equations (1)–(4) and setting $P_b = \pi$. This completes the proof of Proposition 2.

A.2 Derivation of Proposition 3

In view of equation (14), it is straightforward to verify that

$$\frac{\partial \pi}{\partial \tau} = \frac{\lambda \beta r}{\{(1 - \tau)\lambda[\beta + (1 - \beta)(\eta - \rho)] + \tau(1 - \lambda)r\}^2}, \quad (51)$$

which is clearly positive. It also follows from equation (14) that $(1 + \lambda)\pi < 1$. Using equation (15), we obtain

$$\frac{\partial(D^*/V)}{\partial\tau} = \frac{\pi^{1/\lambda}(1-\beta)}{\lambda\pi} \cdot \frac{\partial\pi}{\partial\tau}, \quad (52)$$

which is positive because it is a product of two positive terms. Using equation (16), we obtain

$$\begin{aligned} \frac{\partial(B^*/V)}{\partial\tau} = \frac{\pi^{1/\lambda}}{\lambda\pi} \cdot \frac{\partial\pi}{\partial\tau} \cdot [1 - (1 + \lambda)\pi] \cdot \left(\frac{1 + \lambda}{\lambda(1 - \tau)} - (1 - \beta) \frac{r - \eta + \rho}{r} \right) \\ + (1 - \pi)\pi^{1/\lambda} \frac{1 + \lambda}{\lambda(1 - \tau)^2}. \end{aligned} \quad (53)$$

The difference between the above two equations is

$$\begin{aligned} \frac{\partial(B^*/V)}{\partial\tau} - \frac{\partial(D^*/V)}{\partial\tau} = \frac{\pi^{1/\lambda}}{\lambda\pi} \cdot \frac{\partial\pi}{\partial\tau} \cdot \left\{ [1 - (1 + \lambda)\pi] \frac{1 + \lambda}{\lambda(1 - \tau)} \right. \\ \left. + (1 - \beta) \left(\frac{\eta - \rho}{r} + (1 + \lambda)\pi \frac{r - \eta + \rho}{r} \right) \right\} \\ + (1 - \pi)\pi^{1/\lambda} \frac{1 + \lambda}{\lambda(1 - \tau)^2}. \end{aligned} \quad (54)$$

Since each term in the above equation is positive, the chain of inequalities in (19) hold. Using equation (17), we obtain

$$\frac{\partial s^*}{\partial\tau} = \frac{r}{(1 - \pi)^2} \cdot \frac{\partial\pi}{\partial\tau}, \quad (55)$$

which is positive because the right-hand side is a product of two positive terms. This gives the last inequality in (19).

A.3 Derivation of Proposition 4

From equation (5), it is straightforward to calculate the partial derivatives of λ with respect to σ and δ and to obtain

$$\frac{\partial\lambda}{\partial\sigma} = -\frac{\sigma\lambda^2(1 + \lambda)}{\frac{1}{2}\sigma^2\lambda^2 + r} < 0 \quad \text{and} \quad \frac{\partial\lambda}{\partial\delta} = -\frac{\lambda^2}{\frac{1}{2}\sigma^2\lambda^2 + r} < 0. \quad (56)$$

From equation (14), we can also calculate the partial derivative of π with respect to λ and obtain

$$\frac{\partial\pi}{\partial\lambda} = -\frac{\pi}{1 + \lambda} \left[1 + \frac{(1 - \tau)\tau\beta r^2\pi}{[(1 - \tau)(1 - \beta)(\eta - \rho)\theta + \tau r]^2} \right] < 0, \quad (57)$$

where $\theta = \lambda/(1 + \lambda)$. It follows that

$$\frac{\partial\pi}{\partial\sigma} = \frac{\partial\pi}{\partial\lambda} \cdot \frac{\partial\lambda}{\partial\sigma} > 0 \quad \text{and} \quad \frac{\partial\pi}{\partial\delta} = \frac{\partial\pi}{\partial\lambda} \cdot \frac{\partial\lambda}{\partial\delta} > 0. \quad (58)$$

Since the partial derivative of $\pi^{1/\lambda}$ is

$$\frac{\partial\pi^{1/\lambda}}{\partial\lambda} = \frac{\pi^{1/\lambda}}{\lambda^2} \left[\frac{\lambda}{\pi} \frac{\partial\pi}{\partial\lambda} - \ln(\pi) \right], \quad (59)$$

we can substitute equation (57) into the above to obtain

$$\frac{\partial \pi^{1/\lambda}}{\partial \lambda} = \frac{\pi^{1/\lambda}}{\lambda^2} \left[\ln\left(\frac{1}{\pi}\right) - \frac{\lambda}{1+\lambda} \left(1 + \frac{(1-\tau)\tau\beta r^2 \pi}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2} \right) \right]. \quad (60)$$

There is a well-known inequality: $\ln(1+x) > x/(1+x)$ for $x > -1$ and $x \neq 0$. Letting $x = (1-\pi)/\pi$ and applying this inequality, we obtain $\ln(1/\pi) > 1-\pi$, which implies

$$\frac{\partial \pi^{1/\lambda}}{\partial \lambda} \geq \frac{\pi^{1/\lambda}}{\lambda^2} \left[\frac{1}{1+\lambda} - \left(1 + \frac{(1-\tau)\tau\beta \theta r^2}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2} \right) \pi \right]. \quad (61)$$

Substituting π by equation (14), we have

$$\begin{aligned} \left(1 + \frac{(1-\tau)\tau\beta \theta r^2}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2} \right) \pi &= \frac{1}{1+\lambda} \\ &\cdot \frac{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2 + (1-\tau)\tau\beta \theta r^2}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2 + (1-\tau)\tau\beta \theta r^2 + (1-\tau)\tau(1-\beta)\beta(\eta-\rho)\theta^2}. \end{aligned} \quad (62)$$

Since the last long fraction in the above equation is less than 1, we have

$$\frac{\partial \pi^{1/\lambda}}{\partial \lambda} > 0, \quad (63)$$

and thus, in view of the inequalities in (56), we further have

$$\frac{\partial \pi^{1/\lambda}}{\partial \sigma} = \frac{\partial \pi^{1/\lambda}}{\partial \lambda} \cdot \frac{\partial \lambda}{\partial \sigma} < 0 \quad \text{and} \quad \frac{\partial \pi^{1/\lambda}}{\partial \delta} = \frac{\partial \pi^{1/\lambda}}{\partial \lambda} \cdot \frac{\partial \lambda}{\partial \delta} < 0. \quad (64)$$

The inequalities in (20) and (21) follow from equations (15)–(18) and inequalities (56), (58), and (64).

In view of equation (14), it is easy to see that $\partial \pi / \partial \eta > 0$, which implies that $\partial \pi^{1/\lambda} / \partial \eta > 0$. Then, the inequalities in (22) follow from equations (15)–(18).

A.4 Some Stylized Facts on Cooperative Credit Banks (CCBs) in Italy

In our study, we focus on banche di credito cooperative (hereinafter cooperative credit banks, or CCBs). The main purpose of the CCBs is to support the development of the community where they operate. For this reason, regulations provide that CCBs can only conduct their business locally. Formally, the CCBs' incorporation deed must state that they can only carry out their activities in the area of their territorial jurisdiction. The territorial jurisdiction consists of the municipalities where the bank has at least one branch and their neighboring municipalities. CCBs are public companies even if they cannot be listed: equity must not be less than EUR 5 million and must be held by at least 200 shareholders who are resident or working in the area where each CCB operates. Each shareholder has the right to one vote at the general meeting, regardless of the value of its holding.

Another important purpose of CCBs is to operate in the interest of these partners or shareholders. Hence, the operations of a CCB are to be carried out mainly in respect of its sharehold-

ers: more than 50% of assets should be loans to shareholders (or other assets which involve the assumption of a risk to shareholders) or risk-free assets. The legislation also places limits on permissible activities of CCBs, excluding the riskiest ones. For example, a CCB cannot take speculative positions in derivatives and it is allowed to employ derivatives only for the purpose of hedging.

There are further restrictions on CCBs. Firstly, a CCB is prohibited from holding more than 20% of capital of other banks. This means that CCBs cannot be part of a banking group. Secondly, the allocation of earnings is subject to constraints. At least 70% of net profits have to be allocated to a reserve, which can never be distributed to shareholders; in addition, 3% of net profits should be paid to specific funds designed to support other cooperatives. The remainder can be used to re-evaluate stocks, to increase other reserves for the payment of dividends or to support charities.

The pay out of a CCB share is not fixed ex-ante. Indeed, as in the case of other financial intermediaries, the remuneration of CCBs' shareholders depends on the profitability of the bank and consists both of dividends and of an increase in the share value: whilst the amount of dividends is capped by the law (the dividend pay out ratio must be not higher than the yield of the postal savings certificate plus 2.5 p.p), the remaining net profit can be freely utilized to increase the share value. However, the whole remuneration is limited by the rule that provides for a compulsory destination of 73% of net profit to the non-distributable reserves and to cooperation funds. CCBs' share capital is not fixed as new shares can be issued during the year, depending on the request of new and old shareholders; in other words, the amount of new shares to be issued is not fixed ex ante by the board.

While there is no exemption from a IRAP tax for other cooperative companies, a more lenient corporate income tax (IRES) regime is provided for CCBs. Although the tax rules provided always for the taxation of profits not allocated to not distributable reserve, most of the profits are not taxed. Until 2001 the whole amount of the profits allocated to not distributable reserve was not taxed. In 2002 and 2003, at least 18% of the profits must be taxed; this share increased to 27% in 2004–2011. It means that 82% of the net profits are not subject to the IRES until 2003 and that at least 73% of the net profits are not subject to IRES in the period 2004–2011.

CCBs represent more than half of the banks operating in Italy. Though there has been a constant decrease in the number of CCBs (also because many have undergone M&A operations), at the end of 2011 there were 405 CCBs out of a total number of banks of 651. Due to their operational limits, they account only for about one-sixteenth of the total assets of the Italian banking system.

A.5 Robustness to the GMM Test

We have estimated regression models in the form of equation (25) using a within group fixed effect estimator. This approach has advantages and disadvantages, compared to a dynamic econometric specification estimated in a Generalized Method of Moments (GMM) approach taken by Arellano and Bond (1991). There are two advantages: First the within group fixed effect estimator is generally more efficient in practice than a GMM (Arellano and Honoré, 2001; Kiviet, 1995; Alvarez and Arellano, 2003). Second, we can avoid making somewhat arbitrary choices about the instrument's specific structure and the number of lags that would be necessary when implementing the GMM estimator. However, to avoid the presence of a Nickell's bias we could not include in the specification a lagged dependent variable that could be used to limit possible problems of omitted variables. For this reason, we have used the GMM to estimate the models that include a lagged dependent variable to check for robustness of our results. This robustness test is reported in Table A1 and shows that our results are qualitatively the same in the GMM test.

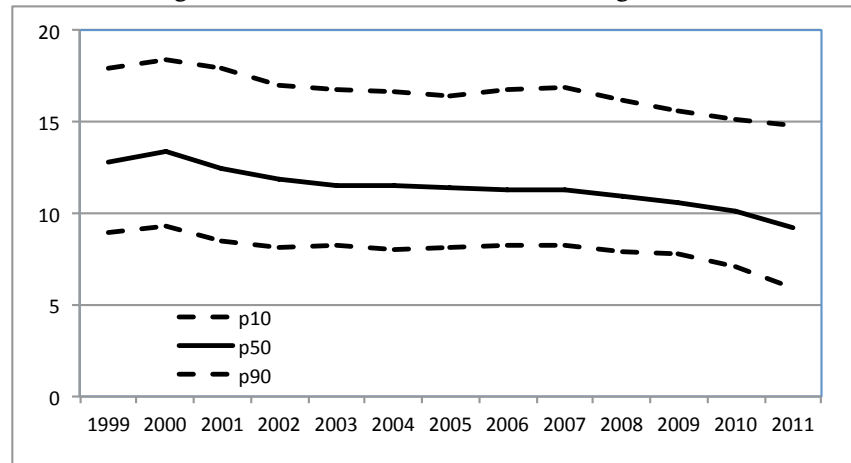
References

- Alvarez, J., M. Arellano, 2003, The time series and cross-section asymptotics of dynamic panel data estimators, *Econometrica*, 71, 1121–1159.
- Arellano M., S. Bond, 1991, Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *The Review of Economic Studies*, 58, 277–97.
- Arellano, M., B. Honoré, 2001, Panel data models: some recent developments, *Handbook of Econometrics*, 5, 3229–3296.
- Brei M., L. Gambacorta, G. von Peter, 2013, Rescue Packages and Bank Lending. *Journal of Banking and Finance*, 37, 490–505
- Berger, A., C. Bouwman, 2013, How does capital affect bank performance during financial crises? *Journal of Financial Economics*, 109, 146–176.
- Bolton P., X. Freixas, L. Gambacorta, P. Mistrulli, 2016, Relationship and transaction lending in a crisis, *Review of Financial Studies*, 29(10), 2643–76.
- Bond, S., K. Ham, G. Maffini, A. Nobili, G. Ricotti, 2016, Regulation, tax and capital structure: evidence from administrative data on Italian banks, *Questioni di Economia e Finanza*, 361.
- Célérier, C., T. Kick, S. Ongena, 2016, Changes in the cost of bank equity and the supply of bank credit, mimeo.
- Diamond, D., R. Rajan, “A Theory of Bank Capital”, 2000, *Journal of Finance*, 55, 2431–2465.
- Duffie, D., R. Jarrow, A. Purnanandam, and W. Yang, 2003, Market pricing of deposit insurance, *Journal of Financial Services Research*, 24, 93–119.
- EBA, 2015, 2015, EU-wide transparency exercise results, EBA, London.
- Federal Deposit Insurance Corporation, 2011, Assessments, large bank pricing: final rule, Federal Register, Vol. 76, No. 38.
- Gambacorta L., H. Shin, 2016, Why bank capital matters for monetary policy, *Journal of Financial Intermediation*, forthcoming.
- Gobbi, G., E. Sette, 2015, Relationship Lending during a Financial Crisis, *Journal of European Economic Association*, forthcoming.
- Goldstein, R., N. Ju, H. Leland, 2001, An EBIT-based model of dynamic capital structure”, *Journal of Business*, 74, 483–512.
- Gropp, R., F. Heider, 2010, The Determinants of Bank Capital Structure, *Review of Finance*, 17, 1947–1988.
- Heckemeyer, J., R. de Mooij, 2013, Taxation and corporate debt: are banks any different? IMF Working Paper 221.
- Kashyap, A., J. Stein, 1995, The Impact of Monetary Policy on Bank Balance Sheets. *Carnegie-Rochester Conference Series on Public Policy* 42, 151–195.
- Kashyap, A., J. Stein, 2000, What Do a Million Observations on Banks Say about the Transmission of Monetary Policy? *American Economic Review*, 90, 407–428.

- Keen, M., 2011, The taxation and regulation of banks, IMF Working Paper 206.
- Keen, M., R. de Mooij, 2012, Debt, Taxes, and Banks, Working Paper, International Monetary Fund, (12/48).
- Hemmelgarn, T., D. Teichmann, 2013, Tax Reforms and Capital Structure of Banks, Working paper, No 37, European Commission.
- Kishan, R., T. Opiela, 2000, Bank Size, Bank Capital and the Bank Lending Channel. *Journal of Money, Credit and Banking* 32, 121-141.
- Kiviet J., 1995, On bias, inconsistency, and efficiency of various estimators in dynamic panel data models, *Journal of Econometrics*, 68, 53–78.
- Michelangeli V., E. Sette, 2016, How Does Bank Capital Affect the Supply of Mortgages? Evidence from a Randomized Experiment, BIS Working Paper, 557.
- Schepens, G., 2016, Taxes and bank capital structure, *Journal of Financial Economics*.
- Sundaresan, S., Z. Wang, 2014, Bank Liability Structure, Working paper, Columbia University and Indiana University.

Tables and Figures

Figure 1: Distribution of the leverage ratios



Note: A leverage ratio is the equity divided by the total assets in a bank. The solid line represents the median of the leverage ratios in each year. The dotted lines show the 10th percentile and the 90th percentile of the leverage ratios.

Table 1: The IRAP rates during 1999–2011

Region	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	#(1)	% (2)
ABRUZZO	5.40	5.40	5.00	4.75	4.25	4.25	4.25	5.25	5.25	4.82	4.82	4.82	5.57	8	1.7
BASILICATA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	3.90	3.90	3.90	4.65	6	1.3
CALABRIA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	3.90	4.82	4.97	5.72	16	3.5
CAMPANIA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	5.25	5.25	4.82	4.82	4.97	5.72	26	5.6
EMILIA-ROMAGNA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	5.25	4.82	4.82	4.82	5.57	25	5.4
FRIULI-VENEZIA GIULIA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	3.90	3.90	3.90	4.65	19	4.1
LAZIO	5.40	5.40	5.00	5.75	5.25	5.25	5.25	5.25	5.25	4.82	4.82	4.97	5.57	25	5.4
LIGURIA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	5.25	5.25	4.82	4.82	4.82	5.57	3	0.6
LOMBARDIA	5.40	5.40	5.00	5.75	5.25	5.25	5.25	5.25	5.25	4.82	4.82	4.82	5.57	49	10.6
MARCHE	5.40	5.40	5.00	5.75	5.15	5.15	5.15	5.15	5.15	4.73	4.73	4.73	5.48	20	4.3
MOLISE	5.40	5.40	5.00	4.75	4.25	4.25	5.25	5.25	5.25	4.82	4.82	4.97	5.72	4	0.9
PIEMONTE	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	5.25	4.82	4.82	4.82	5.57	11	2.4
PUGLIA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	4.82	4.82	4.82	5.57	19	4.1
SARDEGNA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	3.90	3.90	3.90	4.65	4	0.9
SICILIA	5.40	5.40	5.00	5.25	5.25	5.25	5.25	5.25	5.25	4.82	4.82	4.82	5.57	23	5.0
TOSCANA	5.40	5.40	5.00	4.75	4.40	4.40	4.40	4.40	5.25	4.82	4.82	4.82	5.57	36	7.8
TRENTINO-ALTO ADIGE	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	3.44	3.40	3.19	4.65	114	24.7
UMBRIA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	4.82	4.82	4.82	5.57	6	1.3
VAL D'AOSTA	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	3.90	3.90	3.90	4.65	3	0.6
VENETO	5.40	5.40	5.00	4.75	4.25	5.25	5.25	5.25	5.25	4.82	4.82	4.82	5.57	45	9.7
Basic IRAP Rate	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	3.90	3.90	3.90	4.65		
Min	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.25	4.25	3.44	3.40	3.19	4.65		
Median	5.40	5.40	5.00	4.75	4.25	4.25	4.25	4.33	5.25	4.82	4.82	4.82	5.57		
Max	5.40	5.40	5.00	5.75	5.25	5.25	5.25	5.25	5.25	4.82	4.82	4.97	5.72		
Total														462	100.0

Notes: (1) Number of banks in the database that are headquartered in a specific region. (2) Percentage of the banks in the specific region as a percentage of the total in the database.

Table 2: Assets and liability composition for CCBs and Ltd Banks in Italy

	1999	2005	2011	1999	2005	2011
	Assets (1)					
Loans to resident banks	6.3	5.5	4.9	12.1	17.6	11.1
Loans to public administration and other residents	58.8	71.8	73.9	60.8	56.0	56.2
Government bonds	28.6	18.7	14.6	5.4	3.2	5.2
Securities issued by residents	3.5	1.8	5.0	5.0	5.8	13.5
Shares issued by residents	0.9	1.0	0.9	4.6	4.7	3.7
Loans to non-residents and securities issued by non-residents	1.9	1.2	0.8	12.2	12.7	10.5
Total	100.0	100.0	100.0	100.0	100.0	100.0
	Liabilities					
Deposits held in central bank and other resident banks	8.0	2.1	9.0	16.6	19.4	17.9
Deposits from public administration and other residents	58.8	56.7	48.0	36.0	35.6	38.9
Bonds	19.7	29.9	31.0	19.9	23.2	24.8
Foreign liabilities	0.2	0.2	0.2	17.0	13.0	7.7
Capital and reserves	13.4	11.1	11.8	10.5	8.9	10.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: *Annual Report for 1999, 2005 and 2011 — Statistical Annexes* by Bank of Italy. Notes: (1) Assets do not include cash, fixed assets and intangibles. These items represent a negligible part of total balance sheet items (less than 2% for the average Italian bank in the sample period).

Table 3: Types of changes in IRAP rate

Types of change	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Percent
Number of changes	20	20	19	1	1	3	3	20	2	5	20	114	100.0
Directions of changes:													
Increases	0	4	0	1	1	3	3	2	1	4	20	39	34.2
Reductions	20	16	19	0	0	0	0	18	1	1	0	75	65.8
Decision taken by:													
Central government	20	16	17			2		17		4	20	96	84.2
Regional government		4		1	1	1	3		2	1		13	11.4
Both			2					3				5	4.4

Table 4: Exogeneity of the changes in IRAP rate

Dependent variable:	(I)	(II)	(III)	(IV)
	ΔIRAP_t	ΔIRAP_t	ΔIRAP_t	ΔIRAP_t
	Baseline	Control for changes by government	Control for bank health	Control for economic indicators
Independent variables				
(Bad Loans/Total assets) $_t$	-0.0013 (0.0130)	-0.0033 (0.0120)	-0.0231 (0.0154)	-0.0127 (0.0175)
(Equity/Total assets) $_t$	-0.0196 (0.0145)	-0.0127 (0.0135)	-0.0122 (0.0137)	-0.0200 (0.0164)
ROE $_t$	0.0048 (0.0032)	0.0039 (0.0031)	0.0039 (0.0032)	0.0040 (0.0044)
$\Delta \text{Log}(\text{Regional GDP per capita})_t$	0.5735 (0.8796)	0.5112 (0.8683)	0.5386 (0.8818)	0.6727 (0.9299)
$\Delta(\text{Regional employment ratio})_t$	0.3571 (1.2849)	0.2931 (1.2695)	0.3256 (1.3583)	-1.0209 (1.5721)
(IRAP GOV UP) $_t$	0.6117*** (0.0633)			
(IRAP GOV DOWN) $_t$	-0.4455*** (0.0275)			
(IRAP GOV HEALTH UP) $_t$	-0.0028 (0.0019)	-0.0149** (0.0066)	-0.0586*** (0.0107)	0.0051*** (0.0013)
(IRAP GOV HEALTH DOWN) $_t$		0.3823** (0.1718)	0.3844** (0.1708)	0.4363*** (0.1596)
(IRAP GOV OTHER UP) $_t$		-0.1398** (0.0672)	-0.1104 (0.0691)	-0.0805 (0.0820)
(IRAP GOV OTHER DOWN) $_t$		0.6786*** (0.0358)	0.6331*** (0.0536)	0.6037*** (0.0724)
(Bad Loans/Total assets) $_{t-1}$			0.0188 (0.0189)	0.0145 (0.0213)
(Equity/total assets) $_{t-1}$			-0.0092 (0.0100)	-0.0122 (0.0118)
ROE $_{t-1}$			-0.0052 (0.0046)	-0.0086 (0.0070)
$\Delta(\text{Regional GDP per capita})_{t-1}$				1.7036 (1.0539)
$\Delta(\text{Regional Employment ratio})_{t-1}$				1.2897 (1.3021)
Regional fixed effects	Yes	Yes	Yes	Yes
Number of observations	256	256	256	256
Adjusted R-squared	0.5341	0.5454	0.5429	0.5504

Notes: The left hand side variable is the first difference in the IRAP rate. The macroeconomic regional **controls** include the first difference of regional GDP per capita and the first difference of the employment ratio, provided by ISTAT. Regional GDP per capita is deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. Parameter estimates are reported with robust standard errors in brackets (clustered at bank-year level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic **controls** and fixed effects are not reported.

Table 5: Summary statistics of the variables used in the regressions

Variable definition	#Obs	Mean	Stdev	Levels			Mean	Stdev	First differences		
				Min	Max				Min	Max	
IRAP rate	4,940	4.794	0.581	3.190	5.750		-0.010	0.405	-0.810	1.460	
Equity/Total assets	4,940	11.866	3.560	-0.765	27.163		-0.286	1.054	-16.356	14.844	
Bonds/Total assets	4,940	24.724	12.050	0.004	69.023		0.899	3.051	-16.335	16.983	
Deposits/Total assets	4,940	50.290	12.055	15.644	89.694		-0.815	3.570	-23.203	21.109	
Bank credit/Total assets (1)	4,940	83.825	6.330	47.598	95.646		0.703	4.280	-25.467	29.366	
Securities/Total assets	4,940	21.772	9.909	0.753	65.573		-1.054	4.211	-19.063	28.795	
Performing loans/Total assets	4,940	59.205	13.212	11.484	84.986		1.021	4.020	-17.376	19.684	
Bad loans/ Total assets	4,940	2.465	2.352	0.003	23.098		0.092	0.981	-18.485	11.152	
Total assets growth (2)	4,940	9.294	10.627	-18.041	156.691		-0.299	14.433	-196.161	153.749	
Bank size (3)	4,940	19.094	0.965	16.215	22.817		0.085	0.083	-0.199	0.943	
ROE (4)	4,940	6.024	6.301	-109.301	45.707		-0.877	5.850	-121.417	41.071	
ROA (5)	4,940	0.691	0.650	-9.220	3.668		-0.096	0.617	-9.547	12.247	
Commissions and fees over total assets	4,940	0.007	0.003	0.001	0.122		0.000	0.003	-0.118	0.117	
Cost of non-equity funding (6)	4,940	2.121	0.714	0.160	4.490		-0.195	0.716	-2.890	2.160	
RWA/Total assets (7)	4,940	65.476	14.185	17.546	131.114		1.233	5.927	-36.007	70.508	
Log GDP at regional level	4,940	12.182	0.875	8.714	13.800		-0.026	0.199	-0.784	0.071	
Log GDP per capita at regional level	4,940	10.138	0.262	9.418	10.471		0.022	0.023	-0.070	0.069	
Log Employment ratio at regional level	4,940	-0.832	0.174	-1.274	-0.671		0.003	0.014	-0.050	0.043	

Notes: (1) Bank credit is the sum of securities, performing loans and bad loans. (2) Annual growth in percent. (3) Log of Total assets. (4) Profits before taxes to total equity and reserves in percentage points. (4) Profits before taxes to total assets in percentage points. (6) Weighted average cost of non-equity forms of funding (deposits and bonds). (7) Density function given by the ratio between risk weighted assets and total assets. (8) Employment ratio is given by total employed units over population in a region.

Table 6: Effects on equity over total assets

Dependent variable:	(I)	(II)	(III)
	$\Delta(\text{Equity/Total assets})_t$		
	Baseline	Including regional economic controls	Including bank risk control
Independent variables			
$\Delta(\text{IRAP rate})_{t-1}$	-0.1496*** (0.0545)	-0.1430** (0.0588)	-0.1520*** (0.0582)
$\Delta(\text{Bank total assets growth})_{t-1}$	0.0014 (0.0013)	0.0013 (0.0013)	0.0005 (0.0012)
ΔROE_{t-1}	0.0077 (0.0051)	0.0079 (0.0050)	0.0079 (0.0050)
$\Delta(\text{Comm\&Fees/Total assets})_{t-1}$ (1)	-3.5696* (2.1039)	-3.5666* (2.1382)	-3.5782* (2.2426)
$\Delta(\text{RWA/Total assets})_{t-1}$ (2)			0.0033 (0.0020)
Regional economic controls (3)	No	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Number of observations	4940	4940	4940
Adjusted R-squared	0.1753	0.1751	0.1724

Notes: The left hand side variable is the first difference of the leverage ratio, given by total equity over total asset multiplied by 100. (1) The proxy for service income (η) is given by the volume of overdraft commissions and other fees on current accounts over total assets. (2) Bank risk is proxied by the density function given by the risk-weighted assets over total assets. (3) The macroeconomic regional controls include the first difference in the logarithm of the Gross Domestic Product (GDP), the first difference of regional GDP per capita, the first difference of the employment ratio, provided by ISTAT. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. Parameter estimates are reported with robust standard errors in brackets (clustered at bank-year level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic controls and fixed effects are not reported.

Table 7: Effects on bank deposits and debt

Dependent variable:	(I)	(II)	(III)	(IV)	(V)	(VI)
	$\Delta(\text{Bonds/Total assets})_t$			$\Delta(\text{Deposits/Total assets})_t$		
	Baseline	Including regional economic controls	Including bank risk control	Baseline	Including regional economic controls	Including bank risk control
Independent variables						
$\Delta(\text{TRAP rate})_{t-1}$	0.3897** (0.1767)	0.3718** (0.1729)	0.3906** (0.1835)	0.1779 (0.1453)	0.1095 (0.1580)	0.0878 (0.0561)
$\Delta(\text{Bank total assets growth})_{t-1}$	-0.0097** (0.0040)	-0.0098** (0.0040)	-0.0092** (0.0040)	-0.0108** (0.0054)	-0.0107** (0.0054)	-0.0113** (0.0054)
ΔROE_{t-1}	-0.0086 (0.0101)	-0.0083 (0.0102)	-0.0086 (0.0102)	-0.0149 (0.0118)	-0.0149 (0.0118)	-0.0146 (0.0119)
$\Delta(\text{Comm\&Fees/Total assets})_{t-1}$ (1)	20.6210*** (7.9484)	20.5520** (8.1497)	20.5980** (8.1391)	63.8637 (64.0008)	60.1089 (64.0298)	57.8681 (63.8887)
$\Delta(\text{RWA/Total assets})_{t-1}$ (2)			-0.0138 (0.0179)			-0.0653*** (0.0108)
Regional economic controls (3)	No	Yes	Yes	No	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	4,940	4,940	4,940	4,940	4,940	4,940
Adjusted R-squared	0.1494	0.1500	0.1505	0.1660	0.1674	0.1677

The left hand side variable in the first three columns is the first difference of the ratio between bonds and total assets multiplied by 100. The left hand side in last three columns is the first difference of the deposit ratio, given by total deposits and total assets multiplied by 100. (1) The proxy for service income (η) is given by the volume of overdraft commissions and other fees on current accounts over total assets. (2) Bank risk is represented by the density function given by the risk-weighted assets over total assets. (3) The macroeconomic regional controls include the first difference in the logarithm of the Gross Domestic Product (GDP), the first difference of regional GDP per capita, the first difference of the employment ratio, provided by ISTAT. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. Parameter estimates are reported with robust standard errors in brackets (clustered at bank-year level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic controls and fixed effects are not reported.

Table 8: Effects on the cost of non-equity funding

Dependent variable:	(I)	(II)	(III)
	$\Delta(\text{Cost of non-equity funding})_t$		
	Baseline	Including regional economic controls	Including bank risk control
Independent variables			
$\Delta(\text{IRAP rate})_{t-1}$	0.1185*** (0.0173)	0.1295*** (0.0185)	0.1247*** (0.0180)
$\Delta(\text{Bank total assets growth})_{t-1}$	0.0009** (0.0004)	0.0009** (0.0004)	0.0011*** (0.0004)
ΔROE_{t-1}	0.0070*** (0.0014)	0.0072*** (0.0014)	0.0071*** (0.0014)
$\Delta(\text{Comm\&Fees/Total assets})_{t-1}$ (1)	1.6622* (0.9264)	1.6368* (0.9273)	1.2213* (0.6452)
$\Delta(\text{RWA/Total assets})_{t-1}$ (2)			0.0053*** (0.0013)
Regional economic controls (3)	No	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Number of observations	4,940	4,940	4,940
Adjusted R-squared	0.7914	0.7916	0.7938

Notes: The left hand side variable is the annual change in non-equity funding, expressed in percentage points. The latter is given by the weighted average cost of non-equity forms of funding (deposits and bonds). (1) The proxy for service income (η) is given by the volume of overdraft commissions and other fees on current accounts over total assets. (2) Bank risk is represented by the density function given by the risk-weighted assets over total assets. (3) The macroeconomic regional controls include the first difference in the logarithm of the Gross Domestic Product (GDP), the first difference of regional GDP per capita, the first difference of the employment ratio, provided by ISTAT. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. Parameter estimates are reported with robust standard errors in brackets (clustered at bank-year level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic controls and fixed effects are not reported.

Table 9: Effects on total bank credit portfolio

Dependent variable:	(I)	(II)	(III)
	$\Delta(\text{Credit/Total assets})_t$		
	Baseline	Including regional economic controls	Including bank risk control
Independent variables			
$\Delta(\text{IRAP rate})_{t-1}$	-0.8320*** (0.2115)	-0.5128** (0.2173)	-0.5461** (0.2174)
$\Delta(\text{Bank total assets growth})_{t-1}$	0.0193*** (0.0058)	0.0177*** (0.0054)	0.0138*** (0.0052)
ΔROE_{t-1}	0.0164 (0.0181)	0.0325* (0.0178)	0.0355** (0.0173)
$\Delta(\text{Comm\&Fees/Total assets})_{t-1}$ (1)	-87.6229 (87.615)	-78.3497 (60.1971)	-66.3094 (52.0036)
$\Delta(\text{RWA/Total assets})_{t-1}$ (2)			-0.0980*** (0.0124)
Regional economic controls (3)	No	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Number of observations	4,940	4,940	4,940
Adjusted R-squared	0.0691	0.0698	0.081

Notes: The left hand side variable is the first difference in the ratio between bank total credit and total assets. Bank total credit includes securities and loans (both performing loans and bad loans). (1) The proxy for service income (η) is given by the volume of overdraft commissions and other fees on current accounts over total assets. (2) Bank risk is represented by the density function given by the risk-weighted assets over total assets. (3) The macroeconomic regional controls include the first difference in the logarithm of the Gross Domestic Product (GDP), the first difference of regional GDP per capita, the first difference of the employment ratio, provided by ISTAT. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. Parameter estimates are reported with robust standard errors in brackets (clustered at bank-year level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic controls and fixed effects are not reported.

Table 10: Effects on banks' securities holding, performance, and bad loans

	(I)	(II)	(III)
Dependent variable:	$\Delta(\text{Securities} / \text{Total assets})_t$	$\Delta(\text{Performing loans} / \text{Total assets})_t$	$\Delta(\text{Bad loans} / \text{Total assets})_t$
	Baseline	Including regional economic controls	Including bank risk control
Independent variables			
$\Delta(\text{IRAP rate})_{t-1}$	-0.4525** (0.2150)	-0.4024** (0.1981)	0.1174** (0.0546)
$\Delta(\text{Bank total assets growth})_{t-1}$	0.0037 (0.0061)	0.0106** (0.0054)	-0.0048*** (0.0017)
ΔROE_{t-1}	0.0277* (0.0144)	0.0836*** (0.0154)	-0.0176*** (0.0042)
$\Delta(\text{Comm\&Fees} / \text{Total assets})_{t-1}$ (1)	-18.3029 (36.7975)	-75.2146 (51.0826)	6.9933* (4.2157)
$\Delta(\text{RWA} / \text{Total assets})_{t-1}$ (2)	-0.056*** (0.0119)	-0.0609*** (0.0102)	0.0047 (0.0029)
Regional economic controls (3)	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Number of observations	4,940	4,940	4,940
Adjusted R-squared	0.055	0.1875	0.1422

Notes: The left hand side variable is the first difference in ratio between each component of total credit (securities, performing loans and bad loans) and total assets. Each ratio is expressed in percentage points. (1) The proxy for service income (η) is given by the volume of overdraft commissions and other fees on current accounts over total assets. (2) Bank risk is represented by the density function given by the risk-weighted assets over total assets. (3) The macroeconomic regional controls include the first difference in the logarithm of the Gross Domestic Product (GDP), the first difference of regional GDP per capita, the first difference of the employment ratio, provided by ISTAT. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. Parameter estimates are reported with robust standard errors in brackets (clustered at bank-year level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic controls and fixed effects are not reported.

Table 11: Effects on banks' liability: different impact for low-capitalized banks

	(I) Impact on leverage	(II) Impact on subordinated debt	(III) Impact on insured forms of funds	(IV) Impact on non-equity funding costs
Dependent variable:	$\Delta(\text{Equity} / \text{Total assets})_t$	$\Delta(\text{Bonds} / \text{Total assets})_t$	$\Delta(\text{Deposits} / \text{Total assets})_t$	$\Delta(\text{Cost of non-equity funding})_t$
Independent variables				
$\Delta(\text{IRAP rate})_{t-1}$	-0.1213** (0.0594)	0.3737** (0.1895)	0.0971 (0.2617)	0.1064*** (0.022)
$\Delta(\text{IRAP rate})_{t-1} \cdot (\text{Low capitalization dummy})_{t-1}$	-0.1870** (0.0832)	0.1515 (0.3867)	0.0915 (0.5472)	0.0587* (0.0328)
$(\text{Low capitalization dummy})_{t-1}$	-0.5999*** (0.0699)	-0.0090 (0.2644)	-0.3789 (0.3028)	-0.0192 (0.0192)
$\Delta(\text{Bank total assets growth})_{t-1}$	0.0002 (0.0013)	-0.0029 (0.0046)	-0.0095* (0.0054)	0.0011*** (0.0004)
ΔROE_{t-1}	0.0086* (0.0050)	-0.0086 (0.0111)	-0.0173 (0.0127)	0.0071*** (-0.0015)
$\Delta(\text{Comm\&Fees} / \text{Total assets})_{t-1}$ (1)	-2.4960 (2.3940)	80.4919 (58.9283)	36.5891*** (13.7592)	1.2041* (0.6353)
$\Delta(\text{RWA} / \text{Total assets})_{t-1}$ (2)	-0.0028 (0.0019)	-0.0149*** (0.0066)	-0.0586*** (0.0107)	0.0051*** (0.0013)
Regional economic controls (3)	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Number of observations	4,940	4,940	4,940	4,940
Adjusted R-squared	0.2211	0.1663	0.1725	0.7940

Notes: The left hand side variable is the first difference in ratio between each component of bank balance sheet and total assets. The only exception is column IV where the dependent variable is the annual change in non-equity funding, expressed in percentage points. The latter is given by the weighted average cost of non-equity forms of funding (deposits and bonds). (1) The proxy for service income (η) is given by the volume of overdraft commissions and other fees on current accounts over total assets. (2) Bank risk is represented by the density function given by the risk-weighted assets over total assets. (3) The macroeconomic regional **controls** include the first difference in the logarithm of the Gross Domestic Product (GDP), the first difference of regional GDP per capita, the first difference of the employment ratio, provided by ISTAT. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. Parameter estimates are reported with robust standard errors in brackets (clustered at bank-year level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic **controls** and fixed effects are not reported.

Table 12: Effects on banks' assets: different impact for low-capitalized banks

	(I) Impact on banks' credit portfolio	(II) Impact on bank security holding	(III) Impact on performing loans	(IV) Impact on bad
Dependent variable:	$\Delta(\text{Credit} / \text{Total assets})_t$	$\Delta(\text{Securities} / \text{Total assets})_t$	$\Delta(\text{Performing loans} / \text{Total assets})_t$	$\Delta(\text{Bad loans} / \text{Total assets})_t$
Independent variables				
$\Delta(\text{IRAP rate})_{t-1}$	-0.7776*** (0.2302)	-0.5269** (0.2311)	-0.6285*** (0.2000)	0.0207 (0.0573)
$\Delta(\text{IRAP rate})_{t-1}$ Low capitalization dummy	0.9644 (0.7105)	-0.3160 (0.6561)	1.8203*** (0.6815)	0.2160* (0.1277)
Low capitalization dummy	-1.3097*** (0.4142)	0.1071 (0.3200)	-1.4549*** (0.3100)	0.0952 (0.1060)
$\Delta(\text{Bank total assets growth})_{t-1}$	0.0143*** (0.0052)	0.0074 (0.0057)	0.0104* (0.0053)	-0.0047*** (0.0015)
ΔROE_{t-1}	0.0319* (0.0173)	0.0311** (0.0146)	0.0790*** (0.0150)	-0.0299*** (0.0049)
$\Delta(\text{Comm\&Fees} / \text{Total assets})_{t-1}$ (1)	-62.0859 (50.0256)	-14.5888 (31.0006)	-75.2314* (39.7992)	7.4076** (3.7617)
$\Delta(\text{RWA} / \text{Total assets})_{t-1}$ (2)	-0.0932*** (0.0124)	-0.0517*** (0.0121)	-0.0628*** (0.0105)	0.0041 (0.0028)
Regional economic controls (3)	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Number of observations	4,940	4,940	4,940	4,940
Adjusted R-squared	0.0810	0.0550	0.1875	0.1422

Notes: The left hand side variable is the first difference in ratio between each component of bank balance sheet and total assets. The only exception is column IV where the dependent variable is the annual change in non-equity funding, expressed in percentage points. The latter is given by the weighted average cost of non-equity forms of funding (deposits and bonds). (1) The proxy for service income (η) is given by the volume of overdraft commissions and other fees on current accounts over total assets. (2) Bank **risk** is represented by the density function given by the risk-weighted assets over total assets. (3) The macroeconomic regional **controls** include the first difference in the logarithm of the Gross Domestic Product (GDP), the first difference of regional GDP per capita, the first difference of the employment ratio, provided by ISTAT. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. Parameter estimates are reported with robust standard errors in brackets (clustered at bank-year level). The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic **controls** and fixed effects are not reported.

Table A1: Dynamic model and GMM estimator

	(I)	(II)	(III)	(IV)	(V)
	Impact on leverage	Impact on subordinated debt	Impact on insured forms of funds	Impact on non-equity funding costs	Impact on banks' credit portfolio
Dependent variable:	$\Delta(\text{Equity} / \text{Total assets})_t$	$\Delta(\text{Bonds} / \text{Total assets})_t$	$\Delta(\text{Deposits} / \text{Total assets})_t$	$\Delta(\text{Cost of non-equity funding})_t$	$\Delta(\text{Credit} / \text{Total assets})_t$
Independent variables					
$\Delta(\text{IRAP rate})_{t-1}$	-0.1328*** (0.0495)	0.3327* (0.1891)	0.2126 (0.3248)	0.1698*** (0.0233)	-1.0450** (0.444)
$\Delta(\text{Bank total assets growth})_{t-1}$	0.0009 (0.0017)	-0.0008 (0.0058)	0.0043 (0.0067)	0.0023** (0.0010)	0.0022 (0.0076)
ΔROE_{t-1}	0.0024 (0.0049)	0.0139 (0.0261)	0.0431 (0.0301)	0.0062* (0.0032)	-0.7925** (0.3623)
$\Delta(\text{Comm\&Fees} / \text{Total assets})_{t-1}$ (1)	-29.8251* (16.9556)	2.3529 (7.5322)	7.3152 (8.8645)	2.2816 (1.4465)	-0.6470 (21.6479)
$\Delta(\text{RWA} / \text{Total assets})_{t-1}$ (2)	0.0014 (0.0054)	-0.0028 (0.0353)	-0.0924*** (0.0305)	0.0053* (0.0028)	-0.0372 (0.0300)
Lagged endogenous variable	Yes	Yes	Yes	Yes	Yes
Regional economic controls (3)	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	4,940	4,940	4,940	4,940	4,940
Serial correlation test (4)	0.267	0.623	0.513	0.171	0.094
Hansen Test (5)	0.189	0.205	0.622	0.156	0.109

Notes: The left hand side variable is the first difference in ratio between each component of bank balance sheet and total assets. The only exception is column IV where the dependent variable is the annual change in non-equity funding, expressed in percentage points. The latter is given by the weighted average cost of non-equity forms of funding (deposits and bonds). The model is estimated using the dynamic Generalized Method of Moments (GMM) panel methodology. (1) The proxy for service income (η) is given by the volume of overdraft commissions and other fees on current accounts over total assets. (2) Bank risk is represented by the density function given by the risk-weighted assets over total assets. (3) The macroeconomic regional **controls** include the first difference in the logarithm of the Gross Domestic Product (GDP), the first difference of regional GDP per capita, the first difference of the employment ratio, provided by ISTAT. Regional GDP and GDP per capita are both deflated using CPI with 2005 as the reference year. The employment ratio is defined as the total number of employed divided by total population in each region. (4) Reports p -values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (5) Reports p -values for the null hypothesis that the instruments used are not correlated with the residuals. Parameter estimates are reported with robust standard errors in brackets. The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively. Coefficients for regional macroeconomic **controls** and fixed effects are not reported.

Previous volumes in this series

No	Title	Author
610 February 2017	Global impact of US and euro area unconventional monetary policies: a comparison	Qianying Chen, Marco Lombardi, Alex Ross and Feng Zhu
609 February 2017	Revisiting the commodity curse: a financial perspective	Enrique Alberola and Gianluca Benigno
608 January 2017	Redemption risk and cash hoarding by asset managers	Stephen Morris, Ilhyock Shim and Hyun Song Shin
607 January 2017	The real effects of household debt in the short and long run	Marco Lombardi, Madhusudan Mohanty and Ilhyock Shim
606 January 2017	Market volatility, monetary policy and the term premium	Sushanta K Mallick, M S Mohanty and Fabrizio Zampolli
605 January 2017	Wage and price setting: new evidence from Uruguayan firms	Fernando Borraz, Gerardo Licandro and Daniela Sola
604 January 2017	Endogenous wage indexation and aggregate shocks	Julio A Carrillo, Gert Peersman and Joris Wauters
603 January 2017	Multiplex interbank networks and systemic importance – An application to European data	Iñaki Aldasoro, Iván Alves
602 January 2017	The globalisation of inflation: the growing importance of global value chains	Raphael Auer, Claudio Borio and Andrew Filardo
601 January 2017	Asymmetric information and the securitization of SME loans	Ugo Albertazzi, Margherita Bottero, Leonardo Gambacorta and Steven Ongena
600 December 2016	The currency dimension of the bank lending channel in international monetary transmission	Előd Takáts and Judit Temesvary
599 December 2016	Banking Industry Dynamics and Size-Dependent Capital Regulation	Tirupam Goel
598 December 2016	Did the founding of the Federal Reserve affect the vulnerability of the interbank system to contagion risk?	Mark Carlson and David C Wheelock
597 December 2016	Bank Networks: Contagion, Systemic Risk and Prudential Policy	Iñaki Aldasoro, Domenico Delli Gatti, Ester Faia
596 December 2016	Macroeconomics of bank capital and liquidity regulations	Frédéric Boissay and Fabrice Collard
595 December 2016	Bank lending and loan quality: the case of India	Pallavi Chavan and Leonardo Gambacorta
594 December 2016	A quantitative case for leaning against the wind	Andrew Filardo and Phurichai Rungcharoenkitkul

All volumes are available on our website www.bis.org.