# Tax Effects on Bank Liability Structure

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**Abstract**

Using the supervisory data on Italian Mutual Banks (CCB) and the historical changes in the Italian IRAP tax rates, we show that reductions in tax rates lead the banks to reduce their nondeposit liabilities more than their deposits. This evidence is consistent with the predictions of our dynamic structural model, in which the banks optimally balance deposit insurance premium, tax advantages of debt, and liquidity services with potential costs of bank closure. Our empirical identification of the tax effects takes advantage of the business restrictions of the CCBs and the exogenous variations in the IRAP rates across regions and over time. We also find evidence that a cut in the IRAP rates is associated with a drop in the cost of non-equity funding in the CCBs. In addition, we find that the CCBs trim the proportion of risky loans in their assets when they increase the proportion of the total credit in response to a tax cut.

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# Contents

# 1 Introduction

What are the determinants of bank capital structure? The literature has argued that some factors that determine the optimal capital structure in banks are distinct from the determinants in nonfinancial institutions while some other factors are shared by banks and nonfinancial institutions. For instance, Diamond and Rajan (2000) stress that FDIC deposit insurance and regulatory capital requirements play special roles in bank leverage, and they theorize that the optimal bank capital structure results from the trade-off between liquidity service and the ability to force borrower repayment, as well as benefit of issuing debt and the cost of financial distress, which are also faced by nonfinancial firms. Gropp and Heider (2010) empirically examine the cross-sectional determinants of bank leverage and find that bank capital ratios tend to be close to the minimum required by regulation. They observe that the same factors, such as taxes and financial-distress costs, which determine the leverage of nonfinancial firms, also determine the leverage of banks. Sundaresan and Wang (2014) develop a dynamic structural model to show how the optimal bank liability structure (composition of deposits and nondeposit debt), as well as the bank optimal leverage, depends on taxes, bankruptcy costs, deposit insurance, minimum capital requirement, and the value of liquidity service.

The benefits of tax deduction from interest expenses are generally believed to motivate banks to increase leverage and adjust liability structure when debt and equity are treated differently in taxation. Although the special features, such as liquidity service, deposit insurance, and capital requirement, are the causes for banks to choose higher leverage than nonfinancial firms do, taxation have effects on the leverage and liability structure of banks as the tax benefits interact with the special features of banks. Theoretically, the interest expenses should be larger in a bank than in a nonfinancial firm with the same total assets if the bank's special features make the bank take a higher leverage. Therefore, the tax benefits of interest expenses are more significant for banks than for nonfinancial firms.

Recent empirical research has documented the link between taxes and bank leverage. Heckemeyer and de Mooij (2013) and Keen (2011) have examined this link. Schepens (2016) presents evidence that a reduction in tax discrimination between debt and equity funding leads to better-capitalized banks. He exploits an exogenous variation in the tax treatment of debt and equity created by the introduction of a tax shield for equity. He shows that reducing the difference in the tax treatment of debt and equity increases bank capital ratios. Célérier et al. (2016) produce similar evidence on the effects of tax reforms in Europe. Bond et al. (2016) employ regional and time variation in Italian tax rates to show that changes in the tax rates affect the leverage of banks that are not constrained by regulatory capital.

The banking literature has not empirically explored how changes in taxation might affect banks' liability structure, namely, the composition of deposits and nondeposit debt. Our paper fills this gap. Bank liability structure is important at least for the following three reasons. First, banks perform liquidity service and maturity transformation by accepting deposits and extending long-term loans. This implies that tax rates may have an effect on the credit channel of the economy. Second, since deposits are less expensive than nondeposit debt as sources of funding, banks' costs of capital depend on the liability structure. A tax-rate change may influence the costs of non-equity funding and the average cost of capital. Third, nondeposit debt is often viewed as protection for deposits. Many long-term debt instruments are treated as Tier 2 capital in Basel III. Therefore, the tax effects on liability structure may have implications for financial stability.

In this paper we provide a detailed analysis of how tax-rate changes cause banks to adjust the composition of funding sources, separating the effects on equity, subordinated debt, and deposits. We construct a model to capture the institutional feature of the banks in our data and derive testable predictions on the optimal response to changes in tax rates. Our model recognizes the tax advantages brought by both deposits and nondeposit liabilities. Banks in our theoretical setting are also cognizant of the fact that deposits provide liquidity services and hence are cheaper capital compared to nondeposit liabilities. By virtue of deposit insurance, deposits are sticky. The model, based on these economic underpinnings, produces sharp predictions. An implication of the model is the well-known hypothesis that banks increase their equity base in response to a reduction in the corporate tax rate. A sharper prediction from our theoretical model is that banks reduce nondeposit funding more than deposit funding, in response to a tax cut. Our model also predicts that the increased capitalization improves the credit spread, which lowers the total cost of non-equity funding.

There are usually two difficulties in testing the tax effects with data. First, tax rates do not vary much over time or across banks. Second, a bank's business activities are often not subject to a single tax rate that occasionally changes. In this paper we overcome these difficulties by using the Italian mutual banks (credit cooperative banks, or CCBs) and the special Italian tax, named as IRAP (Imposta regionale sulle attività produttive). This is the same set of banks and tax rates employed by Bond et al. (2016). The data of CCBs are provided by the Bank of Italy. The CCBs and IRAP in Italy present a laboratory for this study. The CCBs are allowed to conduct their business only locally. The IRAP changes generate large variations in tax rates over time and across regions in Italy. Because of the restriction on the business activities of the CCBs and the large variations in the IRAP rates, we can exploit the difference in the tax exposure of the banks across regions and over time and directly test the implications of our theoretical model.

A challenge in testing the effects of tax on banks is that tax-rate changes are often endogenously associated with the business conditions under which banks operate. We argue that the tax-rate changes in our data are exogenous to the business conditions of the CCBs because the IRAP rates are regional surcharges adopted to finance the regional health care expenditures. The changes in the IRAP rates are therefore very likely unrelated to bank balance-sheet conditions and are decided autonomously by the (local or national) governments. One may suspect that the changes in the health care deficit could be correlated with the regional economic situations, and thus the changes could be correlated with the demand for bank loans and deposits. We address this issue in detail by analyzing the tax-rate changes in our sample period and showing that they are unrelated to the financing environment of the banking sector. To further mitigate any concern of a potentially-endogenous relation between the IRAP tax rates and the business environment, we control for regional economic conditions in our empirical tests.

Using the supervisory data of CCBs and IRAP rates, we empirically examine the optimal response of banks to the changes in tax rates along the following three dimensions. First, we study how banks adjust their optimal leverage, although this question has already been examined in the literature. Second, we explore how the exogenous variations in tax rates are related to the mix of deposit and nondeposit liabilities. Finally, we investigate how the credit spreads of debt liabilities in CCBs respond to the exogenous variations in tax rates.

We obtain the following empirical results about bank liability structure. Consistent with the prior empirical evidence presented by Bond et al. (2016) and Schepens (2016), we find that banks reduce their leverage in response to reduction in tax rates. 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. Consistent with the prediction of our model, we find that banks reduce their nondeposit debt more than deposits in response to a reduction in tax rates. 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 nondeposit debt to total assets. The changes in the tax rates, however, have much smaller effects on the deposit-to-asset ratio. Finally, we find that the credit spreads of bank liabilities fall in response to a reduction in tax rates, as predicted by our theory.

Banks may also adjust the composition of assets in response to tax rate changes. Since a reduction in tax rates results in greater after-tax earnings, a bank is incentivized to lend more. In addition, the literature argues that better-capitalized banks may supply more credit. Empirical evidence on the relation between capitalization and credit are provided by the European Banking Authority (2015) and Michelangeli and Sette (2016). Theoretical arguments for the relation are provided by Bolton et al. (2016) and Gobbi and Sette (2015). Since a reduction in tax rate leads to better capitalization, a reduction in tax rate should also result in increased bank credit. Therefore, we step outside our model to investigate the effects of the IRAP rate changes on CCB credit portfolios. We find that banks allocate a larger proportion of funds to credit in response to a reduction in tax rate but curtail the proportion of risky loans in the meantime. Our finding of the credit increase associated with tax cut is consistent with Célérier et al. (2016), who show that the change in tax allowance for equity in some European countries has effects on bank credit supply. Our finding of the bank curtailment of risky loans associated with a tax cut is new .

We organize the paper as follows. Section 2 describes the institutional features of the IRAP rates and their variations over time and across Italian regions. This section also describes the bank data used in the analysis. Section 3 develops the model of bank liability structure and the model's empirical predictions. Section 4 explains our econometric tests and presents our empirical results. Section 5 offers concluding remarks. In the appendix, we provide additional background information about the banks in our data, besides supplying the proofs of all propositions in our theoretical model.

# 2 Data on the IRAP Rates and CCBs

To assess the effects of taxation on bank liability structure, we use a set of supervisory data regarding a special type of Italian taxes, the IRAP taxes, and a specific typology of Italian banks, the cooperative credit banks.

## 2.1 Italian IRAP Taxes

The IRAP was introduced in 1998 as regional tax, mainly aimed at financing the national health system. The tax is levied on the net value of production generated by all sectors of the Italian economy including the public administration. All types of business (corporations as well as unincorporated businesses, partnerships, and sole traders) are subject to the IRAP. The basic IRAP tax rates initially established were national, flat rates, which were 4.25% for the nonfinancial sector and 5.4% for the financial sector. The 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 Figure 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.

Initially, all regions had to use the same IRAP rate. Since 2002, each region has been allowed to deviate the IRAP tax rate from the national basic rate. The deviation is limited within one percentage point until 2008 and 0.92 percentage points since then. Figure 1 shows the evolution of the maximum, minimum, and median IRAP rate applied to banks across Italian regions during 2002–2011. The time variations in the regional rates are heterogenous across regions due to regional surcharges, as shown in Table 1. Because IRAP revenues are earmarked to finance health care expenditure, in 2006 the Italian central government 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 are employed in this study to identify the effect of taxes on the liability structure of banks.

Although the IRAP levies tax by applying the tax rate on the tax base, which is the net value of production in any corporation, nonfinancial firms and financial firms however calculate the tax base differently. The tax base of a nonfinancial firm includes its profits, wages, and interest payments. It does not discriminate between debt and equity financing: neither interest payments nor dividend payments are deductible from the tax base. Hence, for nonfinancial firms, the IRAP is different from the Italian corporate income tax, which is called IRES. However, this is not the case for financial firms. The tax base of a financial firm includes its profits and wages but not interest payments. Accordingly, banks can deduct interest expenses from the tax base for IRAP.[1] While the IRAP and the IRES share deductibility of interest payments, the IRAP is more suitable than the IRES for examining the effect of tax rates on bank liability structure because the IRAP rate varies across regions and over time. By contrast, IRES is set at a uniform, national rate of 27.5% across all banks in Italy, and there is little variation over time.

## 2.2 Italian Cooperative Credit Banks

In our study, we focus on Italian cooperative credit banks (CCBs). These banks are restricted by law to operate only in their local areas to support their communities. 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. At least half of CCBs' credit is granted to their own shareholders. The shareholders bear the same risks of commercial banks' shareholders: CCBs can go bankrupt, in which case the shareholders lose their investment in equity. These mutual banks are subject to the same regulation (and closure policies) as other banks and are under the supervision of the Bank of Italy. More institutional

[1] Banks were able to deduct the entire amount of the interest expenses from 1998 to 2007. A cap on deductibility was introduced in 2008; banks were allowed to deduct 97% of their interest expenses. During 2009–2011, banks were allowed to deduct 96% of their interest expenses.

details on the functioning of CCBs are reported in Appendix A.1.

Our database includes 462 mutual banks operating in the regions of the Italian territory during the period from 1999 to 2011 (see Table 1). The top part of Table 2 compares the assets of CCBs and other banks in three different years: the beginning of our sample (1999), in the middle (2005) and at the end (2011). Majority of a CCB's loans are made to nonbank residents, which include the Public Administration of the region. This remains true after the recent financial crisis. CCBs invest a large share of their assets in government bonds but only a small proportion in private sector securities. In comparison with the CCBs, the other banks use a smaller portion of their assets to make loans to nonbank residents and invest a larger portion in nonresidents' loans and securities. The other banks also allocate a larger portion of assets to the loans to resident banks and invest a much smaller portion in government bonds.

The bottom part of Table 2 describes the composition of the liability side. Due to their regulatory restrictions, CCBs are more conservative in their financing methods than the other banks. For example, CCBs are mostly funded by deposits received from residents, while the other banks are financed through a significant amount of deposits from abroad. The level of capitalization of CCBs is higher than the other banks. For instance, in 2011, the ratio of capital and reserves to total assets was 11.8%, which is about one percentage point higher than capital ratio of the other banks. Figure 2 illustrates the distribution of the deposit, bond, and equity ratios among the CCBs in our sample. The cross-sectional variation of the ratios is substantial. The spread between the 90th and 10th percentiles is nearly 18 percentage points for the equity ratios. This spread is much larger for the deposit and bond ratios.

CCBs have four important features that are particularly useful for the econometric identification of tax effects. First, most commercial banks in Italy operate in multiple regions 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. Therefore, it is difficult to identify the effects of the IRAP rate changes on the liability structure of commercial banks because the overall tax rate is a weighted average of the IRAP rates weighted by the bases of deposits in the regions. Moreover, the analysis of changes in the corporate tax rate is further complicated for the banking groups that operate in different jurisdictions and are subject to several different taxes (corporate income taxes, bank levies, local business taxes, etc.). Instead, a CCB generally operates only in one region. So, a change in the statutory IRAP rate set by the region applies to the whole tax base of the bank.

Second, it is relatively easy to control for potential shifts in loan demand faced by CCBs in the empirical analysis because the demand 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. We deflate the regional

GDP and GDP per capita using the consumer price index (CPI) with 2005 as the reference year. The employment ratio is the total number of employed divided by total population in each region. All economic data in our analysis are provided by Istituto Nazionale di Statistica (ISTAT).

Third, CCBs allow us to avoid a potential distortion caused by equity allocation in bank groups. Taxes are generally computed at the individual bank level in Italy even for a bank belonging to a group. However, the riskiness is measured at the bank group level, and equity is often allocated among the banks in the group regardless the actual leverage of the individual banks. Regulators supervise the financial ratios of bank group instead of the ratios of the individual banks. The relation between the tax rate and liability structure estimated for banks belonging to bank groups can be distorted by the equity allocation decided by the group's management. As CCBs are not allowed to be part of any banking group, we eliminate the complications arising from studying the other banks, which are often part of groups.

Finally, despite the low tax rate, the IRAP accounts for a relevant part of the tax burden of the CCBs because their IRAP tax base is broader than the corporate income tax (IRES). The IRAP tax base is broader for the following two reasons. First, wages were not deductible from the IRAP tax base until 2015, but they were always deductible from the IRES. Second, a CCB must set aside at least 70% of its profit in a reserve, which is unavailable for distribution, and the profits in reserve are taxed for the IRAP but not for the IRES. During 1998–2011, the effective IRES rate for CCBs ranged from 0% (if all profits are retained) to 11.11% (if 70% of the profits are retained). The IRAP rate in some region reached 5.56%, which is half of the highest effective corporate income tax (IRES) rate.

The supervisory data on CCBs offer a rich set of observable financial ratios about equity, bonds, deposits, and credit portfolio. The data show the income, which consists of commissions and fees, from liquidity provision in bank account services. The risk-weighted assets (RWA) is observable and gives the bank RWA density, the measure of the riskiness of bank assets. The data also offer information about the profitability and cash flows of CCBs: the return on equity (ROE) and return on assets (ROA). In addition, we observe each bank's non-equity funding cost, which is the weighted average cost of deposits and bonds.

To examine the effects of IRAP rates on CCBs, we need to control for the regional economy. The regional economic data consist of the gross domestic product (GDP), the regional GDP per capita, and the employment ratio. The GDP and GDP per capita are both deflated to the 2005 value using the CPI. The employment ratio is the total number of employed divided by the total population in the region. The source of the economic data is ISTAT. Table 3 presents the summary statistics of all variables used in our analysis.

## 2.3 Exogeneity of IRAP Rate Changes

In a study of banks and regional taxation, a potential concern is whether the choice of bank location endogenously depends on the regional tax rates. There should be no such concern in our study of CCBs and IRAP tax rates. Once established, a CCB must operate in the same area. To move to another region, the shareholders must liquidate the bank and reopen another bank. However, liquidation of a CCB is prohibitively expensive to shareholders because, by law, all reserved earnings accumulated as untaxed profits must be paid to the central government. Therefore, it is impossible for CCBs to optimally change locations based on the IRAP rates.

The initial locations of the CCBs are not endogenously related to the IRAP rates either. Among the 462 CCBs in our sample, 428 were established before 2002, the first year when regions were allowed to deviate from the IRAP tax basic rate. Since 2002, 34 CCBs have been established. Of these new CCBs, 24 banks choose regions where the IRAP rates are higher than the cross-sectional median of the IRAP rates. Even though Trentino Alto Adige has the lowest IRAP rate on average over time, no CCB has been established in this region since 2002. All the CCBs in this region were established long before the introduction of IRAP. CCBs were historically popular in this region even before its annexation by Italy in 1919.

Another potential concern is that the activities of the CCBs may cause changes in the IRAP rates. To examine the tax effects on liability structure, the changes in the tax rates should not be induced by the changes in the bank liability structures. As we have discussed in the previous section, a change in the IRAP rate in a region is a fiscal decision. The causality between the IRAP rate and the bank liability structure will not be correctly identified if the condition of the banking sector has impact on fiscal decisions. We therefore check whether the financial conditions of the banks influence the actions in the fiscal policy because such influence distorts the estimation of the tax effects on bank liability structure.

We investigate the above potential issue in several ways. As we have noted earlier, the CCBs are very small financial intermediaries and have limited systemic relevance. Therefore, it is unlikely that changes in their specific banking conditions could influence fiscal decisions on the IRAP rate. Such influence is especially less likely because the IRAP is set up to finance the national health system.

Decisions on changes in the IRAP rates are for reasons that are unrelated to the the regional banking sector or to the regional business cycle. During 1999–2011, there were 114 changes in the IRAP tax rates—39 increases and 75 decreases. In Table 4 we divide the IRAP rate changes into three categories based on the decisions made by: i) the central government, ii) the regional government, or iii) both. The table shows that 96 out of 114 changes were exclusively decided by the central government, 13 changes were decided by the local governments, and the remaining 5 changes were decided by the central and local governments jointly.

The 96 changes in the IRAP rates decided by the central government are of two types. The first type is automatic change in the IRAP rates resulted from health care deficit. The second type is discretionary change in the basic tax rate to modify the design of taxation rules or to increase the tax revenue. Most of the 96 changes are discretionary changes; only seven of them are automatic changes resulted from healthcare deficit. The discretionary changes are obviously not the consequence of the banking conditions because neither the state of the regional banking system nor the dynamics of the regional economic cycle affect the decisions on the changes of the IRAP made by the central government.

Moreover, these changes in the IRAP rates do not affect the demand for credit by nonfinancial firms. Through the changes in the IRAP, the national and local governments can modify the tax rates that are applied to only the banking sector. Indeed, during 1999–2011, 80 of the 114 IRAP rate changes applied to only banks, which include all financial intermediaries. Six of the changes applied to banks and certain firms such as oil companies. The other 28 changes applied to all banks and nonfinancial firms.

To be sure, we test exogeneity of the IRAP rate. For this test, the IRAP rate changes are regressed on a set of variables the characterize the banking conditions and regional macroeconomic conditions. Explicitly, our regression model for the test is

$$\begin{aligned}\Delta(\text{IRAP rate})_{jt} = \alpha \cdot B_{jt} + \beta \cdot Y_{jt} + \ \gamma \cdot (\text{IRAP GOV UP})_t \\ + \ \delta \cdot (\text{IRAP GOV DOWN})_t + \theta_j + \epsilon_{jt}\end{aligned} \quad (1)$$

In the regression, $B_{jt}$ is a vector of variables that captures the conditions in the banking system in region $j$ at time $t$. The variables are the ROE, the ratio of non-performing loans to total assets, and the leverage ratio. The vector of macroeconomic variables, $Y_{jt}$, consists of the change in regional per-capita GDP and the change in regional employment ratio. We control for the motivations for the changes in the IRAP rates by including two dummy variables: one indicates the increases (IRAP GOV UP), and the other indicates decreases (IRAP GOV DOWN).

The regression also includes the regional fixed effects ($\theta_j$) to control for the possibility that enforcement of the IRAP may differ across regions. When we divide the Italian regions between north (12 regions) and south (8 regions), 106 CCBs in our sample locate in the south regions where 46 changes in the IRAP rates happened during our sample period. By contrast, 356 CCBs reside in the north where the IRAP rates changed 68 times. The differences in the number of IRAP rate changes do not stem from differences in regional enforcement, but from the decisions of the central government. Of the changes decided solely or partially by the local government, 4 were in southern regions and 14 in northern regions.

The results reported in the first column of Table 5 show that regional banking and macroeconomic conditions do not significantly affect the changes in the IRAP rates. The results do not change if we split the dummies to take into account the specific motivations of the changes. In the second column of Table 5, we split dummies to indicate whether a change is for the automatic increase to finance the budget of the national health system or for other reasons. The regional banking and macroeconomic conditions are still insignificant. Since the governments' decisions are more likely to be based on the of recent past, we test whether the IRAP rate change is related to the past banking and macroeconomic conditions. We find that the results are robust to the inclusion of the lagged values of regional banking and economic conditions (the third and last column of Table 5).

We obtain very similar results (not reported for the sake of brevity) when using the change of bank characteristics, instead of the levels, in regression (1). Another way to mitigate endogeneity issues is to use of the dynamic Generalized Method of Moments (GMM) panel methodology. Our empirical results about the tax effects on bank liability structure remain in the GMM. We discuss this methodology and the results from the GMM in Annex A.5.

# 3 A Model of CCB Liability Structure

## 3.1 Bank Liabilities and Valuation

Our model of the CCB liability structure follows Sundaresan and Wang (2014) but is modified to be consistent with the bank regulation and deposit insurance for the banks in our data. 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. The 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 $\sigma$. The model highlights the role of corporate tax. Denote the tax rate by $\tau$. To focus on the tax effects on banks' liability structure, we do not explicitly model the tax rate faced by investors.[2]

Given the assumption on the asset cash flow, the before-tax value of the assets $\tilde{V}$ should also follow a geometric Brownian motion with volatility $\sigma$. Let $\delta$ be the rate of cash flow; 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. Since the cash flow is the cash distributed out from the assets, excluding the money reinvested back into the assets, a larger cash flow means a 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

[2]By contrast, Goldstein et al. (2001) explicitly model different tax rates faced by corporations, bond investors, and equity investors. One may interpret $\tau$ as the difference between the tax rate faced by the bank and tax rate faced by the investors.

$V = (1-\tau)\tilde{V}$, and the after-tax dividend is $\delta V$. 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 $dV = (r-\delta)Vdt + \sigma VdW$, where $W$ is a Brownian motion (Wiener process) and $r$ is the risk-free interest rate.

The bank in our model takes deposits, which function as a source of funding. The bank uses deposits to finance the loans made to individuals and businesses. As required by the regulations in Italy, the bank is covered by compulsory 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 deposit insurance in Italy are Fondo di Garanzia dei Depositanti del Credito Cooperative (FGD) and Fondo Interbancario di Tutela dei Depositi (FITD). The FGD insures the deposits held by credit cooperative banks while the FITD insures the deposits held by 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 value of deposits to the bank is that they bring a source of income, besides being a source of funding. The bank earns income on deposits because it provides account service to depositors so that it enjoys fees and interest rate discounts or both. The income from fees and interest discounts on deposits is assumed to be $\eta D$, proportional to deposits $D$, where $\eta$ is the reduction from the risk-free rate. In the literature, account service is sometimes called liquidity service, and the associated income is sometimes called liquidity premium. With the income from account service, the bank's net liability to depositors is $C_D = (r-\eta)D$, 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 the loans in its assets by borrowing from 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 bonds. 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 bonds: $D+B$. 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 the deposits and bonds. Since bank earnings do not include expenses on interests and insurance premium, the total after-tax liability of the 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 a bank for liquidation if its total capital ratio, which is $(V-D)/V$, falls to or below a threshold $\beta$. 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 liquidation discount and legal expenses. If the 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 loss in liquidation. If the bank is liquidated, depositors are paid in full because the insurance organization covers the shortfall. If there is money left after repaying the depositors, it will be paid to the 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 called endogenous default. Let $V_d$ be the asset value at which endogenous default happens, the liquidation value of the assets is $(1-\alpha)V_b$. The liquidation value is first used to pay for the depositors' claim, and then the remainder is used to pay for the 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, the 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 called 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 depends on the bank's liability structure $(I,C_D,C_B)$. The closed-form formula for each part of the bank value can be derived by following Sundaresan and Wang (2014). Given a liability structure $(I,C_D,C_B)$, the deposits, the bond, the equity, and the bank are priced by

$$D = C_D/(r-\eta) \tag{2}$$
$$B = (1-P_b)C_B/r + P_b[(1-\alpha)V_b - D]^+ \tag{3}$$
$$E = V - (1-\tau)(1-P_b)(I + C_D + C_B)/r - P_b V_b \tag{4}$$
$$F = V - P_b \min\{\alpha V_b, V_b - D\} + (1-P_b)[C_D\eta/(r-\eta) + \tau(I + C_D + C_B) - I]/r\,, \tag{5}$$

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

$$\lambda = \frac{1}{\sigma}\left\{\left[\left(\frac{r-\delta}{\sigma} - \frac{\sigma}{2}\right)^2 + 2r\right]^{1/2} + \frac{r-\delta}{\sigma} - \frac{\sigma}{2}\right\}. \tag{6}$$

The bank closure boundary in the pricing functions is $V_b = \max\{V_a, V_d\}$, where the regulatory closure boundary and the endogenous default boundary are give by

$$V_a = C_D/[(r-\eta)(1-\beta)] \tag{7}$$
$$V_d = (1-\tau)[\lambda/(1+\lambda)](I + C_D + C_B)/r\,. \tag{8}$$

In the above bank valuation, it is assumed that the deposit insurance premium $I$ is exogenously set by the insurance organization. In practice, many modern insurance organizations levy insurance premium based on the total deposits in the bank. Let $\rho$ be the assessment rate, the insurance premium is $I_\rho = \rho D$. The insurance organization may use a single assessment rate $\rho$ 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 2006. It started to incorporate banks' Camels ratings since 2006. The FGD and FITD in Italy use a single assessment rate for the deposit insurance of Italian banks. If an insurance organization uses a single fixed assessment rate, it should 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 $\rho < \eta$ for Italian deposit insurance, where 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

$$\rho_a = r(1-\beta)^{-1}[\alpha-\beta]^+ P_a/(1-P_a)\,, \tag{9}$$

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 (9), 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.

## 3.2 Optimal Liability Structure and Comparative Statistics

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

For the endogenous deposit insurance $I_\omega$, 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 $\rho_a$ is defined by equation (9). The optimal liability structure $(C_D^*, C_B^*)$ is given by

$$C_D^*/V = \pi^{1/\lambda}(1-\beta)(r-\eta) \tag{10}$$

$$C_B^*/V = \pi^{1/\lambda}\left[\frac{(1+\lambda)r}{(1-\tau)\lambda} - (1-\beta)(r-\eta) - (1-\omega)(\alpha-\beta)\frac{\pi}{1-\pi}\right], \tag{11}$$

where $\pi$ is the state price of bank closure, which is given by

$$\pi = \frac{1}{1+\lambda}\cdot\frac{\eta(1-\tau)\lambda(1-\beta) + r\tau(1+\lambda)}{r(1-\tau)\lambda[(1-\omega)(\alpha-\beta)+\omega\beta] + \eta(1-\tau)\lambda(1-\beta) + r\tau(1+\lambda)}. \tag{12}$$

The state price $\pi$ in the optimal liability structure is an elementary function of the exogenous parameters, which are $r$, $\sigma$, $\delta$, $\tau$, $\eta$, $\alpha$, $\beta$, and $\omega$. Substituting equations (10) and (11) into equations (2)–(5) and setting $P_b = \pi$, they obtain analytical solutions, which we omit to save space, to the deposit ratio $D^*/V$, the bond ratio $B^*/V$, and the tangible equity ratio $T^*/V$ in the optimal liability structure. We also obtain an analytical solution to the credit spread $s^*$ for the optimal liability structure. These financial ratios and the credit spread 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.2 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*

$$C_D^*/V = \pi^{1/\lambda}(1-\beta)(r-\eta) \tag{13}$$
$$C_B^*/V = \pi^{1/\lambda}\left[\frac{r(1+\lambda)}{(1-\tau)\lambda} - (1-\beta)(r-\eta+\rho)\right], \tag{14}$$

*where $\pi$ is the state price of bank closure, which is given by*

$$\pi = \frac{1}{1+\lambda} \cdot \frac{(1-\tau)\lambda(1-\beta)(\eta-\rho)+\tau(1+\lambda)r}{(1-\tau)\lambda\beta r+(1-\tau)\lambda(1-\beta)(\eta-\rho)+\tau(1+\lambda)r}. \tag{15}$$

Here, the state price $\pi$ in the optimal liability structure is an elementary function of the exogenous parameters.

Substituting equations (13) and (14) into equations (2)–(5) and setting $P_b = \pi$, we obtain analytical solutions to the deposit ratio $D^*/V$ and the bond ratio $B^*/V$ in the optimal liability structure for the exogenous assessment rate. The optimal tangible equity ratio $T^*/V$ also has a closed-form formula. We obtain the credit spread from $s^* = C_B^*/B^* - r$. 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*

$$D^*/V = \pi^{1/\lambda}(1-\beta) \tag{16}$$
$$B^*/V = (1-\pi)\pi^{1/\lambda}\left(\frac{1+\lambda}{\lambda}\cdot\frac{1}{1-\tau} - (1-\beta)\frac{r-\eta+\rho}{r}\right) \tag{17}$$
$$s^* = r\pi/(1-\pi) \tag{18}$$
$$T^*/V = 1-\pi^{1/\lambda}(1-\beta) - (1-\pi)\pi^{1/\lambda}\left(\frac{1+\lambda}{\lambda}\cdot\frac{1}{1-\tau} - (1-\beta)\frac{r-\eta+\rho}{r}\right). \tag{19}$$

The optimal financial ratios depend on all the parameters except $\alpha$. This is different from Sundaresan and Wang (2014). The ratios are independent of $\alpha$ because of the fixed assessment rate in deposit insurance. In the optimal liability structure, the bank is closed when the asset value reaches $V_a^* = D^*/(1-\beta)$. The deadweight loss at bank closure is supposed to be $\alpha V_a^*$. Since $\beta$ is smaller than $\alpha$, 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 $\rho D^*$, despite $\alpha$. 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 $\alpha$.

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 derive the following effects of tax changes. The proof of this proposition is provided in Appendix A.3.

**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 $\tau$ on the optimal financial ratios of the banks are:*

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

The first chain of inequalities in (20) implies that both the optimal deposit ratio $D^*/V$ and optimal bond ratio $B^*/V$ decrease if the tax rate $\tau$ 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 (20), 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 are consistent with the predictions in Proposition 3.

In view of Proposition 2, the tax rate $\tau$ is only one of the many parameters that determine the financial ratios. The other parameters are the asset volatility $\sigma$, cash flow rate $\delta$, deposit rate discount $\eta$, liquidation cost $\alpha$, capital requirement $\beta$, and the market risk-free interest rate $r$. The first four, $\sigma$, $\delta$, $\eta$, and $\alpha$ 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 $\sigma$, $\delta$, and $\eta$ but are independent of $\alpha$. 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 $\sigma$, asset cash flow $\delta$, and* *account service income $\eta$ on the optimal financial ratios of the banks are*

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

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

$$\frac{\partial(B^*/V)}{\partial\eta} > 0\,, \quad \frac{\partial(D^*/V)}{\partial\eta} > 0\,, \quad \frac{\partial(T^*/V)}{\partial\eta} < 0\,, \quad \frac{\partial s^*}{\partial\eta} > 0\,. \tag{23}$$

The mathematical proof of this proposition can be found in Appendix A.4. 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, the changes in tax rate are more likely to be exogenous.

# 4 Empirical Results

## 4.1 Effects of the IRAP Rate Changes on Bank Leverage

We estimate the effects of changes in the IRAP rates on the liability structure of CCB banks. The effects we focus on are those listed in Proposition 3. Our first hypothesis 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 $\Delta(\text{Equity/Assets})_{ijt}$ to denote the change in its 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 $t-1$ in region $j$. Hemmelgarn and Teichmann (2013) and Bond et al. (2016) take the same approach because they find that the lagged change in the IRAP rate is more informative than the current change. They show that the changes in the IRAP rates take approximately one year to affect the bank leverage.

We focus our analysis on an accounting measure of leverage instead of the market measure for two reasons. The market measure of equity is volatile and does not reflect a bank's choice on its funding structure (Gambacorta and Shin, 2016). For example, a change in corporate tax rate could be immediately incorporated into the market value of a firm and causes a change in the market value of equity even if the bank does not changed the strategy in its capital structure.

To test hypothesis H1, we estimate the following regression:

$$y_{ijt} \;=\; \gamma \cdot \Delta(\text{IRAP rate})_{jt-1} + \phi \cdot X_{ijt-1} + \mu_i + \theta_t + \epsilon_{ijt}\,, \tag{24}$$

in which we use $\Delta$(Equity/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 the inclusion of bank-specific characteristics. The control variables are lagged by one period to mitigate possible endogeneity problems. These bank-specific characteristics are denoted by vector $X_{ijt-1}$ in the regression. We also include the year-fixed effect ($\theta_t$) and bank-fixed effect ($\mu_i$) in the regression. The inclusion of the year-fixed effect controls for both the change in the risk-free interest rate and the global financial crisis. The inclusion of the bank-fixed effect allows us to interpret the coefficient estimates as the tax effects within banks over time.[3]

In view of equation (19), the optimal tangible equity ratio is a function of $\sigma$, $\delta$, $\eta$, $\beta$, $r$, and $\rho$. Parameters $\sigma$, $\delta$, and $\eta$ are bank characteristics. Any changes in these parameters may cause the bank to adjust its liability structure, as theorized in Proposition 4. Since direct data on these parameters are not available, we use a set of observable variables that are believed to be proxies of those parameters. Since the volatility parameter $\sigma$ measures the risk in bank assets, we use the lagged change in the RWA density as a independent variable in the regression. Recall that the RWA density is the ratio of the risk-weighted assets to the total assets. The lagged change in the RWA density is denoted by $\Delta$(RWA density)$_{ijt-1}$ for bank $i$ located in region $j$ in year $t-1$.

The rate of asset cash flow, represented by parameter $\delta$, affects both the growth of assets and the return on equity because the cash flows are taken out of assets accumulation or reinvestment for paying equity holders as well as other liabilities. We therefore include the lagged change in bank's return on equity and the lagged change in asset growth rate as two additional independent variables, which are denoted by $\Delta$ROE$_{ijt-1}$ and $\Delta$(Asset growth)$_{ijt-1}$ respectively. Parameter $\eta$ measures the bank's profitability in serving deposits and should also affect the bank's return on equity. We proxy the account service income by the volume of overdraft commissions and other fees on the current accounts over total assets. The lagged change in the service income is denoted by $\Delta$(Service income)$_{ijt-1}$ and is included as another independent variable in our regressions.

Empirical studies in the literature of bank lending channel also include bank size (measured by the logarithm of total assets) as a control variable. Bank size controls for the 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

[3] Although the fixed effect approach has advantages, Arellano and Bond (1991) argue that it also has some disadvantages, compared to the GMM test of dynamic econometric specification. We address this issue and check the robustness of our results in the GMM test in Appendix A.5.

not include it in our baseline specification. Moreover, the 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) remain same qualitatively.

The bank asset risk, the cash flows, and the account service income depend on the economic environment in which a bank operates. It is arguable that our variables, RWA density, ROE, asset growth, and service income, may not provide complete control for the change of the parameters $\sigma$, $\delta$, and $\eta$ in the model. It is further arguable that the bank characteristics that we have missed are affected by the regional economy. Therefore, we examine the robustness of our empirical results by controlling for the change in regional economic variables.

The empirical results of econometric specification (24) are reported in Table 6. The numerical results in the first column are obtained from a regression that 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 about 0.15 percentage points in the ratio of tangible equity to total assets. This effect is significant at the 1% level, 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 the regional economy (second column of Table 6) and for the bank characteristics (third column of Table 6).

While our focus is on the effects of tax, the cash flow, service income, and asset risk all have effects that are broadly consistent with the predictions of our model in Proposition 4. The model predicts that the cash flow and asset risk have positive effects on equity. In Table 6, the coefficients of $\Delta(\text{Asset growth})_{ijt-1}$, $\Delta\text{ROE}_{ijt-1}$, and $\Delta(\text{RWA density})_{ijt-1}$ are all positive, although they are not significant. Our model predicts a negative effect of service income on equity. We find the coefficient of $\Delta(\text{Service income})_{ijt-1}$ is indeed negative and significant.

## 4.2 Effects of the IRAP Changes on Bank Liability Structure

While the drop in leverage associated with a cut in the tax rate has been documented in the literature, there has been no empirical work on the structural adjustment of bank liabilities in response to the 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 by 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 (24) by the change in bank deposit ratio, which is denoted by $\Delta(\text{Deposits/Assets})_{it}$. Similarly, we replace the dependent variable by change in bank bond ratio, which is denoted by $\Delta(\text{Bonds/Assets})_{ijt}$, to test hypothesis H3. The estimated coefficient of the change in the IRAP rate in these two regressions suggest the result of hypothesis H4, but for a formal statistical inference, we use the difference between the two changes,

$$y_{ijt} = [(\Delta\text{Bonds} - \Delta\text{Deposits})/\text{Assets}]_{ijt}, \tag{25}$$

as the dependent variable in regression (24) and examine the coefficient of the change in the IRAP rate.

The empirical results for the effects on bonds are reported in Table 7. The coefficient of the IRAP rate change is significant at the 5% level in the regression in which the change in the bond ratio is used as the dependent variable. The estimate of the coefficient is about 0.39 if we do not control for bank riskiness or regional economy. The estimate is about 0.37, only slightly smaller if we control for regional economy. It is about 0.39 after controlling for both bank riskiness and regional economy. Therefore, a reduction of one percentage point in the IRAP rate tends to cause a reduction of 0.39 percentage points in the ratio of bond to total asset. This effect of tax rate change is consistent with the prediction of our theoretical model.

The empirical results for the effects on deposits are reported in Table 8. The effect of tax rate change on bank deposit ratio is much smaller. With the change in 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 riskiness or regional economy. After controlling for the regional economy and bank riskiness, the estimate drops to 0.08. This estimate is not notably affected by the control for bank risk. Although the positive estimate indicates the negative association between deposit ratio and tax rate, which is consistent with our model's prediction, the estimated association is insignificant statistically.

The difference in the estimates of the coefficient of the IRAP rate change for bond ratio and deposit ratio suggests the differential effects of the tax rate on banks' choice of the bond and deposits in their liability structure. When the tax rate is cut down, banks reduce bonds more than deposits because the tax is 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. The difference in the effects on bonds and deposits is estimated to be 0.31 with a standard error of 0.16 based on the regression that uses the $y_{ijt}$ defined in (25) as the dependent variable and includes all bank-specific controls.

In Tables 7 and 8, the coefficients of $\Delta$(Asset growth)$_{ijt-1}$, $\Delta$ROE$_{ijt-1}$, $\Delta$(Service income)$_{ijt-1}$, and $\Delta$(RWA density)$_{ijt-1}$ have the signs that are consistent with the predictions of our model in Proposition 4. Our model predicts that the cash flow and asset risk have negative effects on the optimal bond and deposit ratios. The coefficients of $\Delta$(Asset growth)$_{ijt-1}$, $\Delta$ROE$_{ijt-1}$, and $\Delta$(RWA density)$_{ijt-1}$ are all negative in the tables, although some are significant and some are not. Our model predicts that the service income has a positive effect on the optimal bond and deposit ratios. The coefficients of $\Delta$(Service income)$_{ijt-1}$ is positive in both tables, while it is significant for the bond ratio.

Since a cut in tax rate reduces bank leverage, it should be associated with a lower premium for the credit risk. This is another prediction of our model, as presented in the last inequality of Proposition 3. We do not directly observe the 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. We denote this average cost by (Nonequity cost)$_{ijt}$ for bank $i$ of region $j$ in year $t$. Since this cost excludes the funding cost of the bank owners, this average cost of deposits and bonds should be positively related to 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 use the change of the average non-equity funding cost the dependent variable $y_{ijt}$ in regression (24). Obviously, the use of the average funding cost as proxy requires us to control for the risk-free interest rate. In fact, the inclusion of the year fixed effects serves as such control in our regressions.

The empirical results for hypothesis H5 are reported in Table 9. 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 at the 1% level. 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 or 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. Our results are also consistent with Berger and Bouwman (2013) who provide evidence that better capitalized banks have a greater capacity to absorb risk and hence have better access to wholesale funding markets.

## 4.3 Effects on Bank Credit Portfolio

In Proposition 3 and the empirical tests we have discussed so far, we focus on the change in bank the liability structure, but banks may adjust the composition of assets in response to tax rate changes. Since a reduction in tax rates leaves more money for the after-tax earnings, a bank is incentivized to lend more.

There is another reason for the link between tax and bank lending. In a cross-country study, the European Banking Authority (2015) finds that raising bank capital has beneficial effects on the credit supply by European banks. Similarly, Michelangeli and Sette (2016) use a dataset of internet-based mortgage brokers to show that better capitalized banks lend more. Bolton et al. (2016) and Gobbi and Sette (2015) argue that in economic systems underpinned by relationship-based lending, adequate bank capital allows financial intermediaries to shield firms (borrowers) from the effects of exogenous shocks. Since reduction in tax rates leads to lower leverage and higher capital leads to more lending, reduction in tax rates should bring on increased bank credit.

Therefore, we go beyond our model of liability structure to investigate the effects of the IRAP rate changes on CCB credit portfolios. Lending can be measured by the value of the credit portfolio of banks. The data of CCB credit portfolios are available for investigating the relation between the IRAP rates and the credit provision. We test the following hypotheses:

H6: A reduction in tax rates leads to an increase in the ratio of the total credit portfolio to the total assets in a bank.

To test this hypothesis, we use the change in the ratio of credit portfolio to the total assets as the dependent variable $y_{ijt}$ in regression (24). The change in this ratio from year $t-1$ to $t$ in bank $i$, which is operated in region $j$, is denoted by $\Delta(\text{Credits/Assets})_{ijt}$. The control variables in the regressions are the same as those in the tests of other tax effects.

The empirical results for hypothesis H6 are displayed in Table 10. The results show that without the control for bank risk and regional economic conditions, a reduction of one percentage point in the IRAP rate is associated with an increase of 0.8 percentage points in the bank credit-to-asset ratio. The effect is significant at the 1% level. With the control for regional economy conditions, the effect of tax drops to 0.5 percentage points, and the significance is weakened to the 5% level. With the control for the regional economy, the effect of tax stays at

0.5 and remains significant at the 5% level. The negative link of tax to both equity and credit is consistent with the empirical evidence on the positive link between bank capitalization and credit supply in the literature we discussed at the beginning of this section. These result agrees with Célérier et al. (2016), who find that the change in the tax allowance for corporate equity in some European countries has positive effects on bank credit.

After controlling for bank risk the coefficient of the tax change becomes insignificant, as shown in the last column of Table 10, although the estimate of the coefficient remains similar. The coefficients of assets growth, ROE, and service income are also all insignificant after controlling for bank risk. As it turns out, the tax effects on the components of CCBs credit portfolios are not all in the same direction, complicating the changes in the total credit portfolio, especially for the banks with notable bad loans.

We further investigate the effects of the IRAP rate changes on various components of the bank credit portfolio. Our data contain information on 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. The information allows us to construct the ratio of each category to the total assets and examine the change:

$$\Delta(\text{Security/Assets})_{ijt}, \quad \Delta(\text{Performing loans/Assets})_{ijt}, \quad \Delta(\text{Bad loans/Assets})_{ijt}.$$

We use each of the above variables as the dependent variable $y_{ijt}$ in regression (24). We can include or exclude the control variables as we do in other regressions, but, to save space, we report only the results with all the control variables included. Particularly, we control for bank risk in the reported results.

The empirical results on the composition of the credit portfolio are presented in Table 11. Unlike the results in the last column of Table 10, the tax effect on each component of the credit portfolio is significant at the 5% level. Moreover, we find that the effects on the components are heterogeneous. The estimated coefficient of the IRAP rate change is negative and significant for securities and for performing 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. By contrast, the estimated coefficient of the IRAP rate change is positive and significant for bad loans. The CCBs' response to a reduction of one percentage point in the IRAP rate is to cut down the ratio of bad loans to total assets by 0.11 percentage points. This result suggests that banks use the tax savings to clean up their balance sheets and recognize losses or to reallocate assets from riskier to safer ones. Therefore, banks offer more credit but cut down risky loans in response to reduction in tax rates. We have not seen the heterogenous tax effects on the components of bank credit portfolios reported in the banking and finance literature.

# 5 Conclusions

We provide evidence that banks optimally respond to changes of tax policy by modifying their liability structure, in addition to adjusting their leverage. The Italian mutual banks (CCB) and the Italian tax rates on productive activities (IRAP) present a laboratory for examining the role of taxation in the optimal composition of deposits and nondeposit debt in banks. Our dynamic structural model of the CCBs incorporates deposit insurance and minimum capital requirement and captures banks' tradeoff between liquidity and maturity transformation on the one hand and the costs of closure by regulators on the other. The model predicts that nondeposit debt is more sensitive than deposits to a cut in tax rate although they both decrease, leading to a lower credit spread. Our identification of the tax effects takes advantage of the business restrictions of the CCBs and the exogenous variations in the IRAP rates across regions and over time. The empirical results show that the CCBs reduce nondeposit liabilities more than deposits in response to reductions in the IRAP rates, as predicted by our model. We also find evidence that a cut in the IRAP rates is associated with a drop in the cost of non-equity funding in the CCBs.

Our empirical results offer support to the theoretical predictions that tax rate changes affect the levels of nondeposit debt more than the level of deposits, as in Sundaresan and Wang's (2014). Our theoretical and empirical results for Italian taxes and banks complement the empirical findings of Bond et al. (2016), Célérier et al. (2016), and Schepens (2016). They all show that bank leverage responds to tax rate changes. Bond et al. use the same Italian tax and banks, Célérier et al. use the taxes and banks in some European countries, and Schepens uses Belgian tax and banks. Although none of these authors examines the tax effects on the composition of bank liabilities, their results on the link between tax and leverage and our results collectively confirm the importance of fiscal policy on bank capital structure.

Going beyond our model, we test the effects of the IRAP rate changes on CCB credit portfolios and find that banks allocate a larger proportion of their funds for making credit in response to a reduction in tax rates. This finding supports the existing theoretical and empirical work arguing that better-capitalized banks supply more credit to the economy. We also find that banks trim the proportion of risky loans in their assets in response to a tax cut. This is a new contribution to the literature.

# A Appendix

## A.1 Additional Information on CCBs

In our study, we focus on banche di credito cooperative (hereinafter cooperative credit banks, or CCBs). The main purpose of 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 the partners or shareholders. Hence, the operations of a CCB are to be carried out mainly in respect of its shareholders: 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. Moreover, CCBs hold almost no foreign assets. The off-balance-sheet items in the data indicate that the activities of CCBs in the securitization market were modest.

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 CCB 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. CCB 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 non-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 during 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.2 Derivation of Propositions 1 and 2

We introduce the following notions:

$$x = C_B/C_D, \quad c = C_D/(rV), \quad v_a = rV_a/C_D, \quad v_d = rV_d/C_D, \quad v_b = \max\{v_a, v_d\}\,. \tag{26}$$

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

$$P_a = [V_a/V]^{\lambda} = (v_a c)^{\lambda} \tag{27}$$

$$P_d = [V_d/V]^{\lambda} = (v_d c)^{\lambda} \tag{28}$$

$$P_b = [V_b/V]^{\lambda} = (v_b c)^{\lambda}\,. \tag{29}$$

It follows from equations (7) and (8) that

$$v_a = r/[(r-\eta)(1-\beta)] \tag{30}$$

$$v_d = (1-\tau)[\lambda/(1+\lambda)][\rho/(r-\eta)+1+x]\,. \tag{31}$$

Let $f$ be the bank's return on assets, i.e., $f = F/V$. Dividing equation (5) by $V$, using the notations in equations (26)–(29), and incorporating equations (30)–(31), the bank's return on assets can be written as

$$
\begin{aligned}
f(x,c) = 1 - c(v_b c)^\lambda \min\left\{\alpha v_b, v_b - \frac{r}{r-\eta}\right\} \\
+\ c[1-(v_b c)^\lambda]\left(\frac{\eta-(1-\tau)\rho}{r-\eta} + \tau(1+x)\right).
\end{aligned} \tag{32}
$$

Then, choosing $(C_D, C_B)$ to maximize $F$ in equation (5) is equivalent to choosing $(x, c)$ to maximize $f(x, c)$ in equation (32). 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

$$
\begin{aligned}
f_c'(x,c) = \ -(1+\lambda)(v_b c)^\lambda \min\left\{\alpha v_b, v_b - \frac{r}{r-\eta}\right\} \\
+\ [1-(1+\lambda)(v_b c)^\lambda]\left(\frac{\eta-(1-\tau)\rho}{r-\eta} + \tau(1+x)\right).
\end{aligned} \tag{33}
$$

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 (33), we obtain

$$
(v_b c_x)^\lambda = \frac{1}{1+\lambda} \cdot \frac{[\eta-(1-\tau)\rho]/(r-\eta)+\tau(1+x)}{\min\{\alpha v_b, v_b - r/(r-\eta)\} + [\eta-(1-\tau)\rho]/(r-\eta)+\tau(1+x)}. \tag{34}
$$

Keeping $c$ fixed, the gross return on assets $f(x, c)$ is continuous but not continuously differentiable 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 (30) and (31) that

$$
\hat{x} = \frac{1}{r-\eta}\left[\frac{(1+\lambda)r}{\lambda(1-\tau)(1-\beta)} - \rho\right] - 1. \tag{35}
$$

In function $f$ expressed in equation (32), the term with $\min\{\alpha v_b, v_b - \eta/(r-\eta)\}$ depends on the comparison of $\alpha v_b$ 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

$$
\tilde{x} = \frac{1}{r-\eta}\left[\frac{(1+\lambda)r}{\lambda(1-\tau)(1-\alpha)} - \rho\right] - 1. \tag{36}
$$

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

$$
f(x,c) = 1 - \frac{c(v_a c)^\lambda r\beta}{(r-\eta)(1-\beta)} +\ c[1-(v_a c)^\lambda]\left(\frac{\eta-(1-\tau)\rho}{r-\eta} + \tau(1+x)\right). \tag{37}
$$

The partial derivative of $f$ with respect to $x$ is

$$f_x'(x,c) \; = c[1-(v_a c)^\lambda]\tau\,, \tag{38}$$

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

$$\begin{aligned} f(x,c) = 1 - c(v_d c)^\lambda \Big[ \Big( (1-\tau)\frac{\lambda}{1+\lambda}\rho - r \Big) \frac{1}{r-\eta} + (1-\tau)\frac{\lambda}{1+\lambda}(1+x) \Big] \\ + \; c[1-(v_a c)^\lambda] \Big( \frac{\eta-(1-\tau)\rho}{r-\eta} + \tau(1+x) \Big). \end{aligned} \tag{39}$$

The partial derivative of $f$ with respect to $x$ is

$$\begin{aligned} f_x'(x,c) = \Big\{ \frac{\tau\rho}{r-\eta} + \tau(1+x) - (v_d c)^\lambda \Big( \frac{\tau\rho}{r-\eta} - \lambda + (\lambda+\tau)(1+x) \Big) \Big\} \\ \cdot \; \frac{c}{\rho/(r-\eta)+1+x}\,. \end{aligned} \tag{40}$$

The restriction of $c_x$ in equation (34) becomes

$$(v_d c_x)^\lambda = \frac{\eta-(1-\tau)\rho+\tau(r-\eta)(1+x)}{(1+\lambda)(\eta-r)-(1-\tau)\rho+(\tau+\lambda)(r-\eta)(1+x)}\,. \tag{41}$$

Imposing $f_c'(x,c_x) = 0$ and substituting equation (41) into equation (40), we obtain

$$f_x'(x,c_x) \; = \; - \, \frac{[1-(v_d c_x)^\lambda](\eta-\rho) + r(v_d c_x)^\lambda}{\rho+(r-\eta)(1+x)} \cdot c_x\,. \tag{42}$$

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

$$\begin{aligned} f(x,c) = 1 - c(v_d c)^\lambda \alpha \Big( \frac{\rho}{r-\eta} + 1 + x \Big) \\ + \; c[1-(v_a c)^\lambda] \Big( \frac{\eta-(1-\tau)\rho}{r-\eta} + \tau(1+x) \Big). \end{aligned} \tag{43}$$

The partial derivative of $f$ with respect to $x$ is

$$\begin{aligned} f_x'(x,c) \; &= \frac{c}{\rho+(r-\beta)(1+x)}\cdot\big\{\tau\rho+(r-\eta)\tau(1+x) \\ &\quad - (v_d c)^\lambda[(1+\lambda)(\alpha+\tau)\rho+\lambda(\eta-\rho)+(r-\eta)(\alpha+\tau)(1+x)]\big\}\,. \end{aligned} \tag{44}$$

The restriction of $c_x$ in equation (34) becomes

$$(v_d c_x)^\lambda = \frac{1}{1+\lambda}\cdot\frac{\eta-(1-\tau)\rho+\tau(r-\eta)(1+x)}{\eta-(1-\tau-\alpha)\rho+(\tau+\alpha)(r-\eta)(1+x)}\,. \tag{45}$$

Imposing $f_c'(x,c_x)=0$ and substituting equation (45) into equation (44), we obtain

$$f_x'(x,c_x) \;=\; -\frac{[1-(v_d c_x)^\lambda](\eta-\rho)}{\rho+(r-\eta)(1+x)}\cdot c_x\,. \tag{46}$$

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 (35), we have

$$(r-\eta)(1+x^*)=\frac{(1+\lambda)r}{\lambda(1-\tau)(1-\beta)}-\rho\,. \tag{47}$$

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 (41) that

$$\pi=\frac{\eta-(1-\tau)\rho+\tau(r-\eta)(1+x^*)}{(1+\lambda)(\eta-r)-(1-\tau)\rho+(\tau+\lambda)(r-\eta)(1+x^*)}\,. \tag{48}$$

Substitution of equation (47) into equation (48) gives formula (15). Then, $c^*=\pi^{1/\lambda}/v_a$ and $C_D^*=c^*rV$ give equation (13). Equation (14) follows from $C_B=x^*C_D^*$ and equation (47). These complete the proof of Proposition 1.

Equations (16)–(19) can be obtained by substituting equations (13) and (14) directly into equations (2)–(5) and setting $P_b=\pi$. This completes the proof of Proposition 2.

## A.3 Derivation of Proposition 3

In view of equation (15), it is straightforward to verify that

$$\frac{\partial\pi}{\partial\tau}=\frac{\lambda\beta r}{\{(1-\tau)\lambda[\beta+(1-\beta)(\eta-\rho)]+\tau(1-\lambda)r\}^2}\,, \tag{49}$$

which is clearly positive. It also follows from equation (15) that $(1+\lambda)\pi < 1$. Using equation (16), we obtain

$$\frac{\partial(D^*/V)}{\partial\tau} = \frac{\pi^{1/\lambda}(1-\beta)}{\lambda\pi}\cdot\frac{\partial\pi}{\partial\tau}, \tag{50}$$

which is positive because it is a product of two positive terms. Using equation (17), we obtain

$$\begin{aligned}\frac{\partial(B^*/V)}{\partial\tau} = \frac{\pi^{1/\lambda}}{\lambda\pi}\cdot\frac{\partial\pi}{\partial\tau}\cdot[1-(1+\lambda)\pi]\cdot\left(\frac{1+\lambda}{\lambda(1-\tau)} - (1-\beta)\frac{r-\eta+\rho}{r}\right) \\ +\ (1-\pi)\pi^{1/\lambda}\frac{1+\lambda}{\lambda(1-\tau)^2}.\end{aligned} \tag{51}$$

The difference between the above two equations is

$$\begin{aligned}\frac{\partial(B^*/V)}{\partial\tau} - \frac{\partial(D^*/V)}{\partial\tau} &= \frac{\pi^{1/\lambda}}{\lambda\pi}\cdot\frac{\partial\pi}{\partial\tau}\cdot\Bigg\{[1-(1+\lambda)\pi]\frac{1+\lambda}{\lambda(1-\tau)} \\ &\quad +\ (1-\beta)\left(\frac{\eta-\rho}{r} + (1+\lambda)\pi\frac{r-\eta+\rho}{r}\right)\Bigg\} \\ &\quad +\ (1-\pi)\pi^{1/\lambda}\frac{1+\lambda}{\lambda(1-\tau)^2}.\end{aligned} \tag{52}$$

Since each term in the above equation is positive, the chain of inequalities in (20) hold. Using equation (18), we obtain

$$\frac{\partial s^*}{\partial\tau} = \frac{r}{(1-\pi)^2}\cdot\frac{\partial\pi}{\partial\tau}, \tag{53}$$

which is positive because the right-hand side is a product of two positive terms. This gives the last inequality in (20).

## A.4 Derivation of Proposition 4

From equation (6), it is straightforward to calculate the partial derivatives of $\lambda$ with respect to $\sigma$ and $\delta$ and to obtain

$$\frac{\partial\lambda}{\partial\sigma} = -\frac{\sigma\lambda^2(1+\lambda)}{\frac{1}{2}\sigma^2\lambda^2 + r} < 0 \quad \text{and} \quad \frac{\partial\lambda}{\partial\delta} = -\frac{\lambda^2}{\frac{1}{2}\sigma^2\lambda^2 + r} < 0. \tag{54}$$

From equation (15), we can also calculate the partial derivative of $\pi$ with respected to $\lambda$ and obtain

$$\frac{\partial\pi}{\partial\lambda} = -\frac{\pi}{1+\lambda}\left[1 + \frac{(1-\tau)\tau\beta r^2\pi}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2}\right] < 0, \tag{55}$$

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

$$\frac{\partial \pi}{\partial \sigma} = \frac{\partial \pi}{\partial \lambda} \cdot \frac{\partial \lambda}{\partial \sigma} > 0 \quad \text{and} \quad \frac{\partial \pi}{\partial \delta} = \frac{\partial \pi}{\partial \lambda} \cdot \frac{\partial \lambda}{\partial \delta} > 0 \,. \tag{56}$$

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

$$\frac{\partial \pi^{1/\lambda}}{\partial \lambda} = \frac{\pi^{1/\lambda}}{\lambda^2}\left[\frac{\lambda}{\pi}\frac{\partial \pi}{\partial \lambda} - \ln(\pi)\right], \tag{57}$$

we can substitute equation (55) into the above to obtain

$$\frac{\partial \pi^{1/\lambda}}{\partial \lambda} = \frac{\pi^{1/\lambda}}{\lambda^2}\left[\ln\left(\frac{1}{\pi}\right) - \frac{\lambda}{1+\lambda}\left(1 + \frac{(1-\tau)\tau\beta r^2 \pi}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2}\right)\right]. \tag{58}$$

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

$$\frac{\partial \pi^{1/\lambda}}{\partial \lambda} \geq \frac{\pi^{1/\lambda}}{\lambda^2}\left[\frac{1}{1+\lambda} - \left(1 + \frac{(1-\tau)\tau\beta\theta r^2}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2}\right)\pi\right]. \tag{59}$$

Substituting $\pi$ by equation (15), we have

$$\begin{aligned} \left(1 + \frac{(1-\tau)\tau\beta\theta r^2}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2}\right)\pi &= \frac{1}{1+\lambda} \\ \cdot \frac{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2 + (1-\tau)\tau\beta\theta r^2}{[(1-\tau)(1-\beta)(\eta-\rho)\theta + \tau r]^2 + (1-\tau)\tau\beta\theta r^2 + (1-\tau)\tau(1-\beta)\beta(\eta-\rho)\theta^2} &. \end{aligned} \tag{60}$$

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

$$\frac{\partial \pi^{1/\lambda}}{\partial \lambda} > 0 \,, \tag{61}$$

and thus, in view of the inequalities in (54), we further have

$$\frac{\partial \pi^{1/\lambda}}{\partial \sigma} = \frac{\partial \pi^{1/\lambda}}{\partial \lambda} \cdot \frac{\partial \lambda}{\partial \sigma} < 0 \quad \text{and} \quad \frac{\partial \pi^{1/\lambda}}{\partial \delta} = \frac{\partial \pi^{1/\lambda}}{\partial \lambda} \cdot \frac{\partial \lambda}{\partial \delta} < 0 \,. \tag{62}$$

The inequalities in (21) and (22) follow from equations (16)–(19) and inequalities (54), (56), and (62).

In view of equation (15), 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 (23) follow from equations (16)–(19).

## A.5 Tests Using the Dynamic GMM Panel Method

We have estimated regression models in the form of equation (24) 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 12 and shows that our results are qualitatively the same in the GMM test.

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# Figures and Tables

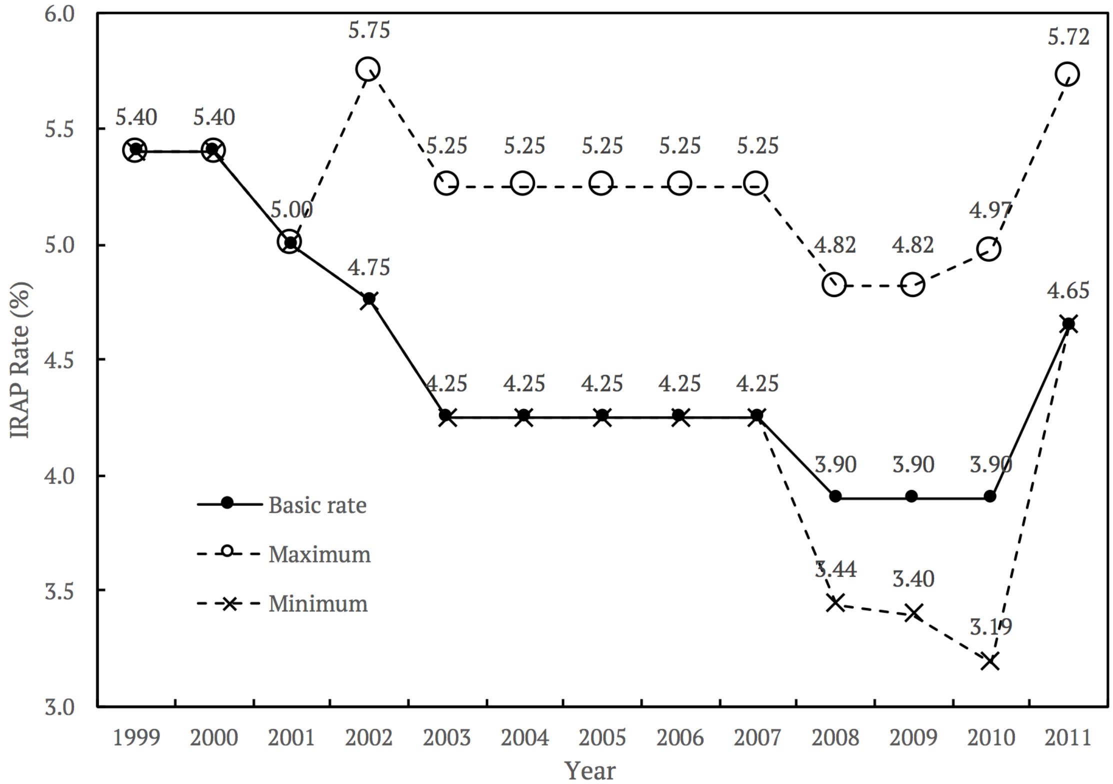


Figure 1: The basic IRAP rate and the cross-sectional maximum and minimum of the IRAP rates in the Italian regions are presented in percentage points over the period of 1999–2011.

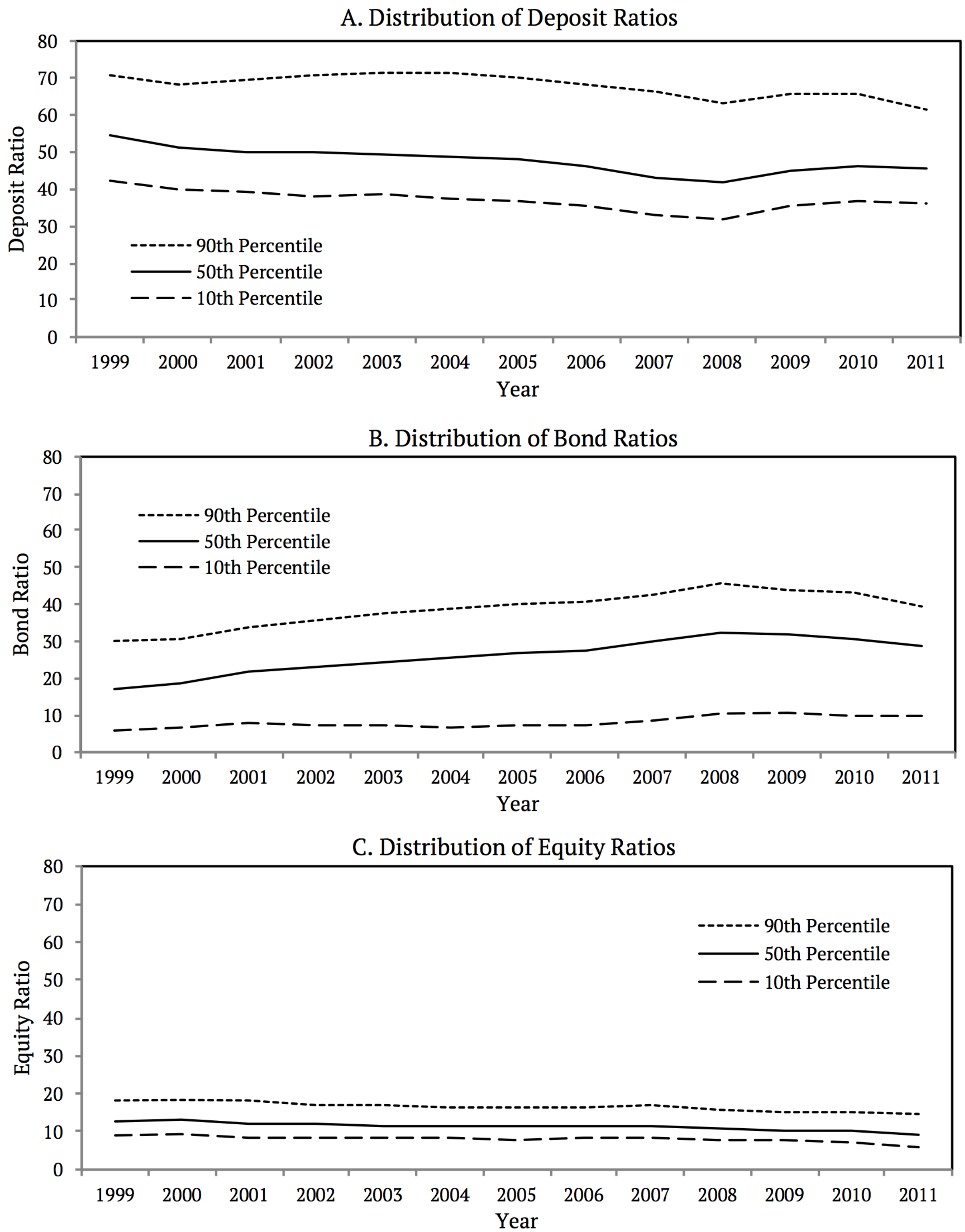


Figure 2: Distribution of the CCBs' deposit, bond, and equity ratios in percentage points cross Italian regions are illustrated by the percentiles. A deposit ratio is the total deposits divided by the total assets in a bank. The bond ratio is the total bonds divided by the total assets in a bank. The deposit ratio is the total deposits divided by the total assets.

| | IRAP Rate | | | | CCB | |
|---|---|---|---|---|---|---|
| Region | Mean | Stdev | Min | Max | Number | Percent |
| Abruzzo | 4.91 | 0.46 | 4.25 | 5.57 | 8 | 1.7 |
| Basilicata | 4.47 | 0.53 | 3.90 | 5.40 | 6 | 1.3 |
| Calabria | 4.71 | 0.57 | 3.90 | 5.72 | 16 | 3.5 |
| Campania | 4.93 | 0.48 | 4.25 | 5.72 | 26 | 5.6 |
| Emilia-Romagna | 4.83 | 0.48 | 4.25 | 5.57 | 25 | 5.4 |
| Friuli-Venezia | 4.47 | 0.53 | 3.90 | 5.40 | 19 | 4.1 |
| Lazio | 5.23 | 0.27 | 4.82 | 5.75 | 25 | 5.4 |
| Liguia | 4.91 | 0.46 | 4.25 | 5.57 | 3 | 0.6 |
| Lombardia | 5.22 | 0.29 | 4.82 | 5.75 | 49 | 10.6 |
| Marche | 5.15 | 0.31 | 4.73 | 5.75 | 20 | 4.3 |
| Molise | 5.01 | 0.44 | 4.25 | 5.72 | 4 | 0.9 |
| Piemonte | 4.83 | 0.48 | 4.25 | 5.57 | 11 | 2.4 |
| Puglia | 4.76 | 0.49 | 4.25 | 5.57 | 19 | 4.1 |
| Sardegna | 4.47 | 0.53 | 3.90 | 5.40 | 4 | 0.9 |
| Sicilia | 5.18 | 0.24 | 4.82 | 5.57 | 23 | 5.0 |
| Toscana | 4.88 | 0.42 | 4.40 | 5.57 | 36 | 7.8 |
| Trentino-Alto Adige | 4.34 | 0.71 | 3.19 | 5.40 | 114 | 24.7 |
| Unbria | 4.76 | 0.49 | 4.25 | 5.57 | 6 | 1.3 |
| Valle d'Aosta | 4.47 | 0.53 | 3.90 | 5.40 | 3 | 0.6 |
| Veneto | 5.06 | 0.36 | 4.25 | 5.57 | 45 | 9.7 |
| Total | | | | | 462 | 100.0 |

Table 1: The time-series statistics of the IRAP rates (in percentage points) during 1999–2011. The last two columns are the number of CCBs in Italian regions and the percentage of the CCBs located in each region.

| | CCBs | | | Other Banks | | |
|---|---|---|---|---|---|---|
| | 1999 | 2005 | 2011 | 1999 | 2005 | 2011 |
| *Assets:* | | | | | | |
| Loans to resident banks | 6.3 | 5.5 | 4.9 | 12.1 | 17.6 | 11.1 |
| Loans to nonbank residents | 58.8 | 71.8 | 73.9 | 60.8 | 56.0 | 56.2 |
| Securities issued by residents | 3.5 | 1.8 | 5.0 | 5.0 | 5.8 | 13.5 |
| Nonresidents loans/securities | 1.9 | 1.2 | 0.8 | 12.2 | 12.7 | 10.5 |
| Government bonds | 28.6 | 18.7 | 14.6 | 5.4 | 3.2 | 5.2 |
| Shares issued by residents | 0.9 | 1.0 | 0.9 | 4.6 | 4.7 | 3.7 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| *Liabilities:* | | | | | | |
| Deposits by banks | 8.0 | 2.1 | 9.0 | 16.6 | 19.4 | 17.9 |
| Deposits by nonbank 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 |

Table 2: Assets and liabilities in CCBs and other banks are presented for selected years. Assets do not include cash, fixed assets, and tangibles. Residents in a region include individuals, business, banks, and public administrations located in the region. Source: *Annual Report for 1999, 2005, and 2011 — Statistical Annexes*, published by Bank of Italy.

| | Level | | | | Change | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Stdev | Min | Max | Mean | Stdev | Min | Max |
| *Bank financial ratios and returns:* | | | | | | | | |
| Equity/Assets | 11.866 | 3.560 | 3.560 | 27.163 | -0.29 | 1.05 | -16.36 | 14.84 |
| Bonds/Assets | 24.724 | 12.050 | 12.050 | 69.023 | 0.90 | 3.05 | -16.34 | 16.98 |
| Deposits/Assets | 50.290 | 12.055 | 12.055 | 89.694 | -0.82 | 3.57 | -23.20 | 21.11 |
| Credit/Assets | 83.825 | 6.330 | 6.330 | 95.646 | 0.70 | 4.28 | -25.47 | 29.37 |
| Securities/Assets | 21.772 | 9.909 | 9.909 | 65.573 | -1.05 | 4.21 | -19.06 | 28.80 |
| Perf. loans/Assets | 59.205 | 13.212 | 13.212 | 84.986 | 1.02 | 4.02 | -17.38 | 19.68 |
| Bad loans/Assets | 2.465 | 2.352 | 2.352 | 23.098 | 0.09 | 0.98 | -18.49 | 11.15 |
| Asset growth | 9.294 | 10.627 | 10.627 | 156.691 | -0.30 | 14.43 | -196.16 | 153.75 |
| Bank size | 19.094 | 0.965 | 0.965 | 22.817 | 0.09 | 0.08 | -0.20 | 0.94 |
| ROE | 6.024 | 6.301 | 6.301 | 45.707 | -0.88 | 5.85 | -121.42 | 41.07 |
| ROA | 0.691 | 0.650 | 0.650 | 3.668 | -0.10 | 0.62 | -9.55 | 12.25 |
| Service income | 0.007 | 0.003 | 0.003 | 0.122 | 0.00 | 0.00 | -0.12 | 0.12 |
| Nonequity cost | 2.121 | 0.714 | 0.714 | 4.490 | -0.20 | 0.72 | -2.89 | 2.16 |
| RWA density | 65.476 | 14.185 | 14.185 | 131.114 | 1.23 | 5.93 | -36.01 | 70.51 |
| *Regional tax and economic variables:* | | | | | | | | |
| IRAP rate | 4.794 | 0.581 | 0.581 | 5.750 | -0.01 | 0.41 | -0.81 | 1.46 |
| Log(GDP) | 12.182 | 0.875 | 0.875 | 13.800 | -0.03 | 0.20 | -0.78 | 0.07 |
| Log(GDP per capita) | 10.138 | 0.262 | 0.262 | 10.471 | 0.02 | 0.02 | -0.07 | 0.07 |
| Log(Employment) | -0.832 | 0.174 | 0.174 | -0.671 | 0.00 | 0.01 | -0.05 | 0.04 |

Table 3: Summary statistics of the variables used in regressions are calculated for both their levels and changes. A change in a variables is the difference between its levels at time $t$ and $t-1$ (i.e., first difference). There are 4940 observations for the change in the bank variable and 240 observations for the change in each economic variable. Equity, bonds, deposits, credit, securities, performing loans, and bad loans are reported as percentage of the total assets. Asset growth is the percentage of change in total assets. Bank size is the logarithm of the total assets, where total assets are measured in million euros. Service income is the total commissions and fees as a percentage of the total assets. Nonequity cost is the average funding cost of deposits and bonds. The RWA density is ratio between the risk-weighted assets and the total assets. The regional economic variables are also presented in their logarithms.

| Year | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of changes | 20 | 20 | 19 | 1 | 1 | 3 | 3 | 20 | 2 | 5 | 20 | 114 | 100 |
| Direction: | | | | | | | | | | | | | |
| increase | 0 | 4 | 0 | 1 | 1 | 3 | 3 | 2 | 1 | 4 | 20 | 39 | 34 |
| decrease | 20 | 16 | 19 | 0 | 0 | 0 | 0 | 18 | 1 | 1 | 0 | 75 | 66 |
| Decision by | | | | | | | | | | | | | |
| central gov | 20 | 16 | 17 | | | 2 | | 17 | | 4 | 20 | 96 | 84 |
| regional gov | | 4 | | 1 | 1 | 1 | 3 | | 2 | 1 | | 13 | 11 |
| both | | | 2 | | | | | 3 | | | | 5 | 4 |
| Applied to | | | | | | | | | | | | | |
| only banks | 20 | 18 | 19 | 1 | | 1 | 1 | | | | 20 | 80 | 70 |
| banks and some firms | | 2 | | | 1 | | 2 | 1 | | | | 6 | 5 |
| all banks and firms | | | | | | 2 | | 19 | 2 | 5 | | 28 | 25 |

Table 4: The changes in the IRAP rates are categorized by the direction, the decision makers, or the coverage of firms. The directions of the changes are increases and decreases. The decision makers are (1) the central government, (2) the regional government, or (3) both. The coverages of firms are classified by (1) only banks, which include all financial intermediaries, (2) banks plus certain firms such as oil companies, and (3) all banks and nonfinancial firms.

| Independent variable | Baseline estimation | Adding government controls | Adding bank risk controls | Adding economic controls |
|---|---|---|---|---|
| (Bad loans/Assets)$_{jt}$ | -0.0013 | -0.0033 | -0.0231 | -0.0127 |
| | (0.0130) | (0.0120) | (0.0154) | (0.0175) |
| (Equity/Assets)$_{jt}$ | -0.0196 | -0.0127 | -0.0122 | -0.0200 |
| | (0.0145) | (0.0135) | (0.0137) | (0.0164) |
| ROE$_{jt}$ | 0.0048 | 0.0039 | 0.0039 | 0.0040 |
| | (0.0032) | (0.0031) | (0.0032) | (0.0044) |
| $\Delta$Log(GDP per capita)$_{jt}$ | 0.5735 | 0.5112 | 0.5386 | 0.6727 |
| | (0.8796) | (0.8683) | (0.8818) | (0.9299) |
| $\Delta$Log(Employment)$_{jt}$ | 0.3571 | 0.2931 | 0.3256 | -1.0209 |
| | (1.2849) | (1.2695) | (1.3583) | (1.5721) |
| (IRAP GOV UP)$_t$ | 0.6117$^{***}$ | | | |
| | (0.0633) | | | |
| (IRAP GOV DOWN)$_t$ | -0.4455$^{***}$ | | | |
| | (0.0275) | | | |
| (IRAP GOV HEALTH UP)$_t$ | | -0.0149$^{**}$ | -0.0586$^{***}$ | 0.0051$^{***}$ |
| | | (0.0066) | (0.0107) | (0.0013) |
| (IRAP GOV HEALTH DOWN)$_t$ | | 0.3823$^{**}$ | 0.3844$^{**}$ | 0.4363$^{***}$ |
| | | (0.1718) | (0.1708) | (0.1596) |
| (IRAP GOV OTHER UP)$_t$ | | -0.1398$^{**}$ | -0.1104 | -0.0805 |
| | | (0.0672) | (0.0691) | (0.0820) |
| (IRAP GOV OTHER DOWN$_t$ | | 0.6786$^{***}$ | 0.6331$^{***}$ | 0.6037$^{***}$ |
| | | (0.0358) | (0.0536) | (0.0724) |
| (Bad loans/Assets)$_{jt-1}$ | | | 0.0188 | 0.0145 |
| | | | (0.0189) | (0.0213) |
| (Equity/Assets)$_{jt-1}$ | | | -0.0092 | -0.0122 |
| | | | (0.0100) | (0.0118) |
| ROE$_{jt-1}$ | | | -0.0052 | -0.0086 |
| | | | (0.0046) | (0.0070) |
| $\Delta$log(GDP per capita)$_{jt-1}$ | | | | 1.7036 |
| | | | | (1.0539) |
| $\Delta$log(Employment)$_{jt-1}$ | | | | 1.2897 |
| | | | | (1.3021) |
| Regional fixed effects | Yes | Yes | Yes | Yes |
| Adjusted R-squared | 0.5341 | 0.5454 | 0.5429 | 0.5504 |

Table 5: Exogeneity of the changes in the IRAP rates are tested by using the change in the IRAP rates, $\Delta$IRAP$_{jt}$, as the dependent variable in regressions. Each regression uses 256 observations. Robust standard errors of the estimates are reported in brackets (clustered at region-year level). The symbols *, **, and *** represent the significance levels of 10%, 5%, and 1% respectively.

| Independent variable | Baseline estimates | Adding economic controls | Adding bank risk controls |
|---|---|---|---|
| $\Delta$(IRAP rate)$_{jt-1}$ | -0.1496$^{***}$ | -0.1430$^{**}$ | -0.1520$^{***}$ |
| | (0.0545) | (0.0588) | (0.0582) |
| $\Delta$(Assets growth)$_{ijt-1}$ | 0.0014 | 0.0013 | 0.0005 |
| | (0.0013) | (0.0013) | (0.0012) |
| $\Delta$ROE$_{ijt-1}$ | 0.0077 | 0.0079 | 0.0079 |
| | (0.0051) | (0.0050) | (0.0050) |
| $\Delta$(Service income)$_{ijt-1}$ | -3.5696$^{*}$ | -3.5666$^{*}$ | -3.5782$^{*}$ |
| | (2.1039) | (2.1382) | (2.2426) |
| $\Delta$(RWA density)$_{ijt-1}$ | | | 0.0033 |
| | | | (0.0020) |
| Regional economic controls | No | Yes | Yes |
| Bank fixed effects | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes |
| Adjusted $R$-squared | 0.1753 | 0.1751 | 0.1724 |

Table 6: The tax effects on equity are estimated by regressions that use the change in the ratio of equity to total assets, $\Delta$(Equity/Assets)$_{ijt}$, as the dependent variable in the regressions. The regional economic controls include the change in the logarithm of regional GDP, the change in the logarithm of regional GDP per capita, and the change in the logarithm of regional employment ratio. 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.

| Independent variable | Baseline estimates | Adding economic controls | Adding bank risk controls |
|---|---|---|---|
| $\Delta$(IRAP rate)$_{jt-1}$ | 0.3897$^{**}$ | 0.3718$^{**}$ | 0.3906$^{**}$ |
| | (0.1767) | (0.1729) | (0.1835) |
| $\Delta$(Assets growth)$_{ijt-1}$ | -0.0097$^{**}$ | -0.0098$^{**}$ | -0.0092$^{**}$ |
| | (0.0040) | (0.0040) | (0.0040) |
| $\Delta$ROE$_{ijt-1}$ | -0.0086 | -0.0083 | -0.0086 |
| | (0.0101) | (0.0102) | (0.0102) |
| $\Delta$(Service income)$_{ijt-1}$ | 20.6210$^{***}$ | 20.5520$^{**}$ | 20.5980$^{**}$ |
| | (7.9484) | (8.1497) | (8.1391) |
| $\Delta$(RWA density)$_{ijt-1}$ | | | -0.0138 |
| | | | (0.0179) |
| Regional economic controls | No | Yes | Yes |
| Bank fixed effects | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes |
| Adjusted $R$-squared | 0.1494 | 0.1500 | 0.1505 |

Table 7: The tax effects on non-deposit debt are estimated by regressions that use the change in the ratio of bonds to total assets, $\Delta$(Bonds/Assets)$_{ijt}$, as the dependent variable in the regressions. The regional economic controls include the change in the logarithm of regional GDP, the change in the logarithm of regional GDP per capita, and the change in the logarithm of regional employment ratio. 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.

| Independent variable | Baseline estimates | Adding economic controls | Adding bank risk controls |
|---|---|---|---|
| $\Delta$(IRAP rate)$_{jt-1}$ | 0.1779 | 0.1095 | 0.0878 |
| | (0.1453) | (0.1580) | (0.0561) |
| $\Delta$(Assets growth)$_{ijt-1}$ | -0.0108$^{***}$ | -0.0107$^{**}$ | -0.0113$^{**}$ |
| | (0.0054) | (0.0054) | (0.0054) |
| $\Delta$ROE$_{ijt-1}$ | -0.0149 | -0.0149 | -0.0146 |
| | (0.0118) | (0.0118) | (0.0119) |
| $\Delta$(Service income)$_{ijt-1}$ | 63.8637 | 60.1089 | 57.8681 |
| | (64.0008) | (64.0298) | (63.8887) |
| $\Delta$(RWA density)$_{ijt-1}$ | | | -0.0653$^{***}$ |
| | | | (0.0108) |
| Regional economic controls | No | Yes | Yes |
| Bank fixed effects | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes |
| Adjusted $R$-squared | 0.1660 | 0.1674 | 0.1677 |

Table 8: The tax effects on deposits are estimated by regressions that use the change in the ratio of deposits to total assets, $\Delta$(Deposits/Assets)$_{ijt}$, as the dependent variable in the regressions. The regional economic controls include the change in the logarithm of regional GDP, the change in the logarithm of regional GDP per capita, and the change in the logarithm of regional employment ratio. 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.

| Independent variable | Baseline estimates | Adding economic controls | Adding bank risk controls |
|---|---|---|---|
| $\Delta(\text{IRAP rate})_{jt-1}$ | $0.1185^{***}$ | $0.1295^{***}$ | $0.1247^{***}$ |
| | (0.0173) | (0.0185) | (0.0180) |
| $\Delta(\text{Assets growth})_{ijt-1}$ | $0.0009^{**}$ | $0.0009^{**}$ | $0.0011^{***}$ |
| | (0.0004) | (0.0004) | (0.0004) |
| $\Delta\text{ROE}_{ijt-1}$ | $0.0070^{***}$ | $0.0072^{***}$ | $0.0071^{***}$ |
| | (0.0014) | (0.0014) | (0.0014) |
| $\Delta(\text{Service income})_{ijt-1}$ | $1.6622^{*}$ | $1.6368^{*}$ | $1.2213^{*}$ |
| | (0.9264) | (0.9273) | (0.6452) |
| $\Delta(\text{RWA density})_{ijt-1}$ | | | $0.0053^{***}$ |
| | | | (0.0013) |
| Regional economic controls | No | Yes | Yes |
| Bank fixed effects | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes |
| Adjusted *R*-squared | 0.7914 | 0.7916 | 0.7938 |

Table 9: The tax effects on the cost of non-equity funding are estimated by regressions that use the change in the cost of non-equity funding, $\Delta(\text{Nonequity cost})_{ijt}$, as the dependent variable in the regressions. The regional economic controls include the change in the logarithm of regional GDP, the change in the logarithm of regional GDP per capita, and the change in the logarithm of regional employment ratio. 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.

| Independent variable | Baseline estimates | Adding economic controls | Adding bank risk controls |
|---|---|---|---|
| $\Delta$(IRAP rate)$_{jt-1}$ | -0.8320$^{***}$ | -0.5128$^{**}$ | -0.5461 |
| | (0.2115) | (0.2173) | (0.2174) |
| $\Delta$(Assets growth)$_{ijt-1}$ | 0.0193$^{***}$ | 0.0177$^{***}$ | 0.0138 |
| | (0.0058) | (0.0054) | (0.0052) |
| $\Delta$ROE$_{ijt-1}$ | 0.0164 | 0.0325$^{*}$ | 0.0355 |
| | (0.0181) | (0.0178) | (0.0173) |
| $\Delta$(Service income)$_{ijt-1}$ | -87.6229 | -78.3497 | -66.3094 |
| | (87.6150) | (60.1971) | (52.0036) |
| $\Delta$(RWA density)$_{ijt-1}$ | | | -0.0980 |
| | | | (0.0124) |
| Regional economic controls | No | Yes | Yes |
| Bank fixed effects | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes |
| Adjusted $R$-squared | 0.0691 | 0.0698 | 0.081 |

Table 10: The tax effects on the bank credit are estimated by regressions that use the change in the total credit, $\Delta$(Credits/Assets)$_{ijt}$, as the dependent variable in the regressions. The regional economic controls include the change in the logarithm of regional GDP, the change in the logarithm of regional GDP per capita, and the change in the logarithm of regional employment ratio. 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.

| Independent variable | Securities | Performing loans | Bad loans |
| --- | --- | --- | --- |
| $\Delta$(IRAP rate)$_{jt-1}$ | -0.4525** | -0.4024** | 0.1174** |
| | (0.2150) | (0.1981) | (0.0546) |
| $\Delta$(Assets growth)$_{ijt-1}$ | 0.0037 | 0.0106** | -0.0048*** |
| | (0.0061) | (0.0054) | (0.0017) |
| $\Delta$ROE$_{ijt-1}$ | 0.0277* | 0.0836*** | -0.0176*** |
| | (0.0144) | (0.0154) | (0.0042) |
| $\Delta$(Service income)$_{ijt-1}$ | -18.3029 | -75.2146 | 6.9933* |
| | (36.7975) | (51.0826) | (4.2157) |
| $\Delta$(RWA density)$_{ijt-1}$ | -0.0560*** | -0.0609*** | 0.0047 |
| | (0.0119) | (0.0102) | (0.0029) |
| Regional economic controls | Yes | Yes | Yes |
| Bank fixed effects | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes |
| Adjusted $R$-squared | 0.0550 | 0.1875 | 0.1422 |

Table 11: The tax effects on the composition of bank credit are estimated by regressions that use $\Delta$(Securities/Assets)$_{ijt}$, or $\Delta$(Performing loans/Assets)$_{ijt}$, $\Delta$(Bad loans/Assets)$_{ijt}$, as the dependent variable in the regressions. The regional economic controls include the change in the logarithm of regional GDP, the change in the logarithm of regional GDP per capita, and the change in the logarithm of regional employment ratio. 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.

| Independent variable | Leverage | Bonds | Deposits | Cost | Credit |
|---|---|---|---|---|---|
| $\Delta$(IRAP rate)$_{jt-1}$ | -0.1328*** | 0.3327* | 0.2126 | 0.1698*** | -1.0450** |
| | (0.0495) | (0.1891) | (0.3248) | (0.0233) | (0.4440) |
| $\Delta$(Assets growth)$_{ijt-1}$ | 0.0009 | -0.0008 | 0.0043 | 0.0023** | 0.0022 |
| | (0.0017) | (0.0058) | (0.0067) | (0.0010 | (0.0076 |
| $\Delta$ROE$_{ijt-1}$ | 0.0024 | 0.0139 | 0.0431 | 0.0062* | -0.7925** |
| | (0.0049) | (0.0261) | (0.0301) | (0.0032) | (0.3623) |
| $\Delta$(Service income)$_{ijt-1}$ | -29.8251* | 2.3529 | 7.3152 | 2.2816 | -0.6470 |
| | (16.9556) | (7.5322) | (8.8645) | (1.4465) | (21.6479) |
| $\Delta$(RWA density)$_{ijt-1}$ | 0.0014 | -0.0028 | -0.0924*** | 0.0053* | -0.0372 |
| | (0.0054) | (0.0353) | (0.0305) | (0.0028) | (0.0300) |
| Lagged endogenous | Yes | Yes | Yes | Yes | Yes |
| Regional economy | Yes | Yes | Yes | Yes | Yes |
| Bank fixed effects | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes |
| Serial correlation test | 0.267 | 0.623 | 0.513 | 0.171 | 0.094 |
| Hansen test | 0.189 | 0.205 | 0.622 | 0.156 | 0.109 |

Table 12: The regression models of the tax effects are estimated using the dynamic Generalized Method of Moments (GMM) panel methodology. The regional economic controls include the change in the logarithm of regional GDP, the change in the logarithm of regional GDP per capita, and the change in the logarithm of regional employment ratio. In a serial correlation test, the null hypothesis is that the errors in the first difference regression exhibit no second-order serial correlation, and the $p$-value of the test is reported in the send last row. In a Hansen test, the null hypothesis is that the instruments used are not correlated with the residuals, and the $p$-values of the test is reported in the last row. Parameter estimates are reported with robust standard errors in brackets. The symbols *, **, and *** represent significance levels of 10%, 5%, and 1% respectively.