Taxing Bank Leverage: The Effects on Bank Capital Structure, Credit Supply and Risk-Taking*

Claire Célérier [†] Thomas Kick [‡] Steven Ongena [§]

This Draft: November 16, 2018

Abstract

We first investigate the use of taxation as a complementary tool to capital requirements to monitor bank risk in a simple mean-variance model for portfolio selection, where banks are subjects to capital regulation and regulatory risk weights are not perfectly aligned with the risk of the bank assets. We show that when the fiscal cost of leverage decreases: (1) banks rely more on equity, (2) shift the composition of their assets towards loans, (3) and take less risk. Overall, taxes partly offset distortions induced by capital requirements. To test the model predictions, we then exploit the staggered introduction of tax reforms across Europe between 1996 and 2012 that increase the fiscal cost of leverage either by subsidizing equity or by taxing bank liability net of equity. Employing both bank- and loan-level data, we confirm that when the fiscal cost of leverage increases, banks simultaneously decrease leverage and lend relatively more.

JEL Codes: E51, E58, G21, G28 *Key words*: Credit, Bank Capital, Regulation

---

*Previously circulated with the title "Changes in the Cost of Bank Equity and the Supply of Bank Credit". We thank Olivier de Bandt, Lamont Black, Robert DeYoung, Tim Eisert, Victoria Ivashina, German Lopez Espinosa, Sergio Mayordomo, Alexander Popov, Andrea Resti, Jean-Charles Rochet, Boris Vallee, participants at the Central Bank of Ireland Workshop on "Banking, Credit and Macro-prudential Policy" (Dublin), CEPR-RELTIF Workshops (Milan, Capri), the Chicago Financial Institutions Conference, the Empirical Financial Intermediation Research Network Workshop (Brussels), the European Banking Association Fifth Policy Research Workshop (London), the Financial Intermediation Research Society Conference (Lisbon), the Fourth Research Workshop of the MPC Task Force on Banking Analysis for Monetary Policy (Vienna), the EFA, the Midwest Finance Association Conference (Chicago), the Spanish Finance Association (AEFIN) XXV Finance Forum (Barcelona), the Second Sydney Banking and Financial Stability Conference, the Swiss Finance Institute Finance Workshop (Zurich), Workshop on "Recent Advances in Empirical Banking" (Maastricht), the Southern Finance Association Conference (Key West), with Jason Na as the discussant, the ROME Workshop (Frankfurt am Main), and seminar participants at the Bank of Spain, Deutsche Bundesbank, Copenhagen Business School, Goethe University Frankfurt, Higher School of Economics Moscow, National Bank of Romania, National University of Singapore, Norges Bank, Reserve Bank of Australia, Rotman School of Management, Swiss National Bank, University College Dublin, University of Glasgow, University of Groningen, University of Navarra, University of Zurich and Vienna Graduate School of Finance for helpful comments. Celerier and Ongena acknowledge financial support from CEPR-RELTIF and Ongena from ERC ADG 2016 - GA 740272 lending. We thank Tila Maierovits for excellent research assistance.

[†]Claire Célérier - Rotman School of Management, E-mail: claire.celerier@rotman.utoronto.ca

[‡]Thomas Kick - Bundesbank, E-mail: thomas.kick@bundesbank.de

[§]Steven Ongena - University of Zurich, SFI, KU Leuven and CEPR, E-mail: steven.ongena@bf.uzh.ch.

1 Introduction

The financial crisis of 2007-2008 demonstrated that highly levered banks can generate substantial negative externalities. As a consequence, a vigorous debate has ensued regarding the optimal level of capital requirements (Hanson et al., 2011; Admati et al., 2013). While increasing capital requirements in principle makes banks safer, it also leads to a decrease in bank lending (Aiyar et al., 2014; Fraisse et al., 2015; Jiménez et al., 2017) with adverse consequences for firms, employment, and households. High capital requirements may also spur regulatory arbitrage (Kashyap et al., 2010; Vallascas and Hagendorff, 2013; Efing, 2016; Greenwood et al., 2017). This paper investigates whether the taxation of banks - by making leverage more costly - can be a complementary regulatory tool to control bank leverage without affecting the supply of credit. Hence, the question we aim to answer is: What are the effects of a tax reform that alters the cost of leverage on bank capital structure, credit supply and risk?

To address this question, we investigate the effect of taxes that increase the relative cost of leverage on bank capital structure, asset composition and lending in a simple mean-variance model of portfolio selection (Rochet, 1992; Freixas and Rochet, 2008).[1] We assume that banks are subject to capital requirements, capital requirements are binding, and regulatory risk-weights do not perfectly reflect the risk of each asset. The following stylized facts support the latter assumption: (1) the risk of each asset is not perfectly observable and varies across banks, and regulation is mostly at the international level; (2) capital requirements are in some dimension arbitrary: for example there are zero-risk weights for some category of assets that are clearly risky, such as sovereign bonds from the peripheral countries in Europe; (3) banks engage in regulatory arbitrage to minimize the risk weighted assets. In this framework, banks underinvest in the assets that are "over-weighted", i.e., with high risk weights relative to their risk, such as corporate loans. Consistent with the findings of the recent empirical literature, increasing capital requirements

[1] See also Koehn and Santomero (1980), Kim and Santomero (1988) , Glasserman and Kang (2014) Glasserman and Kang (2014) and Juelsrud and Wold (Juelsrud and Wold)

leads banks to decrease lending (Aiyar et al., 2014; Fraisse et al., 2015; Jiménez et al., 2017), shift the composition of their balance sheet away from loans (Haubrich et al., 1993; De Jonghe et al., 2016; Gropp et al., 2016), and increase their leverage ratio less than their regulatory ratio.

We consider two tax designs that increase the relative cost of leverage: an *Allowance for Corporate Equity* (ACE), which allows banks to deduct a notional interest on the book value of their equity from their taxable income, and a *Liability Tax*, which is applied to all bank non-equity liabilities. While the Liability Tax increases the cost of leverage by directly increasing the cost of debt, an ACE increases the cost of leverage by neutralizing the tax advantage of debt and making equity relatively less costly.[2] We show that both the ACE and the Liability Tax partly offset the cost induced by the excess capital allocated to the "over-weighted" assets - corporate loans -, as equity becomes relatively cheaper. Hence, when the ACE or the Liability Tax increase, banks not only decrease leverage, but also rebalance their assets towards corporate loans while decreasing bank risk. Overall, taxes can improve the bank asset mix by partly offsetting the distortions induced by the capital requirements.

To test empirically the model predictions, we exploit, first, the introduction of an ACE in Belgium in 2005, second, of a Liability Tax in seven European countries from 2010 to 2012. These two sets of reforms, the Belgian ACE and the European Liability Tax, offer nice quasi-experiments to address our research question because: (1) they are not simultaneous to any other major tax reforms; (2) they applied only to a subset of banks subject to the same regulatory framework, the European one - among the fifteen European countries with the largest banking systems, seven countries adopted either the ACE or the Liability Tax between 1996 and 2012, while the remaining eight countries did not -; (3) they applied to banks that are actively lending abroad, allowing us to investigate the effect of the reforms on bank lending in markets that these tax reforms did not affect.

Our empirical analysis proceeds in three steps. We first show that bank leverage

[2]Assume that T is the tax rate, τ_E is the notional interest deducted from taxes in the ACE and τ_{LT} is the tax rate of the Liability Tax. The cost of capital increases by $(T\tau_E + \tau_{LT}) \times L$ where L is bank leverage.

decreases when the fiscal cost of leverage increases. More precisely, a 1 percentage point (pp) increase in the fiscal cost of bank leverage following the implementation of an ACE or a Liability Tax leads to a 0.7 to 1.4 pp increase in leverage ratios.[3] This is a potentially large effect, given that, for instance, the transition from Basel II to Basel III is supposed to raise minimum capital requirements from 4.5% to 6% over the course of six years. These results are in line with the findings of Schepens (2016) and Devereux et al. (2017) for, respectively, the ACE and the Liability Tax. Consistent with the model predictions, we also find that the effect is larger for banks that are more likely to be constrained by capital regulation, i.e., with an ex-ante low level of equity, and that it is persistent. We obtain these results in a difference-in-differences setting where the control group of banks is obtained through propensity score matching.[4] The results also hold in a large set of alternative specifications - such as when we vary the parameters of the matching procedure or include size × year and bank × leverage fixed effects.

Second, we show that the asset mix of banks significantly changes when the fiscal cost of leverage increases, with banks shifting the composition of their assets towards loans and away from securities. More precisely, we find that a 1 pp increase in the cost of bank liabilities leads banks to increase their loan ratios by 2 to 5 pp. The effect is observed both for the ACE, which decreases the cost of capital, and the Liability Tax, which increases the cost of capital, hence relieving the concern that the effect is driven by an increase in demand due to lower interest rates. In addition, the effect is much stronger for banks with ex-ante low leverage ratio, for which the downward effect of the ACE on the cost of capital should be lower, while the upward effect of the Liability Tax should be higher. We obtain this result using the same difference-in-differences setting.

Third, we show that this change in the asset mix of banks is a supply effect - in other words, that this is not driven by a higher demand for credit - and that it

[3]The fiscal cost of leverage is the increase in the cost of capital induced by an increase in leverage. Increasing the fiscal cost of leverage by 1 pp is equivalent to a 1% tax on bank liabilities or a full ACE when the tax rate is 33% and the notional interest is 3%.

[4]Our initial sample includes the fifteen European countries with the highest total banking assets: Austria, Belgium, Denmark, France, Germany, Italy, Ireland, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom.

leads to a better access to credit for affected firms. To do so, we use loan level-data from Germany where: (1) firms are not affected by these reforms; and (2) foreign banks affected by the reforms are lending actively. We once more follow a difference-in-differences approach to compare lending by treated versus control banks before and after each reform. We control for bank, bank-firm relationship and firm characteristics, and in our favorite set of specifications we saturate with firm fixed effects to account for all heterogeneity in the quantity and quality of firm-specific demand for credit (Khwaja and Mian, 2005). The magnitude of the effect is large, both at the intensive and extensive margin. We find that a 1 pp increase in the cost for bank leverage leads to a 20% increase in foreign lending by affected banks. The magnitude of the effect is relatively similar when restricting the sample to foreign lending only, saturating with firm fixed effects, and at the extensive margin of lending.

We then turn to the effect of the reforms on bank risk-taking. Consistent with the model assumption that capital requirements are binding, the ratio of risk-weighted assets to total assets is increasing, while we do not find any effect on bank regulatory ratios. We then turn to two measures of total risk, the Z-score, and the ratio of the leverage ratio to the standard deviation of return on assets. Both indicate a decrease in the bank total risk. Overall, we find that a decrease in leverage following a change in the tax treatment of equity simultaneously leads to a higher leverage ratio, a *higher lending* and a decrease in bank total risk. Our results, therefore, suggest that fiscal policy could be a complementary tool to control bank leverage while maintaining credit supply.

This paper contributes to the literature that identifies the real effects of bank capital regulations. While the existing literature has focused on the effect of capital requirements on bank lending (Kashyap et al., 2010; Aiyar et al., 2014; Gornall and Strebulaev, 2014; Fraisse et al., 2015; Jiménez et al., 2017), we investigate the effect of changes in the *fiscal* cost of leverage. We, therefore, contribute to the debate on optimal capital regulation by providing the first evidence that, in the presence of capital requirements, taxes can give banks incentives to simultaneously decrease leverage *and* increase credit supply - with consequent implications for investment, growth and the possible development of a shadow banking sector. We also show that taxation can mitigate distortions induced by capital requirements when weights do not perfectly reflect the risk of the assets, hence suggesting another way to improve capital regulation without increasing its complexity.

More broadly, our paper adds to the literature on whether taxes can be complementary to quantitative limits to address negative externalities (Cochrane, 2014; Roe and Tröge, 2016). There are three reasons why taxes might be an efficient complementary tool to quantitative regulation. First, with taxes, banks could endogenize the social cost of leverage rather than arbitraging regulation. Second, with taxes one could observe what is the marginal cost of holding equity for banks. Third, adding a single tax rate might be a simple alternative to the complex Basel 3 frameworks, which aims at improving the alignment of capital requirements to the risk of each asset (Greenwood et al., 2017). In many settings, such as in environmental policy making, regulation through prices is found to complement or even dominate regulation through quantities (Pizer, 2002; Hoel and Karp, 2002).

In an environment where interest rates are low, the ACE could also be an alternative to a lax monetary policy to stimulate lending by banks in the next financial crisis. While there is ample evidence that monetary tightening affects bank lending (Kashyap and Stein, 2000; Campello, 2002), lowering interest rates might not have large effects. This lead central banks to use quantitative easing during the last financial crisis. But the effectiveness of quantitative easing has been a topic of vivid debate: While quantitative easing might have fostered bank lending (Rodyansky, Darmouni 2017), quantitative easing might also have fueled asset bubbles. An equity subsidy could allow banks to expand lending while decreasing bank leverage and total risk.

Our results also relate to the debate on whether equity is cheap or not for financial institutions (Admati et al., 2013; Baker and Wurgler, 2015; Gandhi et al., 2016).[5] The moderate effect we observe on bank leverage - in contrast with the strong effect we find on bank lending - suggests that capital requirements are binding and that there are significant frictions in the market of outside equity.

[5]Baker and Wurgler (2015) show that, because of the low risk anomaly, increasing bank capital requirements can increase their cost of capital.

More broadly, our paper relates to the literature that uses changes in taxes to investigate capital structure decisions by firms (Gonzalez-Uribe and Paravisini, 2017) and confirms the existence of market frictions in outside equity markets.

Finally, our study complements the literature on the impact of taxation on bank capital structure (Keen and de Mooij, 2012; Schepens, 2016; Gu et al., 2015; Gambacorta et al., 2017; Devereux et al., 2017), intermediation costs (Capelle-Blancard and Havrylchyk, 2017), and deposit rates (Buch et al., 2016) while an increasing number of countries is considering implementing an ACE or Liability Tax.[6][7]

The remainder of our paper proceeds as follows. Section 2 presents a simple conceptual framework, Section 3 the fiscal reforms we exploit in our study, and Section 4 describes our data. We develop our empirical strategy and results on bank leverage and asset composition in Section 5, on credit supply in Section 6 and on the bank total risk in Section 6.3.2. Section 8 concludes.

2 Conceptual Framework

We present a simple model to investigate how banks react to a change in the fiscal cost of leverage in the presence of capital requirements. We show that, while increasing capital requirements leads banks to inefficiently shift their asset mix away from loans, the ACE and the Liability Tax can allow banks to lend relatively more while decreasing bank total risk.

It is a static model with only two dates: $t = 0$, when the bank chooses the composition of its portfolio; and $t = 1$, where all assets and liabilities are liquidated.[8] Let us assume that a bank can invest in a set of 2 possible assets, or groups of assets: corporate loan, denoted L, and securities, denoted S. $(\tilde{r_L}; \tilde{r_S})$ is the vector of random returns with mean $\mu = (\mu_L; \mu_S)$ and with invertible variance-covariance matrix Σ.[9] We assume that on average corporate loans are riskier than securities

[6] Smolyansky (2016) investigate the effects of changes in profit taxes on bank lending activities across states.

[7] On 28 September 2018, the Swiss Parliament passed the Federal Act on Tax Reform and AHV Financing (TRAF) that allows the implementation of an ACE at the Canton level

[8] We here follow and extend the framework developed in Rochet (1992)

[9]

so that $\mu_L > \mu_S$. $x = (x_L; x_S)$ is the vector of dollar holdings. There are only two liabilities: equity capital E and deposits D. Let E be the dollar amount of equity held by the bank.

2.1 Assumptions

We make the following two assumptions:

1. The return on equity expected by shareholders is exogenous and amounts to R, with $R > 0$, while the return on deposits is 0.

2. The regulator forces the ratio of equity to the sum of the risk-weighted assets to be higher than k. $w = (w_L; w_S)$ is the vector of regulatory risk weights. Thus, the bank is constrained to satisfy

$$kx^T w \leq E. \tag{1}$$

   If the relative risk weights exactly reflect the relative risk of each asset category, we should have $\frac{w_L}{w_S} = \frac{\mu_L}{\mu_S}$, as the traditional CAPM requires that in a competitive market the return-vector μ is colinear to the risk of each asset. Oppositely, if $\frac{w_L}{w_S} > \frac{\mu_L}{\mu_S}$, corporate loans are "overweighted" relatively to securities. We therefore introduce $\alpha_L > 0$ and $\alpha_S > 0$, such that

$$\begin{cases} w_L = \alpha_L \mu_L \\ w_S = \alpha_S \mu_S \end{cases}$$

   We will investigate the effect of taxes and capital requirements on bank asset allocation, lending and capital structure when $\alpha_L = \alpha_S$, and, oppositely, when $\alpha_L > \alpha_S$, i.e., when corporate loans are "overweighted".

There are two main reasons why corporate loans might be overweighted in the formula that defines capital requirements compared to securities. First, the average regulatory risk weight on securities is close to 0, and is even exactly 0 for

$$\Sigma = \begin{bmatrix} \sigma_L^2 & \rho\sigma_L\sigma_S \\ \rho\sigma_L\sigma_S & \sigma_S^2 \end{bmatrix} \qquad \Sigma^{-1} = \frac{1}{1-\rho^2}\begin{bmatrix} \frac{1}{\sigma_L^2} & -\frac{\rho}{\sigma_L\sigma_S} \\ -\frac{\rho}{\sigma_L\sigma_S} & \frac{1}{\sigma_S^2} \end{bmatrix}$$

European sovereign bonds, while it is roughly between 45 and 60% for corporate loans. Second, while there is evidence that banks reach for yield within each asset category, i.e., pick the assets with the highest yield among assets with the same regulatory risk weight, they are less likely to do so for corporate loans. Moral hazard and adverse selection limit the level of interest rate banks can charge on small and medium companies that consequently largely suffer from credit rationing (Stiglitz and Weiss, 1981; Holmstrom and Tirole, 1997).

2.2 Capital Requirements and the Behaviour of Banks

We first investigate the effects of capital requirements on bank lending, asset allocation and capital structure.
The bank's profit in period 1 is

$$\widetilde{\Pi} = x^T(1+\tilde{r}) - D - (1+R)E. \tag{2}$$

By introducing the accounting equation giving the total of the balance sheet at date t=0, $x_1 + x_2 = D + E$, we obtain

$$\begin{aligned} &\widetilde{\Pi} = x^T(1+\tilde{r}) - x_1 - x_2 - R \times E \\ \Leftrightarrow\ &\widetilde{\Pi} = x^T\tilde{r} - R \times E. \end{aligned}$$

We assume that the bank behaves as a mean-variance investor with risk aversion γ. The objective function $\mathcal{V}$ of the bank is

$$\mathcal{V} = \mathbb{E}(\widetilde{\Pi}) - \frac{\gamma}{2}\mathbb{V}ar(\widetilde{\Pi}), \tag{3}$$

where the level of equity is constrained by equation (1). The Lagrangian the bank maximizes is, therefore,

$$\mathcal{L} = x^T\mu - \frac{\gamma}{2}x^T\Sigma x - k\lambda x^T w + E[\lambda - R]. \tag{4}$$

The bank chooses x to maximize $\mathcal{L}$. Therefore, the gradient of $\mathcal{L}$ with respect to x is equal to 0. This implies

$$\nabla_x \mathcal{L} = \mu - \gamma \Sigma x - k\lambda w = 0.$$

The asset portfolio x the bank chooses satisfies

$$x = (\gamma \Sigma)^{-1}(\mu - k\lambda w).$$

The bank also chooses E to maximize $\mathcal{L}$. Therefore, the partial derivative of $\mathcal{L}$ with respect to E is equal to 0

$$\frac{\partial \mathcal{L}}{\partial E} = \lambda - R = 0,$$

$$x = (\gamma \Sigma)^{-1}(\mu - kRw) \tag{5}$$

and

$$E = kx^T w. \tag{6}$$

Equations (5) to (6) shed light on how an increase in capital requirements affects bank lending, asset allocation and capital structure.[10]

First, we observe from equation (5) that if $\rho = 0$, i.e. the correlation between $\tilde{r_L}$ and $\tilde{r_S}$ is negligible, an increase in capital requirement k leads to a decrease in holdings of each asset, as the effective return of each asset is reduced by the binding cost of required capital.[11] Both bank size and lending, therefore, decrease.

Second, an increase in capital requirements might also affect the asset mix of banks. Keeping the assumptions that $\rho = 0$, we indeed have:

$$\frac{x_L}{x_S} = \frac{\mu_L - kRw_L}{\mu_S - kRw_S} \frac{\sigma_S^2}{\sigma_L^2}.$$

If we introduce $w_L = \alpha_L \mu_L$ and $w_S = \alpha_S \mu_S$, we have

$$\frac{x_L}{x_S} = \frac{1 - kR\alpha_L}{1 - kR\alpha_S} \frac{\mu_L \sigma_S^2}{\mu_S \sigma_L^2}. \tag{7}$$

[10] We give the explicit solutions in Appendix A of the online appendix

[11] When $\rho = 0$ all the elements of the matrix Σ are ≥ 0

From (7) we observe that the asset mix of banks is unaffected by a change in capital requirements if and only if $\alpha_L = \alpha_S$, i.e. if the ratio of risk weights $\frac{w_L}{w_S}$ is proportional to the ratio of expected returns $\frac{\mu_L}{\mu_S}$, and thereby to risk. Suppose, alternatively, that $\alpha_L > \alpha_S$, i.e. that corporate loans are *overweighted*. We observe from (7) that an increase in capital requirements leads banks to reallocate their assets away from corporate loans. This result is consistent with the abundant findings of the recent empirical literature that increasing capital requirements leads banks to both decrease lending to firms (Aiyar et al., 2014; Fraisse et al., 2015; Jiménez et al., 2017) and shift the composition of their balance sheet away from loans (Haubrich et al., 1993; De Jonghe et al., 2016; Gropp et al., 2016).

Third, an increase in capital requirements might lead to increased inefficiencies in the asset allocation of banks. Let x^M denote the Markowitz portfolio, i.e. the portfolio the bank chooses in the absence of capital constraints, we have

$$x^M = (\gamma\Sigma)^{-1}\mu,$$

which implies

$$\frac{x_L}{x_S} = \frac{1 - kR\alpha_L}{1 - kR\alpha_S}\frac{x_L^M}{x_S^M}. \tag{8}$$

We see from equations (8) that binding risk-weighted capital requirements could lead to an inefficient allocation across assets relative to the mean-variance efficient benchmark if $\alpha_L > \alpha_S$. The distance to the Markowitz portfolio increases as capital requirement k increases.

Finally, we find that the leverage ratio increases less than the regulatory capital ratio. We define the leverage ratio LR as the ratio of equity E to total assets $x_L + x_S$. When capital requirements are binding, an increase in k implies that E increases while the sum of risk weighted assets $w_L x_L + w_S x_S$ decreases. The sum of risk weighted assets $w_L x_L + w_S x_S$ decreases because the bank size decreases but also because banks reallocate their assets away from the asset with the highest risk weights, i.e., corporate loans. The increase in the leverage ratio is, therefore, lower as $x_L + x_S$ decreases less than $w_L x_L + w_S x_S$.

2.3 Taxing Bank Leverage: The Allowance for Corporate Equity

We now incorporate taxes and investigate the effect of increasing the fiscal cost of leverage through an Allowance for Corporate Equity, or ACE. Let Θ be the income tax rate. In the presence of an ACE, the bank can deduct from the income before taxes a notional interest τ_E applied to the book value of equity E. Taxes, therefore, amount to $\Theta(x^T\tilde{r} - \tau_E \times E)$. The cost of capital is $LR \times (R - \Theta\tau_E)$ and the fiscal cost of leverage is $\Theta\tau_E$.[12]

The bank's after tax profit in period 1 is now:

$$\tilde{\Pi} = (1-\Theta)x^T\tilde{r} - E[R - \Theta\tau_E]$$

and the Lagrangian that the bank maximizes becomes

$$\mathcal{L} = x^T\mu_\Theta - \frac{\gamma}{2}x^T\Sigma_\Theta x - \lambda k w^T x + E[\Theta\tau_E + \lambda - R],$$

where $\mu_\Theta = (1-\Theta)\mu$ and $\Sigma_\Theta = (1-\Theta)^2\Sigma$. The bank chooses x and E to maximize $\mathcal{L}$, which implies

$$\nabla_x\mathcal{L} = \mu_\Theta - \gamma\Sigma_\Theta x - k\lambda w = 0,$$

and

$$\frac{\partial\mathcal{L}}{\partial E} = \Theta\tau_E + \lambda - R = 0.$$

The asset portfolio x now satisfies:

$$x = (\gamma\Sigma_\Theta)^{-1}(\mu_\Theta - (R - \Theta\tau_E)kw) \tag{9}$$

2.3.1 The Effects of the ACE on Bank Size, Lending and Asset Allocation

We observe from equation (9) that, if $\rho = 0$, the amount invested in both loans and securities increases when τ_E increases as the binding cost of required capital

[12] We refer to the fiscal cost of leverage as the effect of an increase in leverage on the amount of taxes paid by the banks for one additional unit of capital.

is reduced.

How is the asset allocation affected? This depends on the ratio $\frac{\alpha_L}{\alpha_S}$. We indeed have

$$\frac{x_L}{x_S} = \frac{1 - \Theta - k(R - \Theta\tau_E)\alpha_L}{1 - \Theta - k(R - \Theta\tau_E)\alpha_S}\frac{x_L^M}{x_S^M}. \tag{10}$$

From (10) we observe that the asset mix of banks is unaffected by the ACE if and only if $\alpha_L = \alpha_S$. However, if $\alpha_L > \alpha_S$, i.e. if corporate loans are "over-weighted", then banks shift the composition of their assets towards loans.[13] We also observe from (10) that the distance to the Markowitz portfolio decreases. The ACE, by decreasing the cost of equity, decreases the cost of binding capital requirements, and the effect is larger on the assets that are over-weighted, i.e. corporate loans. We also have $\frac{\partial(x_L/x_S)}{\partial k \partial \tau_E} > 0$, which implies that the ACE will partly offset the distortionary effects of increasing capital requirements if $\alpha_L > \alpha_S$.

Proposition 1 *When the tax subsidy τ_E increases, the size of the bank portfolio increases. If regulatory risk-weights are high for corporate loans relative to other asset classes:*

1. *The banks rebalance its portfolio towards loans*
2. *The distance to the Markowitz portfolio decreases*

These effects are larger when the level of capital requirements is higher.

2.3.2 The Effects of the ACE on Bank Capital Structure

While the risk-weighted capital ratio stays constant when τ_E increases as capital requirements are binding, we find that the leverage ratio $\frac{E}{x_L + x_S}$ increases when τ_E increases if and only if $\alpha_L > \alpha_S$. The mechanism is the following: when τ_E increases, the level of equity $E = k(w_L x_L + w_S x_S)$ increases as both x_L and x_S increase, and E increases more than the sum of the assets $x_L + x_S$ as the regulatory formula that defines the level of equity puts more weight on the assets that increase the most following an increase in τ_E, i.e., corporate loans. When $\alpha_L = \alpha_S$, however, the leverage ratio is stable as the increase in equity is matched by the exact same increase in total assets. The explicit proof is in Section A of the online appendix.

[13] The Section A in the online appendix provides the explicit solution.

Proposition 2 *When τ_E increases and corporate loans are "overweighted":*

1. *The level of equity increases*

2. *The leverage ratio increases*

3. *The risk-weighted regulatory ratio stays constant*

These effects are larger when capital requirements are more binding.

2.3.3 The Effects of the ACE of Bank Total Risk

We consider as a measure of the bank risk the ratio $1/\Omega$, Ω being the ratio of bank equity to the sum of the *exact risk*-weighted assets, under the assumption that the asset exact risk is colinear to the vector of returns $\mu = (\mu_L, \mu_S)$. Hence :

$$\Omega = k \frac{\alpha_L \mu_L x_L + \alpha_S \mu_S x_S}{\mu_L x_L + \mu_S x_S}.$$

We show in the online appendix that if $\alpha_L > \alpha_S$ $\frac{\partial \Omega}{\partial \tau_E} > 0$, i.e., bank total risk decreases when τ_E increases. The level of equity increases more than the *exact risk*-weighted portfolio, as the formula that defines the required level of equity puts more weight on the assets that increase the most due to the portfolio rebalancing, i.e. corporate loans.

Proposition 3 *When the tax subsidy τ_E increases and corporate loans are "overweighted", the bank total risk decreases*

In the absence of any distortion in the regulatory risk-weights, i.e. if $\alpha_L = \alpha_S$, the risk of the bank is unchanged when τ_E increases. The allowance for corporate equity funds a bank expansion without increasing bank risk.

2.4 Taxing Bank Leverage: The Liability Tax

We now consider the Liability Tax. With the Liability Tax, a rate τ_{LT} is applied to bank liabilities minus equity. The cost of capital becomes $LR \times R + (1 - LR) \times \tau_{LT}$ and the fiscal cost of leverage is τ_{LT}. The taxes the bank pays amount to

$\tau_{LT}(x_1+x_2-E)$. For tractability reasons, we here ignore the corporate tax rate Θ but results are unchanged when we include it. Hence, the Liability Tax affects the behaviour of banks by increasing the cost of capital while decreasing the relative cost of equity.

The bank after tax profit is now:

$$\tilde{\Pi} = x^T(\tilde{r} - \tau_{LT}) - E[1 - \tau_{LT}],$$

.

The Lagrangian that the bank maximizes becomes

$$\mathcal{L} = x^T(\mu - \tau_{LT}) - \frac{\gamma}{2}x^T\Sigma x - \lambda k w^T x + E[\tau_{LT} + \lambda - R].$$

The asset portfolio x now satisfies

$$x = (\gamma\Sigma)^{-1}(\mu - \tau_{LT} - (R - \tau_{LT})kw). \tag{11}$$

2.4.1 The Effects of the Liability Tax on Bank Size, Lending and Asset Allocation

If $\rho = 0$, the portfolio size decreases as soon as $\frac{1-k\alpha_L\mu_L}{\gamma\sigma_L^2} + \frac{1-k\alpha_S\mu_S}{\gamma\sigma_S^2} < 0$, which is probably the case as regulatory risk weights are not higher than 100% in the current regulation, and k is around 10%.

How is the asset allocation affected? This depends on the ratio $\frac{\alpha_L}{\alpha_S}$. We have:

$$\frac{x_L}{x_S} = \frac{1 - \frac{\tau_{LT}}{\mu_L} - k(R - \tau_{LT})\alpha_L}{1 - \frac{\tau_{LT}}{\mu_S} - k(R - \tau_{LT})\alpha_S}\frac{x_L^M}{x_S^M}, \tag{12}$$

We observe from (12) that banks shift the composition of their assets towards corporate loans. Two effects combine: the cost of the binding capital requirements decreases more for corporate loans, while the cost of capital increases relatively less when the Liability Tax increases.

Proposition 4 *When the tax subsidy τ_{LT} increases and corporate loans are "over-weighted", banks rebalance their portfolio towards corporate loans. The effect is* *larger when capital requirements are binding.*

We now consider the case when $\rho > 0$. We show in the online appendix that if $w_L >> w_S$ then there are values of ρ for which bank lending will increase, as banks will strongly substitute securities with loans.

Proposition 5 *When the tax subsidy τ_{LT} increases, corporate loans are "overweighted" and $w_L >> w_S$, bank lending increases.*

2.4.2 The Effect on Bank Capital Structure

While the risk-weighted capital ratio stays constant when τ_{LT} increases as capital requirements are binding, we find that the leverage ratio $\frac{E}{x_L+x_S}$ increases when τ_{LT} increases if and only if $\alpha_L > \alpha_S$. The mechanism is the following: when τ_{LT} increases, the level of equity $E = w_L x_L + w_S x_S$ decreases as both x_L and x_S decrease, and E decreases less than the sum of the assets $x_L + x_S$ as the regulatory formula that defines the level of equity puts more weight on the assets that decreases the least following an increase in τ_{LT}, i.e., corporate loans. When $\alpha_L = \alpha_S$, however, the leverage ratio is stable as the decrease in equity is matched by the exact same decrease in total assets. The explicit proof is in Section A of the online appendix.

Proposition 6 *When $\tau_L T$ increases and corporate loans are "overweighted":*

1. *The level of equity decreases*

2. *The leverage ratio increases*

3. *The risk-weighted regulatory ratio stays constant*

2.4.3 The Effect of Bank Total Risk

Using the same measure of bank risk $1/\Theta$, we show that the bank total risk decreases when τ_{LT} increases. The level of equity decreases less than the *exact risk*-weighted portfolio, as the formula puts excessive weight on the asset that decreases the least.

Proposition 7 *When τ_{LT} increases and $\alpha_L > \alpha_S$, the bank total risk decreases.*

2.5 Empirical Predictions

The model generates the following set of empirical predictions when either an ACE or a Liability tax is implemented:

1. *Capital Structure*: The leverage ratio increases, while the regulatory ratio stays constant. The level of equity increases with the ACE, and decreases with the Liability Tax.

2. *Portfolio Allocation*: The bank rebalances its assets towards corporate loans, and within corporate loans, towards loans that require higher risk weights.

3. *Bank Lending*: Overall, corporate lending increases with an ACE and might also increase with the Liability Tax if there is a strong substitution with other types of assets.

4. *Risk*: While bank asset risk increases, bank total risk decreases.

Table I summarizes the effects of an ACE or a Liability Tax on bank capital structure, asset allocation and total risk in respectively columns 2 and 3, in comparison to the effects of increasing capital requirements (in column 1) or to the hypothetical effect of the ACE in a standard trade-off theory framework where capital requirements are not binding (in column 4). The predictions in column (1) are in line with the existing literature that shows that increasing capital requirements leads banks to decrease lending and shift their asset mix away from loans. The standard tradeoff framework generates opposite predictions for bank asset allocation and capital structure from the predictions generated by our framework after an ACE is implemented: banks should shift their asset mix away from corporate loans, as the excess return of the less risky assets increases relatively more when the ACE is implemented, and regulatory ratio should also decrease.

INSERT TABLE I

3 Taxing Bank Leverage: Implementations in Europe (2005 - 2012)

We investigate the effects of taxing bank leverage on bank capital structure and asset allocation by exploiting the introduction of, first, an ACE in Belgium in 2005, second, a Liability Tax in seven European countries from 2010 to 2012.

3.1 The Belgian ACE (2005)

In June 2005, two years after the European Commission put an end to a unique Belgian fiscal advantage, the Belgian parliament voted the implementation of an ACE. The Belgian ACE offers a clean experimental set-up to investigate the effect of an increase in the fiscal cost of leverage on bank activities for the following reasons.

First, the Belgian ACE is a "full" ACE: 1) The ACE base is the full equity stock, i.e., common equity and retained earnings; 2) the ACE rate τ_E is based on the average rate on 10-year bonds the preceding year with some restrictions; 3) the "notional interest" is fully deducted from taxes.[14] We, therefore, provide evidence of the effects on banks of a direct equity subsidy analogous to the widespread debt subsidy in traditional tax systems.[15].

Second, the Belgian ACE did not coincide with any other major fiscal or macroeconomic change. This is the fear of losing profit centers to other countries following the dismantlement of a fiscal advantage by the European Union, the *coordination center regime*, that lead to the ACE tax reform. The coordination center regime was implemented in 1983 to attract subsidiaries of non-Belgian

[14]The notional interest rate was 3.4% for the 2006 accounting year, and 3.8%, 4.3%, 4.5%, 3.8%, and 3.5 %, respectively, for years 2007 to 2011. Faced with the budgetary consequences of the financial crisis, the Belgian government capped the NID rate at 3.8% for both 2010 and 2011. If the initial NID formula had been applied, the 2011 NID rate would have been 4.1%.

[15]While there has been other experiences of ACE in various countries, for example, in Croatia from 1994 to 2000, in Italy from 1997 to 2003 and since 2012, in Austria from 2000 to 2004, in Liechtenstein since 2011, in Portugal from 2010 to 2013 and in Cyprus since 2015, Belgium is the only country where both a full ACE was implemented and the data are available to investigate its effect. In Italy, for example, the tax base only concerned new equity, while in Austria, a reduced corporate tax rate was applied on the notional return on equity. The Croatian ACE is close to a full ACE but no data is available to investigate its effect on banks (De Mooij and Devereux, 2008; Hebous and Ruf, 2017)

multinationals with a fixed tax rate, ranging from 4 to 10%, based on expenses less financial and salary costs rather than on profits. While at the time the European Commission approved this tax regime, the European Commission decided in 2003 that this was incompatible with EU state aid rules. The decision of the European Commission was not enacted to address changing macroeconomic conditions or a domestic fiscal challenge, a common feature of the majority of tax reforms. The introduction of the ACE only coincided with the elimination of a 0.5% tax on new equity issuance, but this concurrent elimination had only a minor economic importance compared to the recurrent tax benefits from the ACE.

Third, even if the Belgian ACE also concerned firms, it had almost no effects on firm demand for loans. On the one hand, two measures that were favoring the use of equity financing for small firms were repealed concurrently, so that incentives to issue equity instead of debt are unchanged for these small firms.[16] Panier et al. (2013) show that, because of this concurrent repeal, only firms with equity value above €1.3 million had higher incentives to decrease leverage after the implementation of the ACE. On the other hand, while large firms were affected by the ACE, they increased their level of equity without decreasing their debt (Panier et al., 2013).

Finally, in 2006, the Belgian economy was growing steadily and in line with the other European countries we include in our control group (see Section C in the Online Appendix).

Back of the envelope calculations suggest that the Belgian ACE directly increases the fiscal cost of leverage by 1.1 percentage points. Let Θ be the tax rate, τ_E be the notional interest applied to equity and deducted from taxes and L the bank leverage, with $L = \frac{D}{D+E}$. The cost of capital is decreased by $(1-L) \times \Theta \times \tau_E$. The fiscal cost of leverage increases, therefore, by 1.1 percentage points as the tax rate is 35% and the notional rate applied in 2006 is 3.4%. The resulting decrease in the cost of capital amounts to 7.5 basis points when we consider the average

[16] These two measures where a) a (capped) tax credit to firms that increased their equity base that amounted to 7.5% of the equity increase, capped at €19,850; and b) a (also capped) tax deduction for investment funded with equity. This tax deduction regime, the "untaxed investment reserve", allowed firms to deduct up to €18,750 for investments funded with retained earnings.

leverage ratio of Belgian banks at this period.

The Belgian ACE regime has mechanically weakened over the last years, with the progressive reduction of the long term rates that drive the ACE notional rate. Starting in 2012, the interest rate deduction was capped at 3%, and in 2013 the limit was further revised to 2.7%. In 2015, the rate was down to 1,63% and decreased down to 0.7% in 2018. In 2017, the ACE base is reduced only to the new equity.

3.2 The Liability Tax (2009-2012)

The second set of reforms we consider is the Liability Tax that has been implemented across seven European countries over the 2009-2012 period.

The IMF started promoting the implementation of a Liability Tax for banks in the aftermath of the financial crisis. The objective was to make banks pay for the fiscal cost of any future government support to the sector and to internalize banks' contributions to systemic risk (Buch et al., 2016; Devereux et al., 2017). Following the IMF recommendation, in the absence of any multi-country agreement, fourteen EU countries adopted some bank levies unilaterally. Among them, eleven implemented a tax on bank liabilities. Our sample - composed of the fifteen largest European banking economies - includes the following seven countries that adopted a Liability Tax: Austria, Belgium, Germany, the Netherlands, Portugal, Sweden and the UK.

The Liability Tax has the following unique properties that make a nice set-up to address our research question. First, the Liability Tax only concerns banks. We can, therefore, observe the effect on bank activities in a set-up where the demand for loans is not directly affected.

Second, the Liability Tax was implemented in seven countries in our sample of fifteen countries, and the implementation was staggered between September 2009 in Sweden to 2012. We can therefore implement a panel analysis to investigate the effect of the reform. Because France adopted a bank levy with a totally different tax base - the minimum amount of capital necessary to comply with the regulatory requirements - we include France in the control group.

Third, in terms of magnitude, the average tax rate of 8 bps significantly reduced the tax advantage of debt in an environment with low interest rates.[17] Consistent with its significant impact, the UK bank Liability Tax raised on average GBP 2.6 billion each year from 2011 to 2016, the German one €800 million and the Austrian bank Liability Tax raised €645 million each year.

Table II displays the parameters of the Liability Tax across countries. The design of the Liability Tax varies along three dimensions: The base, the rate, and the use of revenues (Devereux et al., 2017). In most countries, the base is the liabilities net of equity and customer deposits of financial institutions.[18] In some countries, however, not all banks are affected. In Austria and in Germany, for example, only banks with respectively more than 1 billion and 300 million euros of liabilities are affected. The rates also vary across banks and countries, from 1 basis point (bp) in Germany for banks with less than 1 billion euros in liabilities to 8.5 bps for Austrian banks with more than 20 billion euros of liabilities. Finally, while in Germany and Sweden, the revenues go to a special reserve fund to support banks in financial distress, in the UK, revenues go to the budget.[19] See the Online Appendix for more details about the scope and parameters of each tax we consider.

INSERT TABLE II

4 Data and Summary Statistics

4.1 Bank-Level Data

Sample Construction

Bank financial data is from the Bureau van Dijk Bankscope database. We select all commercial, savings and cooperative banks from the fifteen largest banking sectors in Europe, i.e., Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Switzerland, Spain, Sweden, and United Kingdom. We restrict our analysis to these fifteen countries because

[17] After 2010, banks funding rates are around 1% in the Euro Zone.

[18] While most levies treat short-term and long-term liabilities symmetrically, the Netherlands and the UK apply a reduced rate to liabilities with a maturity exceeding one year.

[19] The UK government was concerned that the fund will create some moral hazard issues.

we want banks that face similar credit markets and macroeconomic conditions. We also do not restrict our analysis to the EU or the Eurozone, because we want to include UK and Swiss banks as they are comparable in size and business models to other European banks, and because they lend actively in Germany (Table X in the online appendix). We also know that the quality of the coverage of these 15 European countries in Bankscope is good (Duprey and Lé, 2012). We keep all banks that have data available over the 1996-2014 period.

We build our final database on bank financial statements the following way. First, Bankscope collects financial statements with various consolidation status. We, therefore, keep only consolidated statements when available. Second, Bankscope also includes balance sheet information on bank subsidiaries, with no information on the ownership structure of a bank. For each country, we therefore select manually the bank we keep in the sample and drop subsidiaries to avoid double counting. We also drop non-for-profit banks, such as German and Italian cooperative banks. Finally, we convert data into constant 2007 dollars.

Finally, we also employ a number of country-level control variables including inflation rates, real GDP growth rates, and GDP per capita from Eurostat.

Variables

Table III shows summary statistics for our main variables of interest for treated banks and control banks in, respectively, the left-hand and middle parts of the table for each policy reform we consider. The main variables of interest are the leverage ratio, defined as total equity over total assets, the loan ratio, defined as total loans over total assets, and the risk-weighted capital ratio, defined as equity over the risk-weighted assets. The bank-specific characteristics that we use as control variables in our regressions include bank size, defined as the log of total assets, return on assets, and the non-interest income share.

To investigate the effects of changes in the fiscal cost of leverage on bank risk, we break down bank risk into three components: funding risk, asset risk and total risk. The leverage ratio measures the funding risk. We use the ratio of risk-weighted assets to total assets as a measure of asset risk even if we know that regulatory risk weights do not perfectly reflect the risk of each asset. Finally, we use the Z-score and the ratio of the leverage ratio to the standard deviation of returns on assets as measures of bank total risk.

INSERT TABLE III

4.2 Loan-Level Data

Sample Construction

Our principal data source is the German credit register compiled by the Deutsche Bundesbank.

The Bundesbank collects quarterly information on all outstanding loans that exceed €1.5 million at issuance from both domestic and foreign banks which are under supervision in Germany. For each quarter and bank-firm exposure, the German credit register provides information on both the lenders' and the borrowers' identities and on the amount of credit that is outstanding.[20]

We build our sample by selecting German firms that borrowed at least once from one foreign bank over the 1994-2013 period. We then construct a balanced quarterly panel of all the bank exposures of these firms. For each bank-firm pair, we back-fill all quarters for which the pair is not in the credit register with a zero exposure. Hence, if bank b lends to firm f and is repaid within a year, the bf pair will be in our data every quarter during the entire sample period, even though the bank-firm exposure will be equal to zero most of the time.[21]

One concern with this loan-level data is that, by construction, our findings could be biased upward. Indeed, we mechanically set unreported exposures that are initially below €1.5 million at zero, while exposures that start above €1.5 million are always reported, even if they subsequently drop below this threshold through repayment. We might, therefore, overestimate the increase in any bank-firm exposure that jumps above the 1.5 million hurdle. However, by construction, the selection of our sample mitigates this concern. First, we select firms that

[20] The register does not contain immediate information on the interest rate paid or on the maturity of the outstanding loans.

[21] When two banks merge, we artificially create a third bank for the time period after the merger.

borrow from foreign banks. These firms are larger and more likely to borrow in large volumes. Second, among these firms, our favorite specification restricts the sample to those that borrow concurrently from multiple banks, and again especially large firms do so, and to bank-firm exposures that exceed €1.5 million at issuance, to investigate the effect at the intensive margin.

Summary Statistics

Foreign lending is active in Germany over our sample period. Table X in the online appendix shows summary statistics on the lending activities of banks headquartered outside Germany. Over the 1994-2013 period, 257 banks are actively lending in Germany to more than 53,000 firms. The exposure of foreign banks to German firms has significantly increased, at an average rate of 3.5%. Finally, lending by foreign banks is more volatile than lending by German banks. The standard deviation of the yearly growth in the loan exposure to German firms is twice as large for foreign banks than for German banks.

INSERT TABLE IV

4.3 Firm-level Data

Finally, we exploit data on borrowing firms from the *Bundesbank's Corporate Balance Sheets database* (Ustan). Ustan collects information on firms every year in the context of the refinancing policies of the Central Bank. The Bundesbank uses the information to assess whether a loan can be eligible as collateral. The sample of firms with information from Ustan includes all the firms for which an exact match between the credit register and Ustan was possible based on the firm name, location and industry. We extract from Ustan the firm industry classification, total assets, total sales, leverage, employment and return on assets. Firms are classified in close to 100 industries. We also use firm zip codes to measure the borrower's distance to the treated country and hence control for demand effects.

5 The Effects on Bank Capital Structure and Asset Composition

This section describes the methodology used to investigate the effect of the changes in the relative cost of leverage on bank capital structure and asset composition and presents the results. We first focus on the matching procedure and the difference-in- differences strategy that are used to come to consistent estimates of the impact of the changes. After having established that the changes in the fiscal cost of leverage impact leverage ratios, we focus on the effect on loan ratios. We also document the heterogeneity in the impact across banks ex-ante level of leverage ratios.

5.1 Building a Control Group of Banks: Propensity Score Matching

For each policy reform, we estimate the effect on bank balance sheet composition by comparing treated banks to a control group of European banks that we obtain through propensity score matching (Angrist and Krueger, 1999; Roberts and Whited, 2013; Schepens, 2016). We compute propensity scores based on the following bank characteristics in the pre-treatment period: Total assets in log, contemporaneous and lagged leverage ratio, the loan ratio and the growth rates of the leverage ratio, the loan ratio, and total assets. We also include the GDP per capita growth rate as a macroeconomic variable. We include growth rates to make it more likely that both treated and control banks are in a parallel trend in the pre-treatment period.

The matching procedure is done with replacement, which means that each control bank can be used as a neighbor for several treated banks. Smith and Todd (2005) indicate that this should improve the accuracy of the matching procedure. We take the closest five control financial institutions for each treated financial institution. Tables X and Y in the Online Appendix show that our results are robust to resting the sample to the three nearest neighbors, or, oppositely, to extend it to the ten nearest ones.

Table III illustrates the impact of the matching procedure. For each policy reform, this panel shows summary statistics for the pre-treatment period for treated banks, the full sample of non-treated banks and the banks in the control group after the matching procedure. It also reports statistics on the reduction of the differences between the treated banks and the banks in the control group. The summary statistics indicate that full control group is significantly different compared with the treated group in several dimensions for the two policy experiments. For example, treated banks are on average larger.

We measure the success of the matching procedure through three indicators. First, the ***Diff*** column is the difference in means for the treated banks versus the matched control banks. These differences are no longer significant for most variables after the propensity score matching. Second, the ***Bias*** columns show the percentage difference of the sample means in the treated and control sub-samples as a percentage of the square root of the average of the sample variances in the treated and control groups (Rosenbaum and Rubin, 1985). We observe a strong decrease in the standardized percentage bias between the treated banks and, respectively, all banks in the full sample and the banks in the matched control group. Third, Figure 1 to 4 illustrates that there is no significant difference in leverage ratios, loan ratios and risk-weighted leverage ratios in the pre-treatment period of each of the policy reform we consider. More information on the distribution of the matched banks for each policy reform can be found in Table X in the Online Appendix.

5.2 Empirical Analysis

5.2.1 Main Model

For each policy reform, we compare the change in leverage ratios and loan ratios of treated banks after the reform to the change in leverage ratios and loan ratios of the control group of matched banks that were not affected by the reform. The baseline setup is the following:

$$Balancesheet\ Item_{b,t} = \beta Treated_b \times \text{Post}_t + \lambda Y_{b,t-1} + \gamma C_{c,t-1} + \mu_b + \mu_t + \epsilon_{b,t} \quad (13)$$

Where $Balancesheet\ Item_{b,t}$ is the balance sheet item of bank b at time t, $Treated_b$ is a dummy that is equal to 1 for all treated banks and $Post_t$ is a dummy indicator equal to 1 in the post-treatment period. μ_b and μ_t stand respectively for bank and year fixed effects. The model also includes a vector $C_{b,t-1}$ of lagged time varying-country characteristics - GDP per capita, GDP per capita growth rate and the log of the CPI - and a vector $Y_{b,t-1}$ of lagged time-varying bank characteristics to control for bank ex-ante profitability - return on assets -, and bank size - log of total assets, log of total assets squared. The main coefficient of interest is the coefficient β of the interaction variable. Standard errors are clustered at the bank-level in the paper, and at the country level as a robustness check in the Online Appendix. To control for heterogeneous trends across banks based on their characteristics - such as size or leverage ratios - the main specifications also include Year $\times$ size quintile fixed effect, and Year $\times$ leverage ratio quintile fixed effects. Size is measured by bank total assets and quintiles are defined the year before the shock.

Our objective is to investigate to which extent changes in the fiscal cost of leverage affect bank capital structure and, as a consequence, its asset allocation. We, therefore, focus on two types of balance sheet items as dependent variables. The first one concerns the capital structure: the leverage ratio and its components, the total amount of common equity and total assets. We indeed aim at investigating what drives the changes in the capital structure and whether the reforms had an effect on bank total size. We would hence be able to identify whether an increase in lending comes along an increase in all bank activities, or not. The second balance sheet item we are interested in is the loans to assets ratio.

5.2.2 Heterogeneous Effect

We investigate the heterogeneity of the effects of the policy reforms for two reasons. First, regulators might be interested in whether different types of banks react similarly to changes in the fiscal cost of leverage. For example, if only high capitalized banks react to the policy change, then taxing leverage would be less appealing compared with a situation in which it also impacts banks that ex-ante have a low capital buffer. Second, the heterogeneity of the effect will help us disentangle the mechanism that is driving our results. If low-capitalized banks react more to an ACE, for example, then the effect is more likely to be driven by a change in capital constraints than by a decrease in the cost of capital, as the cost of capital is likely to decrease less for banks that ex-ante hold less equity in their balance sheet.

We therefore test the following model:

$$\begin{aligned} \textit{Balancesheet Item}_{b,t} = \beta_1 \text{ Treated}_b \times \text{Post}_t + \\ \beta_2 \text{ Treated}_b \times \text{Post}_t \times \text{EquityRatio}_{b,exante} + \lambda Y_{b,t-1} + \gamma C_{c,t-1} + \mu_b + \mu_t + \epsilon_{b,t} \end{aligned} \quad (14)$$

where $\text{EquityRatio}_{b,exante}$ indicates the bank leverage ratio in the pre-treatment period. The sign of the coefficient β_2 - if negative- would indicate that the effect is larger for banks that are ex-ante less capitalized.

5.3 Results

5.3.1 The Fiscal Cost of Leverage and Bank Leverage

We find that a 1 pp increase in the fiscal cost of leverage leads to a decrease in leverage ratios that ranges from 10% to 30%. This is a potentially large effect, given that, for instance, the transition from Basel II to Basel III is supposed to raise minimum capital requirements from 4.5% to 6% over the course of six years. We also find that the effect is mostly driven by an increase in the level of equity for the ACE and a decrease in total assets for the Liability Tax, is larger for banks with ex-ante low level of equity and is higher when bank funding costs are low.

First, Belgian banks increased their leverage ratios - from 6.8% on average ex-ante - by 0.7 percentage point, or 11%, following the implementation of the ACE. The upper part of Figure 1 first illustrates the dynamics of the effect. While the figure clearly shows that both the treated and the control groups have a similar trend in their leverage ratio during the pre-treatment period, the Belgian banks have leverage ratios more than 10% higher after the 1 pp increase in the fiscal cost of leverage following the implementation of the ACE. Column (1) to (5) in Panel A of Table V show the corresponding regression coefficient in specifications that we progressively saturate with fixed effects. The result is confirmed. Our results are in line with Schepens (2016), but with a relatively smaller magnitude because of the larger set of fixed effects in our specification.[22]

The increase in the fiscal cost of leverage in the context of the European Liability Tax has an effect of a larger magnitude. The upper part of Figure 2 and columns (1) to (5) in Panel B of Table V shows that the average 8 bps increase in the fiscal cost of leverage leads to a 5% increase in bank leverage ratios or 0.5 pp. The low interest rate environment might amplify the effect of an increase in the taxation of leverage.

Second, consistent with the model predictions, columns (6) and (7) in Table V and the middle and lower parts of Figures 1 and 2 indicate that the increase in bank leverage ratio following an increase in the fiscal cost of leverage mostly results from an increase in the level of equity in the case of the ACE and a decrease in total assets in the case of the Liability Tax. Columns (6) and (7) decompose the leverage ratio into its two components: the level of equity and bank assets. In the Belgian ACE, the increase in the fiscal cost of leverage leads to an increase in the level of equity of approximately 12% without any increase in the bank total assets. This result suggests that banks did not react to the decrease in the total cost of capital following the Belgian ACE by expanding their assets. In the context of the Liability Tax, the assets decreased by 2.7%, while the amount of equity remained relatively stable.

Third, column (2) in Table V shows that the effect of a change in the fiscal cost of leverage - either through an ACE or a Liability Tax - is larger for banks that are ex-ante less capitalized and, therefore, more likely to be constrained by the capital requirements. We include interaction terms between the Treated and Post dummy and the pre-treatment leverage ratios. The results indicate that the impact of the policy change on the bank leverage ratio is significantly higher for banks with lower leverage ratios.

Finally, Figures 1 and 2 indicate that the effect is relatively persistent. Our results are also robust to various changes in our main specification. Table A1 to

[22]We indeed includes year fixed effects - instead of a *Post* dummy - as well as Year × Size and Year × Leverage ratio fixed effect.

A5 in the Online Appendix investigate the effect of progressively including fixed effects, clustering at the country rather than at the bank level and building the control group of banks with the three or ten closest banks obtained through the matching procedure.

INSERT FIGURE 1

INSERT FIGURE 2

INSERT TABLE V

5.3.2 The Fiscal Cost of Leverage and Asset Allocation

We next test the prediction of the model that following an increase in the fiscal cost of leverage, banks shift the composition of their assets towards loans. We also find potentially large, persistent and robust effects.

First, Figure 3 illustrates the dynamics of the effect in the case of the Belgian ACE. Columns (1) to (5) in panel A of Table VI indicate that the 0.7 pp increase in the leverage ratio converts in a 5% increase in the loans to assets ratio on average following the implementation of the ACE, or 5 pp. This is potentially a large effect, given that the total assets of Belgian banks amount to approximately 60 billion euros in 2005. If banks allocate an additional 5 pp of their assets to lending, this would lead to an injection of 3 billion euros in the Belgian economy, or 0.8% of the Belgian GDP in 2005. In addition, if the effect comes mostly from a reallocation of credit to small firms that are constrained ex-ante, the effect on lending to these firms might even be magnified. Consistent with banks shifting the composition of their balance sheet away from assets with low regulatory risk weights, the security to asset ratio decreases.

The increase in the fiscal cost of leverage in the context of the European Liability Tax is also followed by a change in bank asset allocation. The upper part of Figure 4 and columns (1) to (5) in Panel B of Table VI shows that the increase in the fiscal cost of leverage leads to a 1 pp increase in bank leverage ratios.

Second, consistent with the model predictions, column (2) in Table VI shows that the effect of a change in the fiscal cost of leverage - either through an ACE or a Liability Tax - is significantly larger for banks that are ex-ante less capitalized and, therefore, more likely to be constrained by the capital requirements.

Finally, the lower parts of Figures 3 and 4, as well as columns (6) to (10) in Table VI, indicate that banks indeed shift their the composition of their assets away from assets with lower risk weights, i.e. securities.

INSERT FIGURE 3

INSERT FIGURE 4

INSERT TABLE VI

6 The Effects on Bank Lending to Firms

We test whether the change in the asset allocation of banks following an increase in the fiscal cost of leverage is indeed a credit supply shock using loan-level data. We then confirm that banks extend lending to small firms that are ex-ante credit rationed using firm level data.

6.1 Identification Strategy

6.1.1 Foreign Lending in Germany

We investigate the effects of an increase in the fiscal cost of leverage focusing on foreign lending by affected firms on the German credit market for the following reasons. First, focusing our analysis on foreign lending in Germany allows us to exploit a treatment that is exogenous both to control bank characteristics - as the treatment is only driven by the home country of the foreign banks - and to the German economic situation. The state of the economy in Germany is unlikely to have affected the adoption of the ACE in Belgium, which was mostly driven by the repeal of a Belgian fiscal advantage by the European Union. Second, Germany has an active bank credit market with a large, but reasonable presence of foreign banks from multiple countries. The significant number of banks active in Germany that are affected by the shock we exploit allows us to ensure that the effect is not driven only by some bank specific trend. Third, the strength of the German economy implies that banks can easily expand lending, and its stability limits the possible effects of confounding factors on our results. Finally, because we compare lending by treated banks versus non-treated German and foreign banks with bank fixed effects we can control for demand and sure that the effect we observe is indeed, a credit supply shock.

6.1.2 Model

The benchmark model is the following:

$$logL_{b,f,t} = \alpha Treated_{b,f} \times Post + \beta X_{f,t} + \gamma Y_{b,t} + \mu_b + \mu_f + \mu_t + \epsilon_{b,f,t} \tag{15}$$

where $logL_{b,f,t}$ is the logarithm of lending exposure of bank b to firm f in quarter t , $Treated_{b,f}$ is a dummy indicating whether the government has implemented a tax reform on bank leverage, $Post$ is a dummy that equals one after the reform is implemented, X_f is a vector of firm specific controls to capture changes in lending policies that are related to firm characteristics rather than regulation and Y_b is a vector of bank controls. Error terms are clustered at the bank and firm levels.

For the Liability Tax, we use this panel model with bank, firm and quarter fixed effects because the implementation is staggered across years. However, for the Belgian ACE, because we compare a pre- to a post-period in a difference-in-differences setting, we estimate the following model:

$$CreditGrowth_{b,f} = \alpha Treated_{b,f} + \beta X_f + \gamma Y_b + \epsilon_{b,f} \tag{16}$$

where $CreditGrowth_{b,f}$ is the growth rate in lending exposure of bank b to firm f between the pre- and the post-shock period using Davis and Haltiwanger (1992)'s growth measure, $Treated_{b,f}$ is a dummy indicating whether the bank has been treated by a tax reform that affects leverage, X_f is a vector of firm specific controls in the pre period to capture changes in lending policies that are related to firm characteristics rather than regulation (size, profitability etc.) or firm fixed effects depending on the specification and Y_b is a vector of bank controls in the pre-period. Error terms are clustered at the bank and firm levels.

In both models, bank controls include the logarithm of total assets, the leverage ratio, and the return on assets (ROA) at date $t-1$, and bank type fixed effects.

Firm controls include information from financial reports - total sales, total assets, leverage, debt structure and returns on assets -, the number of banks the firm is borrowing from, the total volume of bank debt and 100 industry fixed effects. We also control for the distance of the firms to the border or the country where the fiscal reform has taken place. We hence control for demand for credit by firms that are more likely to trade with the affected country and subsequently experience growth in sales or profitability.

In order to comprehensively account for the firm demand for credit, we saturate some specifications with firm $\times$ quarter fixed effects in Model (15), and firm fixed effects in Model (16). We, therefore, restrict our sample to multi-bank firms, i.e., firms borrowing from *at least two different banks* in the period before the shock. This identification relies on the estimation of the evolution of lending to firm f by bank b that is treated by the fiscal reform compared to lending to the same firm f by bank b' that is not exposed to the shock. This approach allows us to control for changes in credit that are driven by changes in firm-specific demand.

Our empirical analysis unfolds in four steps. First, we look at the effects of each event on all bank-firm exposures. In a second step, we restrict our analysis to firms that borrow actively in the pre-period, and, for these firms, we keep only all bank-firm exposures that are strictly larger than zero in the pre-period. With this specification, we estimate how a bank that is treated by a shock in regulation changes its lending to its current borrowers compared to the other competing banks that are also lending to the same borrowers, but that are not treated by the same shock. We also control for relationship characteristics, such as the length of the relationship and the size of the relationship. The length of the relationship is the number of quarters the exposure of bank b to firm f has been strictly positive from 1994 onwards (i.e., the beginning of our sample) to date $t-1$. The size of the bank-firm relationship is the total amount that has been lent by bank b to firm f from 1994 to date $t-1$. Both variables are in logarithm. In a third step, we investigate the effect of each event at the extensive margin by studying new loans. The model we estimate is the same as in (15) and (16) except that the dependent variable is a dummy variable that indicates whether a new loan is granted to a firm with an ex-ante zero exposure to the credit granting bank.

6.2 Results

We find that banks that are affected by an increase in the fiscal cost of leverage subsequently increase lending to German firms.

Figure 5 first plots changes in loan exposure of Belgian banks versus other banks lending in Germany over the 2003-2007 period. We focus only on exposures that are strictly positive in 2003 as these exposures are reported until the loan is fully repaid whatever the amount. There is therefore no concern of censoring related to the 1.5m threshold at the intensive margins. We see that while Belgian banks have largelly extended loans after the shocks as compared to control banks.

Table VII confirms the result. Column (1) shows the coefficient of the *Treated* dummy in regression (16): lending by Belgian firms increased by 20 percentage points more after the implementation of the allowance for corporate equity. The effect is robust to controlling for demand with firm fixed effects (column (2)), and to restricting the sample to lending by foreign banks only (columns (3) and (4)). Finally, the effect is strong both at the intensive and extensive margins.

INSERT FIGURE 5

INSERT FIGURE 6

INSERT TABLE VII

INSERT TABLE VIII

6.3 Firm-Level Analysis

We here use firm level data to investigate whether banks have extended lending mostly to firms that are more likely to be credit rationed and have higher risk weights, as the model predicts.

6.3.1 Identification Strategy

We first restrict the sample to all the firms that are borrowing from affected banks both in the pre and in the post period. We then investigate whether the firms that start borrowing from treated banks in the post period are ex-ante significantly different from the firms the treated banks were already lending to.

We hence test the following model, where $FirmCharacteristics$ is the firm total bank debt, leverage, assets and sales:

$$Log(FirmCharacteristics_{f,before}) = \alpha \text{New Borrower}_f + X_f + \epsilon_f \tag{17}$$

Second, we investigate on the total sample how the increase in lending by affected banks impact borrowers' characteristics. We look at the effect on debt by aggregating lending by all engaged banks at the firm-level and hence observe whether treated banks are substituting or not to other banks when they increase lending. We also look at the effect on firm leverage, total assets and employment. Finally, we explore the effect on the total interest paid by the firm, controlling for the debt structure. We hence get a proxy for the cost of credit and analyze whether these reforms on the fiscal cost of leverage have an effect on the level of interest rates.

We, therefore, test the following model, where our variable of interest $Treated$ indicates firms that are borrowing from at least one treated bank:

$$\Delta logFirmCharacteristics_f = \alpha Treated_f + X_f + \epsilon_f \tag{18}$$

where X_f is a vector of firm controls. Error terms are clustered at the firm-level.

6.3.2 Results

We estimate the change in the loan portfolio of banks that are affected by the Belgian ACE. We do not focus on the Liability Tax as the staggered introduction across a sample of banks does not allow to clearly identify treated from non treated firms.

We start by examining the characteristics of firms banks extend lending to when they face an increase in the fiscal cost of leverage. In the first four columns of Table IX, the sample consists in the firm Belgian banks are borrowing to in the post period. The dummy $NewBorrower$ identifies among these firms those that are new borrowers. We find that new borrowers have ex-ante lower debt (column (1)), but that they are also smaller (column (2)). These results suggest that Belgian banks are lending to firms with ex-ante a lower access to credit and possibly high risk weights.

INSERT TABLE IX

We then turn to investigating how the increase in lending by Belgian banks affected the characteristics of these German firms in columns (5) to (9). We control for firm characteristics ex-ante. Columns (5) to (7) indicate a growth in bank debt, leverage and assets that is respectively 20 pp, 6 pp and 6 pp higher for firms that are borrowing from Belgian banks ex-ante. This result suggests that these firms are ex-ante credit constrained and then benefit from an increase in supply by affected banks.

6.4 Robustness

6.4.1 The Effects of the ACE

One concern with our results may be that the effect is driven by a lower demand for credit from Belgian firms, as these firms are also affected by the ACE. Panier et al. (2013), however, do not find any evidence of a decrease in the amount of total debt for non-financial firms in Belgium following the introduction of the ACE. First, the largest response to these changing tax incentives is found among large and new firms. This evidence is consistent with the idea that small firms may face significant refinancing costs, or that they may not rebalance their capital structure until they deviate substantially from their long-term target (Leary and Roberts, 2005; Strebulaev, 2007). In fact, in several specifications, the post-2006 leverage behaviour of small firms is indistinguishable from the capital structure decisions of the control firms. Second, the increase in leverage ratios of Belgian firms is mostly explained by an economically large and statistically significant increase in the levels of equity, and is not driven by a reduction in the value of non-equity liabilities.

Another concern would be that the effect is driven by the decrease in the cost of capital for banks following the implementation of an ACE - 0.08 pp in the case of the Belgian ACE - and not by the resulting change in capital structure. The introduction of the Liability Tax in Europe from 2010 to 2012 allows us to address this concern. This new tax indeed resulted in an increase in the cost of capital for banks. We find similar results: banks affected by the Liability Tax significantly increase lending, both at the intensive and the extensive margins, and the result is robust to restricting our analysis to lending by foreign banks. In addition, we do not find any effect on the interest paid by firms on the firm-level analysis.

Finally, because the ACE affected both banks and firms, one might be concern that the ACE would have fostered firm consumption in Belgium, hence increasing the profitability of German firms that are exporting to Belgian firms. We address this concern first, by including two digit industry fixed effects. Second, we control for the distance of German firms to affected countries, as a proxy for the strength of business relationships with affected countries. We, therefore, measure the effect within the same industry after controlling for export intensity to the affected country.

7 The Fiscal Cost of Leverage and Bank Risk Taking

Estimating the effect of changes in the fiscal cost of leverage on bank risk taking is challenging. Bank risk includes three components: funding risk, liquidity risk, and asset risk, the latter being particularly difficult to measure.

We first investigate the effect on the asset risk as measured by the regulator. As the model predicts, because the change in capital structure relaxes the constraints on the assets with the highest risk-weights, i.e. corporate loans, the ratio of risk-weighted assets to total assets increases. Because regulatory risk-weights are not perfectly aligned with asset risk, and because banks are more likely to engage in some regulatory arbitrage, we could expect the increase in asset risk as measured by the regulatory ratio to be a higher bound estimate of the effect on bank asset risk.

We next turn to bank total risk. Consistent with the model prediction, column (8) of Table V indicates that the regulatory ratio, which is a combination of both bank funding risk and asset risk, is unchanged following the fiscal reforms. This is consistent with the fact that capital requirements are binding. We hence turn to another measure of bank total risk, the Z-score, which is also a combination of bank funding risk and bank asset risk. In this measure, bank asset risk, measured by the volatility in the return to assets, is not subject to regulatory arbitrage. We find that following the Belgian ACE and the Liability Tax, banks with lower leverage ratio decrease risk more. The Z-score measure, however, has also its own limitations as it is based on the assumption of normally distributed returns on assets.

INSERT TABLE X

8 Conclusion

Our paper contributes to the debate on bank capital regulation by considering a complementary tool to monitor bank leverage: taxing bank leverage. We investigate the effects of taxing bank leverage on bank leverage and credit supply by exploiting the staggered implementation of tax reforms in Europe from 2005 to 2010. The positive impact of an increase in the fiscal cost of leverage resulting from these reforms on both bank leverage ratios and lending suggest that bank funding risk can be controlled through taxes, without negatively affecting bank lending. Our results also suggest that banks are not increasing risk taking.

We consider two types of policy reforms that affect the fiscal cost of leverage. Both trigger future research questions. The first one, the ACE, is a fiscal deduction. Does the resulting benefit of an ACE on financial stability and the real economy compensate for the fiscal cost? In an environment with low interest, can the deduction of a notional interest from taxes still affect bank capital structure? The second one, the Liability Tax, is a tax on bank liabilities. In an open-economy, where domestic banks compete internationally, can a tax on bank liabilities affect the competitiveness of banks and then their profitability?

The limits of regulating bank leverage with capital requirements are well documented. Higher capital requirements may lead to a decrease in bank lending (Aiyar et al., 2014; Fraisse et al., 2015; Jiménez et al., 2017) - with adverse consequences for firms, employment, and households, -, regulatory arbitrage (Kashyap et al., 2010; Efing, 2016; Greenwood et al., 2017), and the growth of the shadow banking sector. Overall, our paper shows that regulation through taxes might complement a regulation through bank capital requirements.

References

Acharya, V. V., P. Schnabl, and G. Suarez (2013). Securitization without Risk Transfer. *Journal of Financial Economics 107*(3), 515–536.

Admati, A. R., P. M. DeMarzo, M. F. Hellwig, and P. C. Pfleiderer (2013). Fallacies, Irrelevant Facts, and Myths in the Discussion of Capital Regulation: Why Bank Equity is Not Expensive. *Working Paper* (2065).

Aiyar, S., C. W. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek (2014). The International Transmission of Bank Capital Requirements: Evidence from the United Kingdom. *Journal of Financial Economics 113*(3), 368–382.

Aiyar, S., C. W. Calomiris, and T. Wieladek (2014). Does Macro-Prudential Regulation Leak? Evidence from a U.K. Policy Experiment. *Journal of Money, Credit and Banking 46*(1), 181–214.

Angrist, J. D. and A. B. Krueger (1999). Empirical Strategies in Labor Economics. *Handbook of labor economics 3*, 1277–1366.

Baker, M. and J. Wurgler (2015). Do Strict Capital Requirements Raise the Cost of Capital? Bank Regulation, Capital Structure, and the Low-Risk Anomaly. *American Economic Review 105*(5), 315–320.

Behn, M., R. Haselmann, and P. Wachtel (2016). Pro-Cyclical Capital Regulation and Lending. *Journal of Finance 71*(2), 919–956.

Belgium National Bank (2008). *Annual Report*.

Bertrand, M., E. Duflo, and S. Mullainathan (2004). How Much Should We Trust Differences-in-Differences Estimates? *Quarterly Journal of Economics 119*(1), 249–275.

Boadway, R. and N. Bruce (1984). A General Propostion On The Design of a Neutral Business Tax. *Journal of Public Economics 24*(23), 231–239.

Bond, S., K. Y. Ham, G. Maffini, A. Nobili, G. Ricotti, et al. (2016). Regulation, Tax and Capital Structure: Evidence from Administrative Data on Italian Banks. *Working Paper*.

Bordignon, M., S. Giannini, and P. Panteghini (1999). Corporate Taxation in Italy: An Analysis of the 1998 Reform. *FinanzArchiv/Public Finance Analysis 56*(3/4), 335–362.

Bordignon, M., S. Giannini, and P. Panteghini (2001). Reforming Business Taxation: Lessons from Italy? *International Tax and Public Finance 8*(2), 191–210.

Buch, C. M., B. Hilberg, and L. Tonzer (2016). Taxing Banks: An Evaluation of the German Bank Levy. *Journal of Banking and Finance 72*, 52–66.

Capelle-Blancard, G. and O. Havrylchyk (2017). Incidence of Bank Levy and Bank Market Power. *Review of Finance 21*(3), 1023–1046.

Cochrane, J. H. (2014). Toward a Run-free Financial System. In M. N. Baily and J. B. Taylor (Eds.), *Across the Great Divide: New Perspectives on the Financial Crisis*, Chapter 10, pp. 197–249. Hoover Institution Press.

Danisewicz, P., D. Reinhardt, and R. Sowerbutts (2017). On a Tight Leash: Does Banks' Organizational Structure Matter for Macroprudential Spillovers? *Journal of International Economics 109*(C), 174–194.

De Haas, R. and N. Van Horen (2013). Running for the Exit? International Bank Lending During a Financial Crisis. *Review of Financial Studies 26*(1), 244–285.

De Jonghe, O., H. Dewachter, and S. Ongena (2016). Bank Capital (Requirements) and Credit Supply: Evidence from Pillar 2 Decisions. *Working Paper* (303).

De Mooij, R. and M. Devereux (2008). Alternative Systems of Business Tax in Europe: an Applied Analysis of ACE and CBIT Reforms.

Devereux, M. P., J. Vella, and N. Johannesen (2017). Can Taxes Tame the Banks? Evidence from European Bank Levies. *Working Paper*.

Duprey, T. and M. Lé (2012). Bankscope Dataset: Getting Started. *Working Paper*, 1–43.

Efing, M. (2016). Arbitraging the Basel Securitization Framework: Evidence from German ABS Investment. *Working Paper*.

Fischer, M., C. Hainz, J. Rocholl, and S. Steffen (2014). Government Guarantees and Bank Risk Taking Incentives. *Working Paper*.

Fraisse, H., M. Lé, and D. Thesmar (2015). The Real Effects of Bank Capital Requirements. *Working Paper*.

Freixas, X. and J.-C. Rochet (2008). *Microeconomics of Banking.* MIT press.

Gambacorta, L., G. Ricotti, S. Sundaresan, and Z. Wang (2017). The Effects of Tax on Bank Liability Structure. *BIS Working Paper* (611).

Gandhi, P., H. N. Lustig, and A. Plazzi (2016). Equity is Cheap for Large Financial Institutions: The International Evidence. *Working Paper*.

Glasserman, P. and W. Kang (2014). Design of Risk Weights. *Operations Research 62*(6), 1204–1220.

Gonzalez-Uribe, J. and D. Paravisini (2017). How Sensitive is Young Firm Investment to the Cost of Outside Equity? Evidence from a UK Tax Relief. *Working Paper*.

Gornall, W. and I. A. Strebulaev (2014). Financing as a Supply Chain: The Capital Structure of Banks and Borrowers. *Working Paper*.

Greenwood, R., S. G. Hanson, J. C. Stein, and A. Sunderam (2017). Strengthening and Streamlining Bank Capital Regulation. *BPEA Conference Drafts*.

Gropp, R., T. Mosk, S. Ongena, and C. Wix (2016). Banks Response to Higher Capital Requirements: Evidence from a Quasi-Natural Experiment. *The Review of Financial Studies*.

Gu, G. W., R. de Mooij, and T. Poghosyan (2015). Taxation and Leverage in International Banking. *International Tax and Public Finance 22*(2), 177–200.

Hanson, S. G., A. K. Kashyap, and J. C. Stein (2011). A Macroprudential Approach to Financial Regulation. *Journal of Economic Perspectives 25*(1), 3–28.

Haubrich, J. G., P. Wachtel, et al. (1993). Capital Requirements and Shifts in Commercial Bank Portfolios. *Economic Review, Federal Reserve Bank of Cleveland* (Q III), 2–15.

Hebous, S. and M. Ruf (2017). Evaluating the Effects of ACE Systems on Multinational Debt Financing and Investment. *Journal of Public Economics 156*, 131–149.

Heckman, J. J., H. Ichimura, and P. E. Todd (1997). Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme. *The Review of Economic Studies 64*(4), 605–654.

Hoel, M. and L. Karp (2002). Taxes Versus Quotas for a Stock Pollutant. *Resource and Energy Economics 24*(4), 367–384.

Holmstrom, B. and J. Tirole (1997). Financial Intermediation, Loanable Funds, and the Real Sector. *the Quarterly Journal of economics 112*(3), 663–691.

IMF (2010). A Fair and Substantial Contribution by the Financial Sector. *IMF Final Report For the G-20* (June), 74.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2017). Macroprudential Policy, Countercyclical Bank Capital Buffers, and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments. *Journal of Political Economy 125*(6), 2126–2177.

Juelsrud, R. and E. Wold. Risk-weighted Capital Requirements and Portfolio Rebalancing. *Working Paper*.

Kashyap, A. K., J. C. Stein, and S. Hanson (2010). An Analysis of the Impact of Substantially Heightened Capital Requirements on Large Financial Institutions. *Booth School of Business, University of Chicago, mimeo 2*.

Keen, M. M. and R. A. de Mooij (2012). *Debt, Taxes, and Banks*. Number 12/48.

Khwaja, A. I. and A. Mian (2005). Do Lenders Favor Politically Connected Firms? Rent Provision in an Emerging Financial Market. *The Quarterly Journal of Economics 120*(4), 1371–1411.

Kim, D. and A. M. Santomero (1988). Risk in Banking and Capital Regulation. *The Journal of Finance 43*(5), 1219–1233.

Koehn, M. and A. M. Santomero (1980). Regulation of Bank Capital and Portfolio Risk. *The Journal of Finance 35*(5), 1235–1244.

Ongena, S., A. Popov, and G. F. Udell (2013). "When the Cat's away the Mice Will Play": Does Regulation at Home Affect Bank Risk-taking Abroad? *Journal of Financial Economics 108*(3), 727–750.

Panier, F., F. Pérez-González, and P. Villanueva (2013). Capital Structure and Taxes: What Happens When You (Also) Subsidize Equity? *Working Paper*.

Panteghini, P. M., M. L. Parisi, and F. Pighetti (2012a). Italy's ACE Tax and Its Effect on a Firm's Leverage. *Economics Discussion Papers* (31).

Panteghini, P. M., M. L. Parisi, and F. Pighetti (2012b). Italy's ACE Tax and its Effect on a Firm's Leverage.

Peek, J. and E. S. Rosengren (1997). The International Transmission of Financial Shocks : The Case of Japan. *American Economic Review 87*(4), 495–505.

Peek, J. and E. S. Rosengren (2000). Collateral Damage : Effects of the Japanese Bank Crisis on Real Activity in the United States. *American Economic Review 90*(1), 30–45.

Pennacchi, G. (Forthcoming). Banks, Taxes, and Nonbank Competition. *Journal of Financial Services Research*.

Pizer, W. A. (2002). Combining Price and Quantity Controls to Mitigate Global Climate Change. *Journal of Public Economics 85*(3), 409–434.

Princen, S. (2012). Determining the Impact of Taxation on Corporate Financial Decision-making. *Reflets et Perspectives de la Vie Economique 51*(3), 161–170.

Roberts, M. R. and T. M. Whited (2013). Endogeneity in Empirical Corporate Finance. *Chapter 7, Handbook of the Economics of Finance 2*(A), 493–572.

Rochet, J. C. (1992). Capital Requirements and the Behaviour of Commercial Banks. *European Economic Review 36*(5), 1137–1170.

Roe, M. J. and M. Tröge (2016). Taxing Banks Properly: The Next Regulatory Frontier. *European Corporate Governance Institute (ECGI) - Law Working Paper February*(317).

Rosenbaum, P. R. and D. B. Rubin (1985). Constructing a Control Group using Multivariate Matched Sampling Methods that Incorporate the Propensity Score. *The American Statistician 39*(1), 33–38.

Santoro, A. (2005). Ex-post Evaluation of Tax Reforms: The Case of the Italian Partial Ace. In *XII Meeting of Public Economy, Assessment of Public Policies: Palma de Mallorca*.

Schandlbauer, A. (2017). How Do Financial Institutions React to a Tax Increase? *Journal of Financial Intermediation 30*(C), 86–106.

Schepens, G. (2016). Taxes and Bank Capital Structure. *Journal of Financial Economics 120*(3), 585–600.

Smith, A. J. and E. P. Todd (2005). Does Matching Overcome LaLonde's Critique of Nonexperimental Estimators? *Journal of Econometrics 125*(1-2), 305–353.

Smolyansky, M. (2016). Policy Externalities and Banking Integration. *Finance and Economics Discussion Series 2016-008, Working Paper*.

Staderini, A. (2001). Tax Reforms to Influence Corporate Financial Policy: The Case of the Italian Business Tax Reform on 1997-98. *Bank of Italy Working Paper 423.*

Stiglitz, J. E. and A. Weiss (1981). Credit rationing in markets with imperfect information. *The American economic review 71*(3), 393–410.

Vallascas, F. and J. Hagendorff (2013). The Risk Sensitivity of Capital Requirements: Evidence from an International Sample of Large Banks. *Review of Finance 17*(6), 1947–1988.

Zangari, E. (2014). Addressing the Debt Bias: a Comparison Between the Belgian and the Italian ACE systems. *European Commission Taxation Papers 44.*

A Figures

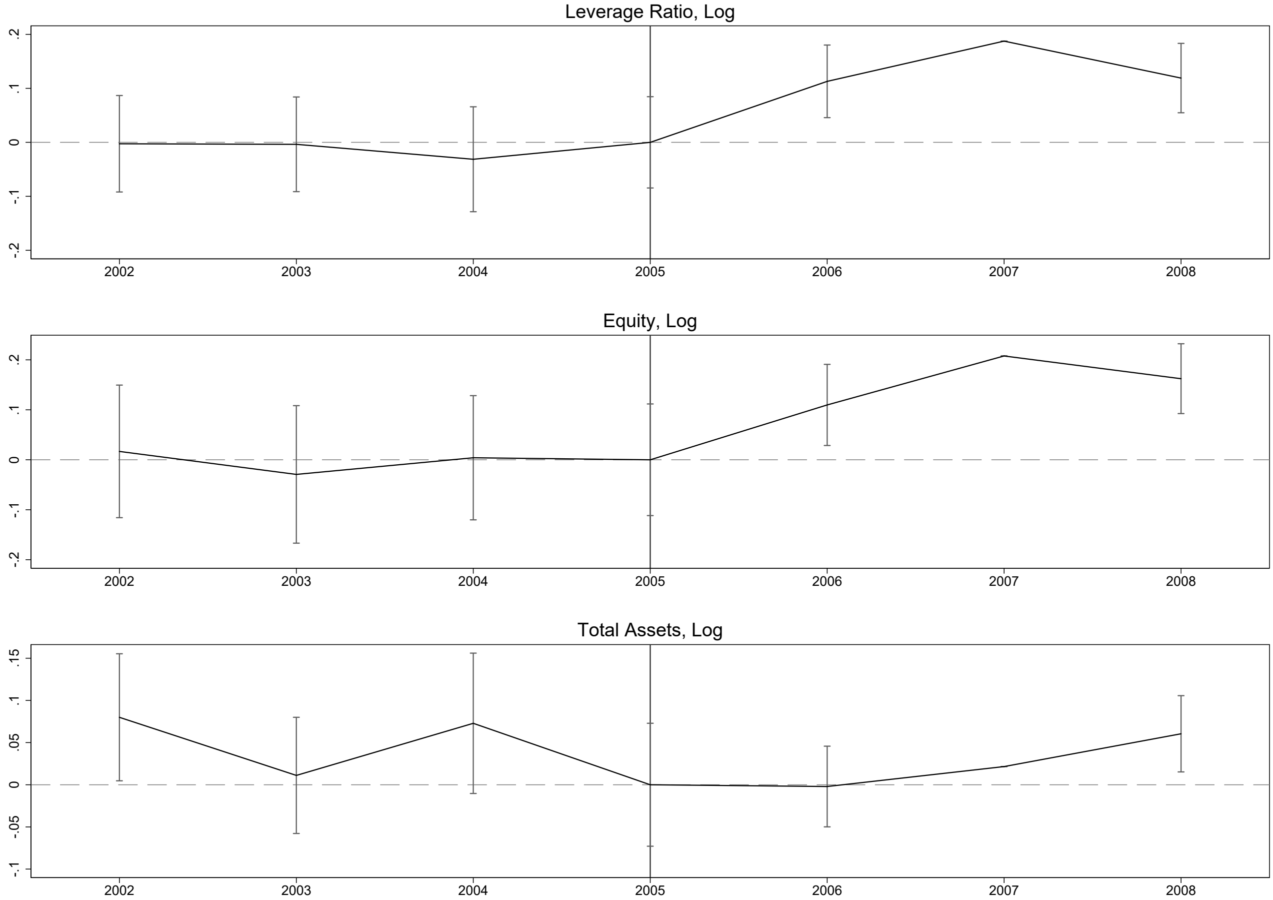

Figure 1: The Effect of the Implementation of an ACE on Bank Capital Structure: Evolution of the Leverage Ratio, Amount of Equity and Total Assets of Belgian Banks following the Belgian ACE

This figure shows the evolution of the leverage ratio, the amount of equity and the total assets for Belgian banks relatively to a control group of European banks obtained through propensity score matching over the 2002-2008 period. The figure illustrates the results from regression (1) where Treated $\times$ Post is replaced with a set of dummies indicating year relative to the introduction of the ACE. The dependent variable is, respectively, equity / total assets, total equity and total assets, in log. The line connects dots that represent point estimates and the bars indicate 90% confidence bounds based on standard errors clustered at the bank levels. The red vertical line corresponds to the year the ACE was approved: 2005. Consistent with the model predictions, the leverage ratio increases as the total equity of affected banks increases following the implementation of the ACE.

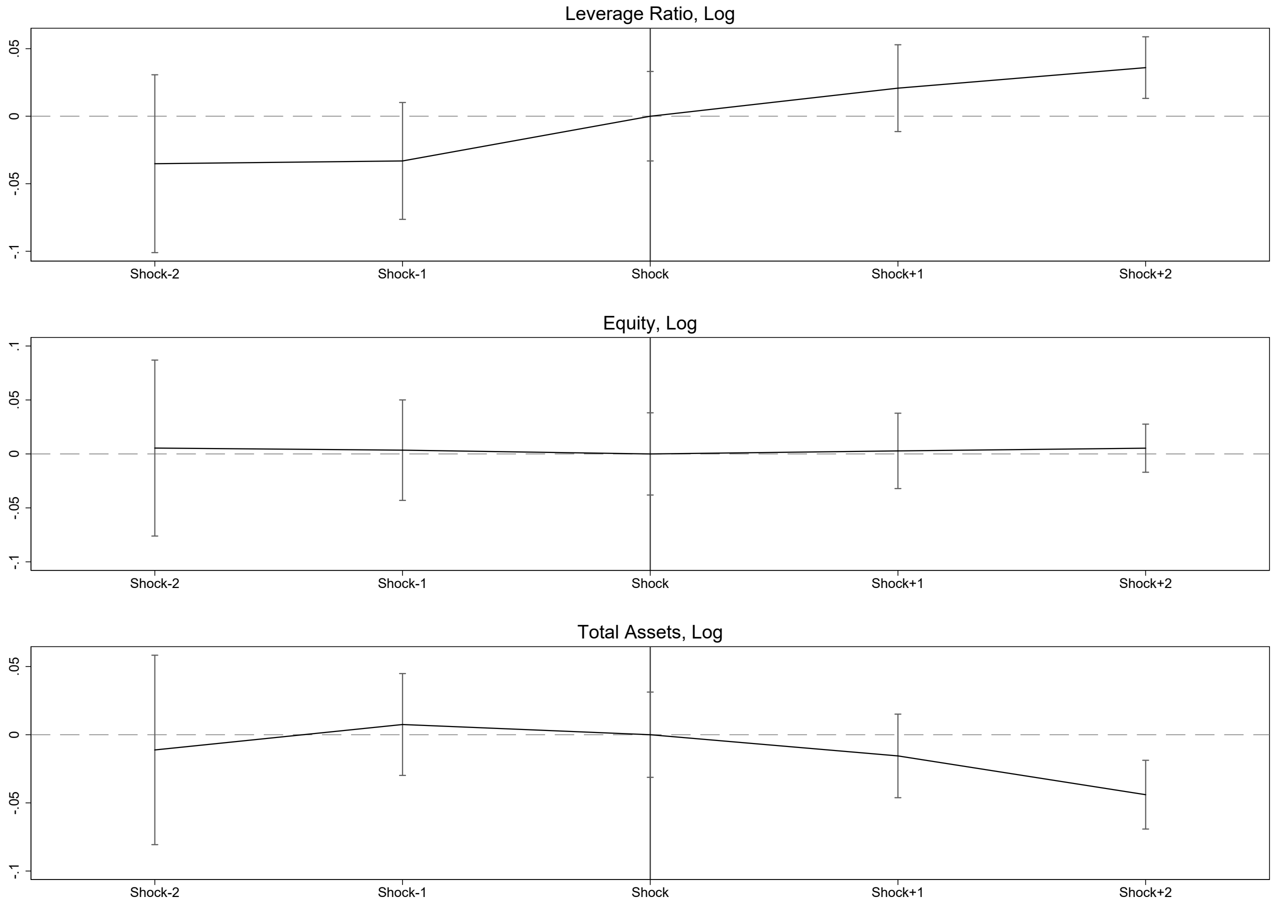

Figure 2: The Effect of a Liability Tax on Bank Capital Structure: Evolution of the Leverage Ratio, Amount of Equity and Total Assets of European Banks after the Implementation of a Liability Tax

This figure shows the evolution of leverage ratios, amount of equity and total assets for banks affected by the implementation of the levy relatively to other European banks over the 2008-2012 period. The figure illustrates the results from regression (1) where Treated $\times$ Post is replaced with a set of dummies indicating year relative to the introduction of the levy. The dependent variable is, respectively, equity / total asset, total equity and total assets, in log. The control group is obtained using propensity score matching as described in (x). The line connects dots that represent point estimates and the bars indicate 90% confidence bounds based on standard errors clustered at the bank levels. The red vertical line corresponds to the year the levy is implemented in each country that is affected (2010, 2011 or 2012). Consistent with the model prediction, the leverage ratio increases as the total assets of affected banks decreases while the level of equity stays constant following the implementation of the ACE.

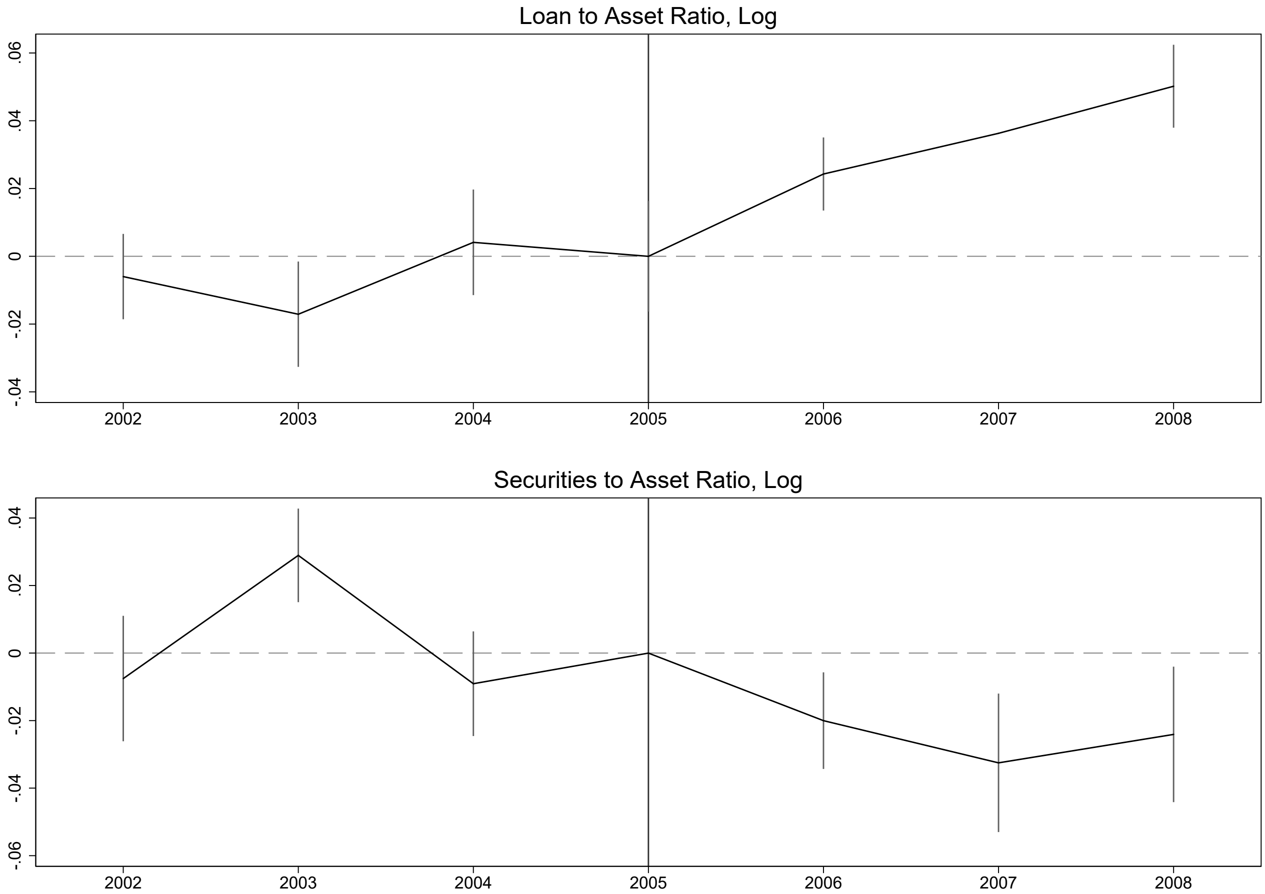

Figure 3: The Effect of the Implementation of an ACE on Bank Asset Allocation: Evolution of the Loan to Assets and Securities to Assets ratios of Belgian Banks following the Belgian ACE

This figure shows the evolution of the loan to assets and securities to assets ratios for Belgian banks relatively to a control group of European banks obtained through propensity score matching over the 2002-2008 period. The figure illustrates the results from regression (1) where Treated $\times$ Post is replaced with a set of dummies indicating year relative to the introduction of the ACE. The dependent variable is, respectively, loans / total assets and securities / total assets, in log. The line connects dots that represent point estimates and the bars indicate 90% confidence bounds based on standard errors clustered at the bank levels. The red vertical line corresponds to the year the ACE was approved: 2005. Consistent with the model predictions, the leverage ratio increases as the total equity of affected banks increases following the implementation of the ACE.

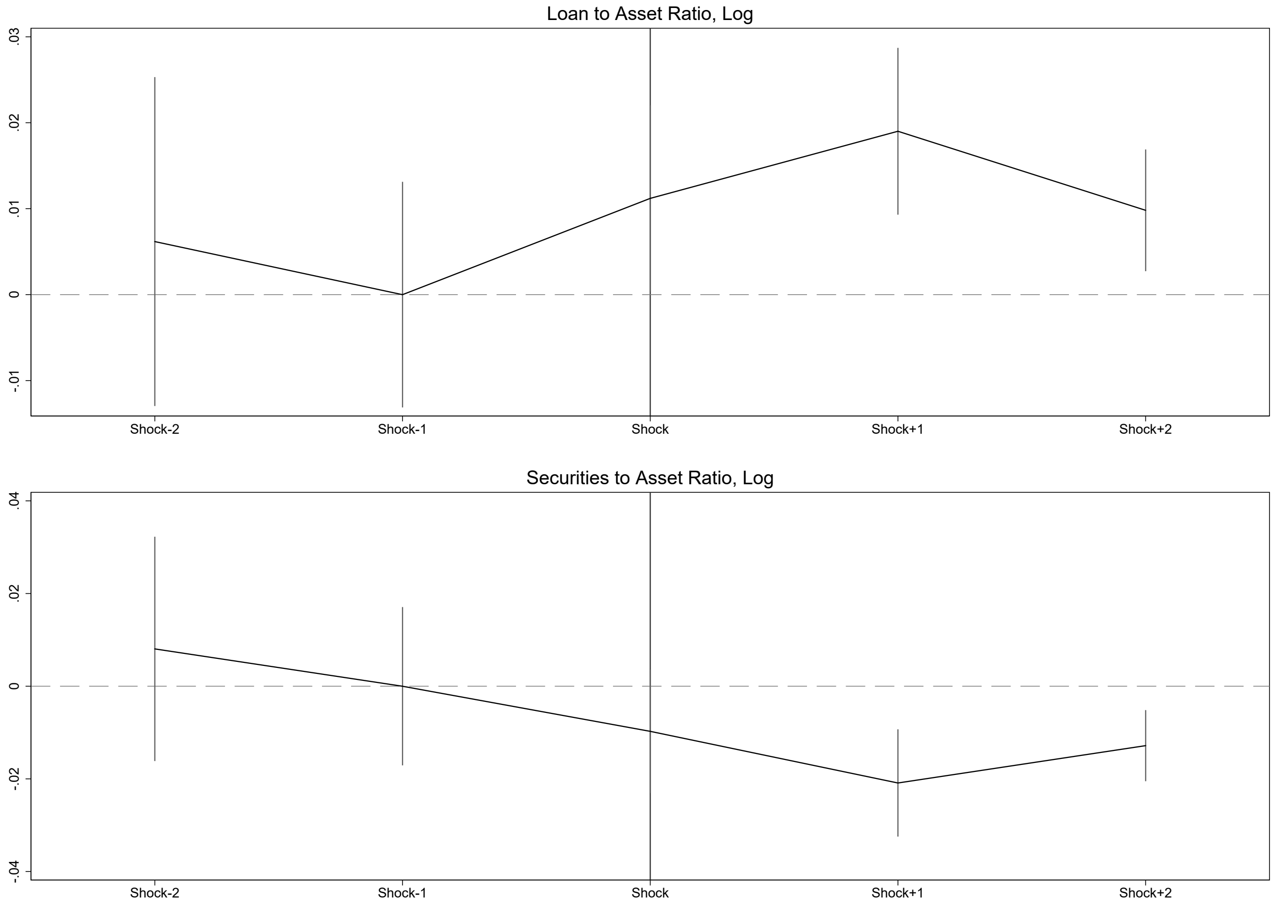

Figure 4: The Effect of a Liability Tax on Bank Asset Allocation: Evolution of the Loan to Assets and Securities to Assets ratios of European Banks after the Implementation of a Liability Tax

This figure shows the evolution of loan to assets and securities to assets ratios for banks affected by the implementation of the levy relatively to other European banks over the 2008-2012 period. The figure illustrates the results from regression (1) where Treated × Post is replaced with a set of dummies indicating year relative to the introduction of the levy. The dependent variable is, respectively, equity / total asset, total equity and total assets, in log. The control group is obtained using propensity score matching as described in (x). The line connects dots that represent point estimates and the bars indicate 90% confidence bounds based on standard errors clustered at the bank levels. The red vertical line corresponds to the year the levy is implemented in each country that is affected (2010, 2011 or 2012). Consistent with the model prediction, the leverage ratio increases as the total assets of affected banks decreases while the level of equity stays constant following the implementation of the ACE.

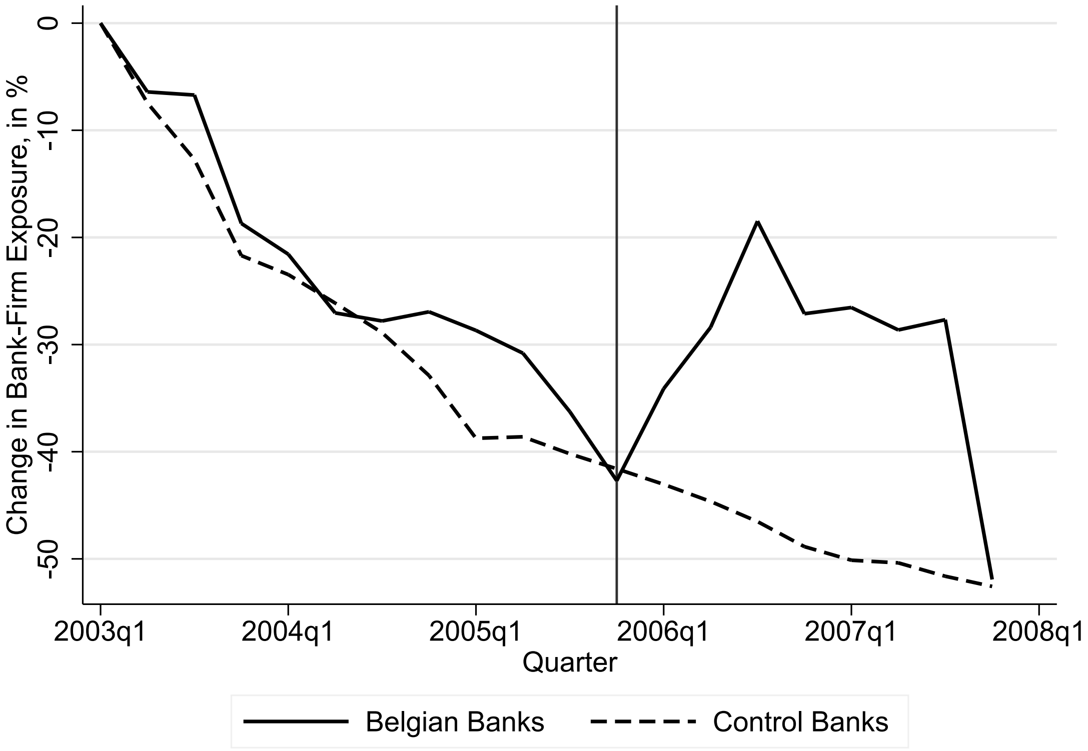

Figure 5: The Effect of the Implementation of an ACE on Bank Lending: Evidence from Lending by Belgian Banks to German Firms

This figure shows the changes in credit exposures of Belgian and Control banks at the intensive margin from 2003 to 2007. The sample only includes bank-firm exposure that are positive in the first quarter to alleviate any concerns relative to the 1.5 million threshold of the German credit register.

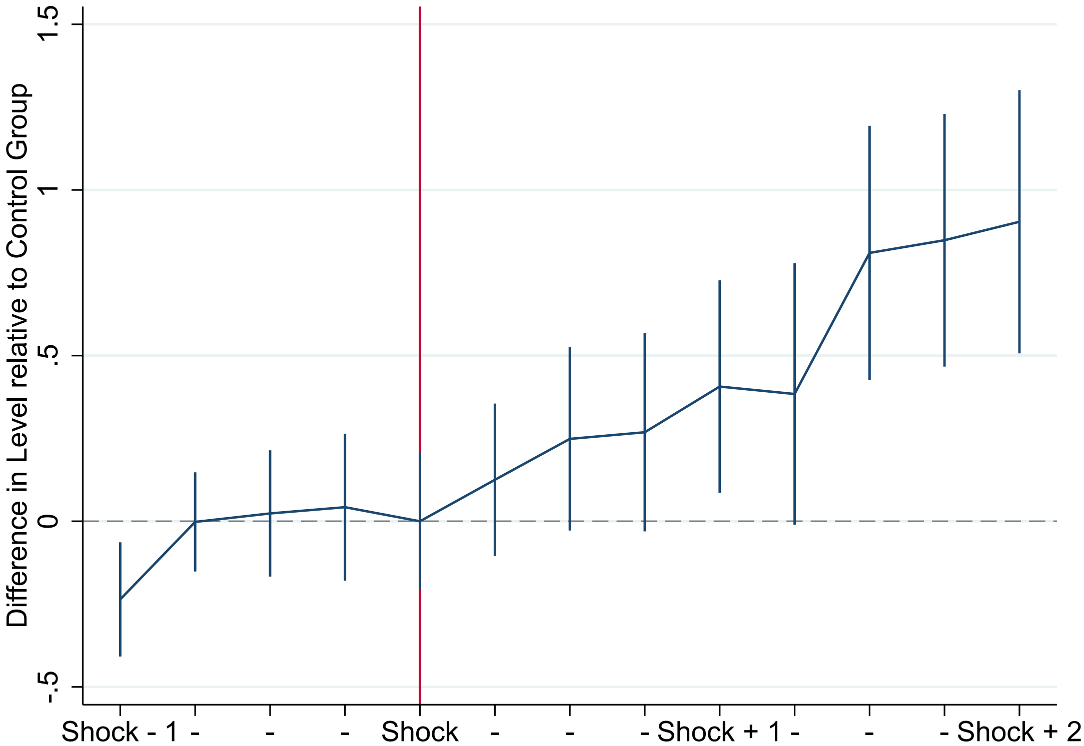

Figure 6: . The Effect of the Implementation of a Liability Tax on Bank Lending: Evidence from the German Credit Market

This figure illustrates the results from regression (15) where $Treated_{b,f}$ is replaced with a set of dummies indicating year relative to the introduction of the liability tax interacted with a dummy for treated banks, and where the dependent variable is the log of all bank-firm loan exposures. The line connects dots that represent point estimates and the bars indicate 90% confidence bounds based on standard errors clustered at the bank and firm levels. The red vertical line corresponds to the year the implementation of the liability tax is acted.

B Tables

Table I. Model Predictions

	Increase in Capital Requirements	ACE	Liability Tax	ACE in the standard tradeoff theory
Capital structure				
Level of Equity	Constant	+	ND	+
Leverage ratio	+	+	+	+
Regulatory Ratio	+	Constant	Constant	+
Asset Allocation				
Share of Corporate Loans	-	+	+	-
Corporate Lending	-	+	ND	+
Distance to the Markowitz Portfolio	+	-	ND	ND
Bank Total Risk	-	-	-	-

This table reports the empirical predictions of our model in Section 2.

Table II. How to Change the Fiscal Cost of Leverage? Description of the Tax Reforms

1. Allowance for Corporate Equity
Definition: The bank deducts a notional interest on the book value of equity from taxes

Country	**Equity Base (Book Value)**	**Notional Interest**	**Tax Rate**	**Time Period**
Belgium	Statutory equity and retained earnings	Average 10-year government bond rate	Fully Deducted	2006 - Today

2. Liability Tax
Definition: The bank pays a tax on liabilities net of equity

Country	**Tax Base**	**Tax Rate**	**Threshold (Min. liabilities, in €billion)**	**Implementation Date**
Austria	Total liabilities net of equity and insured deposits	From 5.5 to 8.5 bps	1	2011
Belgium	-	3.5 bps	None	2012
Germany	-	From 2 to 6 bps	0.3	2011
Sweden	-	1.8 bps in 2009 and 2010, 3.6 bps after	None	2010
Netherlands	-	4.4 bps	20	2012
United Kingdom	-	Increased from 7.5 bps in 2011 to 13 bps in 2013	23	2011
Portugal	Total liabilities net of equity and subordinated debt	5 bps	None	2011

This table reports the parameters of the fiscal reforms that have affected the fiscal cost of leverage of European banks from 1997 to 2015. The legal status and other details about each reform are available in the Online Appendix. Note that the threshold for the liability tax in UK is £20 billion in 2011£, i.e. €23 billion in 2011€. Sources: KPMG, PWC, Devereux et al. (2017).

Table III. Bank Level Data: Summary Statistics and Propensity Score Matching Diagnostics

	Treatment Group				Full Control Group						Matched Control Group					
	Mean	p50	p10	p90	Mean	*Diff*	*Bias*	p50	p10	p90	Mean	*Diff*	*Bias*	p50	p10	p90
Panel A: The Belgian ACE (2006)																
Total Assets	60,575	2,967	371	287,676	18,255	*-42,319***	*-29*	1,292	230	13,493	49,108	*-8,523*	*-4*	2,893	410	33,893
Leverage ratio																
Level	6.8	5.2	2.7	10.9	7.7	*0.93*	*13.8*	6.0	3.1	14.1	6.8	*-0.02*	*-0.0*	5.2	3.0	12.0
Growth	1.4	-2.5	-18.5	25.8	1.6	*1.6*	*0.9*	2.3	-11.2	10.8	-0.0	*-1.5*	*-8.7*	0.4	-21.1	15.0
Loan Ratio	44.4	46.4	13.4	77.1	61.3	*16.9****	*72*	64.1	25.5	89.2	43.4	*-0.55*	*-2.3*	38.5	7.8	79.2
ROA	1.1	0.6	0.2	2.0	0.7	*-0.46***	*-28.3*	0.3	0.1	1.5	0.6	*-0.36*	*-22*	0.4	0.1	1.4
NII Ratio	30.6	27.5	7.1	64.0	31.0	*0.39*	*1.9*	25.7	12.5	58.3	40.1	*8.4*	*38*	32.5	14.7	85.1
ERWA	9.6	9.2	7.4	14.0	12.9	*3.3*	*46.6*	10.4	7.3	20.2						
Impaired Loan Ratio	39.5	38.3	11.2	81.0	34.8	*-4.6*	*-10.9*	17.0	3.1	78.9						
Z-score	86.1	24.2	12.3	115.4	128.4	*42.3*	*21.2*	66.6	21.1	295.6	107	*21*	*10*	46.4	16.8	195.4
GDPPC																
Level	32,500	32,500	32,500	32,500	37,341	*4,840**	*51.3*	29,800	28,000	52,600	39,149	*6,256**	*55*	29,800	28,000	76,500
Growth	1.5	1.5	1.5	1.5	1.5	*-0.03*	*-6.17*	1.4	0.9	1.5		*-0.01*	*-1.7*	1.6	0.9	2.4
Tax Rate																
Marginal	34.0	34.0	34.0	34.0	31.9	*-2.1*	*-40*	35.0	21.3	38.9	32.6	*-1.4*	*-28*	35.0	21.3	38.9
Effective	22.5	23.0	0.0	45.5	36.3	*13.8****	*62*	30.4	0.0	69.2	34.9	*12.4**	*57*	28.2	6.8	73.9
Observations	29				1,346						121					
Panel B: The Liability Tax (2009-2012)																
Total Assets	43,150	1,940	317	18,307	32,167	*-10,982*	*-5.7*	1,398	260	42,640	49,108	*-510*	*-0.2*	2,226	278	41,304
Leverage ratio																
Level	7.7	6.0	4.1	12.5	9.5	*1.76****	*26*	8.1	5.0	14.5	8.8	*1.13***	*17.5*	7.6	4.4	14.1
Growth	5.5	4.0	-7.8	18.7	4.7	*-0.73*	*-4.6*	1.2	-10.3	25.0	4.9	*-0.5*	*-3.3*	1.4	-11.0	29.0
Loan Ratio	55.5	57.9	28.8	78.1	64.4	*16.9****	*72*	74.4	19.6	87.6	60.5	*4.9****	*21.8*	67.5	18.7	87.2
ROA	0.3	0.2	0.0	0.9	0.5	*15.5*	*7.8*	0.5	0.0	1.0	0.3	*0.01*	*0.9*	0.4	-0.0	1.1
NII Ratio	30.9	26.5	18.2	53.7	34.4	*3.5****	*18*	30.3	13.3	70.5	35.1	*1.9****	*26*	31.4	12.5	70.5
ERWA	12.1	10.8	8.3	17.3	14.2	*2.1****	*33.7*	13.1	8.1	19.9	13.9			12.1	7.5	18.9
Impaired Loan Ratio	33.5	17.0	3.0	82.0	29.1	*-4.6*	*-11.5*	16.7	1.8	78.6	40			30.6	2.8	86.9
GDPPC																
Level	32,091	30,800	30,800	37,400	48,060	*15,569****	*51.3*	54,900	23,300	66,600	44,084	*11,999****	*88*	43,200	23,300	76,900
Growth	-5.0	-5.3	-5.3	-4.0	-4.3	*0.65****	*63.4*	-4.4	-6.0	-5.0		*0.03*	*3*	-5.4	-6.1	-3.3
Tax Rate																
Marginal	28.7	30.2	25.0	30.2	26.7	*-2.1****	*-61*	28.0	21.2	31.4	27.2	*-1.5****	*-43*	28.6	21.2	31.4
Effective	40.9	40.5	0.0	80.0	24.7	*-16****	*-64*	28.0	21.2	31.4	26.2	*-14****	*-56*	24.6	0.0	50.0
Observations	843				444						220					

This table reports summary statistics and matching diagnostics for the pre-treatment period of each policy reforms we consider: 1996 for the Italian ACE (Panel A), 2005 for the Belgian ACE (Panel B) and 2009 for the bank levy (Panel C). The left hand side part of each panel shows summary statistics for the treatment group, the middle part focuses on the full sample of non-treated banks and the right hand part shows information for the non-treated banks that are selected for the control group after the matching procedure. The "***Diff***" columns of the middle and right hand side parts of the table show the difference in the average of non-treated banks versus treated banks. ∗∗∗, ∗∗, ∗ indicate p values respectively lower than 0.01, 0.05 and 0.1 for a t -test that checks whether the average for the non-treated banks is equal to the average value for the Belgian banks. The columns "***Bias***" show the standardized percentage bias between the treated banks and the non-treated banks. The bias is the % difference of the sample means in the treated and non-treated sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups (Rosenbaum and Rubin, 1985). Total Assets are reported in million euros, all ratios in % and GDP per capital in euros.

Table IV. Loan-level Data: Summary Statistics

	Control Group					Treated Group				
	N	**Mean**	**p50**	**p10**	**p90**	**N**	**Mean**	**p50**	**p10**	**p90**
					Panel A: The Belgian ACE (2006)					
Bank-Firm Exposures										
Size (in €th.)	27,914	5,361	753.9	0	8,696	1,024	2,956	814	0	6571
% Change	11,714	15.5	-.16	-1	1.5	374	3.6	-.23	-1	2.2
New loans (%)	27,914	6	0	0	0	1,024	11.7	0	0	1
Bank Characteristics										
Total Assets	1,521	23,930	616	160.3	7,183	3	323,742	343,666	200,467	427,094
Leverage ratio	1,521	5.8	5.5	3.9	7.9	3	4.2	4.2	4.0	4.5
ROA	1,498	.8	.78	.25	1.3	3	.63	.64	.51	.75
Firm Characteristics										
Debt	3,572	182,157	20,199	3,670	221,424	355	208,712	40,915	8,243	414,759
# Relationship Banks	29,400	1.9	1.0	0.0	4.0	1,054	4.4	3.0	0.0	9.0
Assets	3,572	270,752	28,647	5,021	329,492	355	320,229	60,181	13,369	613,061
Sales	3,572	215,978	35,777	3,055	298,611	355	232,511	69,529	488	494,668
ROA	3,572.0	6.7	4.9	-1.5	19.1	355	7.2	5.6	-0.8	16.7
Leverage	3,505.0	7.5	2.9	0.8	18.1	355	5.1	2.5	0.8	11.7
Debt Structure	3,572	0.3	0.3	0.0	0.7	355	0.3	0.2	0.0	0.6
Distance from Belgium	23,147	436	470	195	637	918	369	353	176	601
					Panel B: The Liability Tax (2010- 2012)					
Bank-Firm Exposures										
Size (in thousand Euros)	1,313	1,552	0	0	3,112	19,819	4,967	101	0	8,685
Change in exposure, in	603	-0.2	-0.0	-1.0	0.2	11,515	-0.1	-0.0	-0.8	0.2
New loans	1,313	2.7	0.0	0.0	0.0	19,819.0	2.5	0.0	0.0	0.0
Bank Characteristics										
Total Assets	19	142,328	49,859	90.4	585,306	580	9079	890	239	4,795
Leverage ratio	40	7.2	7.5	3.4	10.0	1070	5.7	5.6	4.0	7.7
ROA	40	.3	0	-.6	1.6	1,065	.81	.85	.20	1.4
Firm Characteristics										
Debt	122.0	21,449	3,319.5	1,250	14,159	3,928	251,128.5	25,937	4,447	275,295
# Relationship Banks	4,401	0.3	0.0	0.0	1.0	33,032	2.1	1.0	0.0	4.0
Assets	122.0	26,9423	4,344	1,631	23,043	3,928	371,807	40,435	6,613	421,646
Sales	122.0	35,952	14,303	4,699	70,326	3,928	224,189	39,877	2,478	328,903
ROA	122.0	5.0	4.2	-8.6	15.9	3,928	5.0	3.7	-6.5	17.8
Leverage	117.0	12.8	4.7	0.9	55.5	3,863	6.6	2.6	0.7	14.0
Debt Structure	122.0	0.1	0.1	0.0	0.4	3,928	0.3	0.3	0.0	0.7

For each policy reforms, this table reports summary statistics for banks that are affected, control banks and the control group of matched banks. Panel A reports summary statistics in 1997 before the introduction of the Italian ACE, Panel B in 2005, before the implementation of the ACE in Belgium, and Panel C in 2009, before the introduction of taxes on bank liabilities net of equity.

Table V. Increase in the Cost of Leverage and Bank Capital Structure: Evidence from the Belgian ACE and the European Liability Tax

	Leverage Ratio (Equity/Total Assets)					Equity	Total Assets	Regulatory Ratio
	Amount				Log	Log	Log	Log
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Panel A. The Belgian ACE			
Treated × Post	0.934**	2.092***	0.839**	0.677**	0.110***	0.125**	-0.008	0.090
	(0.377)	(0.532)	(0.365)	(0.327)	(0.040)	(0.058)	(0.038)	(0.122)
Treated × Post × Leverage ratio $_{exante}$		-0.181*** (0.054)						
Observations	3,485	3,485	3,485	3,485	3,485	3,485	3,485	1,616
R^2	0.925	0.925	0.926	0.928	0.931	0.994	0.995	0.881
					Panel B. The Liability Tax			
Treated × Post	0.476***	0.653***	0.433***	0.394***	0.034***	0.008	-0.027**	-0.017
	(0.120)	(0.226)	(0.123)	(0.125)	(0.011)	(0.012)	(0.011)	(0.020)
Treated × Post × Leverage ratio $_{exante}$		-0.020 (0.026)						
Observations	3,485	3,485	3,485	3,485	3,485	3,485	3,485	1,616
R^2	0.925	0.925	0.926	0.928	0.931	0.994	0.995	0.881
Size × Year	-	-	Yes	Yes	Yes	Yes	Yes	Yes
Capital × Year	-	-	-	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Sample	Matched	Matched	Matched	Matched	Matched	Matched	Matched	Matched

This table analyzes the impact of the introduction of the Belgian ACE in 2006 and of the Liability Tax in Europe on bank capital structure in a differences-in-differences setup. The dependent variable is the equity to asset ratio in columns (1) to (5), total equity in column (6), total assets in column (7) and the regulatory ratio in column (8). The table displays the coefficient of the interaction of the dummy variable *Post* - equal to one after the ACE reform - and the dummy *Treated* that indicates whether the bank is a treated bank. The table also displays the coefficient of the triple interaction Treated × Post × Leverage ratio$_{ex-ante}$ where Leverage ratio$_{ex-ante}$ is the leverage ratio of the treated banks in the pre-treatment period. Models are estimated using OLS and include both bank and year fixed effects, time varying bank controls - Return on assets, log of total assets, log of total assets squared - and country controls - GDP per capita and GDP per capita growth rate. All these variables are lagged - and total asset is also lagged twice. The model also includes Year × ex-ante asset quintile fixed effects and Year × ex-ante leverage ratio quintiles in columns (4) to (8). Standard errors are clustered at the bank level. The sample period is 2003 - 2007 for the Belgian ACE and 2009 - 2013 for the liability tax.

Table VI. Increase in the Cost of Leverage and Asset Allocation: Evidence from the Belgian ACE and the European Liability Tax

	Loan to Asset Ratio					Security to Asset Ratio				
	Amount				Log	Amount				Log
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A. The Belgian ACE										
Treated × Post	5.655***	7.096***	5.801***	6.073***	0.040***	-4.064***	-5.347**	-3.999**	-4.302***	-0.034**
	(1.722)	(2.660)	(1.763)	(1.776)	(0.012)	(1.518)	(2.334)	(1.591)	(1.648)	(0.013)
Treated × Post × Leverage ratio $_{exante}$		-0.226					0.200			
		(0.203)					(0.164)			
Observations	867	867	867	867	867	852	852	852	852	852
R^2	0.957	0.957	0.957	0.959	0.960	0.903	0.904	0.906	0.908	0.911
Panel B. The Liability Tax										
Treated × Post	0.826	3.508***	0.894*	1.036**	0.007*	-0.854	-2.485**	-0.962*	-1.077*	-0.009**
	(0.512)	(0.992)	(0.511)	(0.512)	(0.004)	(0.563)	(0.968)	(0.561)	(0.572)	(0.005)
Treated × Post × Leverage ratio $_{exante}$		-0.307***					0.189**			
		(0.096)					(0.086)			
Observations	3,485	3,485	3,485	3,485	3,485	3,442	3,442	3,442	3,442	3,442
R^2	0.953	0.953	0.954	0.955	0.954	0.906	0.907	0.907	0.909	0.911
Size × Year	-	-	Yes	Yes	Yes	-	-	Yes	Yes	Yes
Capital × Year	-	-	-	Yes	Yes	-	-	-	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Sample	Matched	Matched	Matched	Matched	Matched	Matched	Matched	Matched	Matched	Matched

This table analyzes the impact of the introduction of the Belgian ACE in 2006 and of the Liability Tax in Europe on the asset mix of banks in a differences-in-differences setup. The dependent variable is the loan to asset ratio in columns (1) to (5) and the security to asset ratio in column (6) to (10). The table displays the coefficient of the interaction of the dummy variable *Post* - equal to one after the ACE reform - and the dummy *Treated* that indicates whether the bank is a treated bank. The table also displays the coefficient of the triple interaction Treated × Post × Leverage ratio$_{ex-ante}$ where Leverage ratio$_{ex-ante}$ is the leverage ratio of the treated banks in the pre-treatment period. Models are estimated using OLS and include both bank and year fixed effects, time varying bank controls - Return on assets, log of total assets, log of total assets squared - and country controls - GDP per capita and GDP per capita growth rate. All these variables are lagged - and total asset is also lagged twice. The model also includes Year × ex-ante asset quintile fixed effects and Year × ex-ante leverage ratio quintiles in columns (4) to (8). Standard errors are clustered at the bank level. The sample period is 2003 - 2007 for the Belgian ACE and 2009 - 2013 for the liability tax.

Table VII. The Effect of an Increase in the Cost of Leverage on Bank Lending: Evidence from Belgian Banks in Germany (2004-2007)

Model	***All Bank-Firm Exposures*** Growth in Loan Exposure, in %				***Intensive Margin*** Growth in Loan Exposure, in %		***Extensive Margin*** New Loan Dummy	
Sample	All		Foreign Banks		All	Foreign Banks	All	Foreign Banks
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treated	21.2***	22.39***	28.53***	39.78**	18.5***	34.5**	0.05***	0.04***
	(7.2)	(7.4)	(10.92)	(12.8)	(5.6)	9.4)	(0.01)	(0.02)
Firm FE	-	Yes	-	Yes	Yes	Yes	-	-
Industry FE	Yes	-	Yes	-	-	-	Yes	Yes
Firm Characteristics	Yes	-	Yes	-	-	-	Yes	Yes
Bank Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	-	-
Relationship Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	72,460	59,026	15,067	5,878	26,982	1,741	72,460	15,067
R^2	0.45	0.52	0.25	0.55	0.47	0.64	0.40	0.059

This table shows the effect of the introduction of an ACE in Belgium in 2005q2 on lending by Belgian banks in Germany. We take the introduction of the ACE as an event and collapse all quarterly data 1 year before and 2 years after into a single pre- and post-event period. The dependent variable in columns (1) to (6) is the bank-firm exposures growth rate in % between the pre- and post-event period, in columns (7) and (8) a dummy variable that is equal to one if a new loan is granted to a firm with currently zero exposure to the credit granting bank and is equal to zero otherwise. The initial sample comprises all bank-firm exposures involving firms that borrow from at least two banks headquartered in different countries during the 1994-2013 period. In columns (2) and (4) the sample is restricted to firm exposures to foreign banks only and in columns (5) and (6) this sample is restricted to bank-firm exposures that are strictly positive in the first period. Firm characteristics include total bank debt, and the number of relationship banks. Bank characteristics include the leverage ratio, the return on asset, and log of total assets. Relationship characteristics include the length and the size of the relationship. Both firm and bank characteristics are defined the year before the shock. Columns (2), (4), (5) and (6) include firm fixed effects. Standard errors are clustered at the bank and firm levels and reported in brackets, * p<0.10, ** p<0.05, *** p<0.01.

Table VIII. The Effect of an Increase in the Cost of Leverage on Bank Lending: The Liability Tax and Bank Lending by Affected Banks in Germany (2009-2013)

Model	***All Bank-Firm Exposures*** log(Loan Exposure)				***Intensive Margin*** log(Loan Exposure)		***Extensive Margin*** New Loan Dummy	
Sample	All		Foreign Banks		All	Foreign Banks	All	Foreign Banks
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treated	0.56***	0.41***	0.75	0.74	-0.11	0.41	0.01*	0.01
	(0.19)	(0.16)	(0.80)	(0.73)	(0.16)	(0.98)	(0.00)	(0.01)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter × Firm FE		Yes		Yes	Yes	Yes	Yes	Yes
Firm Characteristics	Yes	-	Yes	-	-	-	-	-
Bank Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	-	-
Observations	304,921	293,131	39,306	17,614	238,505	15,342	305,065	40,093
R^2	0.317	0.401	0.613	0.561	0.416	0.602	0.013	0.023

This table shows the effect of the introduction of a tax on bank total liabilities net of equity on lending by affected banks in Germany. We take the implementation of the tax in each country that is affected (Austria, Belgium, Germany, the Netherlands, UK) as an event and collapse all quarterly data 1 year before and 2 years after into a single pre- and post-event period. The dependent variable in columns (1) to (6) is the change in the log of bank-firm exposures between the pre- and post-event period, in columns (7) to (9) a dummy variable that is equal to one if a new loan is granted to a firm with currently zero exposure to the credit granting bank and is equal to zero otherwise. The initial sample comprises all bank-firm exposures involving firms that borrow from at least two banks headquartered in different countries during the 1994-2013 period. In columns (2) and (4) the sample is restricted to firms that borrow from several banks, in columns (3) and (4) to firm exposure to foreign banks only and in columns (5) and (6) this sample is restricted to bank-firm exposures that both involve relationship firms, i.e., firms with a strictly positive exposure to *treated bank* and the year prior to shock, and that are strictly positive in the first period. Standard errors are clustered at the bank and firm levels and reported in brackets, * p<0.10, ** p<0.05, *** p<0.01.

Table IX. The Effect of a Change in the Cost of Leverage on Bank Risk-Taking: Evidence from Borrower Characteristics - The Belgian ACE (2006)

Model	*Ex-Ante Borrower Characteristics*				*Change in Borrower's Characteristics (Δ Log)*				
	Bank Debt	Leverage	Assets	Sales	Bank Debt	Leverage	Assets	Employment	Interest Cost
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
New Borrower	-0.47**	0.31	-0.33**	0.10					
	(0.22)	(1.02)	(0.16)	(0.39)					
Treated Firm					0.21***	0.06**	0.06***	-0.04	0.00
					(0.07)	(0.02)	(0.02)	(0.03)	(0.00)
Industry FE	-	-	-	-	Yes	Yes	Yes	Yes	Yes
Firm Characteristics	-	-	-	-	Yes	Yes	Yes	Yes	Yes
Observations	1,055	355	355	355	3,799	3,571	3,579	3,579	3,571
R^2	0.004	0.000	0.011	0.000	0.045	0.080	0.078	0.020	0.063

This table investigates the characteristics of firms borrowing to Belgian banks following the introduction of the ACE. In columns (1) to (4) the sample is restricted to firms borrowing to Belgian banks. The dependent variable $NewBorrower$ indicates whether this firms is a new borrower to the affected banks . In columns (5) to (9) the sample covers all the firms for which we have detailed information from Ustan. We take the introduction of the ACE as an event and collapse all quarterly data one year before and two years after into a single pre- and post-event period. The dummy variables indicate firms that are borrowing from Belgian banks ex-ante (before the shock). Firm controls include total assets, total sales, ROA, leverage and debt structure before the reform. Standard errors are clustered at the firm-level and reported in brackets, * p<0.10, ** p<0.05, *** p<0.01.

Table X. Increase in the Cost of Leverage and Bank Risk- Taking: Evidence from the Belgian ACE and the European Liability Tax

	Risk-weighted Assets/Total Assets		Log(Z-score)		Log(ETA/sd(Return on Asset))	
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A. The Belgian ACE			
Treated × Post	0.042*	0.037*	0.556**	0.579**	0.585**	0.608**
	(0.023)	(0.019)	(0.281)	(0.269)	(0.283)	(0.272)
Treated × Post × Leverage ratio $_{exante}$			-0.083**	-0.087**	-0.087**	-0.090**
			(0.039)	(0.034)	(0.040)	(0.035)
Observations	191	184	826	826	826	826
R^2	0.961	0.962	0.701	0.708	0.710	0.716
			Panel B. The Liability Tax			
Treated × Post	0.063***	0.057***	0.071**	0.053	0.067**	0.048
	(0.008)	(0.009)	(0.032)	(0.033)	(0.031)	(0.032)
Observations	1,385	1,385	3,455	3,455	3,455	3,455
R^2	0.889	0.904	0.811	0.818	0.810	0.817
Size × Year	-	Yes	-	Yes	-	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Bank	Bank	Bank	Bank	Bank	Bank
Sample	Matched	Matched	Matched	Matched	Matched	Matched

This table analyzes the impact of the introduction of the Belgian ACE in 2006 and of the Liability Tax in Europe on bank risk taking in a differences-in-differences setup. The dependent variable is the risk-weighted assets to total assets ratio in columns (1) to (2), the log of the Z-score in column (3) and (4) and ratio of the leverage ratio to the standard deviation of returns on assets in columns (5) and (6). The table displays the coefficient of the interaction of the dummy variable *Post* - equal to one after the ACE reform - and the dummy *Treated* that indicates whether the bank is a treated bank. The table also displays the coefficient of the triple interaction Treated × Post × Leverage ratio$_{ex-ante}$ where Leverage ratio$_{ex-ante}$ is the leverage ratio of the treated banks in the pre-treatment period. Models are estimated using OLS and include both bank and year fixed effects and time varying bank controls - log of total assets, log of total assets squared. All these variables are lagged - and total asset is also lagged twice. The model also includes Year × ex-ante asset quintile fixed effects in columns (2), (4) and (6). Standard errors are clustered at the bank level. The sample period is 2003 - 2007 for the Belgian ACE and 2009 - 2013 for the liability tax. Consistent with the model prediction, the reforms have a positive effect on the ratio of risk weighted assets to total assets but a negative effect on total risk, as measured by the Z-score and the ratio of the leverage ratio to the standard deviation of returns on assets.