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The Interaction of Bank Regulation and Taxation

Bálint L. Horváth*

Abstract

The tax benefit of interest deductibility encourages debt financing, but regulatory constraints create dependency between bank leverage and asset risk. Using a large international sample of banks this paper shows that banks located in high-tax countries have higher leverage and lower average asset risk-weights. This trade-off is stronger when regulation is more stringent and for banks with less capital. Non-financial firms' leverage and asset risk are positively related to tax rates, as further evidence of the regulatorily induced adjustment of portfolio risk. A difference-in-difference analysis provides support for a causal interpretation of these results. Overall, higher tax rates are positively correlated with systemic risk, suggesting that the lower asset risk does not offset the risk-inducing effect of tax rates on bank leverage.

Keywords: Bank leverage; Bank regulation; Bank risk; Corporate taxation; Debt bias

JEL codes: G21; G28; G32; H25

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1 Introduction

There is consensus among researchers that bank capital structure is an important determinant of financial stability as better capitalized banks tend to be more resilient. This realization motivates a large literature trying to understand the determinants of bank capital structure, one of which is corporate income taxation (CIT). A tax bias arises because in most countries debt financing has a tax advantage through interest deductibility relative to equity financing. It is not surprising then that taxation, among other factors, was identified to have contributed to the financial crisis of 2007 and 2008 through its impact on bank leverage (De Mooij, 2012; Slemrod, 2009; Turner, 2010). While there is some recent work assessing the effect of taxation on bank capital structure (De Mooij and Keen, 2016; De Mooij et al., 2013; Gu et al., 2015; Hemmelgarn and Teichmann, 2014; Schepens, 2016), the implications of corporate income taxation have not been fully explored for bank risk, which is where this paper's main contribution lies.

In this paper I first show that in countries where CIT rates are higher, banks have higher leverage ratios and hold less risky assets. Using a data set that includes 17,003 banks from 71 countries and spans the years 1997-2011, I find 0.9 percentage points higher leverage ratios on average over the whole sample period (conditional on a wide range of bank and country characteristics) for banks located in countries with 10 percentage point higher tax rates. These estimates lie in the range found by previous papers using bank level data (0.14-0.31 in De Mooij and Keen (2016) and De Mooij et al. (2013) and 0.1 in Hemmelgarn and Teichmann (2014)) and country level data (0.04-0.09 in De Mooij et al. (2013)). I also find that a 10 percentage point increase in the tax rate is associated with a 2-7 percentage point decrease of the average risk-weighted assets (RWA) of banks. This association cannot be fully attributed to risk-weight manipulation, since as I show, CIT also has a negative relationship with the volume of relatively risky bank lending and a positive relationship with portfolio quality. I find results consistent with the above in a robustness test using only US banks and effective marginal tax rates, rather than statutory tax rates.

These findings are consistent with the following story: since taxation drives

a wedge between the cost of debt and equity financing, banks' optimal capital structure favors debt financing in countries where tax rates are higher. However, banks are subject to risk-sensitive capital requirements, and in order to mitigate the likelihood of regulatory noncompliance they reduce the riskiness of their assets.

Consistent with this interpretation, I next show that the negative association between asset risk and CIT is stronger in countries where regulators are more stringent, and that non-financial firms' leverage and asset volatility are positively related to CIT. Since non-financial firms are not subject to risk-dependent capital constraints they do not seem to be forced to reduce asset risk in high-tax countries to be able to lever up. These results suggest that the regulatory constraint for banks is operational, which is in contrast with other papers that argue that the regulatory constraint is weak, for example, [Gropp and Heider \(2010\)](#).

These results do not necessarily imply that higher tax rates *cause* banks to choose higher leverage ratios and lower asset risk. In order to address causality, I exploit a quasi-natural experiment, the introduction of allowance for corporate equity (ACE) in Belgium. Introduced in 2006, ACE allowed all firms incorporated in Belgium to deduct a notional interest proportional to the book value of equity. This legislation thus introduced a tax-shield, which lowered the relative tax-advantage of debt financing. Indeed, like [Schepens \(2016\)](#), I find that Belgian banks reduced their leverage compared to other European, otherwise similar, banks after 2006. In addition, I find that undercapitalized Belgian banks increased their loan-to-assets ratio, consistent with the story that regulation constrained these banks to expand their loan exposures to a desired, higher level before 2006.

An implication of these results is that taxation might have an important effect not only on banks' capital structure, but also on the asset side of banks' balance sheets. Thus, corporate income taxes can have an impact on the real economy by affecting banks' portfolio allocation.

In the final part of the paper I study the relationship between corporate income tax rates and bank risk. This relationship is *ex ante* ambiguous, as higher tax rates incentivize higher leverage and lower asset risk. I find that the evidence on the relationship between tax rates and overall bank default risk is inconclusive,

as CIT and marginal effective tax rates are positively related to Z-score, a book value-based measure of risk; and negatively related to Merton's distance-to-default, a market-based measure. Looking at systemic risk, the evidence is more consistent and suggests that higher tax rates unambiguously are related to more systemic risk, either measured at the bank level or as the likelihood of systemic banking crises at the country level. This suggests that the reduced risk taking on the asset side due to regulation does not offset increased leverage risk as a result of higher corporate income taxation, and that high tax rates may contribute to a higher level of systemic risk. Thus, a lowering of tax rates, or the elimination of the tax-bias may be an effective way to reduce the risk of systemic banking crises. Alternatively, high tax rates may necessitate the adoption of appropriate macroprudential policies.

This paper bridges and extends two strands of literature. The first of these aims at quantifying the effect of CIT on bank capitalization. This literature is itself part of a larger research agenda, which seeks to understand whether banks have optimal capital ratios and if so, what their determinants are. Theoretical work includes [Orgler and Taggart \(1983\)](#), [Myers and Rajan \(1998\)](#), [Calomiris and Kahn \(1991\)](#), [Diamond and Rajan \(2000\)](#), and [Allen et al. \(2011\)](#). Empirical evidence is consistent with theories of optimal capital structure ([Schaeck and Čihák, 2012](#); [Flannery and Rangan, 2008](#); [Marcus, 1983](#)); and the literature has also converged to a set of factors that are reliable determinants of bank (and non-financial firm) leverage (c.f. [Gropp and Heider, 2010](#); [Frank and Goyal, 2009](#); [Berger et al., 2008](#)). While evidence on the tax bias is abundant, most papers discard financial firms from the analysis (see e.g. the reviews of [Graham, 2006](#); [Auerbach, 2002](#)).

There are a few recent papers that focus on banks. [De Mooij and Keen \(2016\)](#) find a long run CIT impact on bank leverage close to what the literature covering non-financial firms has found. [Hemmelgarn and Teichmann \(2014\)](#) look at how banks change their leverage, dividend policy and earnings management in reaction to tax rate changes and find a positive, but somewhat lower tax elasticity of leverage for banks. [De Mooij et al. \(2013\)](#) go one step further and estimate the effect of CIT on the likelihood of financial crises through increased leverage. [Gu et al. \(2015\)](#) concentrate on multinational banks' cross-boarder debt-shifting incentives.

Building on [Huizinga et al. \(2008\)](#), who estimated similar effects using a sample of non-financial firms, they find that, beside local tax rates, home-host country tax rate differences induce banks to allocate more capital to subsidiaries where CIT rates are lower. More recently, [Schepens \(2016\)](#) shows that Belgian banks increased their leverage following the introduction of an allowance for equity in Belgium, which reduced the benefits of the debt tax shield.¹ A common feature of these papers is that they treat asset risk as an exogenous variable², and little or no attention is paid to the simultaneous determination of asset risk and leverage. This paper extends this literature by treating both leverage and risk as endogenous variables.

Closest to this paper is [Devereux et al. \(2013\)](#), who estimate the impact of levies imposed on bank liabilities in a number of European countries. As in the present paper, these authors estimate leverage as well as asset portfolio risk regressions and find that higher levies induced banks to reduce leverage and increase asset risk; an analogous result to those presented here. There are a number of differences that distinguish our papers. While [Devereux et al. \(2013\)](#) look at levies imposed on liabilities, this paper uses corporate income taxes, which are more universal. Also, their sample consists of large European banks, while my sample covers a significantly larger range of countries and banks and a longer sample period. Using cross-country variation in the regulatory environment I can thus investigate the interaction between regulation and taxation more deeply, allowing me to identify the source of the trade-off between leverage and asset risk.

Recent work has also been done on the determinants of banks' RWA density (risk weighted assets to total assets). [Le Leslé and Avramova \(2012\)](#) list several bank and country level factors that can potentially influence RWA density. [Mariathasan and Merrouche \(2014\)](#) provide evidence that banks regulated under Basel II took advantage of advanced methods to calculate regulatory capital, which allowed them to lower their capitalization levels. This eventually led to an increased likelihood

¹Some recent work has been done on the effects of taxation on bank lending (see for example [Albertazzi and Gambacorta, 2010](#); [Buch et al., 2016](#); [Smolyansky, 2019](#)).

²[De Mooij and Keen \(2016\)](#) treat risk as an exogenous variable in their theoretical model, and as an endogenous explanatory variable in their empirical work, but they neglect the effects of CIT on bank risk.

of failure during the financial crisis. My paper adds to our understanding of what determines banks' management of risk weighted assets.

I proceed as follows. In section 2 I motivate the hypotheses of this paper. In section 3 I describe the data used in the regressions. In section 4 I provide evidence on the relationship between bank leverage, asset risk and CIT. Section 5 presents results of regressions of overall bank risk and section 6 discusses the results and concludes.

2 Hypotheses

While in a Modigliani-Miller world leverage is irrelevant, in reality firms (including banks) balance the costs and benefits associated with deviations from the MM world. Such deviations may arise as a result of agency problems, the tax bias and bankruptcy costs, leading to an intermediate level of optimal leverage. In particular, corporate income taxes are expected to increase the optimal debt level, because of the tax benefits of debt as a result of interest deductibility.

At the same time, banks are subject to minimum regulatory capital requirements, that are typically proportional to banks' weighted asset risk as in the Basel framework.³ Such requirements introduce a trade-off between bank leverage and risk-weighted assets: a bank that does not meet the regulatory capital requirement can lower leverage, lower asset risk, or choose a combination of these in order to comply.

These arguments suggests that we should observe that banks choose relatively high leverage ratios in countries with relatively high corporate income tax rates, and that they choose an asset mix that results in a relatively low average risk-weighted assets. Furthermore, one should expect that banks choose especially low asset risk in countries with relatively high corporate income tax rates and stringent

³I do not distinguish between different forms of eligible regulatory capital. Under Basel I and II Tier I capital comprises mostly common equity, while Tier II capital denotes various forms of hybrid capital elements, such as subordinated debt. Hybrid capital forms have the benefit that interest repayments on them are generally interest deductible, while they qualify as regulatory capital – up to a certain limit. As a result, as De Mooij and Keen (2016) show, banks have a tendency to choose the maximum amount of hybrid capital funding up to the allowed limit to meet regulatory requirements, the level of which is not effected by CIT. Therefore, abstracting from this capital element has little bearing on the estimated tax effects on bank capital structure.

regulation. This is because in these countries the tax benefits of debt financing are relatively large, which incentivizes leverage, but may require a relatively large adjustment on the asset side.

Finally, the overall impact of corporate income taxes on bank risk is ex ante ambiguous. The higher leverage is expected to increase default risk, while the lower asset risk is expected to lower bank risk. The overall effect of taxes on bank risk is thus an interesting empirical question, which I will address below.

3 Data

I use three samples of banks to study the interaction of bank taxation, leverage and asset risk: the first is a large sample of international banks, the second is a subset of these banks used in a difference-in-difference setting, and the third is a sample of US banks for which data on effective marginal tax rates is available. In the following sections I describe these data.

3.1 International sample of banks

I construct an unbalanced dataset spanning the period 1997-2011 covering 17,003 banks from 71 countries, based on data from Bankscope of Bureau van Dijk. This database contains bank balance sheet and income statement data from annual reports. In order to have a more homogenous sample I exclude financial institutions other than commercial banks, saving banks, and cooperative banks (e.g. investment banks and mortgage banks). Next, I restrict the sample to unconsolidated balance sheet data. This reflects that corporate income taxes are country specific, while consolidated accounting data are often multinational. To reduce the bias due to misreporting and outliers I winsorize all bank level variables at the 1% and 99% levels. Additionally, I remove all banks from the database with negative equity, as these banks might exhibit exceptional balance sheet ratios.

This leaves 148 608 bank-year observations, but due to limitations of Bankscope the sample size drops to 106 688 bank-year observations in the RWA density regressions, and to 103 624 bank-year observations in the regressions on the share

of non-performing loans. About two thirds of the banks in the sample are located in the United States, which potentially has a sample bias effect on the results if US banks respond to taxation differently from banks in other countries. To avoid drawing conclusions from potentially biased results, I also report the main results using a restricted sample excluding US banks.

Panel A of Table 1 shows summary statistics for all variables and the Appendix provides details about the definition and data sources of the variables. The main dependent variables are the *Leverage* ratio, which is defined as liabilities over total assets and *RWA* density, defined as risk weighted assets to total assets. Additionally, I replace *RWA* with two alternative measures of asset composition: *Loans* (relative to total assets); and *NPL*, the natural logarithm of the share of non-performing loans to total loans.⁴ These variables are closely related to bank asset risk. While *Loans* measures banks' exposure to risky assets relative to other, less risky assets, such as government bonds, *NPL* is a measure of the quality of banks' loan portfolios.

Panel A of Table 1 shows that *Leverage* has a mean of 0.89. Mean *RWA* density is 0.68, close to the mean of *Loans* at 0.62. There is a close association between *RWA* density and the loan ratio as shown by the high correlation between them (0.75, see Table 2). The share of non-performing loans (before taking logarithm) is close to 3% with a standard deviation of 0.04.

I assess the overall effects of corporate income taxation on bank stability using various measures. First, *Z-score* measures the losses required to entirely wipe out a bank's equity capital and is defined as $Z - score = \log[(K/A + ROA) / \sigma(ROA)]$, where $\sigma(ROA)$ is the standard deviation of return on assets and is calculated using a three-year rolling window. *Z-score* is thus a measure of distance to default based on book values, with higher values reflecting safer banks.

Next, I also calculate Merton's distance-to-default, *Distance-to-default*, which measures the size of a negative asset shock required to push the bank into negative equity like *Z-score*, but using stock market data.⁵ To estimate equity volatility

⁴I took the logarithm of the share of non-performing loans, because it has a highly skewed distribution.

⁵See e.g. Anginer et al. (2014) for a description of Merton's method to calculate distance-to-default. I exclude bank-year observations with less than 90 days of nonzero stock returns. The maturity of banks' debt is assumed to be one year. Total debt and the dividend yield is taken from Bankscope. The risk free rate is the yield on the one year US Treasury Bill.

and the market value of equity I use stock market data from Datastream, which I matched with Bankscope using ISIN codes.

Next, MES ([Acharya et al., 2017](#)) and COVAR ([Adrian and Brunnermeier, 2016](#)) measure systemic risk. More precisely, MES is the expected loss a bank experiences when the market is in distress and is calculated as the negative of the average daily stock market return of a bank in a given year conditional on the local MSCI banking sector index experiencing one of its 5% lowest returns in the same year. Similarly, COVAR measures a bank’s contribution to systemic risk, and is defined as the difference between the value at risk (VaR) of the financial system conditional on the bank experiencing one of its 5% lowest weekly returns in a given year and the VaR of the financial system conditional on the bank experiencing its median return in the same year. I follow [Adrian and Brunnermeier \(2016\)](#) and estimate COVAR using quantile regressions of weekly returns of the MSCI banking index and the bank’s stock, and calculate the average COVAR for each bank and each year.⁶ Stock market data for estimating MES and COVAR are taken from Datastream.

Finally, I also study the relationship between tax rates and systemic banking crises at the country level. The dummy variable *Crisis* indicates that a systemic banking crisis occurred in a given year in a given country, based on the data collected by [Laeven and Valencia \(2013\)](#).

The main independent variable in regressions using the international sample of banks is the the top statutory corporate income tax rate in the country of a bank’s residency, *CIT*. While the effective marginal tax rate is a better measure in theory ([Graham, 2000](#)), it is likely that the statutory tax rate is a good approximation of banks’ effective marginal tax rates. This is because banks are typically large companies and as such, the progressivity of the tax schedule is unlikely to be relevant.⁷ Regardless, for a sample of US banks I obtain estimates of effective marginal

⁶Following [Adrian and Brunnermeier \(2016\)](#) I condition on aggregate state variables in these regressions by adding the weekly return of the local MSCI stock market index and the weekly change in the VIX index as controls.

⁷As a simple test I calculated the correlation between the ratio of taxes paid to pre-tax income and statutory tax rates for the international sample of banks. At the bank-year level this figure is 0.29 without US banks. Including US banks unsurprisingly lowers this number as they make up two thirds of the sample and there is no variation in statutory tax rates within the US in a given year (and only

tax rates and use these in leverage and asset risk regressions in order to address the concern that using CIT as a proxy for effective marginal tax rates biases the results.⁸

The main sources of the statutory corporate income tax rates are the OECD database and, in case of non-OECD countries, the KPMG Corporate and Indirect Tax Surveys 2007, 2010 and 2011, which cover the period between 1993 and 2011. The average tax rate is 38.6%. This relatively high figure reflects that the sample contains a large number of banks located in the United States, Germany and Japan, all of which have high CIT rates (on average 39.3%, 39.5% and 33.3%, respectively).

I control for a range of bank and country level factors related to bank leverage and assets risk. Since I perform reduced form estimations, I include all control variables in both the leverage and risk equations. Bank size is commonly found to be positively related to leverage, which is explained by large banks' better risk diversification possibilities, better investment opportunities and access to debt capital. *Size* is taken to be the natural logarithm of the book value of total assets and to allow for a non-linear effect I also include the square of this variable. I also control for bank profitability by including two variables, *net interest margin* and the return on average assets (*ROA*): on the one hand firms may choose riskier asset portfolios in return for higher expected returns, on the other hand positive retained earnings improve banks' capitalization keeping other factors constant. *Fee income*, defined as non-interest income over total operating income, and *Wholesale funding*, measured by the ratio of non-deposit funding to total short term funding, control for income diversification and access to whole-sale funding. Both factors are shown to change the risk/return trade-off that banks face by Demirgüç-Kunt and Huizinga (2010). DeAngelo and Masulis (1980) show that non-debt tax shields, such as depreciation and investment tax credits, can crowd out the tax benefits of debt. To control for differences in access to non-debt tax shields I include *Non-*

minimal variation over time). The correlation between the ratio of aggregate taxes paid by banks in a given country in a given year relative to the total amount of pre-tax profits and statutory tax rates is 0.56, including all countries in the sample. These figures suggest that CIT is a reasonably good approximation of banks' effective tax rates.

⁸Additionally, this concern is somewhat mitigated in the difference-in-difference analysis I carry out, as it is likely that for affected banks for which statutory tax rates were lowered effective marginal tax rates decreased as well.

interest expenses relative to total assets, a proxy also used by [Gu et al. \(2015\)](#). The final bank level control variable in the baseline specification is *Market share*, the share of total assets relative to nationwide total bank assets, a proxy for market power. A higher market power may increase a bank's charter value, which reduces risk taking incentives. Alternatively, it can lead to increased risk taking by the bank's borrowers, which increases bank risk.

In robustness checks I also make use of the ownership data of Bankscope as well as the database assembled by [Claessens and van Horen \(2014\)](#) in order to control for the possibility of international debt-shifting by multinational banks. I create three variables: *CIT diff (Local - owner)* is the difference between tax rates applicable to the bank and its owner: for domestically owned banks it is zero (as well as for banks without ownership data), while for banks owned by a foreign parent it is positive if the local tax rate is higher than in the country where the parent bank is headquartered. In a similar fashion *CIT diff (Local - frgn subsidiary)* is calculated as the difference between the local and foreign tax rates, but this time the latter is taken to be the average (unweighted) tax rate of the countries where the subsidiaries are located (domestic subsidiaries are excluded). Subsidiary data is taken from Bankscope, and not from [Claessens and van Horen \(2014\)](#), since the latter does not contain information on subsidiaries (only on ultimate owners). A subsidiary is taken to be owned by a parent company if it has an ultimate ownership larger than 50%. Bankscope does not contain historic ownership data, therefore I assume that subsidiary ownership did not change over the sample period (an assumption also made by [Gu et al. \(2015\)](#)).⁹ Finally, I include a dummy variable (*No ownership data dummy*) indicating if a bank is not in the [Claessens and van Horen \(2014\)](#) database. This variable controls for the possibility that the availability of ownership data is correlated with the tax rate difference between owners and subsidiaries.

In addition to the bank level control variables I also add country level macroeconomic controls. *RGDP growth* controls for the cyclical variation of leverage and risk related to business cycle fluctuations. Leverage is expected to be procyclical

⁹No dummy variable is created to indicate missing subsidiary data as it is not known if a bank truly does not have any subsidiaries or it only appears so because of missing data. Furthermore the sample contains only 24 observations where a bank has exclusively domestic subsidiaries.

(high in upturns, low in downturns) because various constraints, such as collateral and regulatory constraints, are tighter during downturns ([Adrian and Shin, 2010](#); [Geanakoplos, 2010](#)). Asset risk is also expected to be larger in recessions, when borrowers have lower net worth or because risk may be overestimated. *GDP per capita*, calculated on a PPP basis, controls for differences in the economic development between countries, which might be correlated with financial and capital market development. The consumer price index (*CPI*) serves as a proxy for expected inflation. The real value of tax deductions (positively) depends on expected inflation, thus it is an important control variable (as confirmed by [Frank and Goyal, 2009](#)), with a positive expected effect on leverage. *Government debt to GDP* serves to control for “financial repression” and/or banks’ incentives to load on highly indebted governments’ debt. This channel suggests a negative relationship between government indebtedness and *RWA*, because sovereign debt fetches a low regulatory risk weight under Basel I and II. The last macroeconomic control variable is the nominal *Exchange rate change*, which has been shown to affect portfolio risk ([Bock and Demyanets, 2012](#)). A large nominal exchange rate depreciation might reduce borrowers’ ability to service debt denominated in foreign currencies, which –*ceteris paribus*– worsens portfolio quality. On the contrary, depreciation might be beneficial, if this strengthens international competitiveness and improves corporate profits. *RGDP growth*, *GDP per capita*, *Government debt/GDP*, *CPI* and *Exchange rate change* figures were taken from the World Economic Outlook database. *Aggregate credit* controls for loan demand, which is calculated as the sum of gross loans of all other banks in the country, normalized by the sum of total assets. It is common that corporate income taxes are the same for financial and non-financial companies, therefore taxes might be correlated with loan demand (through the same tax-shield effect or by influencing firm profitability) as well as bank leverage and risk. Since loans are generally riskier than other risky assets, such as government bonds, an increase in loan demand may lead to higher *RWA* density through an increased share of loans in total assets.

Next, I control for the regulatory environment by including minimum *Capital requirements* and two other indicators from [Barth et al. \(2001\)](#). The first, *Capi-*

tal stringency is a measure of regulatory oversight of how banks calculate capital, which ranges between 0 and 9, with higher values indicating more stringency. *Activity restrictions* is a variable that measures regulatory restrictions on certain bank activities, such as securities market, insurance, real estate activities and the ownership of non-financial firms, on a scale from 4 to 16, with higher values indicating more restrictions. These regulatory controls are commonly used in the bank risk taking and capital regulation literature (see [Laeven and Levine, 2009](#), for example). On the one hand stricter regulation may result in less levered banks and with less risky assets, reflecting the regulator’s preferences for a more stable banking sector. On the other hand, bankers may compensate for the loss in utility as a result of regulation by increasing risk taking, which may lead to higher leverage and/or higher asset risk. Thus, the impact of regulation is ambiguous ex ante. Bank regulation data are obtained from the World Bank’s Bank Regulation and Supervision Survey database. The survey comprises four waves, 2001, 2003, and 2007, 2011 and I replace missing values of interim years by the values of subsequent years (so, for instance, observations of 2009 are taken from the last wave). I also include the dummy variable *Basel II* indicating whether in a given year and a given country the Basel II guidelines were implemented and in effect. This dummy serves to control for the possibility that Basel II allows for a more lenient way of calculating regulatory capital. Under Basel II banks can opt for internal models to determine risk weights, which opens the door to regulatory arbitrage and risk-weight manipulation through model optimization ([Mariathasan and Merrouche, 2014](#)). The dummy is constructed from data from the BIS progress reports on the implementation of the Basel regulatory framework.¹⁰ Finally, I control for shareholder protection with *Creditor rights*, an index of statutory rights of shareholders from [Djankov et al. \(2007\)](#). The index ranges from zero to four and higher values indicate more creditor protection. It is expected to be positively related with bank loans and bank leverage, since creditors are more willing to lend when they have more powers in case of bankruptcy.

¹⁰The first year in which this variable is nonzero is 2007, when all EU Member States introduced the new regulation, along with few other countries. Some countries, however, waited with the implementation, the US for instance was a slow mover with an adoption year of 2009. By 2011 forty-four countries had adopted the Basel II rules in the sample.

3.2 Sample of US banks

In theory firms make capital structure decisions based on the effective marginal tax rate (MTR) applicable to them. While constructing estimates of the effective marginal tax rate for a large, international sample of banks is difficult, I am able to create a sample of US banks for which such estimates are available. In particular, I matched bank balance sheet data in Compustat with the simulated effective marginal tax rates made available by John Graham.¹¹ I use the simulated corporate MTR based on income before interest expense has been deducted as after-interest MTRs are endogenous to past financing decisions and using them would bias the estimations (Graham et al., 1998).

I created the same bank level variables as described above. All the necessary balance sheet data are available in Compustat except for *RWA*, which I obtained from bank holding companies' FR Y-9C reports. Stock market data to calculate bank risk variables comes from the Center for Research in Security Prices (CRSP).

After merging the various datasets the sample contains 618 banks and the sample period runs from 1993 to 2018, but excludes the years 1999 to 2006, as for these years MTR data for banks is not available. Panel B of Table 1 shows that the average bank characteristics are very similar in the international and US only samples. For example, the average US bank has a leverage ratio of 0.892, *RWA* density of 0.71 and loans to assets ratio of 0.686 in my sample, while these figures for the average bank in the international sample are 0.893, 0.676 and 0.632, respectively. US banks look similar to banks in the international sample along other characteristics as well, except for size, as they are smaller on average.

4 Results – the relationship between taxes, leverage and asset risk

In this section I present results on the trade-off between leverage and asset risk, and how this is affected by corporate income taxation. First, I show that for an

¹¹See Graham (1996a,b) for an explanation of how simulated effective marginal tax rates are obtained.

international sample of banks higher tax rates are related to higher bank leverage and lower asset risk measures. Next, I present the results of a difference-in-difference analysis, which suggests that these patterns are causal. Finally, I show evidence on the relationship between effective marginal tax rates and bank leverage and asset risk.

4.1 Results using the international sample of banks

4.1.1 Long run estimates of tax elasticities

Leverage and asset risk are likely jointly determined. For example, banks with higher asset risk may choose lower leverage ratios to lower expected bankruptcy costs. Ideally one would estimate structural equations of leverage and asset risk using instruments for each of these variables. This is a challenging task as it is difficult to find valid instruments. Instead, throughout the paper, I estimate reduced form regressions to establish the relationship between tax rates, leverage and asset risk.

I obtain baseline OLS estimates of the long run reduced form tax elasticities by estimating the following static regressions:

$$\bar{y}_{ij} = \alpha + \gamma \overline{CIT}_i + \delta \bar{X}_{ij} + \lambda \bar{Y}_i + \varepsilon_{ij}, \quad (1)$$

where $\bar{y}_{ij} = \sum_{t=1}^T y_{ijt}/T$, and y_{ijt} is either leverage or one of the risk/asset composition measures of bank i in country j in year t , CIT_{jt} is the statutory corporate income tax rate, X_{ijt} and Y_{jt} are collections of bank and country level control variables, respectively, ε_{ij} is an error term, and upper bars denote time-averaged variables. The baseline risk measure is risk-weighted assets over total assets and I employ two additional asset composition variables to try to break down the adjustment of risk-weighted assets to total assets into a “quality” and a “quantity” effect. This separation rests on the observation that banks hold large amounts of government securities, which fetch zero or low risk weights. The “quality” effect then refers to the riskiness of the risky asset portfolio, while the “quantity” effect relates to the size of the risky portfolio.

Unfortunately, banks do not report risk weights separately for different asset types, thus I cannot measure the impact of taxation on risk weights of different asset classes directly. Instead, I proxy the average risk weight of risky assets by the share of non-performing loans, while the loans-to-assets ratio proxies the size of banks' risky portfolio.¹² These measures can also be thought of as alternative measures of bank asset risk. There is a tradition of proxying bank risk with the share of non-performing loans. There is also evidence that banks that had higher loans to assets ratios performed worse during the financial crises in 2007 and 2008 (Beltratti and Stulz, 2012).

Regression 1 of Table 3 shows the result of estimating Equation (1) with *Leverage* as dependent variable. The estimate of the *CIT* coefficient is significant in the leverage regression, but at 0.09 it is considerably smaller than what earlier literature found using similar bank level data (e.g. De Mooij and Keen (2016) and De Mooij et al. (2013)). These papers find long run tax effects on leverage in the range of 0.14-0.31. In unreported regressions, which include only the control variables used by the mentioned studies (*Size*, $Size^2$, *ROA*, *CPI*, *RGDP growth*), I find that the difference comes mostly from the inclusion of additional control variables. For example, dropping the dummy *Basel II* increases the coefficient estimate of *CIT* from 0.09 to 0.21. However, dropping any other further control variable does not change this coefficient estimate by more than 0.02.

The control variables have generally the signs found in other studies: *Size* is positively and significantly related to leverage in a non-linear way. *Net interest margin* is also significant and obtains a negative coefficient. Similarly, *ROA* obtains a negative, but insignificant coefficient. Thus, banks seem to use retained earnings to recapitalize. The risk characteristics proxies, *Fee income* and *Wholesale funding*, are negatively related to leverage, which is consistent with a substitution effect between various risk types. The non-debt tax-credit proxy, *Non-interest expenses*, has a significant, negative coefficient, as in Gu et al. (2015). Finally, *Market share* is positively related to leverage, which may be because banks can borrow against

¹²This is a precise measurement in the special case when there are only two asset types, a risky asset with risk weight ω_r and a riskless asset $\omega_i = 0$. Then asset risk is $r = \omega_r A_r / A$ which depends on the amount of risky assets and the risk weight.

the net present value of their monopoly rents. At the country level higher *Capital requirements* and *Activity restrictions* reduce, stronger *creditor rights* enhance debt financing, as expected. *Basel II* and *GDP growth* enter with negative and significant coefficients, while *Aggregate credit* enters with a positive sign.

Regression 2 of Table 3 shows the result of estimating Equation (1) as the risk weighted assets to total assets ratio as a dependent variable. The results are consistent with the buffer theory of bank capital: *CIT* has a negative coefficient of -0.20, significant at the 1% level. A 10 percentage point higher tax rate is thus associated with an expected reduction in the long run of about two percentage points, which seems small compared to the average level of 67%, but it could be significant for the real economy at the aggregate level through its effect on credit supply.

Regressions 3 and 4 are analogous to regression 2, but *RWA* is replaced by alternatively the loans to assets ratio and *NPL* variable, respectively. In regression 3 the estimation results suggest that *CIT* is negatively associated with the share of lending in total assets. *CIT* has a long run marginal impact of -0.20, which is significant at the 1% level. Most coefficients have the same signs as those in the corresponding regression on risk weighted assets, which is not surprising given the high correlation between the two variables. There are differences, however. *Basel II* is not significant, and has a positive coefficient now, which is consistent with banks having achieved a reduction in risk weighted assets by lowering risk weights, and not by cutting lending. Another difference is in the coefficient estimates of *Aggregate credit*, yielding a higher estimate in the loan regression, reflecting a closer association between the two variables. The loan-to-assets ratio is negatively related to government indebtedness, which is expected, if there is regulatory/government pressure on banks to absorb government bonds and this crowds out lending. *Capital requirements* also obtains a negative coefficient in regression 1 suggesting that banks adjust to higher regulatory capital requirements by buying more low risk assets, such as government bonds, relative to lending.

In regression 4, when the dependent variable is the log of the share of non-performing loans to total loans, *CIT* is estimated to have a coefficient of -5.98,

significant at 1%. A 10-percentage-point higher *CIT* is thus associated with a stock of non-performing loans relative to total assets that is 60% lower, which amounts to a difference of 0.36 standard deviations.

Among the control variables that obtain significant and robust coefficients *ROA* has a negative sign, perhaps because less profitable banks take more risk due to risk shifting. *Market share* has a positive and significant coefficient, which is suggestive of laxer lending standards when loan volume is high. *Fee income* also has a positive and significant coefficient. This could be because more fee income yields better diversified banks, which then allows for increased risk taking. Similarly, *Basel II* picks up a positive coefficient in the OLS regression, suggestive of increased risk taking as made possible by the lower risk weights attained under the Basel II framework. As expected, real GDP growth facilitates debt repayment and improves bank portfolio quality, while a nominal exchange rate depreciation is, on average, expected to increase the share of non-performing loans, which thus seems to dominate the positive effects of larger corporate profits as a result of the depreciation.

The regressions results in columns 1-4 of Table 3 suggest that banks choose higher leverage ratios and lower asset risk in high-tax countries. The question arises whether this pattern is causal, and to what extent it is attributable to bank regulation. In subsequent sections I show that an unexpected change in corporate income taxation induced adjustments by Belgian banks that are consistent with a causal interpretation.

Here, I provide evidence on the role of bank regulation by adding the interaction between *CIT* and regulatory stringency to regressions 1 and 2 of Table 3 and report them as regressions 5 and 6. In the leverage regression (regression 5) *CIT* has a positive and significant coefficient, while the interaction term is negative and also significant. The estimated tax effect for a bank located in a country with average regulatory stringency is 0.08 ($=0.24 - 0.03 \times 5.3$, see the descriptive statistics in Panel A of Table 1), close to the baseline estimate without interactions (regression 1). In the RWA regression the standalone *CIT* variable has a coefficient of 1.133, while the interaction term is negative (-0.27), with both coefficients estimated to be significant. This means that banks located in the least stringent regulatory

environments are found to increase RWA in response to taxes, while banks located in countries with a *Regulatory stringency* index larger than 4.18 ($=1.13/0.27$) reduce asset risk. These results suggest that more stringent regulation reduces banks' incentives (or opportunity) to increase leverage in response to higher tax rates.¹³ At the same time, banks seem to be forced to cut back on asset risk more aggressively in more stringent regulatory environments, perhaps in order to be able to increase leverage. These results support the hypothesis that banks trade off leverage against asset risk because of capital regulation.

In Panels A and B of Table 4 I show the results of various robustness tests. First, I recognize that leverage and asset risk may adjust sluggishly, as it is commonly assumed in the capital structure literature (c.f. Gropp and Heider, 2010; Berger et al., 2008). Following these papers I estimate dynamic versions of (1), which allow for sluggish adjustment of the dependent variables. The underlying assumption is that banks have leverage and risk targets and in each period they aim to close a constant fraction of the gap between the target and actual leverage and risk levels, if they differ. I explain these assumptions in section A.2 of the Appendix in greater detail. The estimated partial adjustment model is:

$$y_{ijt} = \beta y_{ijt-1} + \gamma CIT_{it} + \delta X_{ijt} + \lambda Y_{it} + \eta_t + \mu_{ij} + \varepsilon_{ijt}, \quad (2)$$

where y_{ijt} is either *Leverage* or *RWA* for bank i in country j in year t , CIT_{it} is the statutory corporate income tax rate, X_{ijt} and Y_{jt} are bank and country level control variables as before, η_t and μ_{ij} are year and bank fixed effects, respectively, and ε_{ijt} is a potentially serially correlated idiosyncratic error term.

The OLS and within estimators yield biased estimates of the coefficients in (2) because y_{ijt-1} is correlated with the fixed effects in the error term, which cannot be removed by simple demeaning. To overcome this difficulty I employ the system-GMM estimator developed by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). This estimator eliminates bank fixed effects through

¹³Nonetheless, for almost all banks the estimated CIT impact on leverage is positive. The marginal impact of *CIT* on leverage is zero when *Regulatory stringency* is equal to $8.44 = 0.27/0.032$. There are only five observations with *Regulatory stringency* larger than 8.

first differencing, while the resulting endogeneity due to differencing is resolved by instrumenting with lags. The advantage of the GMM estimator is that it exploits both the time and cross-sectional variations of the data, while still controlling for unobserved time-invariant heterogeneity. I employ the two-step GMM estimator to allow for a non-spherical error covariance structure and calculate standard errors clustered at the country level. Furthermore, the finite sample correction to the two-step covariance matrix derived by Windmeijer (2005) is applied.

I report the results of estimating equation (2) in columns 1 and 2 of Panel A of Table 4 with *Leverage* and *RWA* as dependent variables, respectively. In the leverage regression the estimated short run impact is 0.05, significant at 1%, which is about half of what De Mooij and Keen (2016) find. They, however, find a slower adjustment speed than I do: the estimate of the coefficient of the lagged dependent variable in regression 2 is 0.58, significant at 1%. These coefficients combine into a long run marginal effect of 0.11 ($= \gamma/(1 - \beta) = 0.05/(1 - 0.58)$), which is close to the long run estimate using the between estimator in regression 1 of Table 3. A 10% increase in the statutory income tax rate is thus associated with an expected increase in bank leverage by about 0.9-1.1 percentage points.

In regression 2 the dependent variable is *RWA*. Along with other time-invariant bank characteristics, bank fixed effects control for corporate governance performance and ownership structure, which have been shown to be related to bank risk-taking (Laeven and Levine, 2009). To estimate this regression I restricted the sample to exclude years up to 2003, because almost all *RWA* observations prior to 2004 were submitted by US banks. The rate of adjustment is slow, banks close only about 16% ($= 1 - 0.84$) of the gap between target and actual *RWA* density per year. The short run impact of *CIT* is -0.11, which is significant at 5%. This translates into an expected long run elasticity of -0.70, significant at 10%, about three times the between estimate.

In regressions 3 to 6 I provide robustness tests to eliminate the effect of further potential confounding factors. Multinational banks have an incentive to shift debt to subsidiaries located in high-tax countries. Regressions 3 and 4 of Table 4 attempt to control for the possibility that such debt shifting correlates with risk incentives,

which could potentially bias the results. To that end I include *CIT diff (Local - frgn subsidiary)*, which is the difference between the CIT rate applicable in the country of residency of a bank and the average CIT rate of its subsidiaries. Similarly, I add the difference between the local CIT rate and the CIT rate of the country of the parent bank (which is zero in case of same country parent banks). I also include a dummy indicating if no ownership data is available. The main results do not change as the estimated marginal tax elasticity of debt is still around 0.8 and significant, while an offsetting elasticity is measured for *RWA* at -0.2, also significant. The tax rate differences do not enter the regressions with significant coefficients. Interestingly, however, the *No ownership* dummy obtains a positive and significant coefficient in the leverage regression, which is consistent with the possibility that for some foreign subsidiaries located in tax havens ownership information is not available, and that these banks have higher leverage ratios possibly as a results of within-group debt shifting. In regression 4, when *RWA* is the dependent variable, the *No ownership* dummy has a negative and significant coefficient, which is consistent with the previous results, namely that banks without ownership data choose lower *RWA* in order to maintain compliance with regulatory capital requirements while having higher leverage ratios.

In the last four regressions (5 to 8) of Table 4 I study the role of deposit insurance. Theory and empirical evidence suggests that deposit insurance induces moral hazard in the banking sector and reduces financial stability (Demirgüç-Kunt and Detragiache, 2002), which may lead to tighter bank regulation in some countries. As a result, it is possible that the empirical patterns identified in Table 3 are driven by an omitted variable bias. I control for this possibility by including the deposit insurance coverage limit scaled by GDP (*Deposit insurance*) as a control variable. This variable obtains negative and significant coefficients in both the leverage and *RWA* regressions in columns 5 and 6. This suggests that in countries with more generous deposit insurance schemes banks have lower leverage and asset risk ratios, perhaps because regulators subject banks to stronger supervision in these countries. In regressions 7 and 8 I extend regressions 5 and 6 of Table 3, which include the interaction between *CIT* and *Regulatory stringency*, by adding the interaction of

CIT and *Deposit insurance*. The latter term receives a negative and significant coefficient in the leverage regression, suggesting that in countries with stronger deposit insurance banks choose higher leverage, possibly because deposit insurance reduces the risk sensitivity of funding costs, making a higher risk of bankruptcy more optimal for banks. Importantly, the interaction between *CIT* and *Regulatory stringency* continues to be negative and significant, implying that the stronger negative relationship between *RWA* and *CIT* rates in countries with more stringent regulation is not driven by the generosity of deposit insurance.

In Panel B of Table 4 I test the robustness of the results to changing the sample. First, in regressions 1 and 2, I restrict the sample to pre-crisis years (up to 2006) and reestimate the baseline regressions 1 and 2 of Table 3. It is conceivable that during crisis periods other factors influencing banks' capital structure become more important relative to tax incentives. Indeed, in regression 1, when the dependent variable is *Leverage*, the marginal effect of *CIT* is 0.16, almost twice as large as the baseline between estimate. Next, *CIT* obtains a negative and significant coefficient in regression 2, confirming the negative association between *CIT* and asset risk obtained in the baseline regression.

To deal with the overrepresentation of US banks in the sample I also reestimate the baseline estimates excluding US banks. Columns 3 and 4 show the corresponding results. In the leverage regression the coefficient on *CIT* is about the same size as when run on the full sample (0.11 versus 0.9). In the *RWA* regressions *CIT* remains negative at -0.08, but it is not significant anymore.

Finally, in regressions 5 and 6 I restrict the sample to include only banks with loan to assets ratios higher than 0.5 and ratios of non-interest income to total operating income of no greater than 0.2. Banks that do not meet these criteria may not face the same type of trade-off induced by regulation as they possibly rely more on investment bank activities. Consistent with this hypothesis, the estimated coefficients are larger in magnitude than their corresponding estimates in the baseline regressions (columns 1 and 2 of Table 3).

4.2 A quasi-natural experiment: the introduction of Allowance for Corporate Equity in Belgium

In this section I exploit a natural experiment to identify the effect of corporate income taxation on bank leverage and asset risk. The event I study is the introduction of Allowance for Corporate Equity in Belgium, which lowered the tax advantage of debt financing for banks resident in Belgium by allowing a tax deduction proportional to a bank's book value of equity. This paper is not the first to exploit this shock: [Schepens \(2016\)](#) shows that after the introduction of ACE Belgian banks reduced their leverage. The aim of the analysis in this paper is to study how Belgian banks changed their asset portfolios in response to the new tax rule and the resulting weaker incentives for high leverage.

4.2.1 Background for the introduction of ACE

As explained by [Schepens \(2016\)](#), ACE was introduced in Belgium in 2006, after the European Commission ruled that the previously existing tax regime was discriminatory vis-à-vis Belgian companies. This tax regime allowed subsidiaries of foreign companies to be taxed at a relatively low rate based on expenses less financial and salary costs (instead of profits). This created a very favorable tax treatment for multinational companies, which responded by creating so called coordination centers, whose only real purpose was to provide financial and accounting services to their parent banks. In order to retain the attractiveness of Belgium for foreign firms, the Belgian government responded to the end of this favorable tax treatment by introducing ACE, which is applicable to all firms, including Belgian ones.

The Belgian ACE allows firms incorporated in Belgium to deduct a notional interest, which is linked to the yield on the 10-year Belgian government bond. The total deduction then equals the notional rate times a firm's book value of equity, which creates an equity tax shield.¹⁴

¹⁴In the first three years of the implementation the notional interest rates for 3.44%, 3.78% and 4.31%.

4.2.2 Data and methodology for the difference-in-difference regressions

I carry out a standard difference-in-difference estimation to establish the relationship between corporate income taxation, bank leverage and asset risk. Unfortunately risk-weighted assets were not reported by Belgian banks in my sample during this period, hence I use the loans-to-asset ratio as a proxy of asset risk. Regression 3 of Table 3 suggests that banks have significantly lower loan to assets ratios in countries with higher tax rates, suggesting that this variable is a good proxy for RWA density.

To create a sample of treated and control banks I start with the same sample of banks that was used in the previous section and follow the methodology applied by Schepens (2016). First, I restrict the sample to the years 2003 to 2007 and use the years 2003, 2004 and 2005 as the pre-treatment period, and 2006 and 2007 as the post-treatment period. Next, I match Belgian banks with their three nearest neighbors with replacement using the same matching variables as Schepens (2016) (two lags of banks' equity to assets ratio, the natural logarithm of banks' total assets, and the GDP growth and inflation in the country of their residence), and additionally two lags of banks' loans to assets ratios as I want to create a sample of control banks for which the parallel trends assumption is likely to hold.

Table 5 shows the summary statistics for the treatment and control samples in the pre-treatment period, for the years of 2003 to 2005. Belgian banks have leverage and loans to assets ratios with sample means that are not statistically significantly different from those of the matched, non-Belgian banks. In addition, the means of the first difference of these ratios are also not statistically significantly different, providing support for the parallel trends assumption, which is necessary to make unbiased inference using the difference-in-difference approach. Treated and non-treated banks also look similar in other dimensions both at the bank and country levels, although in some cases the differences in means are statistically significant. It is unlikely that these differences bias the estimates, as they are economically small, and are explicitly controlled for in the regressions. What is important is that the dependent variables for control and treated banks seem to have followed

similar trends before treatment.

To estimate the impact of ACE on bank leverage and the loan to assets ratio I run the following regressions:

$$y_{ijt} = \alpha_i + \beta Post_t * Treated_{ij} + \gamma Post_t + \delta X_{ijt} + \lambda Y_{it} + \varepsilon_{ijt}, \quad (3)$$

where y_{ijt} is either leverage or the loan to assets ratio of bank i in country j in year t , $Post_t$ is a dummy variable for the years 2006 and 2007, $Treated_{ij}$ is a dummy variable indicating Belgian banks, X_{ijt} and Y_{it} include the same set of bank and country level control variables as the baseline regressions (equation (1))¹⁵, α_i denote bank fixed effects, and ε_{ijt} is an error term.¹⁶ In these regressions standard errors are clustered at the bank level.

4.2.3 Results of the difference-in-difference regressions

Table 6 shows the results of estimating equation (3). In regression 1 the dependent variable is *Leverage*, and the variable of interest, $Post * Treated$ obtains a negative and significant coefficient. This confirms the result of Schepens (2016), namely that Belgian banks reduced their leverage ratios following the introduction of ACE. In regression 2 the dependent variable is the loan to assets ratio, and the estimated coefficient is positive. This is consistent with Belgian banks increasing their loan exposure as a result of their lower leverage ratios post-treatment. Still, the estimate can hide significant heterogeneity, which might explain why it is estimated to be insignificant. To test for this, I include further interaction terms with a dummy variable indicating that the bank had an above median equity to assets ratio in 2005, before the treatment took place (E/A). Regression 3 reveals that both well-capitalized and under-capitalized Belgian banks reduced their leverage ratios as the interactions $Post * Treated$ and $Post * Treated * E/A$ have negative coefficients, albeit only the latter is estimated with sufficient statistical precision.

In regression 4, with the loan to assets ratio as dependent variable, $Post * Treated$

¹⁵Except that the difference-in-difference regressions exclude *Capital requirements* and *Creditor rights* because of a lack of variation in these variable for the matched sample.

¹⁶The model is saturated by the inclusion of bank fixed effects, hence $Treated_i$ cannot separately be included.

has a positive and significant coefficient, while $Post * Treated * E/A$ obtains a negative and significant coefficient. Thus, undercapitalized Belgian banks increased their loan exposure following the adoption of ACE, suggesting that these banks were constrained before treatment. With the introduction of ACE, lower leverage became more attractive, allowing for higher loan ratios for these banks, consistent with a trade-off between leverage and asset risk induced by regulation, and taxation affecting the optimal choice in this trade-off. The overall effects are economically meaningful: undercapitalized Belgian banks lowered their leverage ratios by around 1.4 percentage points, and increased their loans to assets ratios by around 4.8 percentage points after the introduction of ACE, relative to similar non-Belgian banks.

4.3 Marginal effective tax rates and US banks' leverage and asset composition

Banks make their leverage decisions based on marginal effective tax rates, which do not necessarily equal statutory rates, e.g. because banks may exploit other tax shields. It is difficult to obtain marginal effective tax rates for a large international sample of banks, because one would have to simulate taxable income using detailed tax codes in various countries. Instead, in this section I use a sample of US banks for which marginal effective tax rates data is available, and study whether higher effective tax rates are related to higher leverage ratios, and lower asset risk.

To that end, I estimate regressions that are analogous to those in Table 3, but where the sample includes US banks only, and the statutory corporate income tax rate is replaced by the effective marginal tax rate. These regressions are presented in Table 7. In regression 1 the dependent variable is *Leverage* and *MTR* obtains a positive, significant coefficient, which, at 0.03 is smaller than the estimated coefficient for the statutory rate using the international sample (0.09, regression 1 of Table 3), but is of the same order of magnitude. In regression 2, when the dependent variable is *RWA*, the tax variable obtains a coefficient of -0.17, which is very close to the estimated coefficient of -0.2 for *CIT* in regression 2 of Table 3.

Similarly to the regressions in Table 3, in regressions 3 and 4 I replace *RWA* by

the loan to assets and (log) NPL ratios. In these regressions *MTR* obtains negative coefficients, like their counterparts in Table 3, albeit insignificant ones. Finally, in regressions 5 and 6 I include interactions with a measure of regulatory strictness, analogously to regressions 5 and 6 in Table 3. The included measure of regulatory strictness for a given bank, *Avrg CR*, is the average of the total regulatory capital ratio of all other banks in the state where the bank is headquartered. In states where banks have relatively high regulatory capital ratios it is reasonable to assume that these are at least partly driven by regulators. While the estimated coefficients are insignificant, their signs are consistent with the results in Table 3. In both the leverage and RWA regressions the coefficients of *MTR* have positive signs, while its interaction with other banks' average regulatory capital ratios obtains negative coefficients. Like before, this is consistent with banks responding to high marginal effective tax rates in states with relatively stricter bank supervisors by increasing leverage relatively little, and cutting RWA relatively more.

4.4 Taxation and non-financial firms' leverage and asset risk

A major difference between banks and non-financial firms is that the latter group are not subject to bank regulation and as a result they face fewer constraints on their balance sheets. This suggests that non-financial firms may be able to rely more heavily on debt financing without having to deviate from their optimal project choices. To see if this is the case I look at a sample of non-financial firms and run similar regressions to those in Table 3.

The sample includes all publicly listed firms in the Worldscope database, which is the source of firm level balance sheet data. I restrict the sample to the years 1997-2011 to coincide with the sample period of the sample of banks. The dependent variables are *Leverage*, which is defined as total liabilities of total assets; and *Asset volatility*. Asset volatility is obtained using Merton's option pricing model.¹⁷ The

¹⁷This variable is estimated using the same assumptions, methodology and data sources (except for total debt and the dividend yield which are taken from Worldscope), that were used to calculate the distance-to-default measure described in section 3.

firm level control variables are the same as and defined analogously to those in the bank sample, except for certain variables which are not applicable for non-financial firms (*Net interest margin*, *Fee income*, *Wholesale funding*). I include all macro level control variables in the regressions with the exception of bank related variables (*Basel II*, *Activity restrictions*, *Regulatory stringency*, *Capital requirements*, *Market share*, *Aggregate credit*). Summary statistics of the firm level variables in the sample of non-financial firms are shown in Panel C of Table 1. The sample contains 155,099 observations from 16,350 firms in 62 countries.

Table 8 presents the results of the regressions of non-financial firms' leverage and asset volatility. As before, I look at long run relationships using the between estimator.¹⁸ In regression 1 the dependent variable is *Leverage* and I find that *CIT* obtains a positive and significant coefficient of 0.36. This estimate is about four times as large as that obtained in the OLS regression in column (1) of Table 3. Thus, non-financial firms seem to have relatively higher leverage when taxes are higher in comparison to banks. This is consistent with non-financial firms facing fewer (regulatory) constraints to lever up. This result is robust to the inclusion of industry dummies as seen in regression 2: the coefficient of *CIT* remains 0.36. The industry dummies indicate that a firm belongs to a certain industry according to the three-digit SIC classification system. Frank and Goyal (2009) show that median industry leverage is a core predictor of firm leverage and provide several possible explanations (such as peer effects and industry heterogeneity in the types of assets, business risk, technology, or regulation). The industry dummies capture these factors.

Next, turning to the asset risk regressions, I find that *CIT* is positively related to asset volatility as evidenced by the positive and significant coefficient (at 0.015) in regression 3. When I add industry dummies in regression 4 the estimate changes slightly to 0.014 but remains significant. Thus, for non-financial firms it appears that there is a positive relationship between corporate income tax rates and asset risk, while for banks this relationship is negative. The finding of riskier firms in high-

¹⁸I also ran dynamic panel regressions using GMM in a similar fashion to the regressions in Panel A of Table 4. In the leverage regression *CIT* obtains a negative, but insignificant coefficient. In the *Asset volatility* regression *CIT* obtains a positive and significant coefficient. These results are not reported because the regressions fail the basic diagnostic tests required for unbiased estimation.

tax countries is consistent with moral hazard: firms choosing more risky projects when their profitability is weakened by higher taxes. Furthermore, it also suggests that an alternative explanation for the observed negative relationship between bank asset risk and tax rates is not likely. According to this explanation banks lend to less risky borrowers because taxation is asymmetric: the government shares from the profits but not from losses, thereby reducing risk taking incentives.

5 Taxes and overall bank risk

The previous sections provide evidence that higher corporate income tax rates induce banks to choose lower leverage ratios and lower their asset risk. While the former effect increases overall bank risk *ceteris paribus*, the latter reduces it. The effect of corporate income taxes on overall bank risk is thus *ex ante* ambiguous. In this section I provide evidence that sheds light on this relationship.

I start by running regressions of measures of bank risk on *CIT* and the same set of control variables as in the baseline regressions using the same sample and methodology as in Table 3, except that I exclude *ROA* as a control variable as it is directly related to some of the risk variables (*Z-score*). Table 9 reports the results. In column 1 the risk measure is *Z-score*, and it is estimated to have a positive association with *CIT*. This suggests that higher corporate income taxation can lower bank risk measured using book values.

Next, in regression 2 the risk variable is *Distance-to-default*, which is calculated using stock market data. In this regression *CIT* obtains a negative and significant coefficient, suggesting a negative relationship between bank stability and tax rates. In regressions 3 and 4 the systemic risk measures, *MES* and *COVAR*, obtain insignificant coefficients.

Table 10 shows the results of analogous regressions to those presented in Table 9, but the sample now includes only US banks and the tax rate variable is the effective marginal tax rate.¹⁹ In the *Z-score* regression *MTR* obtains a positive and

¹⁹It would be interesting to carry out a difference-in-difference estimation for bank risk using the introduction of ACE in Belgium. Unfortunately this is not possible because of data issues: it is not meaningful to estimate *Z-score* for this sample, as the post-treatment period contains only two observations per bank which is not enough to estimate the volatility of *ROA*; and there are not enough publicly traded Belgian

significant coefficient consistent with the results obtained using the cross-country sample. In regression 2 *MTR* has a negative coefficient, consistent with the negative relationship found between *CIT* and *Distance-to-default* for the international sample. Finally, in regressions with systemic risk variables as dependent variables (regressions 3 and 4) *MTR* has positive coefficients, significant in the *MES* regression, suggesting that higher tax rates increase the systemic risk contribution of banks, perhaps on account of their higher leverage ratios and possibly because higher corporate income tax rates induce banks to invest in correlated assets.

Next, in Table 11 I show results of country level OLS and probit regressions, where the dependent variable is a dummy variable indicating that a systemic banking crisis took place in a given country in a given year. The sample includes the same countries as in the baseline regressions using the international sample of banks. The control variables are the same as in the other risk regressions reported in Tables 9 and 10, except that bank level variables are replaced by their unweighted average values. The reported standard errors are clustered at the country level. Regressions 1 and 2 report the results of OLS regressions without and with year fixed effects, respectively, while regressions 3 and 4 are analogous probit regressions. The inclusion of year fixed effects controls for global shocks, including the financial crisis of 2007-08. In all four regressions *CIT* obtains positive coefficients that are significant in regressions 1, 3 and 4. This suggests that the positive association between *MTR* and the bank level systemic risk measures shown in Tables 10 translate into higher probabilities of systemic crisis at the country level.

The magnitudes of the estimates in Tables 9, 10 and 11 are as follows. A one standard deviation increase in *CIT* is associated with a 0.7% ($= 0.564 \times 0.0533/4.055$) increase in *Z Score* relative to its mean for the international sample, and with a 22% ($((-26.76 \times 0.0533)/6.502)$) decrease in *Distance-to-default* (calculated using the coefficient estimates in Tables 9 and summary statistics in Panel A of Table 1). For the US sample a one standard deviation increase in marginal effective tax rates is associated with a 28% ($4.350 \times 0.293/4.484$) increase in *Z-score* and a 29% ($0.0214 \times 0.293/0.0218$) decrease in *MES* relative to their sample means (see

banks to run regressions of stock market data-based risk measures.

coefficient estimates in Table 10). Finally, the results in Table 11 imply that a one standard deviation increase in CIT rates is associated with a 0.8 percentage point increase in the probability of a systemic banking crisis based on the OLS regression without year fixed effects (regression 1), and a 0.6 percentage point increase in the same likelihood using the probit estimation without year fixed effects (using that the marginal effect of *CIT* is 0.119 at the means of the dependent variables).

Overall, the results in Tables 9, 10 and 11 provide mixed evidence about the relationship between corporate income tax rates and overall bank default risk. Banks' Z-scores seem to correlate positively with tax rates, while for distance-to-default I find the opposite. The results are more consistent across different measures of systemic risk, suggesting that higher corporate income tax rates are unambiguously correlated with higher systemic risk, either measured at the bank, or at the country level.

6 Discussion and conclusions

In the previous sections I established that in countries where corporate income tax rates are higher, banks have higher leverage and less risky assets, irrespective of whether risk is measured as the average regulatory risk weight, loan to assets ratio or as the share of non-performing loans. Furthermore, the evidence suggests that this pattern is causal. In particular, I find that in response to the weakening of the tax advantage of debt financing as a result of a tax reform in Belgium in 2006, Belgian banks lowered their leverage, and increased their loan exposure compared to otherwise similar banks.

Consistent with the hypothesis that there is a tradeoff between leverage and asset risk induced by risk-weighted capital requirements, I find that the association between tax rates and leverage is weaker in countries where regulation is stricter, while in these countries the negative association between asset risk and tax rates is stronger. The difference-in-difference results provide further support for this story, since I find that while both undercapitalized and well-capitalized Belgian banks lowered their leverage after the introduction of the new tax allowance, only

undercapitalized affected banks increased their loan exposure, consistent with well-capitalized banks not being constrained by regulation.

The interpretation that banks reduce asset risk when CIT rates are higher as a result of regulatory pressure is reinforced by the results from the sample of non-financial firms. In particular, I find that the positive relationship between tax rates and leverage for these firms is larger than for banks. Additionally, the relationship between asset volatility and tax rates is positive for the sample of non-financial firms, as opposed to the negative association for banks, probably because these firms do not face an asset-risk dependent capital constraint and may take more risk as a result of eroded profits.

In the last part of the paper I study the relationship between corporate income taxes and overall bank risk. For overall bank default risk I find mixed evidence. However, the results suggest an unambiguous, positive relationship between systemic risk and tax rates, as I find that banks contribute more to systemic risk when they are subject to higher tax rates, and the likelihood of systemic banking crises is also higher in countries with higher corporate income tax rates.

These results have several important implications. First, they highlight that corporate income taxation has implications not only for bank capital structure, but also for the asset side of banks' balance sheets. In particular, taxation seems to influence the types of investments banks make, and can thus impact the real economy. Whether lower tax rates induce banks to extend more welfare improving loans is an interesting question, but falls outside the scope of this paper.

Still, it is important for policy makers to be aware of the potential trade-offs when they implement tax policies. For example, several European countries implemented laws that require banks to pay levies after their liabilities. In some cases the explicit purpose of the levies is to discourage banks from relying excessively on (short term) debt financing and thus reduce funding risk. Like CIT, these levies create a wedge between the cost of debt and equity financing, albeit with an opposite sign. This suggests that the regulatorily induced trade-off between leverage and asset risk will encourage banks to choose riskier assets after the introduction of the levies. [Devereux et al. \(2013\)](#) present evidence that this has already occurred

in countries that introduced the new duties.

The results in this paper show that these asset side adjustment may not be sufficient to offset tax rates' impact on systemic risk. This suggests that lower CIT rates and/or the elimination of the tax advantage of debt financing may be an effective way to reduce systemic bank risk. Alternatively, tax policy may need to be accompanied by appropriately designed macroprudential policies in order to curb systemic risk induced by the associated reliance on debt financing.

Finally, some of the portfolio adjustment accompanying the lower bank leverage ratios in response to lower tax rates (or an allowance for corporate equity) may be socially desirable. The evidence suggests that at least partly, banks adjust their portfolios by increasing their loan exposures (as reflected by higher loan to assets ratios), especially to riskier borrowers (as reflected by a higher share of non-performing loans). While it is impossible to draw precise conclusions for welfare based on these results, it is likely that some of these loans are directed towards socially desirable investments.

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Table 1: Descriptive statistics

Panel A: Descriptive statistics for the international sample of banks. The sample corresponds to that used to estimate regression 1 in Table 3. See Table A1 for variable definitions.

	No. of obs.	Mean	St. D.	Minimum	Maximum
CIT	148608	0.382	0.0533	0.100	0.560
Leverage	148608	0.893	0.0678	0.214	0.979
RWA	106688	0.676	0.138	0.238	1.000
Loans	148608	0.632	0.168	0.0659	0.936
NPL	103624	-4.850	1.660	-9.488	-1.465
Z-score	125931	4.055	1.214	0.872	6.972
Distance-to-default	1608	6.502	7.368	0.354	56.09
MES	1130	0.0114	0.0135	-0.0167	0.0631
COVAR	904	0.00538	0.00685	-0.0259	0.0309
Size	148608	12.14	1.470	8.809	16.63
Size ²	148608	149.7	38.33	17.68	454.4
Net interest margin	148608	0.0385	0.0150	0.00500	0.134
ROA	148608	0.00707	0.0121	-0.0530	0.0645
Fee income	148608	0.190	0.151	-0.146	0.968
Wholesale funding	148608	0.0793	0.152	0	0.950
Non-interest expenses	148608	0.0323	0.0339	0.00491	0.453
No ownership data dummy	148608	0.945	0.2285654	0.000	1.000
CIT diff (Local - owner)	148608	-0.000564	0.0115	-0.410	0.300
CIT diff (Local - frgn subsidiary)	148608	0.000291	0.0114	-0.338	0.350
Market share	148608	0.00397	0.0329	3.44e-08	1
Aggregate credit	148608	0.605	0.0612	0	1.060
Basel II	148608	0.202	0.402	0	1
RGDP growth	148608	0.0204	0.0227	-0.177	0.164
CPI	148608	0.0253	0.0204	-0.0638	1.087
Gvt Debt/GDP	148608	0.706	0.227	0.0389	1.864
GDP per capita	148608	10.47	0.411	6.567	10.89
Exchange rate chg	148608	0.000119	0.0577	-0.188	2.198
Activity restrictions	148608	10.79	2.104	4	16
Regulatory stringency	148608	5.343	0.671	2	9
Capital requirements	148608	0.0808	0.00487	0.0600	0.190
Creditor rights	148608	1.338	0.738	0	4
Deposit insurance	146920	4.647	1.006	1.363	5.470

Panel B: Descriptive statistics for the sample of US banks. The sample corresponds to that used to estimate regression 1 in Table 7. See Table A1 for variable definitions.

	No. of obs.	Mean	St. D.	Minimum	Maximum
MTR	2161	0.293	0.0902	0.0153	0.394
Leverage	2161	0.892	0.0279	0.772	0.975
RWA	686	0.710	0.120	0.260	0.969
Loans	2161	0.686	0.127	0.247	0.894
NPL	2129	-4.830	0.991	-7.836	-1.910
Z-Score	2025	4.484	1.050	0.406	6.954
Distance-to-default	833	5.571	1.503	1.778	9.647
Avrg CR	2110	0.154	0.0143	0.112	0.222
Size	2161	8.030	1.675	4.785	12.25
Size ²	2161	67.29	29.04	22.90	150.2
NIM	2161	0.0352	0.00604	0.0174	0.0578
ROA	2161	0.00815	0.00478	-0.0380	0.0202
Non-interest expenses	2161	0.0273	0.00806	0.0109	0.0730
Fee income	2161	0.202	0.120	-0.0572	0.644
Wholesale funding	2161	0.0397	0.0525	0	0.251
MES	787	0.0218	0.0158	-0.0114	0.0815
COVAR	756	0.00598	0.00544	-0.0106	0.0192

Panel C: Descriptive statistics for the sample of non-financial firms. The sample corresponds to that used to estimate all regressions in Table 8. See Table A1 for variable definitions.

	No. of obs.	Mean	St. D.	Minimum	Maximum
CIT	155099	0.337	0.0706	0.100	0.568
Leverage	155099	0.500	0.220	0.0534	0.930
Asset volatility	155099	0.0248	0.0174	0.00432	0.0879
Size	155099	12.41	1.934	6.864	16.58
Size ²	155099	157.8	48.40	47.11	275.0
ROA	155099	0.00877	0.217	-1.461	0.314
Non-interest expenses	155099	0.972	0.0445	0.755	1
GDP per capita	155099	9.950	0.890	7.164	11.02
RGDP growth	155099	0.0334	0.0328	-0.148	0.148
Gvt Debt/GDP	155099	0.735	0.481	0.0389	2.366
Inflation	155099	0.0298	0.0345	-0.0355	0.685
Exchange rate chg	155099	-0.0000317	0.0773	-0.281	2.198
Creditor rights	155099	1.826	1.227	-1	5

Table 2: Correlation matrix of main variables for the sample of international banks

Correlations are calculated for the sample used to estimate regression 1 in Table 3. *CIT* is the top statutory corporate income tax rate in the country of the bank's location. *Leverage* is total liabilities over total assets. *RWA* is risk-weighted assets over total assets. *Loans* is total loans over total assets. *NPL* is the natural logarithm of the ratio of non-performing loans to total loans. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	CIT	Leverage	RWA	Loans	NPL
CIT	1				
Leverage	0.165***	1			
RWA	-0.00755*	0.124***	1		
Loans	-0.0371***	0.220***	0.748***	1	
NPL	-0.200***	-0.0234***	0.0505***	-0.0230***	1

Table 3: Taxes, leverage, asset risk and regulation – International sample of banks

The dependent variable is *Leverage* in columns 1 and 5, risk-weighted assets to total assets (*RWA*) in columns 2 and 6, loans to assets (*Loans*) in column 3, and the natural logarithm of the ratio of non-performing loans to total loans (*NPL*) in column 4. *CIT* is the top statutory corporate income tax rate in the country of the bank's location. *Regulatory stringency* is an index of regulatory stringency of capital calculation rules, higher values reflecting more stringency. See Table A1 for all other variable definitions. All regressions are estimated with OLS on the between-transformed variables. t-statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Leverage	(2) RWA	(3) Loans	(4) NPL	(5) Leverage	(6) RWA
CIT	0.0913*** (7.60)	-0.198*** (-2.80)	-0.199*** (-7.36)	-5.978*** (-15.00)	0.268*** (4.06)	1.331*** (4.84)
CIT *					-0.0316*** (-2.72)	-0.273*** (-5.75)
Regulatory stringency						
Size	0.0315*** (13.58)	0.0582*** (11.71)	0.0837*** (16.00)	-0.00253 (-0.06)	0.0315*** (13.61)	0.0574*** (11.57)
Size ²	-0.000679*** (-7.70)	-0.00137*** (-7.23)	-0.00231*** (-11.61)	0.00141 (0.92)	-0.000680*** (-7.70)	-0.00132*** (-6.97)
Net interest margin	-0.716*** (-16.08)	4.436*** (36.17)	2.855*** (28.44)	12.53*** (15.75)	-0.709*** (-15.90)	4.398*** (35.86)
ROA	-0.0116 (-0.22)	-2.746*** (-21.73)	-2.031*** (-17.16)	-30.74*** (-32.06)	-0.0152 (-0.29)	-2.703*** (-21.38)
Fee income	-0.0343*** (-7.57)	-0.0685*** (-5.40)	-0.248*** (-24.29)	0.446*** (5.17)	-0.0338*** (-7.45)	-0.0702*** (-5.54)
Wholesale funding	-0.0692*** (-18.98)	0.0712*** (5.38)	0.0458*** (5.57)	0.275*** (3.51)	-0.0696*** (-19.08)	0.0703*** (5.32)
Non-interest expenses	-0.341*** (-17.12)	-0.0862 (-1.31)	-0.0602 (-1.34)	-0.995*** (-2.81)	-0.346*** (-17.30)	-0.0923 (-1.40)
Market share	0.0673*** (5.26)	-0.0307 (-0.72)	0.268*** (9.31)	1.010*** (4.19)	0.0692*** (5.40)	-0.00587 (-0.14)
Aggregate credit	0.0783*** (8.30)	0.207*** (6.71)	0.685*** (32.19)	0.634*** (3.27)	0.0776*** (8.22)	0.242*** (7.70)
Basel II	-0.0596*** (-19.63)	-0.149*** (-20.95)	0.00602 (0.88)	0.177*** (3.80)	-0.0601*** (-19.77)	-0.147*** (-20.63)
RGDP growth	-0.358*** (-6.35)	-1.398*** (-7.01)	-0.256** (-2.01)	-5.991*** (-6.49)	-0.364*** (-6.45)	-1.430*** (-7.17)
CPI	0.0218 (0.58)	0.596*** (3.99)	-0.305*** (-3.57)	-1.939*** (-2.62)	0.0257 (0.68)	0.661*** (4.42)
Gvt Debt/GDP	-0.0220*** (-7.41)	0.0873*** (6.35)	-0.0802*** (-12.00)	2.429*** (45.00)	-0.0218*** (-7.34)	0.0718*** (5.14)

GDP per capita	0.00181 (1.03)	0.0397*** (6.43)	0.0282*** (7.14)	-0.857*** (-26.41)	0.000707 (0.39)	0.0327*** (5.20)
Exchange rate chg	-0.0225 (-1.04)	-0.783*** (-6.45)	-0.0771 (-1.59)	-1.350*** (-4.28)	-0.0320 (-1.47)	-0.824*** (-6.78)
Activity restrictions	-0.00425*** (-10.51)	0.00628*** (3.93)	-0.00606*** (-6.64)	-0.00121 (-0.12)	-0.00434*** (-10.68)	0.00408** (2.48)
Regulatory stringency	-0.000376 (-0.45)	-0.00932*** (-3.03)	0.00219 (1.15)	-0.0226 (-1.30)	0.00867** (2.53)	0.0598*** (4.82)
Capital requirements	-0.269** (-2.16)	0.150 (0.42)	-1.408*** (-5.02)	12.61*** (5.56)	-0.341*** (-2.68)	-0.289 (-0.79)
Creditor rights	0.00312*** (3.53)	0.0233*** (4.23)	-0.0118*** (-5.95)	-0.00578 (-0.25)	0.00360*** (4.00)	0.0260*** (4.70)
Constant	0.659*** (21.08)	-0.514*** (-5.36)	-0.470*** (-6.67)	2.951*** (5.38)	0.624*** (18.54)	-0.792*** (-7.38)
Observations	148608	106688	148608	103624	148608	106688
Adjusted R^2	0.354	0.212	0.233	0.430	0.355	0.215

Table 4: Robustness tests

Panel A: The dependent variable is *Leverage* in columns 1, 3 and 5; and risk-weighted assets to total assets (*RWA*) in columns 2, 4, and 6. Regressions 1 and 2 are estimated with the system GMM estimator, where only the lagged dependent variables are treated as endogenous and both regressions include bank and time effects. In regression 1 only the second lag, in regression 2 only the third lag is used to instrument the lagged dependent variable. The sample in regression 2 excludes the years prior to 2004. The two-step estimator with the Windmeijer (2005) correction is applied. In columns 1 and 2 *CIT (Long run)* is the long run marginal effect of *CIT* calculated as $\gamma/(1 - \beta)$ in equation (2). The standard errors of the long run marginal effect of CIT are calculated using the delta method and are clustered at the country level. Regressions 3 to 6 are estimated with OLS on the between-transformed variables. The same control variables as in regression 1 of Table 3 are included but not reported. See Table A1 for variable definitions. t-statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	GMM		Between					
	Leverage	RWA	Leverage	RWA	Leverage	RWA	Leverage	RWA
CIT	0.0473*** (2.77)	-0.109** (-2.20)	0.0777*** (6.27)	-0.196*** (-2.63)	0.127*** (9.43)	-0.306*** (-3.48)	0.275*** (2.90)	1.016** (2.21)
CIT * Regulatory stringency							-0.0127 (-0.98)	-0.225*** (-4.18)
CIT * Deposit insurance							-0.0219* (-1.72)	-0.00833 (-0.12)
L.Leverage	0.576*** (6.63)							
L.RWA		0.843*** (91.03)						
No ownership			0.0160*** (6.30)	-0.0212* (-1.86)				
CIT diff (Local - owner)			-0.0120 (-0.32)	0.0847 (0.56)				
CIT diff (Local - frgn sub)			-0.00582 (-0.14)	-0.0543 (-0.39)				
Deposit insurance					-0.00573*** (-6.43)	-0.0317*** (-8.25)	0.000794 (0.21)	-0.0284 (-1.38)

Regulatory stringency	0.000674 (0.63)	0.000599 (0.31)	-0.000491 (-0.58)	-0.00977*** (-3.15)	-0.000615 (-0.65)	-0.00908** (-2.31)	0.00338 (0.87)	0.0469*** (3.36)
Observations	129378	62806	148608	106688	146920	106333	146920	106333
Adjusted R^2			0.356	0.212	0.357	0.218	0.357	0.219
Number of instruments	57	45						
AR(1) test p value	0.000	0.000						
AR(2) test p value	0.219	0.00503						
AR(3) test p value		0.908						
Hansen test p value	0.278	0.406						
CIT (Long run)	0.112** (2.87)	-0.696* (-2.24)						

Panel B: The dependent variable is *Leverage* in columns 1, 3 and 5; and risk-weighted assets to total assets (*RWA*) in columns 2, 4, and 6. All regressions are estimated with OLS on the between-transformed variables. In regressions 1 and 2 the sample excludes years after 2007. In regressions 3 and 4 the sample excludes banks headquartered in the US. In regressions 5 and 6 the sample excludes observations of banks with a ratio of fee income to operational income ratio (*Fee income*) higher than 0.2, and a loan to assets ratio (*Loans*) smaller than 0.5. The same control variables as in regression 1 of Table 3 are included but not reported. See Table A1 for variable definitions. t-statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Pre-crisis sample		Without US banks		Traditional banks	
	Leverage	RWA	Leverage	RWA	Leverage	RWA
CIT	0.159*** (12.42)	-0.526*** (-3.62)	0.111*** (6.36)	-0.0834 (-0.65)	0.0670*** (6.04)	-0.753*** (-8.23)
Observations	98563	65053	39641	5268	78258	63298
Adjusted R^2	0.317	0.212	0.450	0.185	0.343	0.217

Table 5: Comparison of treated and control samples for difference-in-difference estimations

Columns 1 and 3 show the number of observations in the pre-treatment period (2003, 2004, and 2005) for Belgian (treated) and non-Belgian (control) banks, respectively. Columns 2 and 4 show the sample means of bank and country characteristics for Belgian and non-Belgian banks, respectively. Column 5 shows the difference between columns 2 and 4, and column 6 shows the t-statistic for testing the equality of sample means in columns 2 and 4. Leverage growth and Loans growth are the first difference of *Leverage* and *Loans*. See Table A1 for all other variable definitions. The sample includes all Belgian banks from the full, international sample of banks, and the three nearest neighbors drawn with replacement from all European (non-Belgian) banks in the full sample. The matching variables are two lags of banks' equity to assets ratio, two lags of banks' loan to assets ratio, the natural logarithm of banks' total assets, GDP growth and inflation. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Belgian		non-Belgian			
	Obs	Mean	Obs	Mean	Difference	t-stat
Leverage	63	0.9143	180	0.926	0.0117	(1.44)
Leverage growth	61	0.000094	178	-0.000691	-0.000785	(-0.23)
Loans	63	0.4297	180	0.388	-0.0417	(-1.41)
Loans growth	61	0.02019	178	0.00529	-0.0149	(-1.45)
Size	63	14.0549	180	14.000	-0.0549	(-0.29)
Size ²	63	199.252	180	197.600	-1.652	(-0.31)
Net interest margin	63	0.02128	180	0.0276	0.00632***	(2.79)
ROA	63	0.00455	180	0.00763	0.00308*	(1.68)
Fee income	63	0.196	180	0.324	0.128***	(4.1)
Wholesale funding	63	0.2802	180	0.206	-0.0742**	(-2.18)
Non-interest expenses	63	0.02005	180	0.0262	0.00615**	(2.55)
Market share	63	0.0375	180	0.0158	-0.0217***	(-3.71)
Aggregate credit	63	0.419	180	0.538	0.119***	(9.76)
RGDP growth	63	0.01941	180	0.0142	-0.00521**	(-2.17)
CPI	63	0.02146	180	0.0257	0.00424	(1.28)
Gvt Debt/GDP	63	0.947	180	0.600	-0.347***	(-20.54)
GDP per capita	63	10.337	180	10.180	-0.157***	(-3.48)
Exchange rate chg	63	-0.08576	180	-0.0812	0.00456	(0.47)
Activity restrictions	63	7.6669	180	7.728	0.0611	(0.3)
Regulatory stringency	63	3.334	180	6.166	2.832***	(18.06)
Capital requirements	63	0.07998	180	0.0822	0.00222*	(1.92)
Creditor rights	63	2.000	180	2.339	0.339**	(2.28)

Table 6: The impact of Allowance on Corporate Equity on Belgian banks' leverage and loan ratios

The dependent variable is *Leverage* in columns 1 and 5, risk-weighted assets to total assets (*RWA*) in columns 2 and 6, loans to assets (*Loans*) in column 3, and the natural logarithm of the ratio of non-performing loans to total loans (*NPL*) in column 4. *Post* is a dummy variable equal to one for the years 2006 and 2007, and zero for the years 2003, 2004, and 2005. *Treated* is a dummy variable indicating banks incorporated in Belgium. See Table A1 for all other variable definitions. The sample includes all Belgian banks from the full, international sample of banks, and the three nearest neighbors drawn with replacement from all European banks in the full sample. The matching variables are two lags of banks' equity to assets ratio, two lags of banks' loan to assets ratio, the natural logarithm of banks' total assets, GDP growth and inflation. All regressions include bank fixed effects. The standard errors are clustered at the bank level. t-statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)
	Leverage	Loans	Leverage	Loans
Post * Treated	-0.0534** (-2.12)	0.00495 (0.24)	-0.0142 (-1.31)	0.0547*** (2.66)
Post	-0.0124 (-0.70)	-0.0451 (-1.51)	-0.0215 (-1.35)	-0.0483 (-1.62)
Post * Treated * E/A			-0.0836* (-1.86)	-0.112*** (-3.30)
Post * E/A			0.0195 (1.43)	0.0118 (0.62)
Size	0.138 (1.45)	0.00127 (0.01)	0.165* (1.85)	0.0384 (0.42)
Size ²	-0.00422* (-1.67)	-0.000680 (-0.27)	-0.00523** (-2.05)	-0.00196 (-0.77)
Net interest margin	1.700 (0.66)	3.939** (2.39)	2.219 (0.92)	4.659*** (2.86)
ROA	-0.484 (-1.03)	-0.659 (-1.01)	-0.428 (-0.96)	-0.610 (-0.99)
Fee income	0.134 (1.26)	0.243* (1.78)	0.156 (1.44)	0.280** (2.09)
Wholesale funding	-0.155 (-1.44)	0.166* (1.68)	-0.133 (-1.47)	0.201** (2.06)
Non-interest expenses	-0.993*** (-2.78)	-0.210 (-0.39)	-1.116*** (-3.47)	-0.345 (-0.63)
Market share	0.566 (1.45)	-0.0810 (-0.16)	0.539 (1.40)	-0.182 (-0.41)
Aggregate credit	0.123 (1.10)	-0.131 (-1.31)	0.162 (1.29)	-0.0972 (-1.00)
Basel II	-0.0105	-0.0448	-0.00461	-0.0360

	(-0.44)	(-1.01)	(-0.21)	(-0.87)
RGDP growth	-0.859 (-1.23)	-0.160 (-0.31)	-0.718 (-1.23)	-0.0942 (-0.19)
CPI	-0.305 (-0.91)	0.132 (0.22)	-0.404 (-1.26)	0.0401 (0.07)
Gvt Debt/GDP	-0.0678 (-0.42)	-0.300 (-1.33)	-0.0299 (-0.18)	-0.271 (-1.18)
GDP per capita	0.383 (1.12)	0.752 (1.41)	0.345 (1.11)	0.687 (1.39)
Exchange rate chg	-0.125 (-0.74)	-0.293 (-1.12)	-0.108 (-0.73)	-0.262 (-1.08)
Activity restrictions	0.00157 (0.30)	0.00415 (1.12)	0.000637 (0.13)	0.00304 (0.89)
Regulatory stringency	0.000446 (0.09)	0.00435 (0.72)	0.00108 (0.24)	0.00543 (0.93)
Observations	370	370	370	370
Adjusted R^2	0.379	0.131	0.410	0.181
Bank fixed effects	Yes	Yes	Yes	Yes

Table 7: Effective marginal tax rates and US banks' leverage and asset ratios

The dependent variable is *Leverage* in columns 1 and 5, risk-weighted assets to total assets (*RWA*) in columns 2 and 6, loans to assets (*Loans*) in column 3, and the natural logarithm of the ratio of non-performing loans to total loans (*NPL*) in column 4. *MTR* is the effective marginal tax rate simulated based on income before interest expense has been deducted. *Avrg CR* is the average regulatory capital ratio of all other banks in the state of the bank's location. See Table A1 for all other variable definitions. All regressions are estimated with OLS on the between-transformed variables. The sample includes only US banks. t-statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Leverage	(2) RWA	(3) Loans	(4) NPL	(5) Leverage	(6) RWA
MTR	0.0322* (0.0182)	-0.172 (0.157)	-0.00905 (0.0660)	-0.0551 (0.574)	0.0751 (0.178)	0.235 (1.921)
MTR *					-0.303 (1.138)	-2.688 (12.40)
Avrg CR					-0.380 (0.333)	0.915 (4.052)
Size	0.0161** (0.00657)	0.114* (0.0618)	0.0851*** (0.0238)	-0.281 (0.207)	0.0161** (0.00653)	0.111* (0.0644)
Size ²	-0.000993** (0.000392)	-0.00594* (0.00332)	-0.00486*** (0.00142)	0.0194 (0.0124)	-0.000973** (0.000389)	-0.00570 (0.00346)
NIM	-0.779*** (0.297)	7.364** (2.903)	0.159 (1.075)	17.71* (9.522)	-0.794*** (0.293)	7.353** (2.941)
ROA	-0.501 (0.441)	-2.671 (3.819)	5.013*** (1.597)	-56.61*** (14.03)	-0.786* (0.443)	-2.745 (3.887)
Non-interest expenses	0.379 (0.321)	-0.206 (3.496)	5.320*** (1.162)	28.61*** (10.17)	0.365 (0.321)	-0.113 (3.539)
Fee income	-0.00852 (0.0229)	-0.189 (0.200)	-0.633*** (0.0828)	-0.639 (0.726)	-0.00538 (0.0229)	-0.203 (0.203)
Wholesale funding	0.0622** (0.0268)	-0.388** (0.175)	-0.362*** (0.0969)	1.085 (0.849)	0.0598** (0.0263)	-0.384** (0.177)
Constant	0.839*** (0.0271)	0.0866 (0.288)	0.287*** (0.0980)	-4.776*** (0.856)	0.900*** (0.0587)	-0.0407 (0.734)
Observations	2161	686	2161	2129	2110	671
Adjusted R^2	0.039	0.265	0.231	0.125	0.084	0.255

Table 8: Non-financial firms' leverage and asset risk

The dependent variables are *Leverage* in columns (1) and (2) and *Asset volatility* in columns (3) and (4). All regressions are estimated with OLS on the between-transformed variables. Industry fixed effects account for three-digit SIC sector-specific factors in columns (2) and (4). t statistics in parentheses. See Table A1 for variable definitions. t -statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	Leverage		Asset volatility	
	(1)	(2)	(3)	(4)
CIT	0.352*** (16.05)	0.357*** (16.97)	0.0155*** (11.29)	0.0146*** (11.04)
Size	-0.00965 (-1.53)	-0.0224*** (-3.68)	-0.0185*** (-46.74)	-0.0173*** (-45.20)
Size ²	0.00155*** (6.13)	0.00190*** (7.74)	0.000595*** (37.39)	0.000555*** (35.96)
ROA	-0.0789*** (-12.56)	-0.0997*** (-16.44)	-0.0212*** (-53.74)	-0.0195*** (-51.12)
Non-interest expenses	-1.293*** (-43.82)	-1.475*** (-48.33)	0.0481*** (25.99)	0.0484*** (25.21)
GDP per capita	-0.0316*** (-12.51)	-0.0216*** (-8.81)	0.00590*** (37.27)	0.00512*** (33.18)
RGDP growth	-0.0722 (-0.89)	-0.290*** (-3.74)	0.0547*** (10.77)	0.0640*** (13.12)
Gvt Debt/GDP	0.0481*** (12.21)	0.0267*** (7.03)	-0.00548*** (-22.18)	-0.00425*** (-17.80)
Inflation	-0.370*** (-5.59)	-0.275*** (-4.31)	0.0424*** (10.22)	0.0405*** (10.10)
Exchange rate chg	0.470*** (14.25)	0.307*** (9.73)	-0.0151*** (-7.32)	-0.00579*** (-2.91)
Creditor rights	0.00818*** (7.63)	0.00392*** (3.82)	-0.00103*** (-15.33)	-0.000820*** (-12.68)
Constant	1.796*** (30.77)	1.859*** (30.14)	0.0534*** (14.58)	0.0597*** (15.37)
Observations	155099	155099	155099	155099
Adjusted R^2	0.188	0.279	0.569	0.615
Industry effects	No	Yes	No	Yes

Table 9: The relationship between tax rates and bank risk

The dependent variable is *Z-score* in column 1, *Distance-to-default* in column 2, marginal expected shortfall (*MES*) in column 3, and *COVAR* in column 4. *Z-score* and *Distance-to-default* are measures of the likelihood of bank failure, higher values indicating safer banks. *MES* and *COVAR* are measures of a bank's contribution to systemic risk, higher values reflecting a greater contribution. *CIT* is the top statutory corporate income tax rate in the country of the bank's location. See Table A1 for all other variable definitions. All regressions are estimated with OLS on the between-transformed variables. The sample includes all banks in the international sample of banks. t-statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Z-Score	(2) Distance-to- default	(3) MES	(4) COVAR
CIT	0.564*** (2.62)	-26.76** (-2.23)	0.0116 (0.74)	-0.0182 (-1.02)
Size	-0.0377 (-1.11)	3.241 (0.94)	-0.00775** (-2.25)	-0.00480 (-1.09)
Size ²	0.00171 (1.33)	-0.0860 (-0.68)	0.000330*** (2.63)	0.000162 (1.08)
Net interest margin	-1.654*** (-2.71)	5.604 (0.16)	-0.0977*** (-2.93)	-0.0147 (-0.31)
Fee income	-0.766*** (-11.38)	-3.612 (-0.82)	0.00371 (0.73)	0.0204*** (2.82)
Wholesale funding	-0.209*** (-3.52)	2.576 (0.63)	0.00348 (0.70)	-0.00715 (-1.18)
Non-interest expenses	-1.299*** (-5.49)	33.69 (1.65)	-0.00205 (-0.10)	0.0138 (0.35)
Market share	-0.299 (-1.42)	6.496 (0.81)	-0.00567 (-0.78)	0.0324** (2.48)
Aggregate credit	2.068*** (14.01)	3.998 (0.57)	-0.00593 (-0.77)	0.0129* (1.73)
Basel II	-0.470*** (-11.96)	-1.722 (-0.91)	0.00709*** (3.26)	-0.00146 (-0.55)
RGDP growth	-2.124*** (-2.90)	-31.22 (-0.84)	0.0529 (1.06)	0.149** (2.42)
CPI	-1.106** (-2.37)	50.22 (1.52)	0.0388 (0.94)	0.0420 (1.12)
Gvt Debt/GDP	-0.596*** (-14.71)	6.004 (1.57)	0.000769 (0.17)	0.0138*** (2.62)
GDP per capita	-0.0310 (-1.00)	-0.311 (-0.32)	-0.00100 (-0.88)	0.00102 (0.79)
Exchange rate chg	-0.297 (-1.22)	-46.76** (-2.27)	0.0157 (0.67)	-0.0443* (-1.85)

Activity restrictions	-0.130*** (-20.44)	-0.548 (-1.53)	0.000737* (1.72)	-0.000655 (-1.57)
Regulatory stringency	0.0393*** (2.89)	-0.598 (-1.28)	0.00158** (2.29)	0.000593 (0.83)
Capital requirements	-11.77*** (-5.10)	-93.58 (-1.13)	0.382*** (3.18)	-0.101 (-0.73)
Creditor rights	-0.00431 (-0.30)	-0.579 (-0.88)	0.000812 (1.04)	-0.0000203 (-0.02)
Constant	6.069*** (11.16)	1.593 (0.05)	0.00968 (0.28)	0.0202 (0.54)
Observations	125931	1608	1130	904
Adjusted R^2	0.155	0.082	0.482	0.201

Table 10: The relationship between effective marginal tax rates and US banks' risk

The dependent variable is *Z-score* in column 1, *Distance-to-default* in column 2, marginal expected shortfall (*MES*) in column 3, and *COVAR* in column 4. *Z-score* and *Distance-to-default* are measures of the likelihood of bank failure, higher values indicating safer banks. *MES* and *COVAR* are measures of a bank's contribution to systemic risk, higher values reflecting a greater contribution. *MTR* is the effective marginal tax rate simulated based on income before interest expense has been deducted. See Table A1 for all other variable definitions. All regressions are estimated with OLS on the between-transformed variables. The sample includes only US banks. t-statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Z-Score	(2) Distance-to- default	(3) MES	(4) COVAR
Effective MTR	4.350*** (0.515)	-0.615 (1.559)	0.0214** (0.0106)	0.00145 (0.00860)
Size	-0.375* (0.197)	0.364 (0.485)	0.0186*** (0.00336)	0.00454* (0.00268)
Size ²	0.0116 (0.0118)	-0.0307 (0.0269)	-0.000688*** (0.000188)	-0.000155 (0.000148)
NIM	8.464 (8.923)	-10.33 (21.93)	0.666*** (0.155)	-0.00678 (0.147)
ROA	31.87** (13.10)	6.826 (31.72)	-0.898*** (0.225)	0.0411 (0.195)
Non-interest expenses	-51.79*** (10.01)	-41.33 (26.28)	-0.300 (0.186)	0.0649 (0.175)
Fee income	2.990*** (0.700)	5.212*** (1.519)	0.0194* (0.0108)	0.00211 (0.00997)
Wholesale funding	-1.194 (0.774)	-3.805** (1.533)	0.0227** (0.0105)	-0.00980 (0.00862)
Constant	5.740*** (0.798)	5.427** (2.148)	-0.107*** (0.0147)	-0.0239** (0.0117)
Observations	2025	833	787	756
Adjusted <i>R</i> ²	0.258	0.137	0.731	0.216

Table 11: The relationship between tax rates and the likelihood of banking crises

The dependent variable is Crisis, a dummy variable indicating that a systemic banking crisis occurred in a given country-year. *CIT* is the top statutory corporate income tax rate in the country of the bank's location. The included bank characteristics are unweighted averages of corresponding bank level variables in a given country-year. See Table A1 for all other variable definitions. Regressions 1 and 2 are OLS regressions, regressions 3 and 4 are probit regressions. Regressions 2 and 4 include year fixed effects. Standard errors are clustered at the country level. t-statistics are shown in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	OLS		Probit	
	(1)	(2)	(3)	(4)
CIT	0.158* (1.80)	0.0773 (0.89)	3.797** (2.38)	3.193* (1.80)
Size	-0.0739* (-1.70)	-0.0545 (-1.43)	-0.622 (-1.61)	-0.496 (-1.06)
Size ²	0.00287* (1.94)	0.00215 (1.65)	0.0253** (2.13)	0.0240* (1.68)
Net interest margin	0.224 (0.37)	0.267 (0.47)	8.904 (0.87)	19.12 (1.47)
Fee income	-0.00372 (-0.06)	0.0503 (0.87)	0.0828 (0.10)	0.925 (1.07)
Wholesale funding	0.0847** (2.44)	0.0607** (2.08)	1.421*** (2.74)	1.362** (2.26)
Non-interest expenses	0.0601 (0.16)	0.0259 (0.06)	-0.0441 (-0.01)	0.230 (0.04)
Market share	-0.0246 (-1.01)	-0.0235 (-1.05)	-0.585 (-1.08)	-0.628 (-0.86)
Aggregate credit	0.0236 (0.63)	0.0134 (0.35)	0.294 (0.55)	0.590 (0.86)
Basel II	0.0793*** (4.37)	0.0802*** (3.63)	1.077*** (4.87)	0.910* (1.89)
RGDP growth	-0.434** (-2.06)	-0.523* (-1.91)	-6.456* (-1.88)	-8.953 (-1.49)
CPI	0.311* (1.87)	0.183 (1.37)	3.481** (2.03)	6.146* (1.93)
Gvt Debt/GDP	-0.0252 (-1.17)	-0.00175 (-0.09)	-0.630 (-1.40)	0.109 (0.24)
GDP per capita	0.000766 (0.13)	0.00104 (0.18)	0.0993 (0.68)	0.303** (2.03)
Exchange rate chg	-0.119** (-2.29)	-0.0767 (-1.65)	-1.648 (-1.17)	-2.834 (-1.27)

Activity restrictions	-0.000217 (-0.11)	-0.000163 (-0.08)	0.00390 (0.12)	0.0128 (0.28)
Regulatory stringency	0.00332 (1.47)	0.00137 (0.60)	0.0425 (1.00)	0.0495 (0.80)
Capital requirements	-0.219 (-0.71)	0.0119 (0.04)	-4.379 (-0.51)	-10.82 (-1.05)
Creditor rights	0.00425 (0.80)	0.00406 (0.78)	0.0536 (0.59)	0.168 (1.46)
Observations	687	687	687	292
Adjusted R^2	0.042	0.166		
Year fixed effects	No	Yes	No	Yes

A Appendix

A.1 Variable definitions

Table A1: Variable definitions and source of data

Variable	Definition	Source
CIT	Top statutory corporate income tax rate.	OECD, KPMG Corporate and Indirect Tax Surveys 2007, 2010 and 2011
MTR	The effective marginal tax rate simulated based on income before interest expense has been deducted.	Graham (1996a,b)
Leverage	Total liabilities over total assets.	Bankscope, Worldscope
RWA	Risk-weighted assets over total assets.	Bankscope
Loans	Total loans to total assets.	Bankscope
NPL	Natural logarithm of non-performing loans to total loans.	Bankscope
Z-score	Natural logarithm of Z-score = (Total equity/Total assets + ROA) / standard deviation of ROA. The standard deviation of ROA is calculated over rolling three-year windows.	Bankscope
Distance-to-default	Distance-to-default = $\frac{\log\left(\frac{V_A}{X}\right) + \left(m - d - \frac{s_A^2}{2}\right)T}{s_A\sqrt{T}}$, where V_A and s_A denote the value and volatility of assets, respectively, and are calculated using Merton's model (see for example section A1 in Anginer et al., 2014); X denotes the face value of debt, m is the equity premium and is assumed to be 6%, d is the dividend rate, and T is the average maturity of debt, which is assumed to be one year.	Bankscope and Datastream for banks in the international sample; Worldscope and Datastream for non-financial firms; CRSP and Compustat for US banks.
MES	Negative of the average daily stock market return of a bank in a year conditional on the local MSCI banking sector index experiencing one of its 5% lowest returns in the same year.	Datastream, CRSP
COVAR	A bank's contribution to systemic risk, measured as the difference between the value at risk (VaR) of the financial system conditional on the bank experiencing one of its 5% lowest weekly returns in a year and the VaR of the financial system conditional on the bank experiencing its median return in the same year, averaged over the year.	Datastream, CRSP
Crisis	Dummy variable indicating that a systemic banking crisis occurred in a given year in a given country.	Laeven and Valencia (2013)
Size	Natural logarithm of the book value of total assets.	Bankscope, Worldscope

Size ²	The square of the natural logarithm of the book value of total assets.	Bankscope, Worldscope
Net interest margin	Interest income minus interest expenses over interest-bearing (total earning) assets.	Bankscope
ROA	Return over average assets.	Bankscope, Worldscope
Fee income	Non-interest income over total operating income.	Bankscope
Wholesale funding	Non-deposit funding over total deposits and short term funding.	Bankscope
Non-interest expenses	Non-interest expenses over total assets.	Bankscope, Worldscope
Asset volatility	Calculations based on Merton's option pricing model. See e.g. Appendix A1 of Anginer et al. (2014) .	Worldscope, Datastream
No ownership data dummy	1 if there is no ownership information available, zero otherwise.	Claessens and van Horen (2014)
CIT diff (Local - owner)	Top statutory CIT rate in the country of the bank's location minus the top statutory CIT rate applicable in the country where its owner is headquartered. Zero if no data is available.	Claessens and van Horen (2014)
CIT diff (Local - frgn subsidiary)	Top statutory CIT rate in the country where the bank is headquartered minus the (unweighted) average of the top statutory CIT rates applicable in the countries where its foreign subsidiaries are located. A Parent-subsidiary relationship is established if the parent has an ultimate ownership larger than 50% in the subsidiary. Zero if no data is available.	Bankscope
Market share	Total assets relative to the sum of all other banks' assets in the country of residence.	Bankscope
Aggregate credit	Sum of all other banks' loans relative to all banks' assets in the country of residence.	Bankscope
Basel II	1 if the Basel II rules were effective in the country of residence and 0 otherwise.	BIS progress reports on the implementation of the Basel regulatory framework
RGDP growth	Annual percentage change of constant price GDP.	World Economic Outlook database
CPI	Inflation, annual end of period consumer price change.	World Economic Outlook database
Gvt Debt/GDP	General government gross debt to GDP.	World Economic Outlook database
GDP per capita	GDP per capita on a US dollar PPP basis.	World Economic Outlook database
Exchange rate chg	Annual percentage point changes in the nominal exchange rate.	World Economic Outlook database

Activity restrictions	Index of regulatory restrictions of certain activities.	Barth et al. (2001) , Barth et al. (2004) , Barth et al. (2008) , Čihák et al. (2012)
Regulatory stringency	Index of regulatory stringency of capital calculation rules.	Barth et al. (2001) , Barth et al. (2004) , Barth et al. (2008) , Čihák et al. (2012)
Capital requirements	Minimum capital adequacy requirement expressed as a percentage of Tier I + Tier 2 capital over risk-weighted assets.	Barth et al. (2001) , Barth et al. (2004) , Barth et al. (2008) , Čihák et al. (2012)
Creditor rights	An index of statutory rights of creditors.	Djankov et al. (2007)
Deposit insurance	The deposit insurance coverage limit relative to GDP.	Demirgüç-Kunt et al. (2014)
Avrg CR	The average regulatory capital ratio of all other banks in the state of the bank's location.	Compustat

A.2 Partial adjustment model

The partial adjustment model (equation (2)) used in this paper is standard in the bank capital structure literature. It builds on [Shrieves and Dahl \(1992\)](#), who assume that observed changes in capital and risk have two components, discretionary adjustment and exogenous shocks. Discretionary changes are the result of banks' optimal capital and risk decisions, while exogenous shocks to risk might reflect unexpected changes in the business cycles or in case of capital, unexpected loan losses. Denoting y_{ijt} either leverage or asset risk, this assumption can be formulated as

$$\Delta y_{ijt} = \Delta y_{ijt}^b + u_{ijt} \quad (4)$$

The econometrician observes Δy_{ijt} , the change of leverage/asset risk of bank i in country j in year t . However, banks' planned leverage and risk adjustment Δy_{ijt}^b , and the exogenous shocks u_{ijt} and v_{ijt} are unobservable. [Shrieves and Dahl \(1992\)](#) and the subsequent literature assume that banks have target leverage and risk levels

(y^*) . The final assumption of the model is that banks do not immediately adjust to their target levels after either leverage and/or risk was hit by a shock in the previous period. Instead, it is assumed that the speed of adjustment is proportional to the distance from the target level:

$$\Delta y_{ijt}^b = \psi(y_{ijt}^* - y_{ijt-1}) \quad (5)$$

Inserting the equation for banks' planned adjustment (equation (5)) into the observed adjustment equation (4) and assuming that the target levels (y^*) are a linear function of some determinants yields equation (2) after some rewriting.