The Impact of Taxation on Bank Leverage and Asset Risk

Secondary Job Market Paper

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Abstract

The tax benefit of interest deductibility encourages debt financing, but regulatory and market constraints create dependency between bank leverage and asset risk. Using a large international sample of banks this paper estimates long run effects of corporate income taxes (CIT) on bank capital structure and portfolio risk accounting for their simultaneous determination. A 10 percentage point increase in the statutory CIT rate is associated with an increase of 0.9-1.1 percentage points in bank leverage and a 2-7-percentage point reduction in the average risk-weight of assets. While the estimated overall effect of taxation on bank risk is modest, it induces significant portfolio reallocation toward less lending. These results suggest that any elimination of the tax bias towards debt may not bring the expected benefits for bank stability.

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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). The 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 was identified as one of the possible sources that might have indirectly 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 (Keen and de Mooij, 2012; De Mooij et al., 2013; Gu et al., 2012; Hemmelgarn and Teichmann, 2013), the implications of corporate income taxation have not been fully explored for bank risk. In particular, most papers neglect the effect of taxation on bank portfolio risk, with one notable exception by Devereux et al. (2013). The aim of this paper is to fill this gap by measuring the effect of CIT on bank risk, taking into account that bank leverage and asset risk are possibly intertwined.

The interrelatedness of bank leverage and portfolio risk arises for two main reasons. First, bank regulation directly forces weakly capitalized banks to trade off leverage and asset risk in order to comply with the minimum capital requirements under the widely adopted Basel rules, defined as the ratio of qualifying bank equity and risk weighted assets. This trade-off may be present even if the constraint is not binding, as long as banks want to hold precautionary capital buffers in order to avoid non-compliance costs as a result of unexpectedly falling below the regulatory minimum requirement. Second, banks may also want to voluntarily trade off leverage and asset risk in order to reduce bankruptcy costs, as in Allen and Carletti (2013). In this theory, banks choose a capital structure that balances the marginal costs of equity financing with the marginal expected bankruptcy costs.

Disregarding the possibility that banks change asset risk in response to taxation might lead to biased estimates of the tax elasticity of bank leverage if asset risk is controlled for in the estimation. In addition, not taking into account the asset risk adjustment of banks may lead to the overestimation of the negative effects of taxes on overall bank risk. In this paper I estimate the tax elasticity of leverage as well as that of bank asset risk using reduced form regressions. This enables me to provide a comprehensive view on the overall risk impact of corporate income taxation on banks.

The main results of the paper are as follows. Using a data set that includes 17,003 banks from 71 countries and spans the years 1997-2011, I find that higher corporate income tax rates encourage higher bank leverage ratios with the long run marginal impact estimated between 0.09 and 0.11. These estimates lie in the range found by previous papers using bank level data (0.14-0.31 in Keen and de Mooij (2012) and De Mooij et al. (2013) and 0.1 in Hemmelgarn and Teichmann (2013)) and country level data (0.04-0.09 in De Mooij et al. (2013)).

Extending previous literature, I also find that banks located in countries with higher CIT rates hold lower risk-weighted assets (RWA) – conditional on a wide range of bank and country characteristics. A 10-percentage-point increase in CIT leads to a reduction of RWA relative to total assets of 2-7 percentage points. This impact cannot be fully attributed to risk-weight manipulation, since as I show, CIT also has a negative effect on the volume of relatively risky bank lending and a risk reducing effect on portfolio quality. The asset risk reducing effect of taxation is stronger in countries where regulators are more stringent and for banks that are more constrained by regulatory pressure to meet capital requirements. These results suggest that the regulatory constraint is operational, which is in contrast with other papers that argue that the regulatory constraint is weak, for example, Gropp and Heider (2010).

Looking at the overall impact of taxation on bank stability, I find no evidence that corporate income taxation makes banks less safe. In fact, regressions on banks' Z-score –a measure of the likelihood of bank failure– suggest a risk reducing effect of taxes, but the results are not robust. Overall, the results suggest that the elimination of the debt bias may not bring the expected benefits, since banks may substitute leverage risk for asset risk.

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. Keen and de Mooij (2012) find a long run CIT impact on bank leverage close to what the literature covering non-financial firms has found. Hemmelgarn and Teichmann (2013) 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. (2012) 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. A common feature of these papers is that they treat asset risk as an exogenous variable[1], 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 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. This enables me to investigate the interaction between regulation and taxation more deeply, using cross-country variation in the regulatory environment.

This paper also contributes to the literature trying to understand how banks coordinate capital and risk adjustments and what role capital regulation plays in this relationship. Using a partial adjustment model with simultaneous equations for capital and risk adjustments, originally developed by Shrieves and Dahl (1992) and then applied by Jacques and Nigro (1997), Aggarwal and Jacques (2001), Rime (2001), Heid et al. (2004) and Jokipii and Milne (2011), this literature generally finds a positive relationship between the short run adjustments of capital and asset risk. I extend this literature by adding taxes to the determinants of target leverage and portfolio risk and, to my knowledge, for the first time the simultaneous equations/partial adjustment model is applied to an international sample of banks.

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

[1]Keen and de Mooij (2012) 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.

(2013) 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 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 and in section 3 I explain the applied econometric approach. In section 4 I describe the data used in the regressions. Section 5 presents the results of the regressions and section 6 discusses the results and concludes.

2 Hypotheses and theoretical framework

In this section I motivate the hypotheses with the help of a few simple accounting relationships and a simplified regulatory constraint akin to what is applied under the Basel regime. The key feature is that regulatory requirements are defined by leverage and a regulatory measure of bank risk.

2.1 The interaction between capital regulation and taxation

For simplicity let us assume that there are only two types of liabilities, equity capital K and debt D, and N types of assets, denoted by $A_i, i \in \{1 \dots N\}$. Each asset type's risk is measured by a (regulatory) risk weight ω_i. The following accounting identity must hold at all times:

$$A = \sum_i A_i = K + D, \tag{1}$$

where A denotes total assets. The leverage ratio is then defined as $l = D/A$ and portfolio risk as $r = \sum_i \omega_i A_i / A$.

Banks are required to hold at least a certain amount of capital. This constraint can be expressed as:

$$k \leq \frac{K}{\sum_i \omega_i A_i} = \frac{K}{\sum A_i} \bigg/ \frac{\sum_i \omega_i A_i}{\sum A_i} = \frac{1-l}{r}, \tag{2}$$

where k is the minimum capital adequacy requirement. This form of capital constraint is similar to that implemented under the Basel accords. Under Basel I and the basic forms of Basel II banks are required to hold at least 8% eligible capital relative to risk weighted assets.[2] Notice that a binding capital requirement constraint implies that leverage l and asset risk r become substitutes in the sense that banks can choose higher leverage levels by lowering asset risk.

Later, in the econometric part I assume that banks choose a target leverage ratio. While in a Modigliani-Miller world target 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.

Similarly, I assume that banks have a target asset risk level. Factors that can be related to risk taking include firm governance characteristics and the ownership structure (by influencing the type and severity of agency problems within firms), size (through too-big-to-fail subsidies), the business mix, and the regulatory environment. The optimal asset risk level may also depend on taxes. The main channel taxes are expected to influence bank risk taking works through banks' profitability. The literature establishes a link between risk

[2] I 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 Keen and de Mooij (2012) 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.

taking and bank charter value due to moral hazard. Since corporate income taxes reduce profitability, banks might respond by taking more overall risk, possibly by increasing asset risk.

To summarize, the main hypothesis of this paper is that banks choose higher levels of leverage in countries where CIT rates are higher; and reduce asset risk in order to alleviate regulatory pressure on their capitalization.

3 Econometric approach

From the previous discussion it follows that equilibrium leverage and asset risk are jointly determined. Instead of attempting to estimate structural equations of leverage and asset risk I estimate reduced form, static and dynamic, regressions and measure the overall effect of taxes on leverage and asset risk.

3.1 Long run estimates of tax elasticities

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

$$\overline{y}_{ij} = \alpha + \gamma \overline{CIT}_i + \delta \overline{X}_{ij} + \lambda \overline{Y}_i + \varepsilon_{ij}, \tag{3}$$

where y_{ijt} is either leverage or one of the risk/asset composition measures of bank j in country i in year t, CIT_{it} is the statutory corporate income tax rate, X_{ijt} and Y_{it} 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 (r in the previous section) 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 by the share of non-performing loans, while the loans-to-assets ratio proxies the size of banks' risky portfolio.[3] 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 recent evidence that banks that had higher loans to assets ratios performed worse during the financial crises in 2007 and 2008 (Beltratti and Stulz, 2012).

3.2 Partial adjustment and simultaneous regressions

It is common in the literature to assume that capital structure adjustment is not immediate (c.f. Gropp and Heider, 2010; Berger et al., 2008). Following these papers I estimate dynamic versions of (3), 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:

$$y_{ijt} = \alpha + \beta y_{ijt-1} + \gamma CIT_{it} + \delta X_{ijt} + \lambda Y_{it} + \eta_t + \mu_{ij} + \varepsilon_{ijt}, \tag{4}$$

where ε_{ijt} is a potentially serially correlated idiosyncratic error term. The OLS and within estimators yield biased estimates of the coefficients in (4) 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

[3] This 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.

Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). This estimator eliminates bank fixed effects through 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.

4 Data

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.

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.

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 risk using the natural logarithm of Z-score. 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 over the full sample period. *Z-score* is thus a measure of distance to default, higher values reflecting safer banks. Log is taken of Z-score because it has a highly skewed distribution.

The tax variable (CIT) is the top statutory corporate income tax rate in the country of a bank's residency. While the effective marginal tax rate is a better measure in theory (Graham, 2000), in practice it is difficult to assemble for a multi-country analysis such as this. There are also good reasons why the top statutory tax rate is a good approximation of banks' effective marginal tax rate. First, banks are typically large companies, so the progressivity of the tax schedule is unlikely to be relevant. Second, the present value of the tax benefit of an additional unit of debt declines when a bank is unlikely to be able to take

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

advantage of the tax deduction because of a future possible bankruptcy. However, banks enjoy significant bailout guarantees and thus the difference between the effective marginal tax rate and the statutory rate is expected to be smaller for banks than for non-financial companies.

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-interest expenses* relative to total assets, a proxy also used by Gu et al. (2012). 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 (as assumption also made by Gu et al. (2012)).[5] 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

[5]No 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.

controls. *RGDP growth* controls for the cyclical variation of leverage and risk related to business cycle fluctuations. Leverage is expected to be procyclical (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. These channel suggest a negative relationship between government indebtedness and *RWA*, because sovereign debt fetches 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 form 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, *Capital 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 be 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). In some specifications I include a dummy variable *Buffer dummy*, which takes the value of 1 if a bank has on average over the sample period a capital buffer larger than the median buffer (calculated over the full sample). 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 effective. 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, 2013). The dummy is constructed from data from the

BIS progress reports on the implementation of the Basel regulatory framework.[6] 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.

5 Results

In this section I present the results of the regressions laid out above, starting with single equation regressions of leverage, RWA-to-assets, loans-to-assets and non-performing loans. Subsequently, I investigate whether taxation and bank regulation interact, and finally, I assess the overall impact of taxation on bank stability.

5.1 Leverage regressions

The left panel of Table 3 shows the baseline regressions of bank leverage. Column (1) reports the between estimates, using the full sample. The estimate of the *CIT* coefficient is significant, but at 0.09 it is considerably smaller than what earlier literature found using similar bank level data (e.g. Keen and de Mooij (2012) 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.

[6] The 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.

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. (2012). Finally, *Market share* is positively related to leverage, which may be because banks can borrow against 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.

In column (2) I follow the literature on bank capital structure, and estimate a dynamic panel model (equation (4) in section 3) with the system GMM estimator. The estimated short run impact is 0.05, significant at 1%, which is about half of what Keen and de Mooij (2012) find. They, however, find a slower adjustment speed than I do: the estimate of the coefficient of the lagged dependent variable in column (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 column (1). A 10% increase in the statutory income tax rate is thus expected to increase bank leverage by about 0.9-1.1 percentage points.

5.2 RWA density regressions

The right panel of Table 3 shows the results of regressions on risk weighted assets to total assets. The regressions are analogous to the leverage regressions in columns (1)-(2). In column (3) the OLS regression on the time-averaged variables yields a result that is 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 hike in tax rates has an expected long run effect of about two percentage points, which seems small compared to the average level of 67%, but it could have significant effects on the real economy through loan supply.

Next, in column (4) I allow for sluggish adjustment using the system GMM estimator, also controlling for time and bank fixed effects. Along with other time-invariant bank characteristics, bank fixed effects should 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 marginal effect of -0.70, significant at 10%, about three times the between estimate. Overall, Table 3 suggests that banks reduce asset risk in response to taxation.

Most control variables obtain the expected signs. *Size* is positively associated with risk, which might reflect moral hazard due to too-big-to-fail benefits; but there are diminishing returns as suggested by the significant, negative coefficient of the quadratic term. *Net interest margin* has a positive coefficient, significant in both regressions. This might be because banks charge higher interest rates for more risky loans. *ROA*, on the other hand has a negative coefficient, which could be the result of moral hazard, to the extent that smaller profitability reduces charter value. *Fee income* is negatively associated with *RWA*, perhaps signaling that more income diversification is accompanied by more risk taking (consistent with mean/variance optimization).

The negative and significant coefficient of *Basel II* is evidence of banks reducing risk weights through the adoption of risk models allowed by Basel II. *Exchange rate change* has a significant, negative impact on bank risk, possibly due to a lower income to debt service ratio for borrowers indebted in foreign currency. Loan demand is positively associated with

RWA density, probably as a result of increased lending relative to investing in low-risk securities. Contrary to the expectations, government indebtedness enters with a positive sign. This could be, however, explained if a larger supply of government securities relaxes collateral constraints by providing safe assets, which leads to higher aggregate liquidity and loan supply.

5.3 Robustness: restricted samples, ownership structure and simultaneous regressions estimation

Table 4 presents the results of further robustness checks. First, I restrict the sample to pre-crisis years (up to 2006) and reestimate regressions (1) and (3) 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 long run 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) using the between estimator. This is in between the estimates of the between and GMM regressions of Table 3.

To deal with the overrepresentation of US banks in the sample I also reestimate the baseline between 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.

Multinational banks have an incentive to shift debt to subsidiaries located in high-tax countries. Regressions (5) and (6) 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 in the sample 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 long run 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.

The regressions presented so far were estimated as single equations. Next, I estimate the leverage and RWA regressions as a system of simultaneous equations, which yields more efficient estimates in theory. The model I estimate builds on Shrieves and Dahl (1992) and is formulated as:

$$\Delta Leverage_{ijt} = a_1 Leverage_{ijt-1} + b_1 \Delta RWA_{ijt} + d_1 CIT_{it} + e_1 X_{ijt} + f_1 Y_{it} + \eta_t + \upsilon_{ijt} \quad (5)$$

$$\Delta RWA_{ijt} = a_2 RWA_{ijt-1} + b_2 \Delta Leverage_{ijt} + d_2 CIT_{it} + e_2 X_{ijt} + f_2 Y_{it} + \theta_t + \zeta_{ijt}. \quad (6)$$

In these equations the adjustment of leverage is allowed to depend on the simultaneous adjustment of risk and vice versa, which is captured by the terms b_1 and b_2. X_{ijt} and Y_{it} are bank and country level determinants of leverage and asset risk, while η_t, θ_t, are time effects and υ_{ijt} are ζ_{ijt} possibly correlated disturbance terms.

The results of estimating equations (5) and (6) are presented in columns (7) and (8) of Table 4. In the leverage regression the lag of leverage obtains a coefficient of -0.39, which yields a somewhat slower speed of adjustment than the single equation GMM estimate of regression (2) in Table 3. Similarly, the speed of adjustment of RWA density in the 3SLS model is also smaller (0.13) than the single equation GMM estimate of regression (6) in Table 3 ($1 - 0.85 = 0.15$).

Next, the long run marginal CIT effect on leverage is 0.07 ($= -b_1/a_1 = -0.0268/(-0.386)$), significant at 5%, somewhat smaller then the single equation OLS estimate (at 0.09 in regression 1, Table 3). The long run *RWA* elasticity is -0.76 ($= -b_2/a_2 = 0.099/(-0.130)$), significant at one percent, which is also similar in magnitude to the baseline OLS and

GMM estimates of -0.20 and -0.70 (regressions (3) and (4) in Table 3), respectively.

Turning to contemporaneous adjustments in risk and leverage, banks respond to a positive shock to *RWA* by contemporaneously reducing leverage as evidenced by the significant, negative coefficient of *D.RWA* in column (7), perhaps to buffer themselves against expected losses or to maintain compliance with capital requirements. Interestingly, the positive coefficient of *D.Leverage* in column (8) suggests that banks respond to an increase in leverage by increasing portfolio risk. This behavior is consistent with moral hazard: as banks become less capitalized their risk taking incentives increase.

5.4 Loan-to-assets regressions

Table 5 presents single equation regression results on alternative measures of bank asset risk: the size of banks' loan portfolio and the ratio of non-performing loans to total loans, measuring portfolio quality.

I start with loans to assets in Table 5. The baseline OLS regression on long run averages (column (1)) shows 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 column (1) suggesting that banks adjust to higher regulatory capital requirements by buying more low risk assets, such as government bonds, relative to lending.

Returning to the effects of taxes, in column (2) the dynamic model gives a qualitatively similar result to the between regression, with a short run marginal impact of -0.06 and a long run impact of -0.78, albeit both insignificant.

5.5 NPL regressions

Columns (3) and (4) of Table 5 report results of regressions on portfolio quality. The dependent variable is the log of the share of non-performing loans to total loans. Column (3) presents OLS estimates on the long run averages. *CIT* is estimated to have a long run marginal effect of -5.98, significant at 1%. The dynamic regression in column (4) produces a short run marginal impact of -1.44, significant at 5% and a long run marginal effect of -4.70, significant at 10%. These regressions imply that *CIT* has a sizable impact on bank portfolio quality. A 10-percentage-point increase in *CIT* is expected to reduce the stock of non-performing loans relative to total assets by 47-60%, which amounts to a change of 0.28-0.36 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.

5.6 The effect of regulation

Looking at the results of the previous sections the question arises to what extent the observed pattern, that taxation is positively related with leverage and negatively related with asset risk, is attributable to bank regulation. In this section I aim to provide answer to that by investigating whether banks react differently if 1) they hold lower levels of regulatory capital buffers and 2) if they are subject to stricter regulatory supervision. My approach is to include the interaction terms *CIT * Buffer dummy* and *CIT * Regulatory stringency*. The expectation *a priori* is that especially capital abundant banks increase leverage in response to higher tax rates and stricter regulators force banks to reduce asset riskiness if they wish to increase leverage. The former effect is expected, since banks with higher regulatory capital buffer targets have more room to increase leverage without changing their asset allocations and while still complying with capital standards. Thus, to the extent that deviating from asset risk targets is costly, I expect these banks to be more responsive.

Table 6 shows the results of regressions with the interaction terms included. In column (1) the dependent variable is *Leverage*. Using the between estimator I find a *CIT* coefficient of 0.06 for banks with low excess regulatory capital, which is significant at the 1% level. This is smaller than the baseline estimate in column (1) of Table 3. Next, the dummy variable *Buffer dummy* obtains a significant, negative coefficient, reflecting that better capitalized banks have lower leverage. The interaction term is also significant and has a coefficient of 0.23. Thus well-capitalized banks seem to respond more to taxation with an estimated long run impact of 0.29 (= 0.06 + 0.23) on leverage.

The RWA regression shows mirroring results. The CIT coefficient is significantly negative at -0.14, about half the value of the baseline estimate in column (3) of Table 3. Now the capitalization dummy is insignificant, unlike the interaction term, which obtains a negative and significant coefficient of -0.17, bringing the overall effect of CIT for capital abundant banks to -0.32. This evidence is consistent with better capitalized banks having more leeway to increase leverage as a response to higher corporate tax rates and simultaneously reduce asset risk to maintain a targeted regulatory capital buffer. Furthermore, as expected, capital-tight banks seem to reduce asset risk relative to a unit change in leverage more than capital abundant banks: the former adjust leverage and risk at a ratio of 2.33:1 (= 0.14/0.06), while this is 1.10:1 (= 0.32/0.29) for the latter.

Next, in columns (3) and (4) I add the interaction term between *CIT* and *Regulatory stringency*. In the leverage regression (column (3)) *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*5.3, see the descriptive statistics in Table 1), close to the baseline estimate without interactions (regression 1, Table 3). 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 taxes.[7] 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.

Overall, Table 6 gives some support to the hypothesis that banks trade off leverage against asset risk because of capital regulation.

[7]Nonetheless, 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.

5.7 Overall bank risk – Z-score regressions

In this section I assess how CIT impacts overall bank stability. I regress *Z-score* on *CIT* and the same control variables as before except that I exclude *ROA* as it is directly related to *Z-score*. Table 7 reports the results. In column (1) using the between estimator, I find a significantly positive coefficient estimate of 0.87, which is about the same as the standard deviation of the log of banks' Z-score. Thus, a 10% pp tax increase is associated with an increase of about one tenth of the standard deviation of *Z-score* – a modest change by any account. This suggests that the portfolio risk reduction more than offsets the risk increasing effect of leverage. Since regulation alone does not justify a full, or more than full offset, it seems likely that taxation has an effect on bank risk through other channels as well. One possibility is that taxation reduces the benefit of risk taking because the government shares in a bank's profits, but not in the losses.[8] The GMM regression in column (2) gives further evidence that the quantitative impact of taxation on banks' Z-score is small, as the coefficient estimates are statistically insignificant, but one has to be cautious, since the lagged dependent variable obtains a coefficient close to one, which makes measurement imprecise (Blundell and Bond, 1998).

6 Conclusions

In this paper I estimated the effect of corporate income taxation on bank capital structure and risk. Due to either risk based capital regulation or market based, risk dependent, privately optimal capital ratio targets leverage and risk decisions are potentially interrelated. To tackle this endogeneity, I estimated reduced form regressions, both single equation and simultaneous equation models.

A 10 percentage point increase in the marginal CIT rate leads to an increase in the

[8]This channel depends on country specific rules on loss carryover: in case of full carryover the government shares from profits as well as losses and the effect on risk taking should be eliminated. The analysis of this channel is beyond the scope of this paper.

leverage ratio of about 0.9-1.1 percentage points and a decrease of 2-7 percentage points in risk-weighted assets to total assets. The marginal impact on leverage is smaller than what other papers have previously found, which can be attributed to controlling for a broader set of bank and country factors. The negative impact of CIT on bank portfolio risk is robust to the type of risk measure: loan-to-asset and non-performing loan ratios are lower in high tax countries. While attention in existing literature has mostly focused on the leverage incentivizing effect of corporate income taxation, the results in this paper imply that the portfolio re-allocation effects are at least as important. Furthermore, the measured effect of corporate income taxes on overall bank risk seems to be modest. This can be partly attributed to regulation: banks reduce portfolio risk to a larger extent in response to higher taxation in countries where capital regulation is more stringent.

These results have important policy implications. In particular, they suggest that the elimination of interest deductibility of debt will not make banks safer to the extent that one might have hoped for. In this regard banks are different from non-financial companies as the latter are not regulated and therefore face fewer constraints on asset risk decisions. The observation that the estimated tax elasticity of debt for banks is close to or smaller than that of non-financial firms also suggests that the primary driver for banks' debt bias is not corporate income taxation, but rather other factors, such as access to the financial safety net. An approach that seems more effective at reducing banks' debt-bias thus involves the improvement of the resolution regime and the reduction of implicit subsidies to bank risk taking.

The relative size of welfare costs associated with the taxation of banks as compared to that of non-financial firms is not clear. In both cases higher leverage leads to higher expected costs of bankruptcy. In case of banks, these can be mitigated if they take less risk in the form of less risky lending because of bank regulation (and if capital requirements do not fully eliminate inefficient lending in the absence taxation). However, the converse might also be true: the interaction of taxation and regulation may lead to an inefficiently low level of lending with adverse effects for the real economy, if firms cannot switch to other forms of financing.

References

Adrian, T. and Shin, H. S. (2010). Liquidity and leverage. *Journal of Financial Intermediation*, 19(3):418–437.

Aggarwal, R. and Jacques, K. T. (2001). The impact of FDICIA and prompt corrective action on bank capital and risk: Estimates using a simultaneous equations model and prompt corrective action on bank capital and risk: Estimates using a simultaneous equations model. *Journal of Banking & Finance*, 25(6):1139–1160.

Allen, F. and Carletti, E. (2013). Deposits and bank capital structure. Technical Report 477.

Allen, F., Carletti, E., and Marquez, R. (2011). Credit market competition and capital regulation. *Review of Financial Studies*, 24(4):983–1018.

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58(2):277–297.

Arellano, M. and Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1):29–51.

Auerbach, A. J. (2002). Taxation and corporate financial policy. *Handbook of public economics*, 3:1251–1292.

Barth, J. R., Caprio, G., and Levine, R. (2001). *The regulation and supervision of banks around the world: A new database*. Brookings-Wharton Papers on Financial Services.

Barth, J. R., Caprio Jr, G., and Levine, R. (2004). Bank regulation and supervision: what works best? *Journal of Financial intermediation*, 13(2):205–248.

Beltratti, A. and Stulz, R. M. (2012). The credit crisis around the globe: Why did some banks perform better? *Journal of Financial Economics*, 105(1):1–17.

Berger, A., DeYoung, R., Flannery, M., Lee, D., and Öztekin, Ö. (2008). How do large banking organizations manage their capital ratios? *Journal of Financial Services Research*, 34(2):123–149.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1):115–143.

Bock, R. D. and Demyanets, A. (2012). Bank asset quality in emerging markets: Determinants and spillovers. IMF Working Papers 12/71, International Monetary Fund.

Calomiris, C. W. and Kahn, C. M. (1991). The role of demandable debt in structuring optimal banking arrangements. *American Economic Review*, 81(3):497–513.

Čihák, M., Demirgüç-Kunt, A., Martínez Pería, M. S., and Mohseni-Cheraghlou, A. (2012). Bank regulation and supervision around the world: a crisis update. *World Bank Policy Research Working Paper*, (6286).

Claessens, S. and van Horen, N. (2014). Foreign banks: Trends and impact. *Journal of Money, Credit and Banking*, 46(s1):295–326.

De Mooij, R. A. (2012). Tax biases to debt finance: Assessing the problem, finding solutions. *Fiscal Studies*, 33(4):489–512.

De Mooij, R. A., Keen, M., and Orihara, M. (2013). Taxation, bank leverage, and financial crises. IMF Working Papers 13/48, International Monetary Fund.

DeAngelo, H. and Masulis, R. W. (1980). Optimal capital structure under corporate and personal taxation. *Journal of Financial Economics*, 8(1):3–29.

Demirgüç-Kunt, A. and Huizinga, H. (2010). Bank activity and funding strategies: The impact on risk and returns. *Journal of Financial Economics*, 98(3):626–650.

Devereux, M., Johannesen, N., and Vella, J. (2013). Can taxes tame the banks? evidence from european bank levies.

Diamond, D. W. and Rajan, R. G. (2000). A theory of bank capital. *Journal of Finance*, 55(6):2431–2465.

Djankov, S., McLiesh, C., and Shleifer, A. (2007). Private credit in 129 countries. *Journal of Financial Economics*, 84(2):299–329.

Flannery, M. J. and Rangan, K. P. (2008). What caused the bank capital build-up of the 1990s? *Review of Finance*, 12(2):391–429.

Frank, M. Z. and Goyal, V. K. (2009). Capital structure decisions: Which factors are reliably important? *Financial Management*, 38(1):1–37.

Geanakoplos, J. (2010). The leverage cycle. In *NBER Macroeconomics Annual 2009, Volume 24*, pages 1–65. University of Chicago Press.

Graham, J. R. (2000). How big are the tax benefits of debt? *The Journal of Finance*, 55(5):1901–1941.

Graham, J. R. (2006). A review of taxes and corporate finance. *Foundations and Trends in Finance*, 1(7):573–691.

Gropp, R. and Heider, F. (2010). The determinants of bank capital structure. *Review of Finance*, 14(4):587–622.

Gu, G. W., de Mooij, R. A., and Poghosyan, T. (2012). Taxation and leverage in international banking. IMF Working Papers 12/281, International Monetary Fund.

Heid, F., Porath, D., and Stolz, S. (2004). Does capital regulation matter for bank behaviour? Evidence for German savings banks. Technical Report 2004,03.

Hemmelgarn, T. and Teichmann, D. (2013). Tax reforms and the capital structure of banks. Taxation Papers 37, Directorate General Taxation and Customs Union, European Commission.

Huizinga, H., Laeven, L., and Nicodème, G. (2008). Capital structure and international debt shifting. *Journal of Financial Economics*, 88(1):80–118.

Jacques, K. and Nigro, P. (1997). Risk-based capital, portfolio risk, and bank capital: A simultaneous equations approach. *Journal of Economics and Business*, 49(6):533–547.

Jokipii, T. and Milne, A. (2011). Bank capital buffer and risk adjustment decisions. *Journal of Financial Stability*, 7(3):165–178.

Keen, M. and de Mooij, R. A. (2012). Debt, taxes, and banks. IMF Working Papers 12/48, International Monetary Fund.

Laeven, L. and Levine, R. (2009). Bank governance, regulation and risk taking. *Journal of Financial Economics*, 93(2):259–275.

Le Leslé, V. and Avramova, S. (2012). Revisiting risk-weighted assets. IMF Working Papers 12/90, International Monetary Fund.

Marcus, A. J. (1983). The bank capital decision: A time series-cross section analysis. *The Journal of Finance*, 38(4):1217–1232.

Mariathasan, M. and Merrouche, O. (2013). The manipulation of basel risk-weights. *CEPR Discussion Paper No. DP9494*.

Myers, S. C. and Rajan, R. G. (1998). The paradox of liquidity. *The Quarterly Journal of Economics*, 113(3):733–771.

Orgler, Y. E. and Taggart, R. A. (1983). Implications of corporate capital structure theory for banking institutions: Note. *Journal of Money, Credit and Banking*, 15(2):212–221.

Rime, B. (2001). Capital requirements and bank behaviour: Empirical evidence for switzerland. *Journal of Banking & Finance*, 25(4):789–805.

Schaeck, K. and Čihák, M. (2012). Banking competition and capital ratios. *European Financial Management*, 18(5):836–866.

Shrieves, R. E. and Dahl, D. (1992). The relationship between risk and capital in commercial banks. *Journal of Banking & Finance*, 16(2):439–457.

Slemrod, J. (2009). Lessons for tax policy in the great recession. *National Tax Journal*, 62(3):387–397.

Turner, A. (2010). What do banks do? Why do credit booms and busts occur and what can public policy do about it? *The Future of Finance*, 5.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step gmm estimators. *Journal of Econometrics*, 126(1):25–51.

Table 1: Descriptive statistics

	No. of obs.	Mean	St. D.	Minimum	Maximum
CIT	148608	0.382	0.0533	0.100	0.560
CIT dummy	148608	0.956	0.206	0	1
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	147782	3.219	0.975	.459	5.544
Buffer dummy	127525	0.472	0.499	0	1
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

Table 2: Correlation matrix of main variables

	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

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Single equation leverage and RWA regressions

The dependent variable is *Leverage* in columns (1) and (2) and risk-weighted assets to total assets *(RWA)* in columns (3) and (4). Columns (1) and (3) are estimated with OLS on the between-transformed variables. Columns (2) and (4) 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 column (2) only the second lag, in column (4) only the third lag is used to instrument the lagged dependent variable. The sample in regression (4) excludes the years prior to 2004. The two-step estimator with the Windmeijer (2005) correction is applied. In columns (2) and (4) *CIT (Long run)* is the long run marginal effect of *CIT* calculated as $\gamma/(1-\beta)$ in equation (4). The standard errors of the long run marginal effect of CIT are calculated using the delta method and are clustered at the country level. t statistics in parentheses. See Appendix A.1 for variable definitions. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Leverage		RWA	
	(1)	(2)	(3)	(4)
	Between	GMM	Between	GMM
Lagged value		0.576***		0.843***
		(6.63)		(94.04)
CIT	0.0913***	0.0473***	-0.198***	-0.109**
	(7.60)	(2.76)	(-2.80)	(-2.21)
Size	0.0315***	0.0105***	0.0582***	0.00545***
	(13.58)	(4.27)	(11.71)	(3.98)
Size^2	-0.000679***	-0.000272***	-0.00137***	-0.000145*
	(-7.70)	(-2.79)	(-7.23)	(-1.89)
Net interest margin	-0.716***	0.261***	4.436***	0.564***
	(-16.08)	(3.11)	(36.17)	(3.51)
ROA	-0.0116	-0.947***	-2.746***	-0.206***
	(-0.22)	(-23.09)	(-21.73)	(-2.90)
Fee income	-0.0343***	0.0105	-0.0685***	-0.0303***
	(-7.57)	(1.33)	(-5.40)	(-5.85)
Wholesale funding	-0.0692***	-0.00561	0.0712***	0.0175
	(-18.98)	(-1.44)	(5.38)	(0.94)
Non-interest expenses	-0.341***	-0.355***	-0.0862	0.212***
	(-17.12)	(-8.22)	(-1.31)	(6.43)
Market share	0.0673***	0.0312*	-0.0307	0.0331*
	(5.26)	(1.81)	(-0.72)	(1.71)
Aggregate credit	0.0783***	0.0131	0.207***	0.0585***
	(8.30)	(1.06)	(6.71)	(3.05)
Basel II	-0.0596***	-0.00302	-0.149***	-0.0169***
	(-19.63)	(-1.59)	(-20.95)	(-3.35)
RGDP growth	-0.358***	0.0811***	-1.398***	-0.0435
	(-6.35)	(3.09)	(-7.01)	(-0.31)
CPI	0.0218	-0.0213	0.596***	0.0874
	(0.58)	(-0.88)	(3.99)	(0.63)
Gvt Debt/GDP	-0.0220***	0.000977	0.0873***	0.0168**
	(-7.41)	(0.18)	(6.35)	(2.47)
GDP per capita	0.00181	0.00232	0.0397***	0.00327
	(1.03)	(0.96)	(6.43)	(0.71)

Exchange rate chg	-0.0225	-0.0224***	-0.783***	-0.107*
	(-1.04)	(-5.75)	(-6.45)	(-1.72)
Activity restrictions	-0.00425***	-0.000895	0.00628***	0.00121
	(-10.51)	(-1.42)	(3.93)	(0.77)
Regulatory stringency	-0.000376	0.000674	-0.00932***	0.000599
	(-0.45)	(0.63)	(-3.03)	(0.31)
Capital requirements	-0.269**	-0.359	0.150	-0.0466
	(-2.16)	(-1.62)	(0.42)	(-0.14)
Creditor rights	0.00312***	0.000825	0.0233***	-0.00452
	(3.53)	(0.45)	(4.23)	(-1.04)
Constant	0.659***	0.280***	-0.514***	-0.00273
	(21.08)	(3.78)	(-5.36)	(-0.03)
Observations	148608	129378	106688	62806
Adjusted R^2	0.354		0.212	
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		0.448		0.911
CIT (Long run)		0.112**		-0.696*
		(2.88)		(-2.23)

Table 4: Robustness checks

The dependent variable is *Leverage* in columns (1), (3) and (5), the first difference of *Leverage* in column (7); risk-weighted assets to total assets *(RWA)* in columns (2), (4) and (6) and the first difference of *(RWA)* in column (8). Columns (1)-(6) are estimated with OLS on the between-transformed variables. Columns (7)-(8) are estimated as a system of simultaneous equations using 3SLS and include time effects. *L.Leverage* (*L.RWA*) is the first lag of *Leverage* (*RWA*) and *D.Leverage* (*D.RWA*) is the first lag of *Leverage* (*RWA*). *CIT (Long run)* is the long run marginal effect of *CIT* calculated as $-b_1/a_1$ and $-b_2/a_2$ in equations (5) and (6) for *Leverage* and *RWA*, respectively. The standard error of the long run tax impact is calculated with the delta method. t statistics in parentheses. See Appendix A.1 for variable definitions. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Pre-crisis sample		Without US banks		Ownership structure		SUR	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Leverage	RWA	Leverage	RWA	Leverage	RWA	D.Leverage	D.RWA
CIT	0.159***	-0.526***	0.111***	-0.0834	0.0777***	-0.196***	0.0268***	-0.0994***
	(12.42)	(-3.62)	(6.36)	(-0.65)	(6.27)	(-2.63)	(3.06)	(-4.92)
L.Leverage							-0.386***	
							(-209.97)	
L.RWA								-0.130***
								(-83.97)
D.Leverage								0.356***
								(36.28)
D.RWA							-0.0924***	
							(-17.17)	
CIT diff					-0.00582	-0.0543		
(Local - frgn subsidiary)					(-0.14)	(-0.39)		
CIT diff					-0.0120	0.0847		
(Local - owner)					(-0.32)	(0.56)		
No ownership					0.0160***	-0.0212*		
data dummy					(6.30)	(-1.86)		
Size	0.0439***	0.0344***	0.0447***	0.104***	0.0303***	0.0607***	0.00796***	0.00739***

	(15.90)	(5.89)	(9.89)	(6.09)	(12.97)	(11.70)	(21.14)	(8.52)
$Size^2$	-0.00122***	-0.000367	-0.000971***	-0.00350***	-0.000619***	-0.00148***	-0.000269***	-0.000195***
	(-11.45)	(-1.61)	(-5.73)	(-5.99)	(-6.94)	(-7.40)	(-18.51)	(-5.86)
Net interest margin	0.429***	5.632***	-1.241***	1.610***	-0.701***	4.435***	0.347***	0.515***
	(7.85)	(40.22)	(-17.59)	(4.91)	(-15.76)	(36.15)	(37.74)	(22.66)
ROA	0.607***	-2.220***	-0.700***	0.554	-0.0307	-2.739***	-1.045***	-0.0188
	(10.28)	(-15.64)	(-7.77)	(1.41)	(-0.59)	(-21.67)	(-118.10)	(-0.81)
Fee income	0.0342***	-0.0538***	-0.0780***	-0.0462	-0.0334***	-0.0690***	0.0211***	-0.0241***
	(6.45)	(-3.55)	(-10.78)	(-1.23)	(-7.36)	(-5.43)	(23.14)	(-11.46)
Wholesale funding	-0.0622***	0.0653***	-0.0682***	0.0347	-0.0695***	0.0715***	0.00491***	0.0136***
	(-14.56)	(4.12)	(-13.64)	(1.36)	(-19.01)	(5.38)	(4.34)	(5.21)
Non-interest expenses	-1.080***	-0.277***	-0.0984***	0.656***	-0.351***	-0.0834	-0.317***	0.0803***
	(-35.62)	(-3.79)	(-3.46)	(3.58)	(-17.57)	(-1.26)	(-58.09)	(6.50)
Market share	0.0427***	0.125	0.0520***	-0.0568	0.0722***	-0.0374	0.0317***	0.0484***
	(2.94)	(1.60)	(3.19)	(-0.98)	(5.62)	(-0.88)	(5.92)	(3.93)
Aggregate credit	-0.000366	0.212**	0.0806***	0.0684	0.0790***	0.206***	0.0284***	0.0587***
	(-0.03)	(1.98)	(6.32)	(1.41)	(8.37)	(6.64)	(6.27)	(5.64)
Basel II			-0.0471***	-0.0391**	-0.0591***	-0.150***	-0.00552***	-0.0187***
			(-10.24)	(-2.42)	(-19.43)	(-20.97)	(-5.08)	(-7.48)
RGDP growth	-0.363***	-1.817***	-0.342***	-0.753**	-0.343***	-1.341***	0.165***	0.0701
	(-4.95)	(-4.03)	(-4.63)	(-2.28)	(-6.10)	(-6.61)	(6.41)	(1.18)
CPI	-0.313***	2.565***	0.0980**	0.361*	0.00842	0.587***	0.0421***	0.0226
	(-7.04)	(4.06)	(1.99)	(1.70)	(0.22)	(3.93)	(3.33)	(0.77)
Gvt Debt/GDP	-0.00679*	0.195***	-0.0313***	0.0901***	-0.0237***	0.0938***	0.00187	0.0179***
	(-1.87)	(6.27)	(-6.71)	(4.10)	(-7.95)	(6.57)	(1.07)	(4.47)
GDP per capita	-0.0175***	0.0835***	0.000230	0.0249**	-0.00215	0.0419***	0.00409***	0.00382*
	(-8.56)	(4.81)	(0.08)	(2.48)	(-1.15)	(6.57)	(4.62)	(1.88)

Exchange rate chg	-0.0464**	0.671**	-0.0253	-0.623***	-0.0172	-0.780***	0.00154	-0.0719***
	(-2.06)	(2.10)	(-0.92)	(-3.65)	(-0.80)	(-6.41)	(0.19)	(-3.89)
Activity restrictions	-0.00446***	-0.0254***	-0.00407***	0.00798***	-0.00421***	0.00647***	-0.000656***	0.000350
	(-8.37)	(-4.84)	(-5.38)	(2.79)	(-10.40)	(4.02)	(-3.06)	(0.71)
Regulatory stringency	0.00443***	-0.0395***	-0.000905	0.00269	-0.000491	-0.00977***	-0.00251***	0.00133
	(4.56)	(-5.42)	(-0.84)	(0.65)	(-0.58)	(-3.15)	(-5.41)	(1.25)
Capital requirements	-2.045***	-0.0598	0.181	1.386***	-0.305**	0.139	-0.227***	-0.414***
	(-12.51)	(-0.06)	(1.12)	(2.70)	(-2.45)	(0.38)	(-4.23)	(-3.35)
Creditor rights	0.00125	-0.0275***	0.00342***	0.00132	0.00286***	0.0231***	-0.000136	-0.00476***
	(1.24)	(-2.80)	(2.70)	(0.17)	(3.24)	(4.13)	(-0.19)	(-2.86)
Constant	0.880***	-0.299	0.534***	-0.684***	0.700***	-0.536***		
	(22.98)	(-1.24)	(10.04)	(-3.52)	(21.94)	(-5.52)		
Observations	98563	65053	39641	5268	148608	106688	95259	95259
Adjusted R^2	0.317	0.212	0.450	0.185	0.356	0.212		
CIT (Long run)							0.0695**	-0.763***
							(3.06)	(-4.92)

Table 5: Single equation regressions on alternative portfolio risk measures

The dependent variable is total loans to total assets (*Loans*) in columns (1)-(2) and log-share of non-performing loans to total loans (*NPL*) in columns (3)-(4). Columns (1) and (3) are estimated with OLS on the between-transformed variables. Columns (2) and (4) 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 column (2) only the second lag, in column (4) only the third lag is used to instrument the lagged dependent variable. The two-step estimator with the Windmeijer (2005) correction is applied. In columns (2) and (4) *CIT (Long run)* is the long run marginal effect of *CIT* calculated as $\gamma/(1-\beta)$ in equation (4). The standard errors of the long run marginal effect of CIT are calculated using the delta method and are clustered at the country level. t statistics in parentheses. See Appendix A.1 for variable definitions. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Loans		NPL	
	(1) Between	(2) GMM	(3) Between	(4) GMM
Lagged value		0.920***		0.693***
		(87.53)		(38.82)
CIT	-0.199***	-0.0618	-5.978***	-1.442**
	(-7.36)	(-1.64)	(-15.00)	(-2.36)
Size	0.0837***	-0.00149	-0.00253	0.0691***
	(16.00)	(-0.86)	(-0.06)	(3.56)
Size^2	-0.00231***	0.0000265	0.00141	-0.00163**
	(-11.61)	(0.48)	(0.92)	(-1.99)
Net interest margin	2.855***	0.509***	12.53***	3.752***
	(28.44)	(3.24)	(15.75)	(7.62)
ROA	-2.031***	-0.538***	-30.74***	-13.11***
	(-17.16)	(-4.41)	(-32.06)	(-8.11)
Fee income	-0.248***	-0.0132*	0.446***	0.224***
	(-24.29)	(-1.94)	(5.17)	(3.57)
Wholesale funding	0.0458***	0.0139	0.275***	0.0879
	(5.57)	(1.17)	(3.51)	(0.87)
Non-interest expenses	-0.0602	0.0310	-0.995***	0.0848
	(-1.34)	(1.13)	(-2.81)	(0.25)
Market share	0.268***	0.0414**	1.010***	0.465*
	(9.31)	(2.19)	(4.19)	(1.68)
Aggregate credit	0.685***	0.0900***	0.634***	0.0180
	(32.19)	(4.49)	(3.27)	(0.06)
Basel II	0.00602	-0.0148***	0.177***	-0.0305
	(0.88)	(-2.79)	(3.80)	(-0.80)
RGDP growth	-0.256**	0.0884	-5.991***	-4.414***
	(-2.01)	(1.12)	(-6.49)	(-3.51)
CPI	-0.305***	-0.0399	-1.939***	0.0332
	(-3.57)	(-0.41)	(-2.62)	(0.08)
Gvt Debt/GDP	-0.0802***	0.000851	2.429***	0.722***
	(-12.00)	(0.08)	(45.00)	(12.50)
GDP per capita	0.0282***	0.00399	-0.857***	-0.207***
	(7.14)	(0.66)	(-26.41)	(-4.61)

Exchange rate chg	-0.0771	-0.0326	-1.350***	-0.608***
	(-1.59)	(-1.47)	(-4.28)	(-4.87)
Activity restrictions	-0.00606***	-0.00220***	-0.00121	0.0330**
	(-6.64)	(-3.08)	(-0.12)	(2.42)
Regulatory stringency	0.00219	-0.00114	-0.0226	-0.00542
	(1.15)	(-0.46)	(-1.30)	(-0.19)
Capital requirements	-1.408***	-0.378*	12.61***	2.253
	(-5.02)	(-1.68)	(5.56)	(0.45)
Creditor rights	-0.0118***	-0.00272	-0.00578	-0.0587
	(-5.95)	(-1.42)	(-0.25)	(-1.27)
Constant	-0.470***	0.0377	2.951***	-0.327
	(-6.67)	(0.50)	(5.38)	(-0.40)
Observations	148608	129378	103624	84882
Adjusted R^2	0.233		0.430	
Number of instruments		57		55
AR(1) test p value		0.000		0.000
AR(2) test p value		0.943		0.000
AR(3) test p value				0.526
Hansen test p value		0.342		0.145
CIT (Long run)		-0.777		-4.697*
		(-1.63)		(-2.33)

Table 6: Effect of regulation

The dependent variables are *Leverage* in columns (1) and (3) and risk-weighted assets over total assets (*RWA*) in columns (2) and (4). All regressions are estimated with OLS on the between-transformed variables. t statistics in parentheses. See Appendix A.1 for variable definitions. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Capital tightness		Regulatory stringency	
	(1)	(2)	(3)	(4)
	Leverage	RWA	Leverage	RWA
CIT	0.0619***	-0.137**	0.268***	1.331***
	(3.56)	(-1.99)	(4.06)	(4.84)
CIT * Buffer dummy	0.230***	-0.174***		
	(11.42)	(-3.00)		
CIT * Regulatory stringency			-0.0316***	-0.273***
			(-2.72)	(-5.75)
Buffer dummy	-0.132***	-0.0262		
	(-17.28)	(-1.18)		
Size	0.0106***	0.0375***	0.0315***	0.0574***
	(5.50)	(8.11)	(13.61)	(11.57)
Size^2	-0.000278***	-0.000971***	-0.000680***	-0.00132***
	(-3.83)	(-5.52)	(-7.70)	(-6.97)
Net interest margin	-0.0976**	4.007***	-0.709***	4.398***
	(-2.22)	(34.81)	(-15.90)	(35.86)
ROA	0.101**	-2.635***	-0.0152	-2.703***
	(2.11)	(-22.45)	(-0.29)	(-21.38)
Fee income	0.0328***	-0.103***	-0.0338***	-0.0702***
	(7.27)	(-8.67)	(-7.45)	(-5.54)
Wholesale funding	-0.0376***	0.0850***	-0.0696***	0.0703***
	(-9.22)	(6.87)	(-19.08)	(5.32)
Non-interest expenses	-0.760***	0.132**	-0.346***	-0.0923
	(-31.91)	(2.15)	(-17.30)	(-1.40)
Market share	0.0734***	-0.0493	0.0692***	-0.00587
	(6.30)	(-1.25)	(5.40)	(-0.14)
Aggregate credit	0.0744***	0.146***	0.0776***	0.242***
	(7.85)	(4.99)	(8.22)	(7.70)
Basel II	-0.0267***	-0.114***	-0.0601***	-0.147***
	(-9.32)	(-16.91)	(-19.77)	(-20.63)
RGDP growth	0.0297	-1.504***	-0.364***	-1.430***
	(0.48)	(-8.01)	(-6.45)	(-7.17)
CPI	0.00112	0.701***	0.0257	0.661***
	(0.03)	(5.07)	(0.68)	(4.42)
Gvt Debt/GDP	0.00600**	0.0761***	-0.0218***	0.0718***
	(2.08)	(5.88)	(-7.34)	(5.14)
GDP per capita	-0.00256	0.0361***	0.000707	0.0327***
	(-1.46)	(6.21)	(0.39)	(5.20)
Exchange rate chg	-0.00663	-0.829***	-0.0320	-0.824***
	(-0.24)	(-7.32)	(-1.47)	(-6.78)

Activity restrictions	-0.00257***	0.00804***	-0.00434***	0.00408**
	(-5.75)	(5.25)	(-10.68)	(2.48)
Regulatory stringency	-0.000458	-0.00699**	0.00867**	0.0598***
	(-0.55)	(-2.43)	(2.53)	(4.82)
Capital requirements	-0.769***	0.222	-0.341***	-0.289
	(-6.51)	(0.66)	(-2.68)	(-0.79)
Creditor rights	0.00676***	0.0214***	0.00360***	0.0260***
	(6.39)	(4.11)	(4.00)	(4.70)
Constant	0.890***	-0.250***	0.624***	-0.792***
	(29.27)	(-2.76)	(18.54)	(-7.38)
Observations	127525	106606	148608	106688
Adjusted R^2	0.406	0.325	0.355	0.215

Table 7: Z-score regressions

The dependent variable in columns (1) and (2) is the natural logarithm of Z-score *(Z-score)*. Columns (1) is estimated with OLS on the between-transformed variables. Regression (2) is estimated with the system GMM estimator with only the lagged dependent variable treated as endogenous, instrumented only by the third lag. Column (2) includes bank and time effects as well. The two-step estimator with the Windmeijer (2005) correction is applied. In column (2) *CIT (Long run)* is the long run marginal effect of *CIT* calculated as $\gamma/(1-\beta)$ in equation (4). The standard errors of the long run marginal effect of CIT are calculated using the delta method and are clustered at the country level. t statistics in parentheses. See Appendix A.1 for variable definitions. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Z-score	
	(1) Between	(2) GMM
Lagged value		0.979***
		(173.94)
CIT	0.871***	0.0861
	(4.72)	(1.14)
Size	-0.0722**	-0.00611
	(-2.06)	(-0.95)
Size^2	0.00193	0.000246
	(1.45)	(0.94)
Net interest margin	-1.178*	1.486***
	(-1.89)	(6.08)
Fee income	-0.655***	0.195***
	(-9.84)	(2.79)
Wholesale funding	-0.139**	-0.0877***
	(-2.52)	(-4.86)
Non-interest expenses	-3.198***	-1.155***
	(-10.87)	(-3.79)
Market share	-0.0843	-0.0870
	(-0.42)	(-1.44)
Aggregate credit	2.704***	-0.0260
	(18.91)	(-0.55)
Basel II	-0.0308	0.00401
	(-0.67)	(0.39)
RGDP growth	6.694***	-0.133
	(7.76)	(-0.60)
CPI	-2.465***	-0.362**
	(-4.25)	(-2.01)

Gvt Debt/GDP	-0.450***	-0.000465
	(-10.00)	(-0.02)
GDP per capita	0.0401	-0.00424
	(1.50)	(-0.37)
Exchange rate chg	1.464***	0.0565
	(4.30)	(1.52)
Activity restrictions	-0.163***	-0.00656***
	(-26.37)	(-3.07)
Regulatory stringency	0.0191	0.00456
	(1.48)	(0.94)
Capital requirements	0.744	-0.583
	(0.39)	(-0.94)
Creditor rights	0.0300**	0.00123
	(2.23)	(0.22)
Constant	3.475***	0.159
	(7.33)	(0.75)
Observations	147782	128622
Adjusted R^2	0.165	
Number of instruments		54
AR(1) test p value		0.000
AR(2) test p value		0.000
AR(3) test p value		0.692
Hansen test p value		0.377
CIT (Long run)		4.057
		(1.08)

A Appendix

A.1 Variable definitions

Table 8: Definition and source of variables

Variable	Definition	Source
CIT	Top statutory corporate income tax rate.	OECD; KPMG Corporate and Indirect Tax Surveys 2007, 2010 and 2011
CIT dummy	1 if CIT is higher than the average CIT rate in the sample, which is 27.31% and 0 otherwise.	OECD; KPMG Corporate and Indirect Tax Surveys 2007, 2010 and 2011
Leverage	Total liabilities over total assets.	Bankscope
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
Buffer dummy	1 if a bank has a regulatory capital buffer on average more than the median, which is 0.074 and 0 otherwise. Regulatory capital buffer is Tier I + Tier 2 capital over risk-weighted assets minus capital requirements.	Bankscope and Barth et al. (2001), Barth et al. (2004), Barth et al. (2008)
Z-score	Natural logarithm of Z-score = (Total equity/Total assets + ROA) / standard deviation of ROA.	Bankscope
Size	Natural logarithm of the book value of total assets.	Bankscope
$Size^2$	The square of the natural logarithm of the book value of total assets.	Bankscope
Net interest margin	Net interest margin.	Bankscope
ROA	Return over average assets.	Bankscope
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
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 exhange 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)

A.2 Partial adjustment model

The partial adjustment model (equation (4)) 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

$$\Delta y_{ijt} = \Delta y^{b}_{ijt} + u_{ijt} \tag{7}$$

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^{b}_{ijt}, 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:

$$\Delta y^{b}_{ijt} = \psi(y^{*}_{ijt} - y_{ijt-1}) \tag{8}$$

Inserting the equation for banks' planned adjustment (equation (8)) into the observed adjustment equation (7) and assuming that the target levels (y^*) are a linear function of some determinants yields equation (4) after some rewriting.