



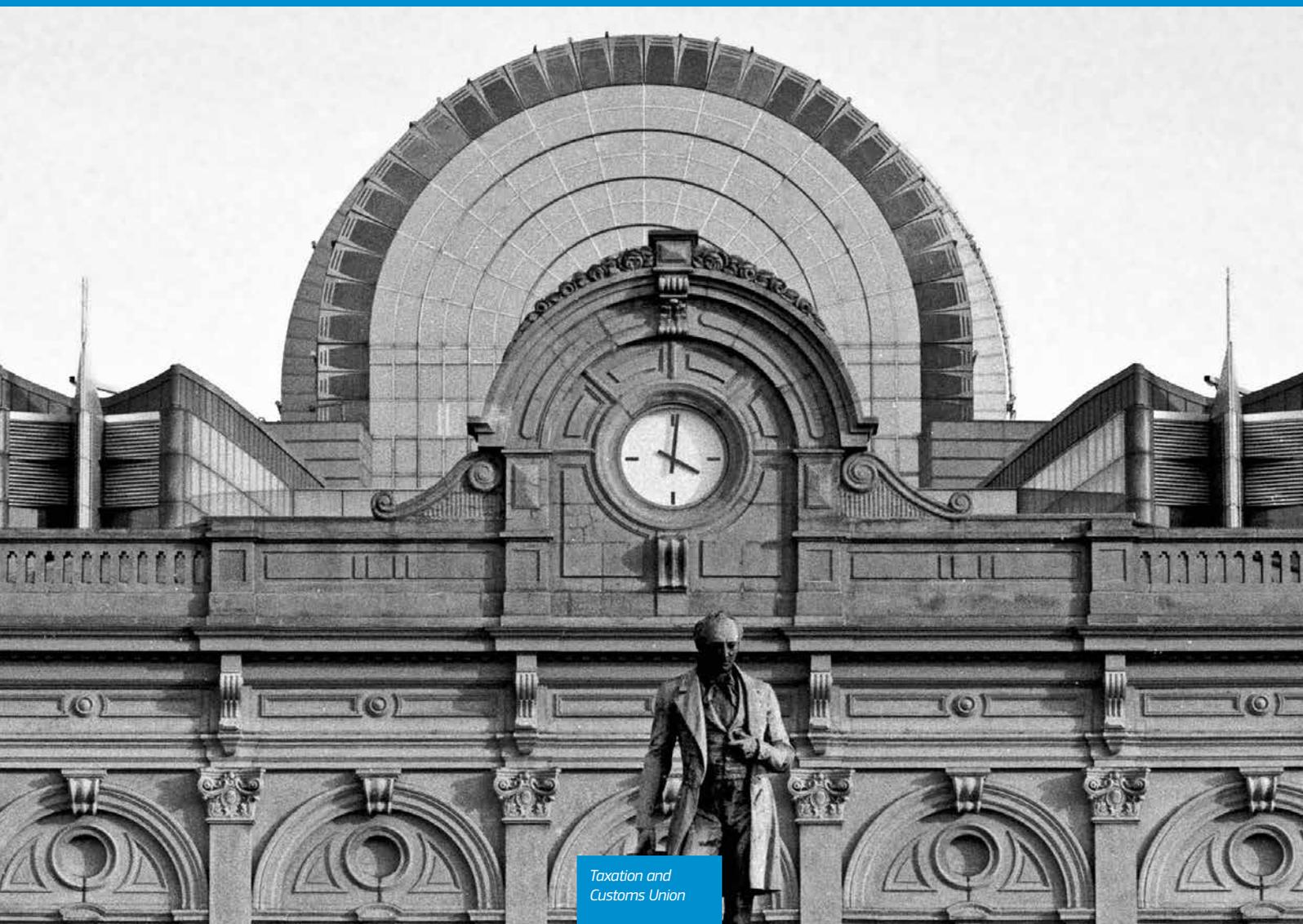
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**Sven Langedijk**  
**Gaëtan Nicodème**  
**Andrea Pagano**  
**Alessandro Rossi**

# Debt Bias in Corporate Taxation and the Costs of Banking Crises in the EU



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# Debt Bias in Corporate Taxation and the Costs of Banking Crises in the EU

Sven Langedijk<sup>†</sup>, Gaëtan Nicodème<sup>‡</sup>, Andrea Pagano<sup>†</sup>, Alessandro Rossi<sup>† 1</sup>

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**Abstract:** During the period 2008-2012, EU governments incurred substantial costs bailing out banks. As corporate income taxation (CIT) in most countries still favors debt- over equity-financing, reducing or eliminating this debt bias would complement regulatory reforms reducing costs of financial crises. To estimate this effect, we use a two-step approach. First, using panel regressions on a dataset of 32,833 bank-year observations we find sizable long-run effects of CIT on leverage in the EU. Second, we simulate the effect of tax reforms on bank losses using a Vasicek-based model with actual banks' balance sheets to estimate costs of systemic crises for six large EU member states. Even if the tax elasticity of bank leverage is taken at the lower end of the ranges found in recent literature, eliminating the debt bias could lead to reductions of public finance losses in the range of 60 to 90%. The results hold even when considering much smaller effects for banks that are close to the regulatory minimum capital requirement of the Basel III framework. Even when asset portfolio risk is allowed to increase endogenously and considering conservative ranges of the parameter space, we conclude that tax reforms to remove the debt bias can result in very sizable reductions in risks and costs of financial crises.

**Key words:** Debt bias; Systemic crisis; Capital structure; Taxation; Allowance for Corporate Equity; Public finance; Bail out

**JEL classifications:** G01, G28, G32, H25

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<sup>1</sup> Corresponding author: [sven.langedijk@jrc.ec.europa.eu](mailto:sven.langedijk@jrc.ec.europa.eu). <sup>†</sup> European Commission – Joint Research Center. <sup>‡</sup> European Commission (DG Taxation and Customs Union), ULB, CEPR and CESifo. The views expressed in this study are those of the author and do not necessarily reflect those of the European Commission. The authors appreciate the helpful comments of Thomas Hemmelgarn, and Ernesto Zangari. Errors and omissions are those of the authors only.

## 1. Introduction

In the period 2008-2012, EU governments provided emergency support to prevent a collapse of the financial system. The overall volume of aid used for capital support to the financial sector (recapitalization and asset relief measures) amounted to € 591.9 billion (4.6 % of EU 2012 GDP).<sup>2</sup> Bank capital was inadequate to cover losses and to prevent a panic in the financial sector. Excessive bank leverage worsened contagion risks and exacerbated the public costs of the financial crisis. A range of explanatory factors have been identified for high bank leverage.<sup>3</sup> Tax rules did not lean against the wind. In many cases, taxation even leaned in the wrong direction, encouraging excessive debt financing, complex financial transactions, poorly designed incentive compensation for corporate managers, and highly leveraged home ownership.<sup>4</sup>

In traditional corporate finance theory, debt financing has tax advantages because interest payments reduce the firm's taxable income while dividends and share repurchases do not. The theoretical framework builds on extensions of the Modigliani-Miller capital structure irrelevance proposition.<sup>5</sup> This proposition suggests that leverage of a firm has no effect on the market value of the firm. When corporate income tax is added to the original irrelevance proposition, this creates a benefit for debt as interest payments shield earnings from taxes. If there is no offsetting cost of debt, this implies 100% debt financing. Modigliani-Miller theorem fails under a variety of other circumstances, including existence of transaction costs, bankruptcy costs, agency conflicts, adverse selection, etc. To avoid the extreme predictions, an offsetting cost of debt is needed. Following Kraus and Litzenberger (1973) and Myers (1984) most studies consider the deadweight costs of bankruptcy providing a counterweight to avoid a corner solution with 100% debt financing. Firms balance the tax benefits of debt against the costs of financial distress. Tax effects dominate at low leverage, while distress costs dominate at high leverage. The firm has an optimal, or target, debt ratio at which the incremental value of tax shields from a small change in leverage exactly offsets the incremental distress costs. This target optimal debt ratio is determined by firm characteristic like profitability and asset risk and the level of corporate taxation.

Removing the debt bias of taxation would provide a level playing field between debt and equity. Eliminating this debt bias for the banking sector would provide banks with an incentive to increase capital

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<sup>2</sup> In addition, guarantees and other form of liquidity supports peaked reached € 906 billion (7.7 % of EU 2012 GDP) in 2009. Source: [http://ec.europa.eu/competition/state\\_aid/scoreboard/financial\\_economic\\_crisis\\_aid\\_en.html](http://ec.europa.eu/competition/state_aid/scoreboard/financial_economic_crisis_aid_en.html)

<sup>3</sup> See e.g. Diamond and Rajan (2009), Crotty (2009), Laeven et al (2010), and Valencia (2011) for an overview of causes of the financial crisis, including bank leverage, excessive short-term debt, hidden off-balance-sheet risks, monetary policy and a benign macroeconomic environment leading to excessive risk-taking and leverage.

<sup>4</sup> See Shaviro (2009), Shackelford et al. (2009), Lloyd (2009), Hemmelgarn and Nicodeme (2010) and IMF (2009) for discussions of tax distortions and the financial crisis.

<sup>5</sup> Modigliani and Miller (1958 and 1963)

and reduce debt financing. Considering the large social costs of financial crises due to excessive bank leverage and regulatory efforts to increase banks capital, the benefits of elimination of tax incentives for holding debt, or even a tax scheme favoring equity over debt, may be particularly desirable for banks.

There is abundant empirical work on the effect of the debt bias of corporate income taxation (CIT) on debt-financing for non-financial corporations (NFCs). Most papers exclude banks from the analysis, considering that the decisions on funding may be very different for banks. Compared to non-financial corporations, leverage ratios of banks are generally much higher and subject to regulatory requirements that may - to a large extent - drive their financing decisions. Ex ante, one could consider the possibility that the impact of regulation, information asymmetry, agency costs and bankruptcy costs, as well as the implicit and explicit guarantees on liabilities, could possibly dwarf the marginal costs and benefits of tax optimization as drivers of bank leverage. Moreover, while banks continuously raise and roll-over debt of different forms, raising new equity or reducing dividends to increase capital may have important transaction and reputation costs. If so, taxation would not be an important driver of strategic decisions on banks' choice between debt and equity financing, and identifying an impact of the CIT on funding might prove more challenging than for NFCs.

A number of recent studies confirm however that the CIT does affect banks capital structure significantly. Using bank level data, Keen and de Mooij (2012) and De Mooij et al. (2014) find a long run CIT impact on bank leverage close to what the literature covering NFCs has found within a range of 0.14-0.31. Horvath (2013) reproduces the Keen and Mooij regressions finding a somewhat lower range (0.08-0.14). An important driver for the lower results is a Basel II dummy that he introduces. When he drops this dummy, the lower-bound coefficient estimate of CIT increases from 0.08 to 0.18. 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 tax elasticity of leverage for banks within the range of Horvath at 0.10. For the period 1991-2004 Gropp and Heider (2009) also find that similarities between banks' and nonfinancial firms' capital structure may be greater than previously thought. Standard cross-sectional determinants of non-financial firms' leverage carry over to banks, except for banks whose capital ratio is close to the regulatory minimum. They find that unobserved time-invariant bank fixed effects are ultimately the most important determinant of banks' capital structures and that banks' leverage converges to bank-specific, time-invariant targets. Schandlbauer (2013) using a difference-in-differences methodology shows that an increase in the local U.S. state corporate tax rate affects both sides of the banks' balance sheet. Banks which are exposed to a tax raise their non-depository debt by approximately 5.9% one period prior to the enactment of the tax change. The overall average however hides a large cross-sectional heterogeneity: better-capitalized banks have the financial flexibility to increase their debt and benefit from an enlarged tax shield. Worse-capitalized banks instead constrain the expansion of customer loans, as their after tax capital and cash is reduced.

As reviewed by Fatica et al. (2013), several instruments are at the disposal of policy-makers to remove the debt bias, such as the Comprehensive Business Income Tax (i.e. CBIT which disallows interest deductibility), the Allowance for Corporate Equity (i.e. ACE which allows the deductibility of a notional interest on equity) or cash-flow taxation (which depending on the design either disallows any deductibility or allows immediate expensing of any financing cost). Schepens (2013) analyses the effect on banks of the Belgian Allowance for Corporate Equity (ACE) that was introduced in 2006. He finds that a reduction in the tax discrimination between debt and equity funding leads to better capitalized financial institutions. He also finds that profitable banks are more sensitive to this change, as they have a stronger incentive to take advantage of the tax discrimination between debt and equity. Furthermore, low capitalized banks profit more of it in terms of overall risk reduction which suggests that the tax discrimination between debt and equity could potentially be an interesting regulatory policy tool.<sup>6</sup> The reduction of the unequal tax treatment of debt and equity has a significant and economically large impact on the capital structure of banks. On average, the equity ratio increases between 0.83 and 0.91 percentage points for the average Belgian bank in the sample.<sup>7</sup>

The capital structure (or liability side) of the bank balance sheet may not be the only item affected by the debt bias in CIT. Several studies indeed suggest that portfolio risk on the asset side may indirectly be sensitive to taxation. Devereux (2014) presents a theoretical framework suggesting that an increase in capital due to a reduction in the debt bias of taxation induces banks to increase risk on the asset side, as the increased capital provides room under the Basel regulatory framework and in particular the Tier I capital ratio. This mechanism would undermine the benefit of higher capital by greater asset risk. Total risk relative to capital may then be expected to be as large as before the reduction of the debt bias of taxation. The degree to which Devereux' theoretical argument holds depends on the extent to which all banks target an internal bank-specific risk-weighted capital ratio, such that any increase in capital is matched by an increase in asset portfolio risk. There is a strand of literature that confirms a positive relationship between short- and long-run adjustments of the capital structure and asset risk; the strength of the relation however varies and does not seem to hold in full for all banks.<sup>8</sup> Horvath (2013) empirically

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<sup>6</sup> First, he shows that the equity ratios of Belgian banks are significantly higher after reducing the relative tax advantage of debt. Second, by comparing the change in equity ratios at Belgian financial institutions before and after the change in tax treatment with a matched group of European financial institutions that were not exposed to the change in tax treatment, he measures the causal impact of these tax frictions on bank capital structure.

<sup>7</sup> Note that measures like ACE do not address excessive leverage due to (ab)use of differences in corporate tax rates across countries by profit-shifting via a transfer of debt and interest expenses within multi-national corporations and banking groups. Fatica, Hemmelgarn and Nicodeme (2012) highlight that in addition to social costs arising from excessive leverage in a financial crisis, this 'debt bias' in taxation also facilitates abuse of differences in corporate tax rates across countries by profit-shifting via a transfer of debt and interest expenses within multi-national corporations and banking groups. Gu et al. (2014) examine multinational banks' capital structures and find that tax differentials lead to cross-border debt-shifting.

<sup>8</sup> See Horvath (2013) for a discussion of this literature. Also, Memmel and Raupach (2007) find that for a significant percentage of German banks there seems to be a certain bank-specific capital ratio that management seeks to

estimates the endogenous dynamics of CIT, leverage and portfolio risk (risk weighted asset density). He finds sizeable effects of CIT on banks asset portfolio risk depending on his data sample and model specification.

Building on their analysis of the CIT effect on leverage, De Mooij et al (2014) link the tax-debt bias to greater risk and costs of financial crises. They suggest welfare gains from policies that alleviate the tax bias, such as cuts in CIT, taxes on bank liabilities and a ‘tax allowance’ for a ‘normal return’ on equity. These results would also support the idea that ending the preferential tax treatment of debt could be a promising avenue to avoid risky leverage of banks and thus reduce the vulnerability of the system to future shocks.

This study adds to this small but rapidly growing literature of empirical research pointing to a relation between corporate taxation, bank leverage and costs of financial crises. We first estimate the effect of corporate taxation on bank leverage with a series of panel regressions, building on the methodology of Keen and Mooij (2012), but focusing on a sample of 3,000 EU banks using data spanning the period 2001-2011. In a second step, we gauge the potential reduction in public finance costs in financial crises that would result from reducing banks’ incentives for debt financing compared to equity financing, using an actual bank balance-sheet-based model of costs of systemic crisis (SYMBOL-model) for six EU member states. Finally, we show under which conditions the results hold when varying the sensitivity of leverage to CIT, when asset portfolio risk is adjusted together with bank leverage, and when allowing for increased asset portfolio risk.

## 2. Empirical analysis

### 2.1 Data description

We estimate the effect of corporate taxation on bank leverage using panel regressions focusing on a sample of around 3,000 EU banks. For this, we use yearly data from the Bankscope database of Bureau van Dijk for the time span 2001-2011. The database contains bank balance sheets and income statements based on annual reports. We only focus on commercial, savings or cooperative banks as defined in Bankscope. Only active banks with unconsolidated accounts are considered, excluding banks under liquidation, takeover or merger.

We consider the following *bank-specific variables* as defined in Bankscope: (a) *Total assets* (TA, in millions euro) which includes total earning assets, cash and due from banks, foreclosed real estate, fixed assets, goodwill, other intangibles, current tax assets, deferred tax, discontinued operations, other

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obtain. Devereux et al (2013) finds that not all banks offset their capital increase by increased assets risk, but in general banks with low capital ratios do.

assets; (b) *Total liabilities* (TL, in millions euro) which includes total interest, bearing liabilities, fair value portion of debt, credit impairment reserves, reserves for pension and other, tax liabilities, other deferred liabilities, discontinued operations, insurance, other non-interest-bearing liabilities; (c) *Return on average assets* (ROA) defined as the ratio of the net income to the average total assets by using the arithmetic mean at the end of the year t and t-1; (d) *Risk weighted assets* (RWA, in millions euro) where the various classes of the bank's assets are weighted for risk with different weights according to Basel rules; (e) *Total regulatory capital* which includes Tier 1 and Tier 2 capital which includes subordinated debt, hybrid capital, loan loss reserves and the valuation reserves; (f) *Regulatory total capital ratio*, i.e. the total capital adequacy ratio under the Basel rules. It measures Tier 1 and Tier 2 capital which includes subordinated debt, hybrid capital, loan loss reserves and the valuation reserves as a percentage of risk weighted assets and off balance sheets risks; (g) *Regulatory Tier 1 Capital* which includes only permanent shareholders' equity and disclosed reserves; and (h) *Tier 1 Regulatory Capital Ratio*, this measure of capital adequacy measures Tier 1 capital. That is shareholder funds plus perpetual non-cumulative preference shares as a percentage of risk weighted assets and off balance sheet risks measured after under the Basel rules.

Using the above, we constructed variables used (or tested) in the panel regressions: (i) *Leverage ratio* (LEV) computed as the ratio of *total liabilities* to *total assets*; (j) *Risk weight variable* (RISK) defined as the ratio of *risk weighted assets* to *total assets*<sup>9</sup>; (k) *Profitability* (PRO) measured as return on average assets.<sup>10</sup>

For each country, the following *country-specific variables* are considered (explicitly used or tested):

1. The corporate income tax rate (CIT from European Commission (2013)).
2. The real GDP growth rate (GDP, from the Ameco database). An alternative would be to use the *output gap* as a better measure of good and bad times.
3. Inflation (INF, from the Ameco database): GDP deflator.
4. Non-performing loan (NPL, from the International Monetary Fund, Global Financial Stability Report database): Bank nonperforming loans to total gross loans are the value of nonperforming loans divided by the total value of the loan portfolio (including nonperforming loans before the deduction of

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<sup>9</sup> When the risk weighted asset of a specific bank was missing we replaced it with the ratio of the total regulatory capital to regulatory total capital ratio or with the ratio of the regulatory Tier 1 capital to Tier 1 regulatory capital ratio. There are a small number of banks for which total liabilities, total assets, return on average assets or risk weighted assets was equal to zero. Those banks were dropped.

<sup>10</sup> Lewellen and Lewellen (2006) argue that firms have three, not two, distinct sources of funds: debt, internal equity, and external equity. Internal equity (retained earnings) is generally less costly than external equity for tax reasons, and may even be cheaper than debt. It follows that, without any information problems or adjustment costs, optimal leverage is a function of internal cash-flows.

specific loan-loss provisions). The loan amount recorded as nonperforming is the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue.

5. Credit (NCREDIT, from the International Monetary Fund, Global Financial Stability Report database): Domestic credit by the banking sector to GDP is an indicator of banking sector development and depth. Domestic credit provided by the banking sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The banking sector includes monetary authorities and deposit money banks, as well as other banking institutions where data are available (including institutions that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other banking institutions are savings and mortgage loan institutions and building and loan associations.
6. Real interest rate (Eurostat database): The real interest rates are calculated by taking the MFI interest rates minus the GDP deflator. The variable was dropped in the regressions as there were many missing values for the period and sample considered and it was not significant for the available data sample.

We start in 2001 since the variables of interest are not much populated before that date, and we focus our regression analysis on European banks. The sample covers all EU countries but Croatia. Banks for which leverage is greater or equal to .6 and lower than .99 have been included in our sample, as a leverage ratio above .99 mostly concerns banks in distress, not meeting regulatory capital requirements, and leverage ratios below .6 generally reflect institutions that do not have the characteristics of a bank.<sup>11</sup> We have a total of 32,833 observations for the time period starting in 2001 and ending in 2011. Table (1) below shows the composition of our sample by country. Note that German and Italian banks together account for more than 60% of the total.

**Table (1).** *Country composition (% of sample)*

<b>AT</b>	<b>BE</b>	<b>BG</b>	<b>CY</b>	<b>CZ</b>	<b>DE</b>	<b>DK</b>	<b>EE</b>	<b>ES</b>	<b>FI</b>	<b>FR</b>	<b>GB</b>	<b>GR</b>	<b>HU</b>
6.66	1.04	.64	.32	.51	46.29	2.76	.15	3.46	.26	5.77	2.83	.45	.48
<b>IE</b>	<b>IT</b>	<b>LT</b>	<b>LU</b>	<b>LV</b>	<b>MT</b>	<b>NL</b>	<b>PL</b>	<b>PT</b>	<b>RO</b>	<b>SE</b>	<b>SI</b>	<b>SK</b>	
.34	18.71	.31	1.92	.65	.18	.60	1.17	.61	.66	2.41	.49	.33	

Table (2) reports some descriptive statistics for the variables under study. In particular, for each variable we show the number of observations, the minimum and maximum, the main percentiles and the standard deviation for the years 2001-2011.

<sup>11</sup> The number of observations excluded due to the constraints imposed on leverage is only 750.

**Table (2).** *Summary statistics for variables included in the panel analysis, period 2001–2011*

	count	min	p5	median	p95	max	sd
<b>LEV</b>	32,833	.60	.82	.93	.96	.99	.05
<b>CIT</b>	32,833	.10	.25	.34	.40	.40	.06
<b>TA</b>	32,833	-1.13	3.98	6.27	9.54	14.47	1.73
<b>TA<sup>2</sup></b>	32,833	.01	15.89	39.30	91.01	209.24	25.06
<b>PRO</b>	32,718	-49.51	-.07	.34	1.66	36.61	1.23
<b>RISK</b>	10,789	.00	.37	.66	.98	542.57	5.26
<b>GDP</b>	32,833	-19.52	-5.26	1.50	4.02	10.57	2.65
<b>INF</b>	32,833	-1.71	.23	1.95	3.61	34.47	1.62
<b>NPL</b>	32,595	.10	.80	3.40	9.50	21.20	2.48
<b>NCREDIT</b>	32,811	13	89	131	197	330	31.82

Note: count is the total number of observations, min the minimum value, p5 and p95 the 5<sup>th</sup> and 95<sup>th</sup> percentiles, max the maximum value and sd is the standard deviation.

90% of leverage ratio distribution ranges between .82 and .96, with a standard deviation of .05, slightly less volatile than reported by Keen and de Mooij (2012) and de Mooij et al (2014)<sup>12</sup>. The average corporate income tax (CIT) rate across years varies in 90% of the cases between 0.25 and 0.40 with a minimum value of .10 and a maximum value of .40 and a tendency to decrease through the years: the median in 2001 was equal to .38 while in 2011 dropped at .30. Log total asset is on average lower than the one reported in Keen and de Mooij (2012) but more volatile with a standard deviation of 1.73 against 1.37. No main differences appear comparing these statistics with those obtained without imposing bounds on the leverage ratio.

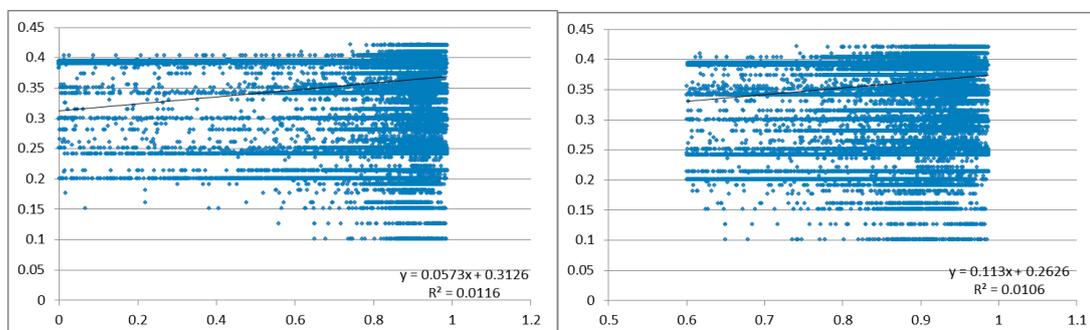
## 2.2 A preliminary view to the data and measurement issues

A birds-eye view at the data shows that the relation between CIT and leverage is not so apparent (Figures 1 and 2). There is very low (virtually no) linear correlation between leverage and CIT when considering the full sample, including non-EU banks, as used by Keen and de Mooij (2012) and de Mooij et al (2014). Also, when constraining the sample by excluding unleveraged institutions that do not have the leverage characteristic of a bank (cut-off 0.6), the correlation does not increase. When considering only EU banks (Figure 2), a positive correlation arises. When doing the panel regressions we investigate

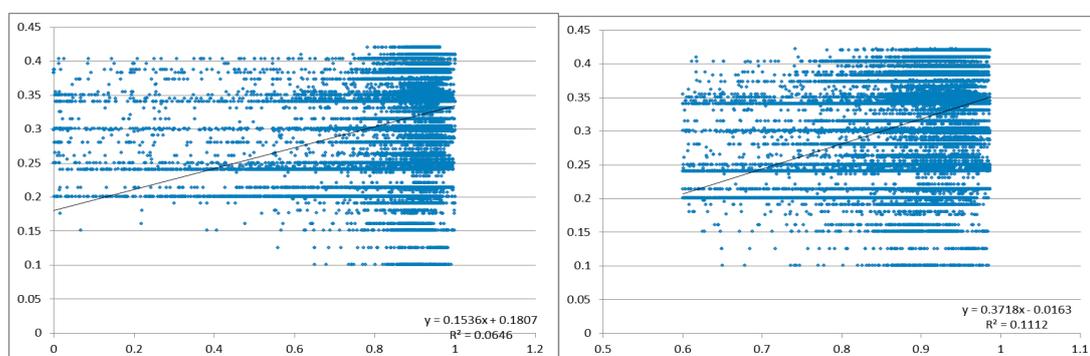
<sup>12</sup> The two databases in Keen and de Mooij (2012) and de Mooij et al. (2014) refer to the same sample of countries but the second is two years longer (2001-2009 versus 2001-2011) and thus more comparable with ours in terms of time length.

whether this is a robust relationship not driven by the particularity of the data (dominated by DE and IT) and consider the importance of the choice of the control variables.

**Figure 1.** Scatter diagram of CIT versus leverage for full sample (incl non-EU banks), without (LHS) and with (RHS) lower bound (0.6) on the leverage ratio



**Figure 2.** Scatter diagram of CIT versus leverage for EU sample, without (LHS) and with (RHS) lower bound (0.6) on the leverage ratio



The study needs to take account of some important challenges due to changes and shocks in the banking landscape in the period considered. Some of the developments may be associated with structural breaks in the drivers of leverage. In particular, regulatory arbitrage may have blurred the measures of bank leverage and debt, as well as changed its drivers.<sup>13,14</sup> One important driver is the *introduction of Basel II* with internal-rating-based assessment of risk weighted assets. The implementation has been phased

<sup>13</sup> Gropp and Heider (2009), assessing the drivers of the bank capital structure, chose 2004 as the end-point of their data series in order to avoid the confounding effects of these possible structural breaks and measurement issues. They find that most banks seem to be optimizing their capital structure in much the same way as firms do, except when their capital comes close to the regulatory minimum.

<sup>14</sup> Also the Committee on the Global Financial System (2009) suggest that a break in the trend in leverage seems to have occurred around 2003–04 as leverage and risk started to build up in less visible ways, as (i) the leverage and risk embedded in structured credit products increased, making traditional measures of balance sheet leverage less meaningful; (ii) assets held in highly leveraged off-balance sheet vehicles increased dramatically; (iii) maturity mismatches, and exposure to funding liquidity risk, increased as off-balance sheet vehicles and some large financial institutions funded a growing amount of long-term assets with short-term liabilities in wholesale markets. The resulting increase in leverage and risk during 2003–07 together with the spread of market-sensitive valuation techniques contributed to an increase in the procyclicality of leverage in the financial system.

differently across countries and the ex-post assessment is that Basel II led to insufficient regulatory capital requirement for trading banks and encouraged high leverage.<sup>15</sup>

### 2.3 Panel regressions

The empirical strategy pursued here follows closely a large body of literature studying the effect of taxation on firm leverage. We fit a series of panel regressions that take the form:

$$lev_{it} = \rho lev_{it-1} + \beta cit_{it} + \sum_j \gamma_j X_{jit} + v_{it} \quad (1)$$

Where  $lev$  is the leverage ratio variable,  $cit$  is the corporate income tax rate, and  $X_j$  are control variables such as log total asset, log total asset squared, profitability, non-performing loan, credit. We also include real GDP growth and Inflation as explicative variables to control for country-specific time variation. The subscripts  $i$  and  $t$  denote the bank  $i$ -th at time  $t$ . Note that we account also for lagged values of leverage in the regressions since we know leverage to be a persistent variable. The error term has the following structure:

$$v_{it} = \alpha_i + \lambda_t + \varepsilon_{it} \quad (2)$$

Where  $\alpha_i$  is the bank-specific fixed effect,  $\lambda_t$  are time effects, and  $\varepsilon_{it}$  are zero mean homoscedastic uncorrelated errors both along the time series dimension and among individuals. The main interest of the regressions lies in the estimate of the short-run marginal effect of the tax variable on bank leverage,  $\beta$ , and the long-run effect  $\beta/(1-\rho)$ .

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<sup>15</sup> Weaknesses of risk-assessment methods led to underpricing of risks in the trading book (Committee on the Global Financial System, 2009), which contributed to sharp increases in leverage at banks with high trading book activity. In addition, a sharp increase in the use of *off-balance sheet activities* in the run-up to the financial crisis may have affected the measured bank leverage. The Committee on the Global Financial System (2009) finds that off-balance sheet vehicles substantially contributed to (invisible) build-up of financial leverage during the current cycle. The measures of bank balance sheet leverage failed to capture this risk. The re-intermediation onto bank balance sheets during the crisis caused traditional balance sheet leverage to expand, ex post, exactly at a time when banks were deleveraging and reducing risk exposures. Furthermore, the time period considered includes the global asset and credit boom and bust that was accompanied by pro-cyclical leverage in the financial system. The *large increase in marked-to-market assets* on banks' balance sheets implied that any gains or losses were taken on the profit and loss account. During the run-up to the crisis, asset price rises were booked as marked-to-market profits counterbalancing the leverage impact of rapidly growing bank balance sheets; in the bust the reverse happened with eventually large losses hitting capital and increasing leverage. Also the *shifts in risk premia and risk spreads* initially reducing debt funding costs and interest rate margins globally, and a reversal after 2008 may have affected leverage decisions. Within the euro-area the risk premia effects were compounded by the risk premia shocks and capital flows across the euro area from core to periphery and their reversal after the crisis.

We use time dummies, which is important to mitigate the correlation (if any) across individuals (see e.g. Roodman (2009)). This hypothesis is shared by all estimators and test statistics used in our analysis. Table (3) shows a series of panel regressions, both static and dynamic, estimated using the generalized method of moments (GMM). In any regression we treat the variable profitability as predetermined meaning that current and future shocks are uncorrelated with this variable, but past shocks are not.<sup>16</sup> In difference and system GMM we need to instrument this variable that becomes potentially endogenous when we take differences of both variables and shocks.

The first two columns of Table (3) reports estimates for the static version of our model. In column (i) we use all explicative variables but non-performing loan and credit, which are inserted in column (ii). The long run response of CIT to bank leverage is .2 significant at 5% level in both specifications. The signs of the coefficients of the control variables are in line with expectations. As expected, larger banks have higher leverage ratios, possibly as creditors expect being bailed out if necessary because of the too-big-to-fail effect reducing the cost of debt funding.<sup>17</sup> Total assets squared have a negative sign reflecting the reducing returns to scale of funding costs benefits. While barely significant, profitability (reflected by average return on assets) has the expected negative sign. Next, bank leverage increases in good times when GDP growth is high, in line with the expectation of procyclical leverage.<sup>18</sup> The GDP coefficient is hardly significant though. Inflation however is significant at the 1% and 5% level in both specifications respectively. It implies low nominal interest rates that are associated with high asset prices and low debt funding costs as share of current income, driving up leverage. A high share of non-performing loans in the domestic economy indicates risks of losses requiring precautionary capital and thus lower leverage

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<sup>16</sup> Future profitability will be affected by current shocks to leverage. Banks' funding costs depend on the banks' riskiness. An unexpected increase in leverage *ceteris paribus* implies higher funding costs for the bank as creditors will require a risk premium for an increased risk of default due to a lower equity buffer to absorb unexpected losses. Liabilities are gradually refinanced at the higher costs when funding instruments (bonds, loans) mature following information on losses (and the impact on leverage). After refinancing the higher interest cost accrue in the following period. Therefore, the impact on profitability of a shock to leverage occurs in future periods and not simultaneously. I.e. the error at time  $t$  does not affect profitability at time  $t$  but it does affect profitability at time  $t+k$ .

<sup>17</sup> Note however that not only debt financing is cheaper for large banks. Yang and Tsatsaronis (2012) find that banks regarded as highly systemically important by international regulators tend to have a lower average stock return and, hence, also a lower cost of equity finance. Alternative explanations for the high leverage of large banks may be (i) their roles as international trading banks as trading books assets increased most rapidly and (ii) their reliance on internal rating based assessment of risk weighted assets under Basel II allowing lower regulatory capital.

<sup>18</sup> Crotty (2009) finds that in good times, (short-term) debt seems relatively cheap compared to (long-term) capital as the costs of illiquidity and loan and trading losses are remote. In good times markets seem to favor a leveraged bank capital structure that generates highest profits. In bad times, though, the costs of illiquidity seem to be more salient, the markets encourage a capital structure with low leverage. Similarly, Yang and Tsatsaronis (2012) find that systemic risk is lower near the top of the business cycle and higher around the trough. Adrian and Shin (2010) have pointed out that, in a financial system in which the balance sheets of major institutions are continuously marked to market, leverage adjustments appear to be strongly pro-cyclical, thus fueling asset price booms as well as amplifying asset price busts.

(although the coefficient is not significant). We would expect credit to GDP to have a positive sign reflecting depth and development of a country's financial market. It however switches sign and is not very significant. In both regressions we made use of 25 instruments to deal with pre-determinateness of profitability. To test for the joint validity of the instruments, we use the Hansen test. Table (3) further reports the p-value of the Arellano and Bond (1991) test-statistics that tests zero autocorrelation of idiosyncratic shocks  $\varepsilon_{it}$  and should reveal that some lags of the instruments are invalid in case of rejection. Usually residuals are correlated at lag 1 by construction, but should be uncorrelated at lag 2. No major problems appear in the static regressions.

Next, we turn to a dynamic panel. The estimation of dynamic panel data models requires a careful choice of the estimator in order to avoid spurious results. The cross-sectional dimension is large, we have on average  $N = 3,000$  banks observed per year, whilst the time series dimension is small as we observe bank features for  $T = 11$  years. In this case removing the fixed effects by the within transformation produces an inconsistent estimator for  $T$  fixed, even when  $N$  tends to infinity. The solution is typically first differencing both side of equation (1) and using a GMM estimator. Holtz-Eakin, Newey, and Rosen (1988) and Arellano and Bond (1991) show how to construct estimators based upon moment equations constructed from lagged levels of the dependent variable and the first difference of the errors (difference GMM estimator). In cases where the dependent variable is very persistent, i.e.  $\rho$  is close to 1, lagged values of the explicative variables are usually weak instruments. Leverage is very persistent over time.<sup>19</sup> Arellano and Bover (1995), and Blundell and Bond (1998) proposed additional moment conditions in which lagged differences of the dependent variable are orthogonal to levels of the disturbances.

To have an idea of the persistence of leverage in our sample we use the Ordinary Least Squares (OLS) estimator in the level equation (1), and the fixed effect estimator (or within estimator) obtained removing the individual means on both side of (1). Both estimators are inconsistent (even when  $N$  tends to infinity) but the first is known to give an upward biased estimates of  $\rho$ , while the second a downward biased estimates when  $N$  grows. This fact can be used to choose between the difference and system GMM estimators (Bond, 2002). Moreover a value of  $\rho$  that is largely outside the lower and upper bound identified by the two inconsistent estimators is an indication of the failure or weakness of the instruments employed. The fixed effect estimator and the OLS estimator in level, not reported in Table (3), give the

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<sup>19</sup> The persistence of leverage is related to the bank profit optimization strategy. In absence of unexpected losses and profits, banks optimize their capital buffers in view of regulatory requirements and funding costs. Higher leverage allows a higher return on equity as it allows holding more assets per unit of equity. High leverage also increases solvency (and liquidity) risk, increasing costs of both equity and debt financing. Banks leverage aims to optimize the risk-return of a leverage level, considering the riskiness of assets and access to debt or equity finance when needed (and subject to the regulatory minimum). The optimal leverage may change with market risk aversion and risk premia or with changes to regulatory requirements. Also transaction costs reduce the ability to change leverage in the short run.

following estimates:  $\hat{\rho}_{FE} = .41$  and  $\hat{\rho}_{OLS} = .88$ . The range where we expect the true  $\rho$  to lie is quite large but it indicates however a non-negligible autocorrelation of our leverage data.

The first consistent estimator we employ is two-stage least squares (2SLS) applied after having differenced equation (1). As can be seen from column (iii) the estimate of the autoregressive coefficient is below .41, indicating efficiency problems. We therefore experiment with the difference GMM estimator, which in theory should be more efficient (column (iv)) but results did not improve.

**Table (3).** *Static and dynamic panel data estimates*

Leverage	Static		Dynamic					
	(i) Base	(ii) Credit controls	(iii) 2SLS	(iv) Diff GMM	(v) System GMM	(vi) System GMM Credit controls	(vii) System GMM Basel sample	(viii) System GMM No DE
$\rho$			.340*** (.051)	.326*** (.103)	.778*** (.078)	.799*** (.074)	.765*** (.081)	.812*** (.071)
CIT	.214** (.095)	.196** (.079)	.031*** (.009)	.016 (.033)	.068** (.032)	.066** (.035)	.078** (.046)	.013 (.029)
$\beta/(1-\rho)$					<b>0.307</b>	<b>0.328</b>	<b>0.332</b>	
TA	.022*** (.003)	.019*** (.004)	.104*** (.011)	.056*** (.019)	.003* (.002)	.003 (.002)	.003* (.002)	.003 (.002)
TA <sup>2</sup>	-.001*** (.000)	-.001*** (.000)	-.004*** (.001)	-.003*** (.001)	-.0001 (.0001)	-.0001 (.00009)	-.00009 (.00008)	-.00009 (.00008)
PRO	-.004* (.003)	-.003 (.003)	-.003*** (.001)	-.002 (.002)	-.005*** (.002)	-.005*** (.002)	-.004*** (.002)	-.005*** (.002)
GDP	.011* (.006)	.001 (.006)	-.0003*** (.0001)	-.0004 (.0004)	.004** (.002)	.005** (.003)	.004** (.002)	.003 (.002)
INF	-.010*** (.002)	-.013** (.006)	-.0003* (.0002)	.0003 (.0008)	-.001 (.001)	.0003 (.0007)	.002 (.002)	.002 (.002)
NPL		-.004 (.003)				.001*** (.000)	.0004 (.0003)	.001 (.001)
CREDIT		-.001** (.000)				.0001** (.00004)	.00005* (.00003)	.00005* (.00003)
# observations	23,908	23,760	23,730	12,251	23,765	23,499	18,525	11,577
# instruments	25	25	15	45	40	42	36	42
A-B test AR(1)	.00	.24	.00	.00	.00	.00	.00	.00
A-B test AR(2)	.15	.66	.00	.12	.03	.05	.02	.22
Hansen test	.06	.10		.00	.14	.08	.04	.05

**Note:** Columns (i) and (ii) reports results for static regressions, (iii) employs the 2SLS estimator, (iv) employs difference GMM estimator, (v)-(viii) employ the system GMM estimator, (vii) uses post-2004 data, (viii) leaves German banks out of the sample. Standard errors between parenthesis; \*, \*\*, and \*\*\* indicate significance level at 1, 5 and 10% respectively; A-B AR(p) is the Arellano-Bond (1991) p-value for lag p=1,2;

Columns (v) - (viii) make use of the system GMM. Results are more in line with those we expect. In column (vii) we use data starting in 2004 when Basel II rules started to take effect. Results are close

enough to those obtained using also previous years. In (v) to (vii), the long-run effect of CIT on leverage is estimated at around 0.3. In column (viii) as we leave German banks out of the sample, the long-term effect remains positive but drops to 0.07 and is no longer significant. The sensitivity of the results to the inclusion of German banks may be related to the relatively large variation in CIT in Germany over the period between 39.6% and 29.8% and the simultaneous large decline in leverage of mostly the smaller German banks, whereas in a number of other countries the CIT rate did not or barely changed.

Finally we note that diagnostics are not fully satisfactory with the Arellano-Bond test and the Hansen test almost acceptable only in the regressions of column (vi) and (viii), revealing that instruments used in Table (3), and in the many unreported attempts are weak.

### **3. Gauging the impact of corporate tax reforms on banking sector losses<sup>20</sup>**

Next, we use a micro-simulation model to gauge the impact of tax reforms on bank losses in case of a financial crisis. The model, first developed by De Lisa et al (2012), was later dubbed SYMBOL (SYstemic Model of Banking Originated Losses) and has been used to assess impacts of regulatory reforms. The micro-simulation model makes use of individual banks' balance sheet data to simulate banks' (aggregated) distribution of losses in a banking crisis. It allows a simulation of the allocation of bank losses across different stakeholders (equity-holders, bond-holders, public finances and safety nets) depending on the chosen regulatory context and scenarios for bank capitalisation. In this exercise, we focus on bank losses affecting public finances, and we vary the banks' capital according to different scenarios for changes in the corporate income tax regime.

As input to the model simulations, we use actual banks balance sheet data from the Bankscope database.<sup>21</sup> We adjust the capital structure of the individual banks in response to different scenarios of changes in the CIT regime. To this end, we use a range of estimates of the tax elasticity of leverage based on our own estimates in the previous section and findings from literature.<sup>22</sup> The banking loss simulation model and the way in which CIT changes are simulated is discussed in more detail in the next section. The inputs for the simulations are Risk Weighted Assets (RWA), regulatory capital and total assets. All data refer to end-2012 consolidated balance sheets. The balance sheet capital and RWA is adjusted to take into account future changes to RWA and capital definitions and requirements. This adjustment reflects better

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<sup>20</sup> Note that 13 EU countries have introduced bank levies recently. Austria (2011), Belgium (2012), Cyprus (2011), Germany (2011), Netherlands (2012), Portugal (2011), Latvia (2011), Slovakia (2012), Sweden (2009) and UK (2011) have introduced taxes on "risky liabilities" while France (2011), Hungary (2010), Slovenia (2011) have introduced other types of levies. These may have contributed to reduce the debt bias in taxation. Specific analysis of these taxes and their effects falls outside the scope of this paper though.

<sup>21</sup> Bankscope is a global database of banks' financial statements provided by Bureau Van Dijk Electronic Publishing.

<sup>22</sup> We do not consider the indirect effects on banks losses of changes in the capital structure of non-financial corporations. As the taxation changes can also reduce the debt bias of firms, it may also reduce default/credit risk in banks portfolios.

actual riskiness and capital quality. Average EU results of the 2012 Quantitative Impact Study (QIS)<sup>23</sup> are employed for the adjustments.

The analysis is based on a sample of 196 banks in six countries (DE, ES, FR, NL, IT, UK) and that represents total assets of EUR 28 trillion in 2012, which is about 75% of total EU banking assets. The financial crisis that is considered in the Figures and Tables reflects a percentile of the loss distribution with bank losses across the EU in the same order of magnitude as the 2008-2012 financial crisis. We do not consider scenarios in which bond-holders are bailed-in, or safety-nets (resolution fund, deposit guarantee scheme) covering part of the losses.

### **3.1 A Vasicek-based micro-simulation model of systemic banking losses**

The model simulates banks' losses due to the failure of its obligors and derives the (aggregated) distribution of losses originated in the banking system by aggregating individual banks' losses. The idea behind this model is that it is possible to estimate an average Probability of Default (PD) of the portfolio of obligors of a bank (the so-called implied obligors' PD) by inverting the Basel FIRB (Foundation Internal Ratings Based) formula for capital requirements. Individual banks' losses are then generated via Monte Carlo simulation using the Basel FIRB loss distribution function, which is commonly used to analyse banks' riskiness by regulators. This function is in turn based on the Vasicek model (see Vasicek, 2002), which in broad terms extends the Merton model (see Merton, 1974) to a portfolio of borrowers.<sup>24</sup> The loss distribution of each bank is calibrated on an estimate of the average default probability of its portfolio of assets, which is derived from the ratio of the banks' Minimum Capital Requirements and its Total Assets (TA).

The model operates in four steps: the first step consist is estimating the average default probability for the loans of any individual bank, by means of the features of the Basel FIRB function; the second in numerically generating the bank's excess losses and capital reduction. The third step consists in checking which banks are in default. The fourth step in obtaining the distribution of aggregate losses at

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<sup>23</sup><http://www.eba.europa.eu/documents/10180/87706/EBA-BS-2012-037-FINAL--Results-Basel-III-Monitoring-.pdf/778804a5-8e3e-4073-83df-afd1be0b626e>

<sup>24</sup> The Basel Committee permits banks a choice between two broad methodologies for calculating their capital requirements for credit risk. One alternative, the Standardised Approach, measures credit risk in a standardised manner, supported by external credit assessments. The alternative is the Internal Rating-Based (IRB) approach which allows institutions to use their own internal rating-based measures for key drivers of credit risk as primary inputs to the capital calculation. Institutions using the Foundation IRB (FIRB) approach are allowed to determine the borrowers' probabilities of default while those using the Advanced IRB (AIRB) approach are permitted to rely on own estimates of all risk components related to their borrowers (e.g. loss given default and exposure at default). The Basel FIRB capital requirement formula specified by the Basel Committee for credit risk is the Vasicek model for credit portfolio losses, default values for all parameters except obligors' probabilities of default are provided in the regulatory framework. On the Basel FIRB approach, see Basel Committee on Banking Supervision (2005, 2006 and 2010 rev. 2011).

the country level.<sup>25</sup> In this exercise we add a further step in which the bank capital structure is adjusted for changes in the CIT regime.

Details of the steps are as follows:

- **STEP 1:** Estimation of the Implied Obligors' Probability of Default (IOPD) of the portfolio of each individual bank.

The model estimates the average IOPD of the portfolio of each individual bank using its total MCR<sup>26</sup> declared in the balance sheet by numerical inversion of the Basel FIRB formula for credit risk. Individual bank data needed to estimate the IOPD are banks' RWA and TA, which can be derived from the balance sheet data. All other parameters are set to their regulatory default values.

- **STEP 2:** Simulation of correlated losses for the banks in the system.

Given the estimated average IOPD, SYMBOL assumes that correlated losses hitting banks can be simulated via Monte Carlo using the same FIRB formula and imposing a correlation structure among banks (with a correlation set to  $R=50\%$ ). This correlation exists either as a consequence of the banks' common exposure to the same borrower or, more generally, to a particular common influence of the business cycle.<sup>27</sup> In each simulation run  $j$ , losses for bank  $i$  are simulated as:

$$L_{i,j} = LGD \cdot N \left[ \sqrt{\frac{1}{1-R}} N^{-1}(IOPD_i) + \sqrt{\frac{R}{1-R}} N^{-1}(\alpha_{i,j}) \right]$$

where  $N$  is the normal cumulative distribution function,  $N^{-1}(\alpha_{i,j})$  are correlated normal random shocks, and  $IOPD_i$  is the average implied obligors' probability of default estimated for each bank in Step 1.  $LGD$  is the Loss Given Default, set as in Basel regulation to 45%.

- **STEP 3:** Determination of the default event.

Given the matrix of correlated losses, SYMBOL determines which banks fail. As illustrated in Figure 3, a bank default happens when simulated obligor portfolio losses exceed the sum of the expected

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<sup>25</sup> It should be noted that in other application, an additional optional step simulating direct bank-to-bank contagion is introduced between steps 3 and 4 described here.

<sup>26</sup> Banks must comply with capital requirements not only for their lending activity and credit risk component. Banks assets are in fact not only made up of loans, and there are capital requirements that derive from market risk, counterparty risk, and operational risk, etc. The main assumption currently behind SYMBOL is that all risk can be approximated as credit risk.

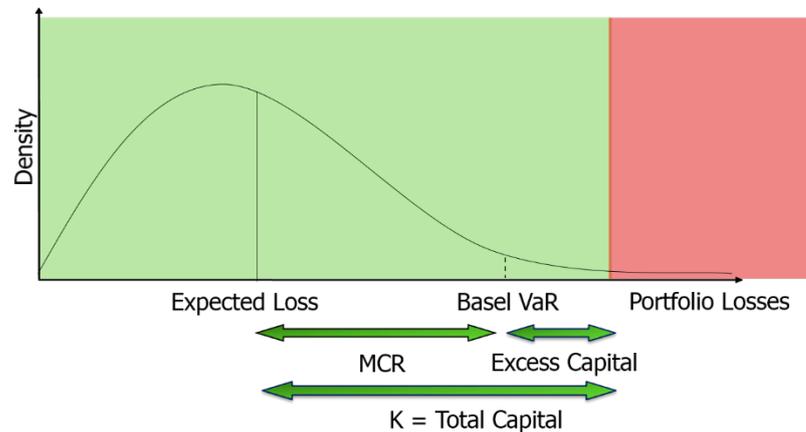
<sup>27</sup> The choice of the 50% correlation is based on Sironi and Zazzara (2004). A discussion and a sensitivity check on this assumption can be found in De Lisa et al. (2011).

losses (EL) and the total actual capital (K) given by the sum of its MCR plus the bank's excess capital, if any :

$$L_{ij} \geq EL_i + K_i$$

The green-shaded area in Figure (3) represents the region where losses are covered by provisions and total capital, while the red-shaded one shows when banks default under the above definition. It should be noted that the probability density function of losses for an individual bank is skewed to the right, i.e. there is a very small probability of extremely large losses and a high probability of losses that are closer to the average/expected loss. The Basel Value at Risk (VaR) corresponds to a confidence level of 0.1%, i.e. the MCR covers losses from the obligors' portfolio with probability 99.9%. This percentile falls in the green-shaded area as banks generally hold an excess capital buffer on top of the MCR.

**Figure (3): Individual bank loss probability density function**



- **STEP 4:** Aggregated distribution of losses for the whole system.

Aggregate losses are obtained by summing losses in excess of capital plus potential recapitalisation needs of all distressed banks in the system (i.e. both failed and undercapitalised banks) in each simulation run.

In order to compute losses increasing outstanding debt, we consider the amount of funds necessary to recapitalize all banks to 8% of RWA.

- **STEP 5:** Introducing the effects of changes to the debt bias of CIT.

We first run the above steps for the baseline with unchanged leverage ratios. Then we introduce the effects of changes to the debt bias in taxation on capital considering that the leverage ratio is the mirror image of the capital-to-total-assets ratio. We use estimates of the elasticity of bank leverage to corporate

income taxation to adjust the excess capital held by banks for different scenarios of reductions in CIT or alternative measures to address the debt bias (such as ACE or CBIT),

$$K_i^* = K_i + \beta_{CIT} \cdot \Delta CIT \cdot TA$$

The changes to excess capital above the MCR differs across banks, as the MCR is measured against RWA and not total assets and the RWA density of total assets differs significantly across banks.

Then we rerun steps 2 to 4 above to gauge the aggregated distribution of losses for the countries' banking systems and the implied costs to public finances, in case different scenarios with changes to the debt bias effects of the CIT.

### 3.2 Results for scenario 1 - Reductions in the CIT rate

First, we estimate how much banking crisis losses affecting public finances would be lowered by reductions in the CIT rate in the order of 1 to 10 percentage points. Figure (4) was constructed following the steps described above. We simulated bank losses with SYMBOL using end-2012 balance sheet data. This is the baseline, i.e. it provides the losses for an unchanged tax-distortion in bank leverage. Using bank level data, the long run marginal impact of CIT on leverage are mostly in the range 0.08 to 0.31, with Horvath (2013) at 0.08-0.14, Keen and de Mooij (2012) and De Mooij et al. (2014) in the range of 0.14-0.31 and Hemmelgarn and Teichmann (2014) at around 0.10. Using country-level rather than bank-level data, De Mooij et al. (2014) find an impact of 0.04-0.09.

Based on this survey and our regression results, our main scenarios use a conservative long-run effect of corporate income tax on bank leverage of  $\beta=0.10$ ; in addition, we provide the simulations  $\beta=0.05$   $\beta=0.20$  to account for the uncertainty. We adjust banks' balance-sheet leverage by replacing debt-financing by Tier 1 capital, for reductions in the corporate tax rate between 1 to 10 percentage points and run again the SYMBOL simulations to obtain bank losses.<sup>28</sup> The results in figure (4) show substantial reductions of banking crises losses by reducing the corporate debt bias. As an illustration, potential losses in France could be reduced from an estimated EUR 120 bn to EUR 73.3 bn in our main scenario, a gain for public finance of close to EUR 50 bn (or about 2.5% GDP).

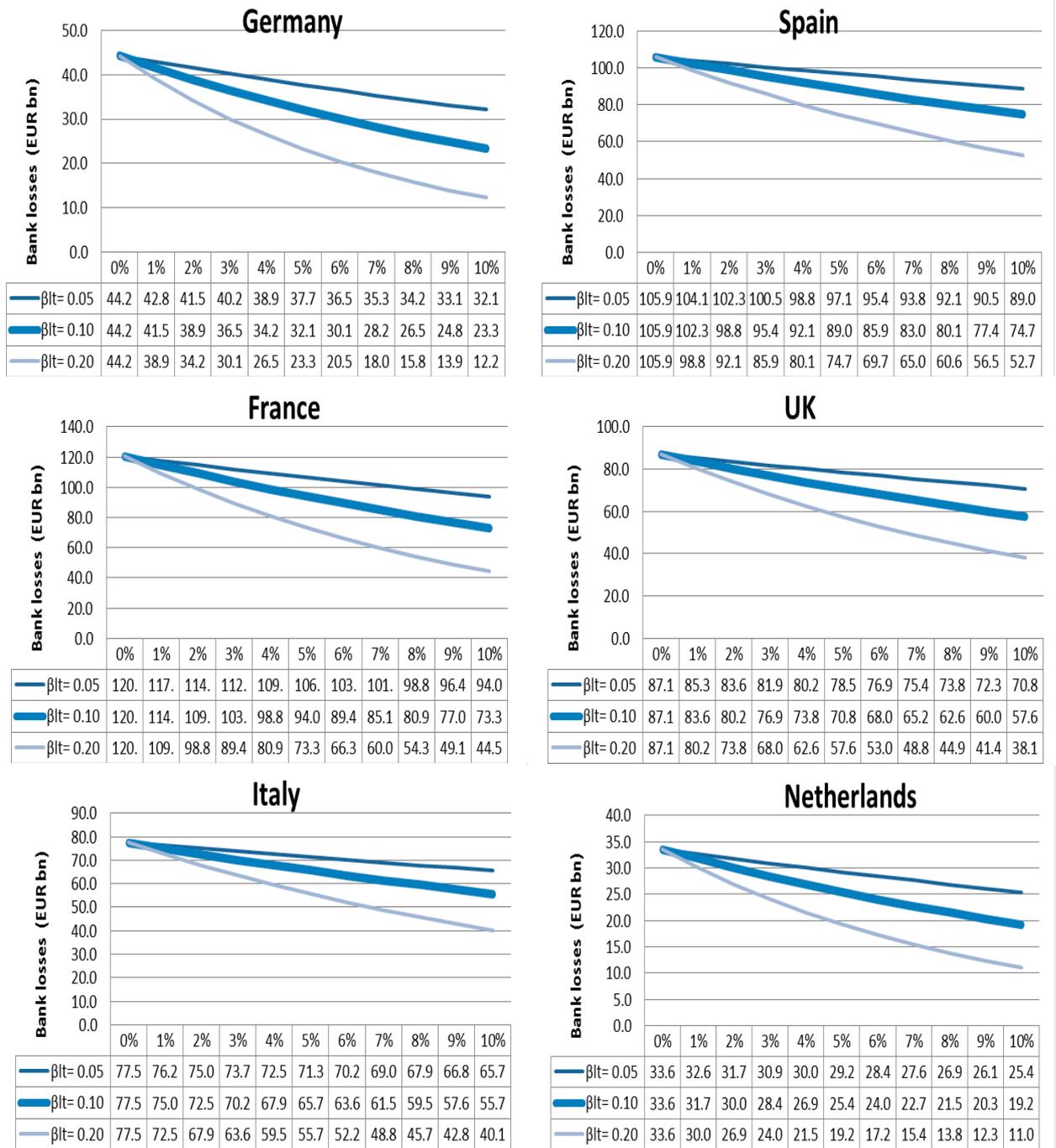
In Figure (5), we check the robustness of our results. The boxplot shows public finance costs (EUR bn) versus reductions in CIT in percentage points under different model assumptions for long-term effects of CIT on leverage, the correlation structure of losses across banks and for different ranges of CIT

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<sup>28</sup> In fact, 20 SYMBOL simulations were run with capital/TA increases in the range [0, 3%]. Then an exponential or polynomial trend line was fitted for the losses for each country (see Annex 2). This trend line was used to obtain actual losses for specific scenarios of corporate income tax increases and  $\beta$  coefficients.

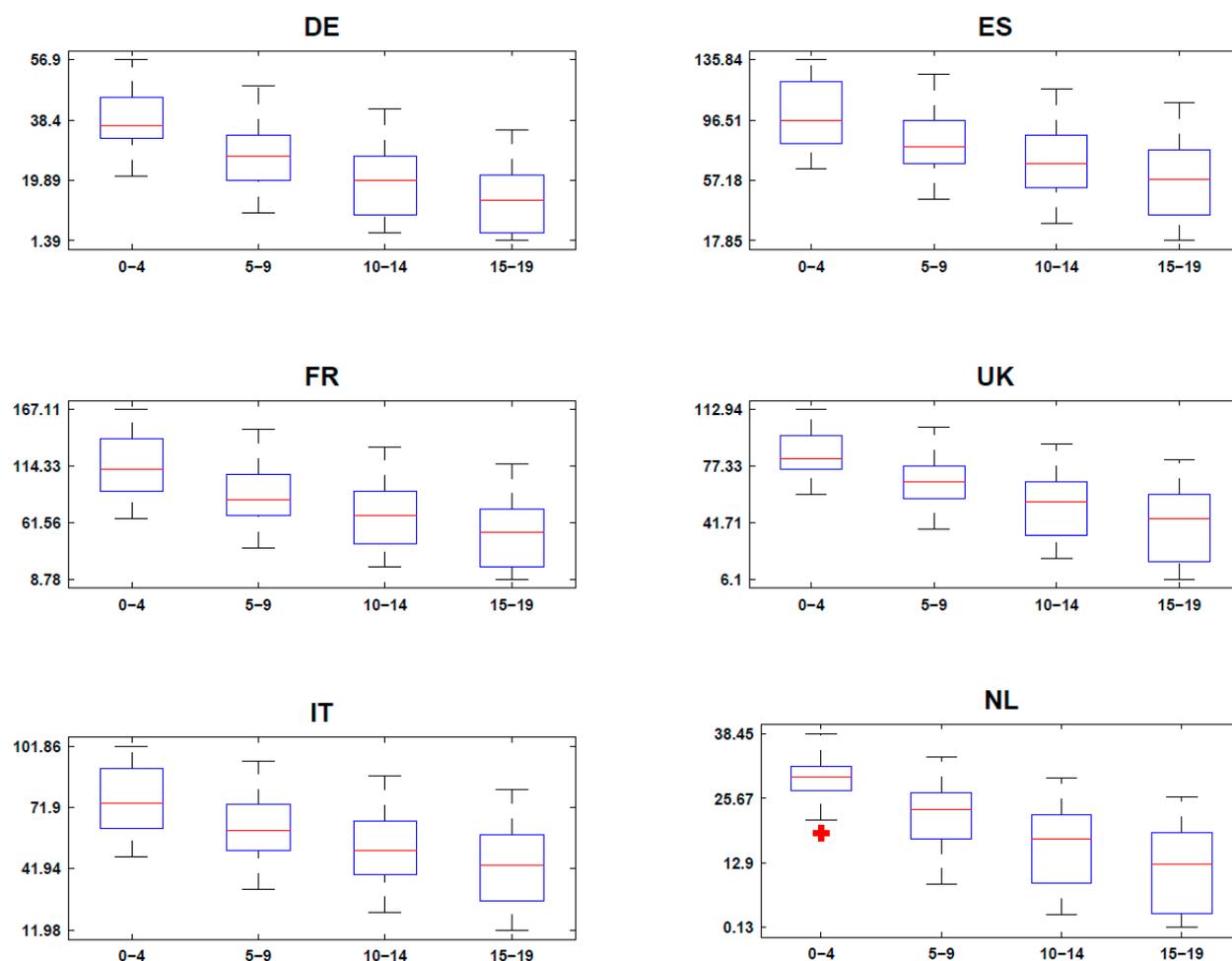
reduction ranges. The variation in the imposed correlation structure in the Monte Carlo simulations of losses hitting banks reflect different degrees of systemic risk versus idiosyncratic risk. The correlation ( $R$ ) ranges from 0.3 to 0.7, elasticity of leverage to CIT is in the range 0.05 to 0.20 and CIT reductions are clustered ranges up to 19 percentage point reduction ((0-4), (5-9), (10-14) and (15-19)). The boxplot analysis shows that the findings of significant reductions of costs of banking sector crisis to public finances are robust across a wide range of model settings.

**Figure (4).** Losses versus reduction in CIT in percentage points (x-axis), for different long-term effects of CIT on leverage (EUR bn)



Note: \*Losses are bank losses in excess of capital plus recapitalisation to 8% RWA in a very severe financial crisis (99.95 percentile of the loss distribution of the SYMBOL simulations)

**Figure (5).** *Boxplot of losses versus reduction in CIT in percentage points (x-axis), under different model assumptions for long-term effects of CIT on leverage [0.05;0.20], correlation of losses across banks [0.3;0.7] and for different ranges of CIT reductions [0-19 percentage points], EUR billion*



### 3.3 Results for scenario 2 - Eliminating the debt bias in taxation (ACE, CBIT)

In this section, we venture beyond a reduction in the tax bias by reducing the CIT rate and gauge the reduction in public finance losses in case the tax debt bias would be eliminated. Reforms that can reduce or eliminate the debt bias in corporate taxation include (i) 'Comprehensive Business Income Tax' (CBIT) that removes the deductibility of interest payments, thus placing debt on a level footing with equity; and (ii) the 'Allowance for Corporate Equity' (ACE), that allows banks/companies to deduct from their taxable profits their interest payments plus an amount equivalent to what they would have to pay their shareholders in interest if all the company's equity were debt (the notional return on equity).<sup>29</sup>

To gauge the effects of an elimination of the debt-bias in CIT, we extrapolate the findings of the empirical papers on the CIT-effect on bank leverage as used in the previous section. For this, we proxy the

<sup>29</sup> There are in addition alternative solutions such as corporate cash-flow taxation (see Fatica et al. 2013).

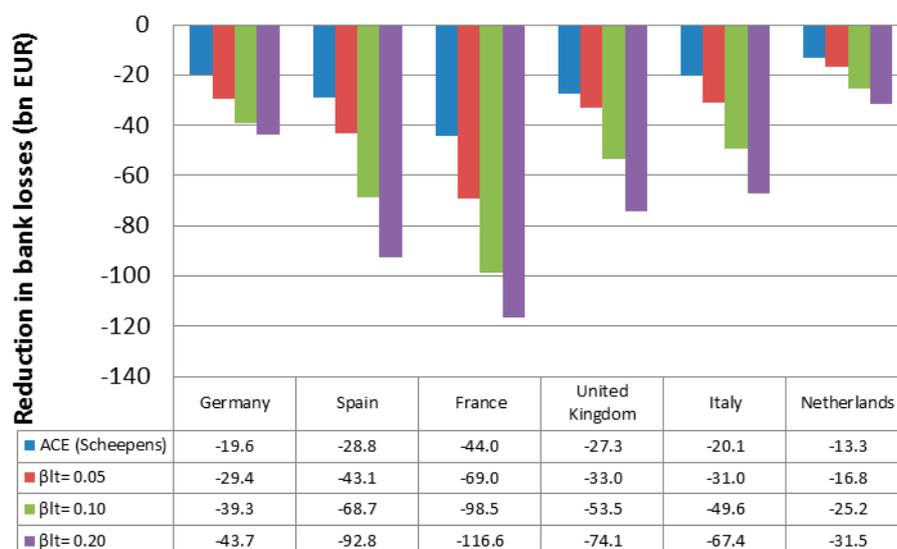
effect of measures to abolish the tax bias by the technical assumption that the CIT rate is reduced to 0 in the 6 countries in the sample, assuming a linear relationship between CIT and leverage. Again, we show the results for a long-term CIT effect on leverage of 0.05, 0.10 and 0.20.<sup>30</sup> In addition, we also use the results of a study by Schepens (2013) on the Belgian ACE that was introduced in 2006, which partly eliminated the debt bias. Schepens considers only the effect over a limited time-period, which may not fully reflect the long-term CIT effect. We use Schepens estimate of a reduction in banks' leverage ratio by on average 0.91 pp due to the ACE, i.e. an increase in the capital to total assets ratio of 0.91%.

The resulting estimated reduction in financial crisis losses that fall on public finances are presented below in Figures (6) and (7), respectively in EUR bn and in % of baseline losses. When we consider the effect on bank leverage of an ACE using the Belgian estimate by Schepens, we find that bank losses that fall on public finances are reduced in the range of 30 to 40 percent compared to the baseline. Using the estimates of the long-run effects of CIT on leverage (from our own analysis and literature), we find even higher reductions in public finance costs, even well in excess of 90% if the CIT-coefficient would be 0.20. For a conservative coefficient of 0.10, in some countries public finance losses could be reduced by more than 80%. The degree to which the local estimations in the regression analysis can be extrapolated to out-of sample changes in the CIT rate of 23 pp (for UK) to 34 pp (for France) remains an issue to consider, but Schepens coefficients may be considered lower bounds considering that the Belgian ACE only partly eliminates the debt bias (notably because of caps).

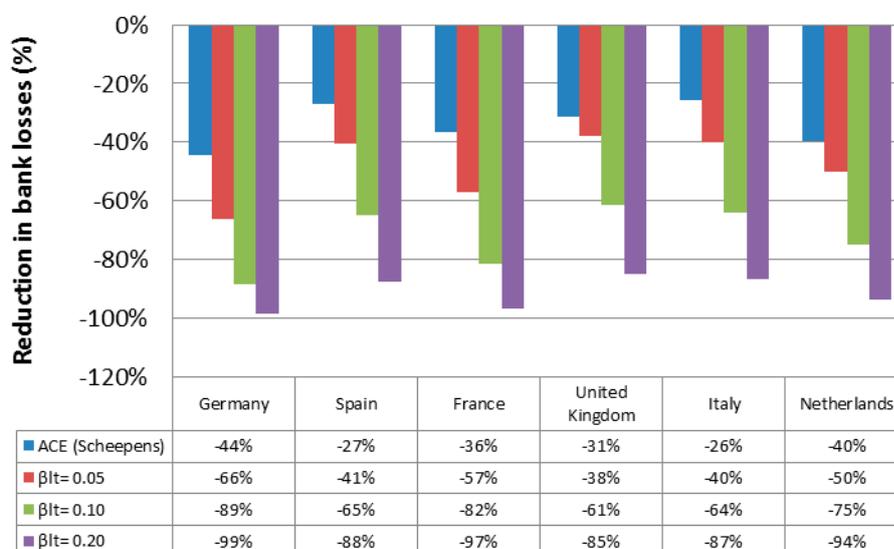
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<sup>30</sup> Mimicking a removal of the corporate debt bias by reducing the CIT rate to zero is justified here by the fact that we are only interested in the effects of the debt bias on the capital structure of the banks, which we then use in SYMBOL. The debt bias is linked to the value of the debt shield, itself proportional to the corporate income tax rate.

**Figure (6).** Elimination of tax debt bias -Reduction in losses\* due to lower bank leverage, under different assumptions of the effects of CIT on leverage (EUR bn)



**Figure (7).** Elimination of tax debt bias - Reduction in losses\* due to lower bank leverage, under different assumptions of the effects of CIT on leverage (% of baseline losses)



Note: \*Bank losses in excess of capital, plus recapitalisation to 8% RWA in a very severe financial crisis (99.95<sup>th</sup> percentile) for different long-term effects of CIT on leverage ( $\beta$ -coefficients).

### 3.4 Results for scenario 3 - Differentiating capital-tight and capital-abundant banks

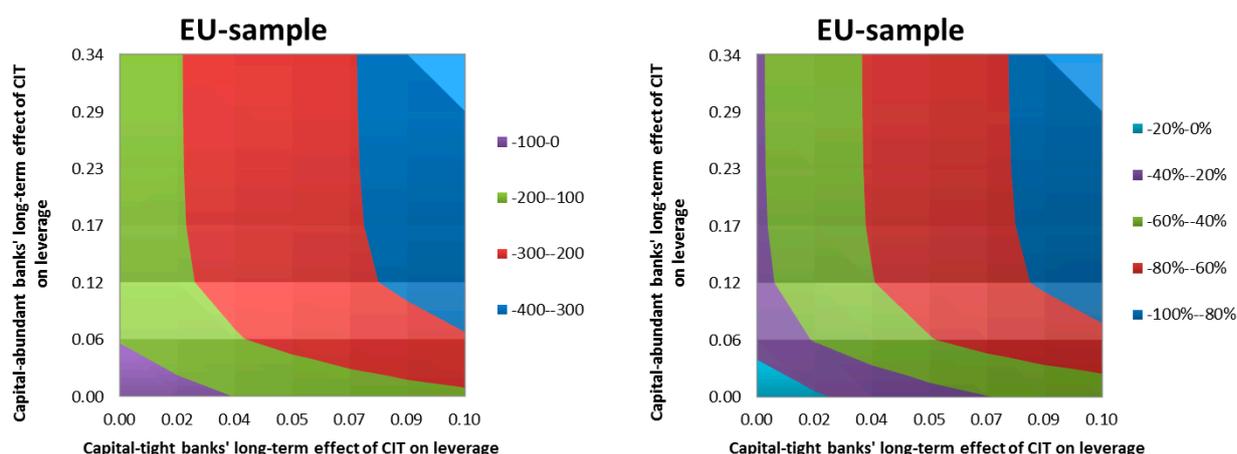
As discussed in Section 1, different studies report heterogeneity across banks as regards the effect of CIT on leverage. Several studies look into differences in size or in the buffer of capital with respect to the minimum capital requirement (MCR). There is no consensus on the importance of the heterogeneity of

the CIT effect to bank size or regulatory capital buffer. Keen and De Mooij (2012) find no significant effects of CIT on leverage for large banks and for banks that are close to the MCR. They suggest that these effects are related as larger banks tend to hold smaller buffers. Schepens (2013) however finds that the Belgian ACE has been most effective in reducing banks Z-scores for capital-tight banks.<sup>31</sup>

To see to what extent the results of the previous sections are robust to heterogeneity across banks, we split the banks into two groups to reflect the sensitivity to changes in CIT of capital-tight and capital-abundant banks. The cut-off is the sample median of the capital buffer with respect to the MCR after QIS adjustment for RWA and capital. We simulate the effects of eliminating the debt bias showing a range of low coefficients for the CIT-effect on leverage for capital-tight (from 0 to 0.10) and a larger range including higher coefficients for capital-abundant banks (from 0 to 0.34).

Figure (8) shows the reduction in losses on public finances due to the effect of eliminating the debt bias for the full EU sample in EUR bn (left) and percent of baseline losses (right) for the range of CIT elasticities of leverage. It shows that for any plausible combination of CIT effects, the reduction in systemic losses on public finances remains very substantial. Even if the long-term effect of CIT on leverage is almost negligible for capital tight banks (say 0.01), overall public finance costs of banking crises could still be reduced by 40-60% for plausible long-term effects of CIT on leverage for capital abundant banks (from 0.10 and above).

**Figure (8).** Reduction in public finance costs of banking crises due to eliminating the tax bias under different assumptions of the effects of CIT ( $\beta$ -coefficients) on leverage for capital tight and capital abundant banks for the full EU-sample, in EUR bn (LHS) and in % of baseline costs (RHS).

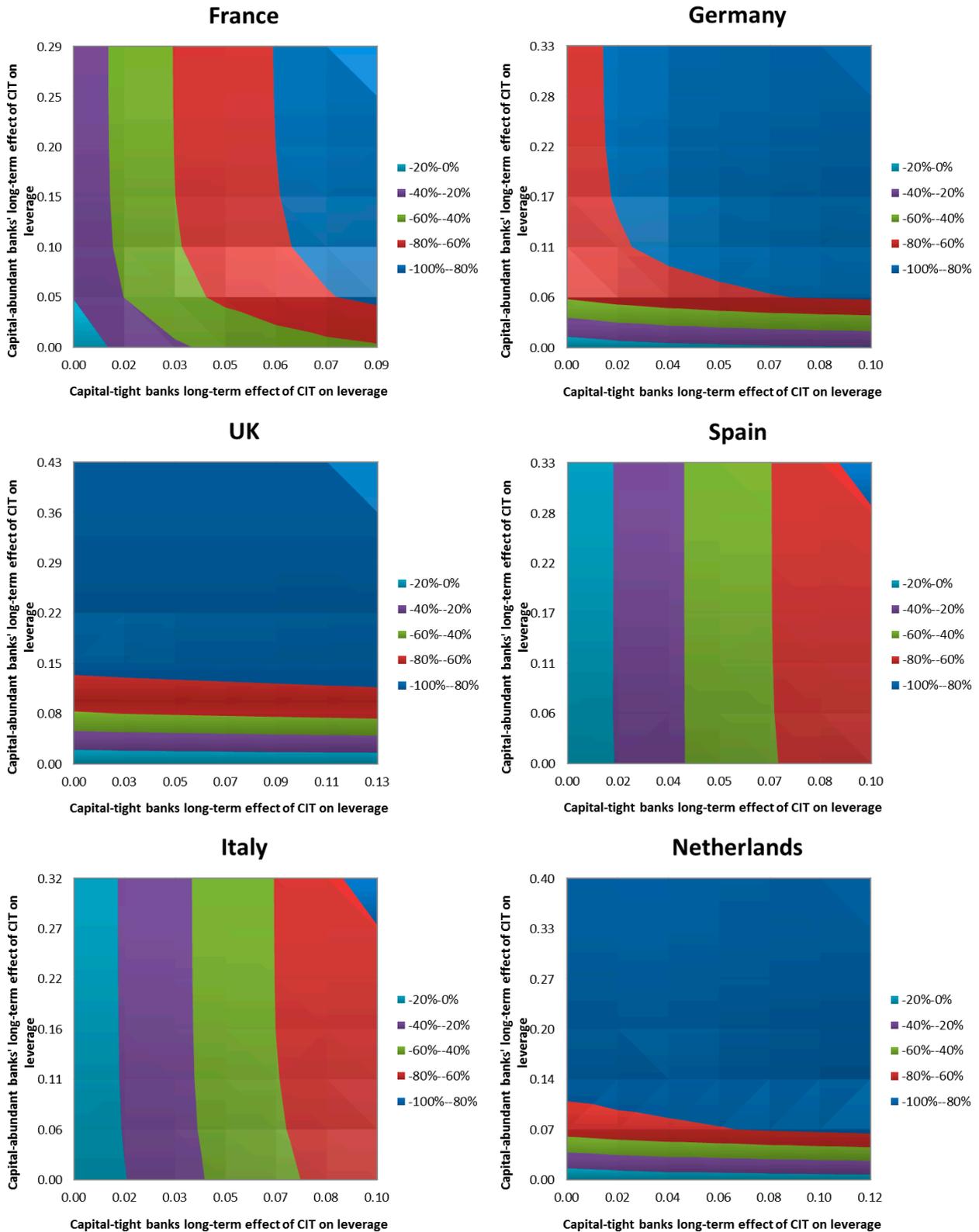


Note that the colored surfaces of the left- and right-hand side are not coinciding.

<sup>31</sup> Z score is a measure of distance to default. It measures the losses required to wipe out a bank's equity capital and is defined as  $Z \text{ score} = \log[(K=A + ROA) / \sigma(ROA)]$ .  $\sigma(ROA)$  is the standard deviation of return on assets.

Figure (9) shows the result for the individual Member States of the sample. The difference in profiles is remarkable and due to substantial differences in capital buffers and RWA density of total assets of the banks across countries. E.g., in the UK and the Netherlands, the coefficient on capital tight banks is not very relevant for the reduction in public sector losses across the banking system, as the large majority of assets are in capital abundant banks. If the average CIT elasticity of leverage for capital abundant banks would be in the range 0.10-0.15, public finance costs of banking crisis could be reduced by 80% or more if the debt bias in taxation would be eliminated in these countries, while the CIT elasticity for capital tight bank is barely relevant. In Italy and Spain, the opposite holds and the elasticity for capital tight banks drives the changes in losses. But even if the elasticity for capital tight banks would only be around 0.05 in these countries, public finances costs of banking crises could still be reduced by half. In Germany and France, the results are more mixed and both CIT elasticities of leverage for capital tight and capital abundant banks drive the outcomes, with France more dominated by capital-tight banks and Germany more by capital abundant banks.

**Figure (9).** *Eliminating the tax debt bias - Reduction in losses due to lower bank leverage under different assumptions of the effects of CIT on leverage for capital-tight and capital-abundant banks*



### 3.5 Results for scenario 4 - Accounting for endogenous risk increase on the asset side

In the above simulations, the distribution of RWA is exogenous. However, as reported earlier, some recent literature points towards an endogenous reaction of asset risk to changes in the capital structure. Changes in CIT, inducing adjustments to the banks' capital structure could thus also induce changes in asset portfolio risk. In particular, to the extent that banks target an internal risk-weighted capital ratio, they may adjust the RWA density (RWA/TA) of their asset portfolio in response to any increase in capital. If so, the reduction of losses in banking crises due to reduction or elimination of the tax bias would be lower. In this section we add some sensitivity analysis to simulate the losses assuming an endogenous increase of RWA following the reduction of the debt bias.

For this sensitivity analysis, we consider the findings of Horvath (2013) as his analysis and set-up most closely resembles ours. He finds a long-term RWA coefficient of between 0.2 and 0.7 for the full Bankscope sample including non-EU banks. The results of Devereux et al (2013) who estimate the impact of bank levies on RWA density and on leverage can be used to check the relative size of the two effects. In most of their specifications they find that both effects are of similar order of magnitude. That is not consistent with the higher end of the range of CIT effects on RWA that we took from Horvath (2013). It also implies that combinations of a low response of leverage to changes in CIT and a high response of RWA/TA to changes in CIT are unlikely.<sup>32</sup>

When setting the parameter space for the sensitivity analysis, we also consider that Horvath's estimates of the effects of CIT on RWA density are very sensitive to the data sample (period and countries). Excluding US banks from the sample, Horvath's estimate of the effect of CIT changes to RWA density drops from 0.70 to 0.16 (and becomes insignificant). Also slow adjustment (only 15% adjustment per year of the gap between target and actual RWA density in the GMM) may indicate high sensitivity of changes in the sample or control variables. An important factor driving the instability seems to be the extent to which introduction of Basel II in the EU drives RWA/TA (down).

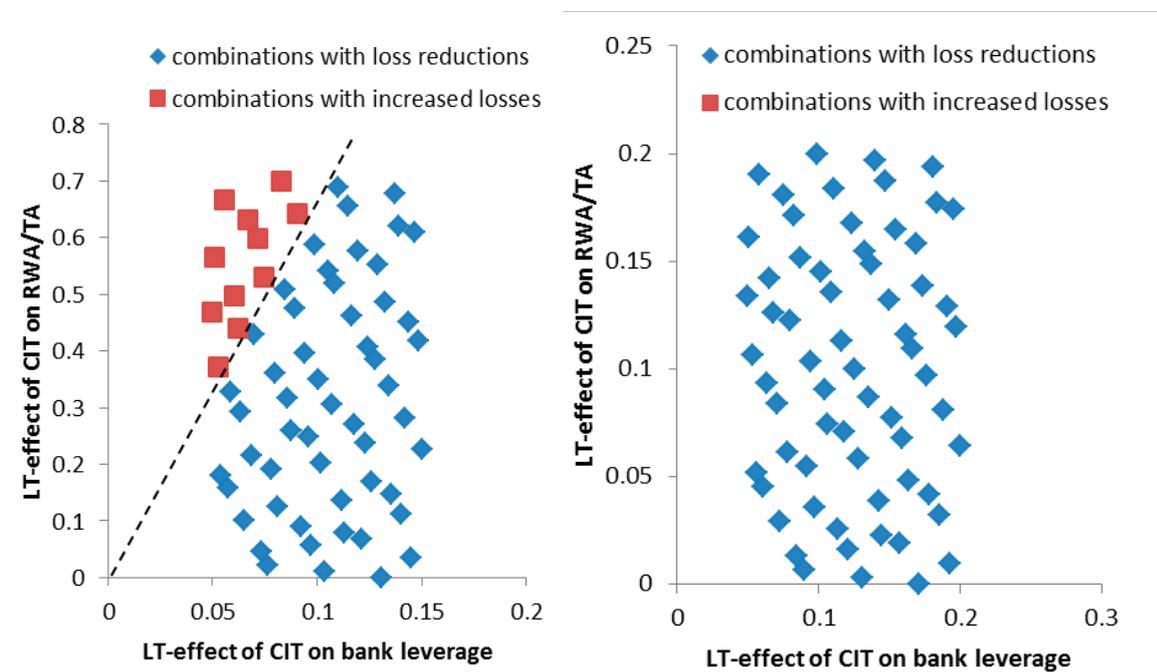
To take account of this uncertainty, we assess our results with two different sensitivity analyses: one varying long-term RWA effects in the range [0.0; 0.2] and long-term leverage effects [0.0; 0.2]; and a very conservative<sup>33</sup> one with the Horvath RWA effects in the range [0.0; 0.7] and leverage effects of [0.0; 0.15]. Figure (10) shows the parameter space indicating for which pairs there is a reversal of the estimated benefits of increased taxation in terms of lower public finance costs of banking crises. Contrary to Horvath (2013) findings, benefits for financial stability may be substantial.

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<sup>32</sup> Devereux et al (2013) however also finds that in general banks with low capital ratios do offset capital increases with increased asset risk.

<sup>33</sup> To consider the degree of conservatism stemming from the Horvath range, it should be noted that the average RWA/TA increase across all banks in this space is more than 11 pp and the maximum is 24 pp, while Devereux et al. (2013) estimates for banks subject to a bank levy are in the range of 2-4 pp.

**Figure (10).** Scatter diagrams of parameter space for sensitivity analysis - 64 points combining effects of (i) CIT on leverage in the range [0.0; 0.15] and effects of CIT on on RWA in range [0.0; 0.7] (LHS); and (ii) CIT on leverage in the range [0.0; 0.2] and effects of CIT on on RWA in range [0.0; 0.2] (RHS)



Notes: 1. In the sensitivity/uncertainty analysis the Design of Experiment DoE uses Sobol sequences (also called LPT sequences, Sobol (1967)). They define the parameter space (leverage effect, RWA effect) by quasi-random low-discrepancy sequences. In our exercise we have used 64 points. Further analyses may be foreseen using larger sequences. 2. The dashed line separates the combinations of long-term effects of CIT on bank leverage and on RWA density for which elimination of the debt bias in taxation leads to (no) increases in public finance losses in any country.

Tables (4) and (5) provide the simulation results in more details. Table (4) shows the results of the simulations with the ‘conservative’ parameter space with very large increases in the CIT effect on RWA density [0; 0.7] and a low leverage effect range [0; 0.15]. While benefits of eliminating the debt bias in CIT are clearly lower than in the previous sections, public sector losses of banking crisis are still substantially lowered in most cases, including up to the third quartile. The median broadly ranges from 30 to 50% loss reduction across countries. The range of outcomes reflects the sizeable uncertainty though. The first order sensitivity index indicates that - for this setting - the importance of variations in the in CIT effect on RWA slightly outweighs that of the variations in the leverage effect.

**Table (4).** Statistics of sensitivity analysis - change in public finance costs of banking crises due to elimination of tax debt bias with different combinations of the effects of CIT on leverage (range [0.0; 0.15]) and on RWA (range [0.0; 0.2]), in % of baseline costs

	Germany	Spain	France	United Kingdom	Italy	Netherlands
Min	-97%	-82%	-96%	-83%	-84%	-97%
Q <sub>1</sub>	-75%	-57%	-72%	-51%	-55%	-66%
Median	-52%	-39%	-45%	-31%	-35%	-38%
Q <sub>3</sub>	-11%	-17%	-14%	-8%	-11%	-8%
Max	105%	30%	73%	51%	38%	48%
Interquartile range	65%	40%	58%	43%	44%	58%
Upper Outliers	1	0	1	0	0	0
Lower Outliers	0	0	0	0	0	0
<b>First order sensitivity index*</b>						
Leverage effect	39%	45%	39%	38%	45%	42%
RWA effect	49%	49%	53%	55%	50%	53%

\*The first order sensitivity index gives the part of the variance in output that can be explained by each parameter. The sensitivity indices have been computed using the Matlab SDR Anova toolbox developed by JRC and academia. The main idea behind the SDR Anova approach is to combine the best of State Dependent Regression and penalized regression techniques such as ACOSSO.<sup>34</sup>

**Table (5).** Statistics of sensitivity analysis - change in public finance costs of banking crises due to elimination of tax debt bias with different combinations of the effects of CIT on leverage (range [0.0; 0.2]) and on RWA (range [0.0; 0.2]), in % of baseline costs

	Germany	Spain	France	United Kingdom	Italy	Netherlands
Min	-100%	-94%	-98%	-95%	-92%	-99%
Q <sub>1</sub>	-98%	-84%	-96%	-87%	-86%	-97%
Median	-90%	-70%	-89%	-68%	-74%	-90%
Q <sub>3</sub>	-74%	-53%	-70%	-49%	-50%	-61%
Max	-38%	-26%	-35%	-26%	-21%	-25%
Interquartile range	23%	31%	26%	38%	37%	36%
Upper Outliers	2	0	0	0	0	0
Lower Outliers	0	0	0	0	0	0
<b>First order sensitivity index*</b>						
Leverage effect	90%	93%	90%	93%	93%	92%
RWA effect	4%	4%	4%	4%	3%	3%

\*The first order sensitivity index gives the part of the variance in output that can be explained by each parameter. The sensitivity indices have been computed using the Matlab SDR Anova toolbox developed by JRC and academia. The main idea behind the SDR Anova approach is to combine the best of State Dependent Regression and penalized regression techniques such as ACOSSO.

Table (5) provides a boxplot of the estimates with the lower range of the CIT effect on RWA density [0; 0.2]. Benefits of eliminating the debt bias in CIT remain very substantial, with public sector losses of banking crisis lower in all cases. The median ranges across countries broadly from 70 to 90% loss

<sup>34</sup> See Ratto et al. (2010), Ratto and Pagano (2010 and 2012) for state dependent regressions and sensitivity analysis and Storlie and Helton (2007) for Acooso.

reduction, despite the adverse effects of increases in portfolio risk. The first order sensitivity index shows that for these ranges, the leverage effect of CIT strongly dominates the RWA effect.

Adding a further dimension to the sensitivity analysis in this section by having different ranges for the RWA and leverage effect of CIT for *capital-tight* and *capital-abundant* banks would however require a very large number of SYMBOL simulations and is beyond the scope of this paper. Considering however that Devereux et al (2013) find that in general banks with low capital buffers to the regulatory minimum do largely offset capital increases with increased asset risk, while banks with high regulatory capital ratios do not, one can combine the results of sections 3.4 and 3.5. We can infer that for countries in which the risk-reduction in *capital-tight* banks drives the overall loss reduction (Italy, Spain and France), the effects of eliminating the debt bias in taxation is more uncertain and reductions in public finance costs are more likely to be in the lower ranges of the distribution in Tables (4) and (5) than for the other countries.

#### **4 Conclusions**

The findings in this paper provide empirical evidence that reducing the debt bias in corporate taxation for banks can very significantly reduce the public finance costs of financial crises. The analysis raises the question why tax policies continue to discourage equity financing in many countries while regulatory policy is tightened to increase it.

The panel regressions support recent findings in empirical literature suggesting that the abundant evidence on the debt bias of taxation for non-financial corporations can be extended to banks. As the econometric evidence on the size and significance of the effect of CIT on bank leverage remains sensitive to the data sample and model setting, further analysis would be insightful though. The (planned) introduction of measures to reduce the debt bias in taxation in a number of countries may provide for a natural experiment as new data becomes available over the next years. An important conclusion of the analysis in this paper is that even if the tax elasticity of bank leverage is at the lower end of the ranges found in recent literature, eliminating the debt bias in CIT could lead to a very sizable reduction in public finance costs of a banking crisis. These results hold when asset portfolio risk is allowed to increase in response to elimination of the debt bias of CIT, as benefits remain sizeable for a large range of the parameter space.

The findings call for addressing the debt bias in taxation by e.g. Allowance for Corporate Equity (ACE) or a comprehensive business income tax (CBIT). Other tax measures can also be considered. Excessive incentives for risk-taking by bank managers and creditors due to the bonus schemes and implicit subsidies for too-big-too-fail banks could be reduced by a Financial Activities Tax (FAT) on supernormal wages and profits. Further work could be done on interactions between the asset side and the liability side of the banks' balance sheets in response to tax and regulatory policies aimed at reducing bank leverage and risk, and the overall impact on banking sector risks, costs of crises and lending

behaviour to the real economy. Future work could also consider the importance of cross-border debt-shifting across subsidiaries of multinational banks in the EU to benefit from intra-country differences in CIT; an issue that is not addressed when eliminating the debt bias with an ACE.

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## Annex (1) - Bank sample for banking losses simulations

	Capital (EUR bn)	TA (EUR bn)	RWA (EUR bn)	Capital/TA	Capital/RWA	RWA/TA
<b>DE</b>	121	4138	1112	2.93%	10.91%	26.88%
<b>ES</b>	153	3613	1912	4.23%	7.99%	52.93%
<b>FR</b>	252	8749	2812	2.88%	8.95%	32.14%
<b>IT</b>	135	2783	1576	4.86%	8.59%	56.62%
<b>NL</b>	86	2157	774	4.01%	11.18%	35.88%
<b>UK</b>	256	6949	2454	3.68%	10.42%	35.31%
<b>Sample</b>	<b>1003</b>	<b>28388</b>	<b>10640</b>	<b>3.53%</b>	<b>9.43%</b>	<b>37.48%</b>

## Annex (2) – Banking losses simulation results

Table A2 presents the simulation results for the public finance costs in case of very severe banking crisis in billion EUR. The public finance costs are considered to reflect the sum of the losses in excess of capital and the recapitalization needs up to the regulatory minimum of 8% RWA. This assumes no creditor bail-in, or use of bank-financed safety-nets such as resolution funds or deposit-guarantee schemes. The exponential trendlines reported in the Table are fitted to allow matching the large number of intermediate capital increase scenarios for combinations of the elasticity of elasticity leverage to CIT (in the range of 0.05-0.2) and reductions in the CIT rate..

**Table A2** - Bank losses in excess of capital plus recapitalisation to 8% RWA (bn EUR) in a very severe financial crisis (99.95 percentile) versus increase in capital/TA relative to the end-2012 balance sheet

capital/TA increase	Germany	Spain	France	United Kingdom	Italy	Netherlands
0.00%	43.8	105.8	123.0	86.7	77.4	31.5
0.10%	41.2	102.2	116.3	83.4	74.8	30.4
0.25%	37.8	96.9	106.5	78.6	71.3	28.4
0.41%	34.4	92.4	97.9	73.5	67.9	26.9
0.56%	31.2	87.3	90.5	69.2	64.5	25.3
0.71%	28.0	82.5	83.6	64.7	61.2	23.4
0.86%	25.2	78.4	77.4	61.0	58.4	21.7
1.02%	22.9	74.2	71.9	57.4	55.5	20.3
1.17%	20.9	70.4	66.6	53.8	52.6	18.5
1.32%	19.2	66.9	62.3	50.7	50.2	16.7
1.47%	17.2	63.3	58.0	47.9	47.6	14.9
1.63%	15.5	60.1	54.1	44.6	45.5	13.5
1.78%	14.1	57.1	50.1	41.7	43.1	11.9
1.93%	12.7	53.9	46.4	38.5	40.9	10.5
2.08%	11.4	51.1	43.0	35.4	38.4	9.0
2.24%	10.2	48.3	39.1	32.2	35.9	7.6
2.39%	9.1	45.3	35.6	29.3	33.7	6.2
2.54%	8.0	42.5	32.5	26.7	31.7	5.0
2.69%	7.0	39.8	29.5	24.0	29.6	3.9
2.85%	6.0	37.3	26.6	21.8	27.6	2.9
3.00%	5.2	34.9	23.7	19.1	25.3	2.3
Exponential trendline of bank losses based on values for capital/TA increase (x) in the range [0, 2%]	$44.25e^{-64.3x}$	$105.9e^{-34.9x}$	$120.7e^{-49.9x}$	$87.09e^{-41.4x}$	$77.46e^{-32.9x}$	$33.56e^{-55.7x}$

Note that the exponential trendline's  $R^2$  exceeds 99% for all countries except NL (for which it is 98.3%).



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