Banks, debt and risk: assessing the spillovers of corporate taxes °

Serena Fatica Wouter Heynderickx Andrea Pagano

Abstract

Using bank balance sheet data, we find evidence that leverage and asset risk of European multinational banks in the crisis and post-crisis period is affected by corporate taxes in their host country as well as by the tax rates in all the jurisdictions where the banking group operates. Then, we evaluate the effects that establishing tax neutrality between debt and equity finance has on systemic risk. We show that the degree of coordination in implementing the hypothetical tax reform matters. In particular, a coordinated elimination of the tax advantage of debt would significantly reduce systemic losses in the event of a severe banking crisis. By contrast, uncoordinated tax reforms are not equally beneficial. This is because national tax policies generate spillovers through cross-border bank activities and tax-driven strategic allocation of debt and asset risk across group affiliates.

Keywords: Corporate tax, Debt bias, Debt shifting, Multinational banks, Leverage

JEL Classification: G21, G28, G32, H25

° All authors are affiliated with the European Commission – Joint Research Centre, Directorate for Innovation and Growth, Economy and Finance Unit. Corresponding author: serena.fatica@ec.europa.eu. We gratefully acknowledge comments from participants at the ZEW Public Finance Conference, the annual Congress of the International Institute for Public Finance and the International Panel Data Conference. Remaining errors are our own. The opinions and views expressed in this paper are those of the authors only and should not be considered as official positions of the European Commission.

1. Introduction

Taxes are a first-order determinant of firms' capital structure choices (Titman and Wessels, 1988; MacKie-Mason, 1990; Desai *et al*., 2004). In particular, by making interest payments deductible from the taxable base, standard corporate income tax systems confer an advantage to debt over equity. The tax benefit of debt encourages excessive corporate indebtedness, and thus represents an important source of risk, particularly for the highly leveraged financial sector (De Mooij, 2014). In fact, it is widely held that banks' high debt levels have increased vulnerability of the financial sector to shocks and amplified the negative impacts of the recent global financial crisis. Therefore, in the aftermath of the crisis, amidst the concerted regulatory initiatives to reduce leverage in the financial sector, the perverse incentives of corporate taxes on banks' debt policies have attracted renewed academic and policy interest. Strikingly, by indirectly penalising equity, standard tax rules undermine the bank solvency and capital adequacy efforts that have been central to the post-crisis reform agenda. Thus, by distorting incentives at the microeconomic level, tax policy ultimately affects systemic risk (Roe and Tröge, 2017). This is the focus of our analysis.

Two issues arise when considering how interest deductibility – not accompanied by an equal relief for equity finance – artificially inflates banks' demand for debt. First, since the value of the tax deduction increases with the corporate income tax rate, the distortion will be particularly marked in high-tax jurisdictions, all else equal. Second, the rise of international banks has highlighted a distinctive feature of multinational groups, that is the potential to take advantage of international tax differences to minimize their tax bill by concentrating debt where the generosity of the tax relief is higher. In particular, in a high-tax location, all else equal, debt finance is attractive because the interest costs can be deducted from taxable income at a high rate. By contrast, in a low-tax jurisdiction, all else equal, equity finance is more attractive since the returns will be taxed at a lower rate with the repatriated dividends usually tax exempt for the parent. All in all, taxation can affect financial structure choices of international banks via two channels. First, there is the standard debt bias effect, which encourages the use of debt because of the level of local taxation. Second, there is a debt shifting effect, which allows multinational groups to minimize the cost of debt by taking advantage of international tax differences.

At the same time, however, banks are subject to regulatory requirements that may, to a large extent, affect not only their financing decisions, but also the composition of their asset portfolio. Bank regulation on minimum capital requirements as in the Basel framework creates dependency between bank indebtedness and asset risk. In particular, leverage risk and portfolio risk become substitutes if banks balance bankruptcy cost with other benefits of debt financing, such as the tax shield (Orgler and Taggart, 1983). In other words, when funding risk is limited by regulation, risk-averse banks at least partly undo the effect on their total risk by taking on more portfolio risk (Devereux *et al*., 2017; Horvath, 2013). This behaviour is fully consistent with theoretical models where banks behave like competitive portfolio managers, in the sense that they structure their balance sheet, taking prices and yields as given, so as to maximise the expected utility of their financial net worth (Koehn and Santomero, 1980; Kim and Santomero, 1988).

In this paper, we investigate the impact of corporate taxation on capital structure choices and asset risk of banking groups in Europe, and evaluate the financial stability implications of eliminating the favourable tax treatment of debt finance. First, we examine how corporate taxes affect two indicators of balance sheet risk, namely debt and risk-weighted assets (RWA), respectively, both normalised with respect to the level of total assets. Specifically, we run panel non-linear regressions using bank balance sheet data for the years 2008-2014. Equipped with the predicted changes to our outcome variables obtained from the econometric estimates, we then quantify the effects of eliminating the favourable treatment of debt on systemic risk. We take the amount of systemic losses originating in the banking sector in the event of a severe crisis as our metric to proxy for financial stability outcomes. In particular, we consider excess losses, i.e. those losses that are not absorbed by ad hoc instruments set up by the banks, notably provisions, regulatory capital and equity cushions (including potential recapitalization). We obtain such losses using a micro-simulation bank portfolio model that fits in the Basel framework for minimum capital requirements. In the model setup, risk on both sides of banks' balance sheets is indeed pivotal in determining the simulated outcomes. When it comes to the policy changes that set a level playing field between debt and equity, we distinguish different reform scenarios, depending on the degree of coordination among reforming countries. A concerted approach to tax reforms matters since the impacts of national policies spill over across countries. This is due to the fact that multinational banks, faced with a trade-off in the standard portfolio selection context, allocate group debt and asset risk internationally among the group affiliates.

Our work contributes to different strands of the literature. First, there is a burgeoning empirical literature on debt bias in the banking sector that builds on the well-established research on non-financial companies (Feld *et al*., 2013, and Huizinga *et al*., 2008). Keen and de Mooij (2016), Hemmelgarn and Teichmann (2015), and Heckemeyer and de Mooij (2016) show that the capital structure of international banks is sensitive to corporate taxes. Similar conclusions are reached by Schepens (2016) and Celerier *et al*. (2017), who focus on the tax shield to the return to equity created by the Belgian allowance for corporate equity (ACE). To the best of our knowledge, the first – and, so far, only – evidence on debt shifting by multinational banks in a cross-country setting has been provided by Gu *et al*. (2015). Reiter (2017) investigates whether the allocation of internal debt within German banks is driven by taxation. Strategic use of debt to shift income to lower taxed group affiliates is particularly relevant for banks, since provisions to curb profit shifting, such as controlled-foreign-corporation and thin capitalisation rules, often do not apply to financial institutions (de Mooij and Hebous, 2018). His focus is indeed on how the internal capital market can be exploited to reduce the total tax burden on multinational banks, while the implications for financial stability are not considered. When it comes to the microsimulation exercise, our work follows Langedijk *et al*. (2015), who investigate the public finance impacts of eliminating the debt bias, and provide a rich set of sensitivity results based on different behavioural parameters for the reaction of bank capital structure to taxation. Like theirs, our contribution adds to the recent literature that emphasizes how tax policy creates distortions in terms of increased systemic risk (de Mooij *et al*., 2014). However, importantly, they neglect the debt shifting channel. This implies that the public finance savings stemming from the elimination of debt bias that they obtain might be overestimated. Moreover, naturally, their framework cannot capture the cross-country spillovers generated by debt shifting, which is instead pivotal to our analysis.

Indeed, we find that, although it creates room for banks to increase the riskiness of their asset portfolio, a level playing field between debt and equity finance improves financial stability, in that it reduces the cost of banking crises. The extent to which any increase in capital is matched by an increase in the risk weight of assets depends on whether banks target an internal bank-specific risk-weighted capital ratio (or a target buffer to the minimum capital requirement). When the international channel of adjustment is factored in, we find that eliminating the tax bias towards debt would result in a significant reduction of the losses generated in the event of a severe bank crisis. Moreover, the degree of coordination in implementing the tax reform matters in terms of financial stability implications, both at the national and at the aggregate level. Unilateral tax reforms, while beneficial for the reforming country, create negative spillovers for the countries where the favourable treatment of debt is still in place. In this respect, our results concur with the conclusions by Hebous and Ruf (2017), who find that the Belgian allowance for corporate equity (ACE), by increasing intra-group lending and other types of passive investments, opened up tax planning opportunities for German multinationals. We show that the lack of coordination entails a similar risk also from a financial stability standpoint.

From a policy perspective, our analysis is both relevant and timely. Major corporate tax reforms on both sides of the Atlantic provide for substantial limitations to the tax advantage of debt over equity. In particular, the Common Consolidated Corporate Tax Base (CCCTB) proposal in Europe introduces an allowance that makes increases in equity deductible from the taxable base. Although our microsimulation setup is admittedly very stylised, our findings suggest that, when applied to banks, this type of allowance has the potential to improve financial stability by reducing systemic losses in the event of a severe crisis. Moreover, if introduced in a coordinated fashion, such reform would eliminate the incentives for banks to shift risk across national borders following existing corporate tax differential in Europe. In this respect, our results highlight important benefits of tax coordination, which have not been contemplated by the traditional public finance literature (Bovenberg *et al.*, 2003).

The rest of the paper is organized as follows. Section 2 describes the empirical analysis, including the econometric model and the data. Section 3 illustrates the results. The setup of the microsimulation exercise is introduced in Section 4, while Section 5 presents the simulation results. Section 6 offers a critical discussion. Finally, Section 7 concludes.

2. Empirical analysis

2.1 Model specification

To assess the impacts of corporate taxes on banks' financing choices and asset risk we specify an estimating equation in the spirit of Huizinga *et al*. (2008). In their setup, as adapted by Gu *et al*. (2015), the capital structure of a bank in a multinational group depends on the tax rates of all the countries where the group has affiliates, not only on the domestic tax rate. Specifically, the outcome variable of interest at time t of bank i belonging to group g can be expressed as:

$$\lambda_{i,g,t} = \beta_0 + \beta_1 tax_{i,g,t} + \beta_2 average\ tax_{i,g,t} + \beta_3 \boldsymbol{X}_{i,g,t} + \phi_g + \rho_t + e_{i,g,t}. \qquad (1)$$

In our main specification, the dependent variable, $\lambda_{i,g,t}$, is defined as the ratio between total liabilities ($D_{i,g,t}$) and total assets ($A_{i,g,t}$) of bank i at year t. As discussed in the Introduction, to fully appreciate the effects of taxes on banks' behaviour, one has to consider that founding risk can be shifted to the asset side of the balance sheet. Accordingly, we use risk-weighted asset density, i.e. the ratio between risk-weighted assets and total assets, as our alternative dependent variable. The two tax terms are the main explanatory variables of interest. First, the variable $tax_{i,g,t}$ is the statutory corporate income tax rate in the host country. This tax rate captures the incentives for a purely domestic bank. Since the tax savings due to interest deduction are proportional to the tax rate, we expect $\beta_1 > 0$ for our leverage equation. By contrast, we anticipate a reversed sign for the same coefficient in the asset risk equation. This is because in the Basel regulatory framework higher debt reduces the scope for taking up risk on the asset side of the balance sheet. The second tax term is the average corporate tax rate of the banking group in all locales where it operates other than the country of affiliate i, indicated with $average\ tax_{i,g,t}$. The composite tax term weighs the statutory tax rates in alternative locations by the shares of assets that each affiliate to group g holds in the respective locale:

$$average\ tax_{i,g,t} = \sum_{j \neq i; i,j \in g} tax_{j,g,t} w_{j,g,t},$$

where $w_{j,g,t} \equiv A_{j,g,t} / \Sigma_{j \in g} A_{j,g,t}$[1]. The rationale for this weighting scheme is straightfoward. The incentives of a bank to take up debt or risky assets depend on its size. Specifically, large subsidiaries have more room for increasing their (absolute) debt level in response to a tax increase without affecting significantly their debt ratio. By contrast, small affiliates have relatively low capacity to absorb debt compared to the large group affiliates. The same holds true for asset risk. The average tax term captures the incentives to shift debt or risk within the multinational group by exploiting international tax differences. Naturally, we expect $\beta_2 < 0$ for the leverage equation. As before, we expect a reversed sign in the asset risk equation[2].

The vector **X** in equation (1) includes a number of bank-level and country-level control variables. First, we use a dummy that takes on the value one if the affiliate is the parent bank in the group considered, and zero if it is a subsidiary. In contrast to Gu *et al*. (2015), we do not limit our analysis to bank subsidiaries. Instead, we estimate the debt ratio equation for all group affiliates, i.e. parent and subsidiaries. In this setup, we can check whether parent banks behave

[1] In a robustness check, we use weights based on employment instead of assets. The results are not affected.
[2] Both Huizinga *et al.* (2008) and Gu *et al.* (2015) constrain the impacts of domestic and foreign taxes to be the same. By using separately the two tax terms, instead of their difference, we allow for a differential effect of domestic and foreign taxation.

differently from their subsidiaries in terms of debt ratios and asset risk, controlling for relevant determinants of the two variables. For instance, Dischinger *et al*. (2014) find a systematic and significant difference in profitability in multinational groups between parents and their subsidiaries, which they attribute to the home market advantage. When it comes to financing choices, the theoretical literature emphasizes the role of debt finance in mitigating managerial incentive problems (Aghion and Bolton, 1989). In that case, we would expect a more substantial use of debt in the subsidiaries than in parent banks, as asymmetric information is a bigger concern for the former.

For the bank-specific controls we rely on the variables usually employed in the literature on banks' capital structure (Rajan and Zingales, 1995; Frank and Goyal, 2004; Gropp and Heider, 2009), which we discuss next. The same controls are then used in the risk-weighted assets equation. First of all, we allow for size effects by including the book value of the bank's fixed assets (in logs). Arguably, a positive relationship between *size* and leverage can be expected due to easier access to credit, also thanks to better diversification opportunities. Similarly, large intermediaries may benefit from a too-big-to-fail guarantee that incentivises taking up debt. *Profitability* is also expected to affect leverage, albeit in an ambiguous way. On one hand, very profitable institutions might gain easier access to external finance because they are perceived as safer than their less profitable peers. On the other hand, if profits are retained within the firm, the need for external finance would decline with the level of profitability, ceteris paribus. We include the return on assets (ROA) as a measure of profitability. Furthermore, to account for the fact that growing banks invest more, and thus could have incentives to accumulate more debt, all other factors being equal, we include also the *growth rate of total assets*. *Collateral* is also linked to capital structure choices, although the direction of the impact is again ambiguous. Collateralised assets might ultimately disincentivise firm reliance on retained earnings by facilitating external borrowing and reducing the cost of issuing debt (Rajan and Zingales, 1995). In this case, we would expect a positive relationship between collateral and leverage, as in Gropp and Heider (2009). At the same time, tangible, depreciable assets may create non-debt tax shields. These might make debt and tangible assets act as substitutes, as an instrument for reducing the tax liability (De Angelo and Masulis, 1980). Following Gropp and Heider (2009), we proxy collateral with the proportion of security assets and non-earnings assets over the book value of total assets. This definition includes liquid securities that can be used as collateral when borrowing from central banks[3]. To avoid simultaneity between the dependent and the explanatory variables, we use lagged values of the bank-specific controls throughout.

We include a set of additional explanatory variables that vary at the country-year level. Specifically, we control for GDP growth and inflation using the annual variation of the consumer price index. Moreover, we account for government intervention in the banking systems in the wake of the crisis using two additional variables[4]. First, we include in the regression the cumulated government spending on bank recapitalization, and government guarantees to bank borrowing, for impaired assets, as well as liquidity and other assistance measures, as a fraction of total assets in the national banking sectors. Arguably, public support to ailing institutions might affect capital structure choices also of healthy intermediaries, not least by acting as an explicit guarantee. Second, we account for the staggered introduction of bank levies in several European countries after the crisis using a dummy that takes the value one for the countries-years where any such taxes are in place. Devereux *et al*. (2017) provide evidence that levies, mostly designed as taxes on the book value of risky liabilities, have prompted banks' reaction along several adjustment channels, including equity ratios. Finally, our main empirical specification includes a full set of time (ρ_t) and group fixed effects (ϕ_g). Year dummies allow us to control for aggregate shocks displaying a common trend across countries and banks. Group fixed effects control for non-observable, group-specific characteristics which might determine the debt choices of all affiliates in the banking group. For instance, group-specific risk would affect the lending rate and the cost of borrowing (Desai, Foley, and Hines, 2004). Conditioning on group-specific fixed effects also allows us to account for the structure of each group. If the location pattern of the group is constant over time, group dummies are enough to control for selection effects. This is also true if the location pattern changes for reasons entirely unrelated to changes in tax policy.

In a robustness check, we also include country fixed effects to control for time-invariant unobserved costs and benefits, potentially heterogeneous across national banking systems, which might drive the optimal level of debt for affiliates in different countries. Given our

[3] To account for the possibility that alternative tax provisions, such as amortization of financial assets, may dampen the impact of interest deductibility we have alternatively used an additional control for non-debt tax shields. This is calculated as the ratio of total non-interest expenses over total assets, as in Gu *et al*. (2015). However, the variable was never significant in our specifications. This might stem from the fact that presumably it captures only imperfectly tax shields other than debt.

[4] We do not include the regulatory variables usually employed in cross-country studies because of their lack of variation in our sample. Since regulation of the financial sector is harmonized in Europe, we do not control for regulatory variables, such as the presence of a deposit insurance scheme, or the minimum capital requirements. Indeed, all European country have a deposit guarantee schemes from 1994 (see the Directive 94/19/EC and the following amendments). Moreover, the minimum capital ratio requirement is fixed to 8% for our sample, since the introduction of directives 2006/48/EC and 2006/49/EC in the European countries.

sample period, these fixed effects likely capture adjustments in debt ratios and asset risk in the wake of the financial crisis. However, they may also per se capture building up and shifting of debt or risk (for example because most banks in high-tax countries would be linked to lower-tax countries), which would result in over-estimating the shifting effect (Buettner and Wamser, 2013)[5].

2.2 Estimation

The debt-to-asset ratio can be considered as the fraction of assets that is financed by debt. Likewise, the risk-weighted asset density is the fraction of assets at risk. Given the balance sheet identity and the regulatory weight structure, the measures are usually bounded between zero and one for viable banks. Linear methods, such as OLS, are inappropriate in this case, since the estimated expected value of the dependent variable will not necessarily be confined into the unit interval. Moreover, OLS estimates a single coefficient capturing the average impact of the explanatory variable on the outcome variable. The fact that the impact is constant over the whole range of values of the variable is difficult to reconcile with the boundedness of the dependent variable, particularly when a significant number of observations is concentrated around the corners. In our case, the distribution of the debt ratio in our sample is clearly skewed to the left (see next section), while that of the risk-weighted asset density is more symmetric. Following Egger *et al*. (2014), we adopt a nonlinear specification. Specifically, we estimate a panel-data fractional response model based on Papke and Wooldridge (2008). In particular, in the baseline formulation, we assume that the conditional expectation of the debt ratio, λ_{it}, with $\lambda_{it} \in [0,1]$, is:

$$E[\lambda_{it}|\mathbf{x}_{ict}] = \Phi(\mathbf{x}'_{ict}\boldsymbol{\beta}), \qquad (2)$$

where $\Phi(.)$ is the standard normal cumulative distribution function (cdf), $\mathbf{x}_{ict}$ is a column vector of explanatory variables, and $\boldsymbol{\beta}$ is the corresponding column vector of parameters[6]. The vector $\mathbf{x}_{ict}$includes the tax variables introduced in equation (1), as well as the other controls discussed above. Papke and Wooldridge (1996) propose a Bernoulli quasi-maximum likelihood estimation method (QMLE) to estimate equations like the one in (2). The log-likelihood function is:

---

[5] The inclusion of country fixed effects implies also that the identification of the host tax term, which does not vary within countries, is due only to time variation.

[6] The use of cumulative distribution function simplifies things. A more general formulation of the type $G(\mathbf{x}'_{ict}\boldsymbol{\beta})$ can be used, where G(z) is a known function satisfying $0 \leq G(z) \leq 1$ for all $z \in \mathbb{R}$.

$$max_{\beta}\sum_{i=1}^{N}\{(1-\lambda_{ic})\log[1-\Phi(\mathbf{x'}_{ict}\boldsymbol{\beta})]+\lambda_{ic}\log[\Phi(\mathbf{x'}_{ict}\boldsymbol{\beta})]\}.$$

In this framework, the estimated coefficients $\boldsymbol{\beta}$ are not readily interpretable. By contrast, the marginal effects, which measure the impact of the explanatory variables on the outcome variable, are[7]. The marginal effects for a continuous variable x_{jt} are obtained by differentiating equation (2) with respect to the variable of interest, is:

$$\frac{\partial E[\lambda_{it}|\mathbf{x}_{ict}]}{\partial x_{jt}}=\beta_j\phi(\mathbf{x'}_{ict}\boldsymbol{\beta}), \tag{3}$$

Equation (3) shows that the marginal effects depend on the level of the covariates. Hence, the impact of each covariate varies with the values of all the other explanatory variables. As a synthetic measure of the estimated impacts, we report the average marginal effects, calculated as the marginal effects averaged over the population distribution of the variables. The asymptotic standard errors of the average marginal effects are obtained with the delta method, so as to account for heteroscedasticity and serial correlation. The standard errors in the regressions are clustered at the bank level, to capture the lack of independence among the residuals for a given bank across years (Cameron and Miller, 2015; Petersen, 2009).

2.3 Data

We focus on banks based in the European Union (EU). Our sample period covers the years from 2008 to 2014. Data from banks' balance sheets are extracted from the Bankscope database compiled by Bureau van Dijk. Since we are interested in the variation of the indebtedness at the level of the individual bank within a banking group, we use unconsolidated statements. Thus, we drop entities that report only consolidated accounts. Likewise, we exclude from the analysis stand-alone intermediaries.

A banking group comprises a parent bank and at least one subsidiary bank. Exploiting the information on the ownership structure provided in Bankscope, we can match banks with their subsidiaries, located in the same country or in other EU countries[8]. In particular, we define a bank as a subsidiary if at least 50% of its shares are owned by another bank. Affiliates owned by another subsidiary are all treated as subsidiaries of the parent bank. Naturally, the latter is

[7] In fact, since $\Phi(.)$ is strictly monotonic, the elements of β only give the directions of the partial effects.

[8] We do not consider branches due to lack of data. Cerutti *et al.* (2007) stress that, unlike non-financial firms, multinational banks often operate through branches instead of subsidiaries. Moreover, they show that local corporate taxes affect the mode of bank entry. In particular, entry through branches would be particularly attractive in countries that have higher tax rates.

identified as the ultimate owner[9]. In the econometric analysis we focus on commercial, cooperative and savings bank affiliates. Therefore, we keep only groups with at least one subsidiary classified as having any of these specialisation types. After this first round of cleaning, our initial dataset comprises (at most) 106 banking groups, with 538 affiliates per year[10].

Table 1 reports the distribution of banking groups by ownership status and host country. Specifically, we distinguish between parent and subsidiaries, and, among the latter, we further parse foreign subsidiaries – i.e. banks with a foreign owner –, and national subsidiaries – i.e. subsidiaries located in the same country as their parent. Parent banks account for 17% of entities in our dataset. Around 40% of the subsidiaries are established in a country other than the one where the parent bank is located. Germany, France, the United Kingdom, Italy, Spain and Austria are the countries with the largest number of parent banks. Indeed, roughly 69% of all the parent banks in the dataset are located in these countries. Expectedly, the largest markets also host most of the national subsidiaries. Foreign subsidiaries (listed by host country) are located predominantly in Germany (12%), Luxemburg (17%) and Poland (10%). Table 2 reports also the distribution of foreign subsidiaries by the country where the parent is located (i.e., by home country). According to the table, France, Germany, Italy and Austria are home countries to relatively many subsidiaries established outside the national borders.

[Table 1 here]

In addition to the information on the ownership structure, we draw data on total assets, debt, profitability and other relevant balance sheet items from the Bankscope database. Corporate income tax (CIT) rates are obtained from ZEW (2017). Importantly, the data allows us to take account of the specificities in the rules for the deductibility of interest, notably limitations in terms of deductible amount[11]. Thus, we can measure incentives to debt financing more precisely than simply resorting to the headline statutory tax rate on corporate income. Table 2 provides descriptive statistics of the main variables employed in the regression.

[Table 2 here]

[9] Bankscope does not record changes to the ownership structure. In practice, the data report the ownership structure observed in the last year, which is then superimposed on the data in the previous years. Thus, the composition of the banking groups in our sample does not change over time.
[10] Among these, 58 have a specialization that is different from commercial, savings or cooperative. Therefore, they will not be considered in the econometric and simulation analyses. Moreover, in the econometric analysis we lose additional observations will due to missing values for the variables of interest in the econometric model.
[11] Limits to deductibility are factored in by applying a correction factor (<1) to the general rate of deduction, normally the statutory tax rate.

3. Econometric results

In this section we present the results from regressing bank debt ratios and risk-weighted asset densities on the tax variables, alongside bank-specific and country-specific controls. We estimate variants of the panel fractional probit model in equation (1) using a pooled quasi-maximum likelihood estimation (QMLE) procedure. In all cases, we report the average marginal effects obtained from the coefficients in the fractional regressions, which can be directly compared to the coefficient estimates from a linear model.

3.1 Debt- to-asset ratios

Table 3 shows our baseline results for the debt-to-asset ratios. In the specification in column (1) the fiscal incentives towards debt are captured only by the local corporate tax rate. This replicates the standard specification used in the literature on the corporate debt bias. The coefficient on the local tax rate is positive, confirming the positive host-country tax effect found in previous studies. In line with expectations, a higher corporate tax rate is associated with higher debt ratios. The average partial effect of 0.3 implies that an increase of 10 percentage points in the corporate tax rate increase the debt ratio of a subsidiary on average by 3 percentage points. The magnitude of the impact is in the same ballpark as in the existing literature (Desai *et al*., 2004; Huizinga *et al*., 2008; Heider and Ljungqvist, 2015), including the recent contributions on the banking sector. In particular, Heckemeyer and de Mooij, (2017) find an average effect of corporate taxes on leverage of 0.23 for international banks. Keen and de Mooij (2014) report a long-run coefficient of 0.24 in a sub-sample that excludes the pre-crisis years.

Further, our findings suggest that parent banks are better capitalised than subsidiaries, although the effect is not estimated with precision in this specification. When it comes to other determinants of the debt ratio, we find that size exerts a positive impact, as expected. Indeed, big banks tend to be more leveraged than small intermediaries. Moreover, banks growing faster in our sample tend to accumulate more debt. Also, profitability is negatively related to leverage, although the effect is not estimated with precision. We also find that the debt ratio depends positively on collateral, presumably because it facilitates external borrowing and reduces the cost of issuing debt. Among the country-specific controls, GDP growth enters the equation with a positive sign, albeit in a non-significant way. By contrast, the coefficient for inflation is negative and statistically significant. The cumulated public aid to the banking sector exerts a positive impact on leverage, in a marginally significant way. We interpret this as a possible moral hazard effect induced by the explicit provision of government guarantees. Finally, we do not find evidence that the introduction of the bank levies has affected the capital structure choices of the banks in our sample. Arguably, this might be due to the fact that we use somewhat a coarse measure for levy exposure – an indicator for the country-year where a bank levy is in place – rather than a more refined variable indicating actual taxation at the bank level (Bellucci *et al*., 2017).

[Table 3 here]

Specification (2) adds the weighted tax term among the explanatory variables. The average tax term reflects incentives for reallocating debt internationally created by differences in the level of corporate taxation across countries. As expected, the estimated partial effect is negative, and statistically significant. Thus, the debt ratios of bank affiliates decrease as the tax rates in locations other than the host country increase, ceteris paribus. This suggests that, in setting their optimal financial structure, banking groups exploit the relative cost advantage of the debt tax shelter across the countries where they have operations. In other words, multinational banks locate their debt where it is comparatively cheaper due to interest deductibility. While sizable, according to our estimates the impact of the international debt shifting remains below that of the traditional debt bias channel. The partial effect implies that an increase of 10 percentage points in the average corporate tax rate in other group locales decreases the debt ratio of a bank affiliate by roughly two percentage points on average. The order of magnitude of the partial effect is consistent with the evidence in Gu *et al*. (2015), who report an estimated linear coefficient of around 0.2 for the average tax rate of the groups, expressed as a difference with respect to that in the host country. The estimated impacts of the other economic and policy controls are quantitatively similar to those in specification (1). However, it is noteworthy that the coefficient for the parent indicator is now strongly significant. The point estimate of -0.04 implies that the debt ratios of parent banks are on average four percentage points lower than those of subsidiaries. In other words, parents are better capitalized than their subsidiaries. This corroborates the view that capital structure choices act as an incentive scheme when contracts are incomplete.

Specification (3) add country fixed effects to the previous model. As discussed above, given our sample period, the country fixed effects might capture unobservable effects that reflect country-specific adjustments in national banking sectors in the crisis and post-crisis period, most notably deleveraging (Feyen and del Mazo, 2013). Moreover, with country fixed effects, identification for the tax level in the host country is obtained only through time variation. The coefficient estimates are quantitatively similar to those without country fixed effects. Finally, for the sake of comparison, column (4) reports the results obtained estimating our capital structure equation, as in specification (2), using a linear model. The order of magnitude of the ordinary least squares parameters is comparable to the average marginal effects from the fractional probit model.

3.1.1 Robustness checks

We perform several robustness tests on our baseline specifications. First, we test if our baseline results are robust to heterogeneity across banks. Compliance with the regulatory capital requirement is an important source of heterogeneity as regards the responsiveness to taxes (Keen and de Mooij, 2016). Banks closer to the regulatory minimum level of capital have relatively less room for increasing their debt level in the presence of high corporate taxes. By contrast, banks with large capital buffers are in principle less constrained to adjust debt following a more generous tax shield. Accordingly, we split our sample in two equally sized sub-samples of banks based on their level of capitalization. Specifically, capital-abundant banks are those above the median level of the country-specific equity to risk-weighted assets. Capital-tight banks are those below the threshold. We run our baseline regressions for the two sub-samples, and report the average marginal effects in columns (1) and (2) of Table 4. The results for capital-abundant banks in column (2) are qualitatively similar to those for the full sample. Column (1) shows that the tax responsiveness of capital-tight banks is indeed smaller than that for the full sample of all banks, for both the debt bias and the debt shifting channels. Thus, while somewhat constrained in their ability to increase debt ratio, taxation is still a significant determinant of the financial decisions of capital-tight banks.

Furthermore, we check the sensitivity of our results to different sample definitions. First, we drop banks that report always negative profits in all sample years. For these banks the interest deduction is less valuable than for profitable banks due to the non-debt tax shield. Moreover, particularly in our sample period, loss-making banks might be close to financial distress, and thus likely to alter their financial policy compared to 'normal times'. The results, reported in column (3), are quantitatively similar to those in our baseline specification. Next, we limit the sample to parent banks and their foreign affiliates. We are left with 1,340 observations, basically half of the initial sample. The results are shown in column (4), and are not significantly different from those obtained for the full sample of banks. Finally, in specification (5), we restrict the analysis to multinational groups, i.e. groups with at least one foreign affiliate. Again, we find robust evidence that both the debt bias and the debt shifting channels drive the financial choices of multinational bank affiliates.

[Table 4 here]

3.2 Risk-weighted asset densities

Next, we estimate the fractional regression model for asset risk, where are dependent variable is the ratio between risk-weighted assets and total assets. The marginal effects are reported in Table 5. As is apparent, the number of observations in our sample decreases considerably, due to missing information on the left-hand side variable. The baseline specification with both tax terms is in column (1). As expected, the local tax rate has a negative impact on risk-weighted asset density. The magnitude implies that a one percent increase in the local tax rate decreases the risk-weighted asset density by roughly one percentage points. The weighted average tax affects the risk-weighted asset density positively, roughly by the same order of magnitude as the local tax rate. Among the other controls that have a significant impact on the risk weight of assets, size has a positive sign. This might reflect moral hazard due to too-big-to-fail implicit guarantees. At the margin, however, the effect of size is decreasing, as suggested by the negative sign on the asset growth variable. Moreover, collateral is negatively associated with asset risk, likely reflecting composition effects with different risk profiles on the asset side of banks' balance sheets. By contrast, profitability, as well as the macroeconomic and policy variables, do not seem to affect risk-weighted assets significantly.

Like for the debt ratio, we test the robustness of the main results across different sample definitions. First, we find that the effects of taxation are qualitatively similar for capital tight banks, whereas capital abundant banks seem to be less sensitive to the tax incentives to shifting asset riskiness. If we restrict the sample to foreign subsidiaries and parent banks, the effects of the local tax rate, while still negative, is not identified with precision. Finally, the results for multinational groups are in line with the baseline specification.

[Table 5 here]

3.3 Interpretation

The fractional model does not constrain the impact of taxation to be constant like a linear regression model does. To evaluate the importance of nonlinearities, and their implications for country-specific results, in Table 6 we report the average marginal effects of the tax variables at the country level. To single out the impact of taxation, the marginal effects are evaluated at the full sample means for all explanatory variables except the two tax terms, for which we use the country-specific averages instead. For reference, we also report the average values of the tax variables and the predicted debt ratios and risk-weighted asset densities.

In the case of the debt ratios, the average country-specific marginal effects for the host country tax level range from 0.22 to 0.43. Those for the weighted tax of the group vary between 0.16 and 0.32 (in absolute value). As is apparent, the marginal effects of the local tax decrease with the level of local taxation, likely reflecting the constraints that banks face in increasing their leverage when debt levels are already high, which is the case in high-tax countries. The impact of the weighted tax increases with the level of this variable. As expected, higher tax rates in the alternative locations where the banking group operates lead to a more pronounced reaction of debt ratios in the local jurisdiction, ceteris paribus.

The marginal effects of taxes on risk-weighted asset densities are larger in magnitude but have a much lower variability than those for the debt ratios. Nonlinearities seem significantly less important for the asset risk variable. Marginal effects of the local tax rate range between 0.8 and 0.9 (in absolute value), while those for the weighted tax term vary between 0.7 and 0.78.

[Table 6 here]

4. The international spillovers of corporate taxes

The econometric analysis highlights the specificities of multinational banks in terms of locations and tax implications of their international operations as a persistent factor that affects their debt choices. Specifically, location of debt within a multinational group is affected by tax considerations, as tax differences among different locales are exploited to minimize the overall cost of debt of the group. The fact that the debt ratio in each affiliate depends not only on the local tax rate but also on the tax rates in the other countries where the bank operates implies that tax reforms in these foreign jurisdictions will have a direct effect on the financial policy of all group affiliates via adjustment on the intensive margin. Otherwise said, tax reforms affect not only the debt level of local banks but also the leverage of banks located in other countries.

We evaluate the implications of hypothetical tax reforms that eliminate the favourable tax treatment of debt over equity by means of simulations. First, starting from our econometric model, we predict the counterfactual debt ratios implied by our estimates in the different reform scenarios. Then, following Langedijk *et al*. (2015), we assess the financial stability implications of the tax reforms using a microsimulation bank portfolio model. The next sections describe more in detail the simulation framework and the working assumptions to build the tax reform scenarios. If multinational banks arbitrage across countries to exploit corporate tax differences, tax reforms generate international spillovers. We highlight that, even in our stylised setup, the degree of coordination in the implementation of tax reforms matters a lot for the aggregate impacts of the reforms.

4.1 The impact of eliminating the tax bias towards debt finance

As a starting point, we consider the counterfactual balance sheet outcomes that would be realized once the debt bias in the corporate income tax is eliminated. If we believe that the econometric model properly captures the determinants of debt ratios and asset risk, we can use its predictions to model adjustments to banks' capital structure choices. Specifically, we assume that banks alter their capital structure and the risk-weight of their asset as a response to the tax reforms without changing the size of their balance sheets. Formally, from model (1) we can directly derive the counterfactual relevant outcome variable for bank i, $\hat{\lambda}_{i,t}$, as:

$$\hat{\lambda}_{i,t} = \lambda_{i,t} + \triangle \hat{\lambda}_{i,t},$$

where $\triangle \hat{\lambda}_{i,t}$ is the predicted change in the debt-to-asset ratio and risk-weighted asset densities, respectively, to be detailed below. Applying the balance sheet identity $TA = Debt + K$, we can retrieve the implied new capital levels which determine the excess losses in the microsimulation exercise, together with asset risk.

The level of the corporate income tax rate determines the value of the deduction for interest payments. Hence, all other things equal, a simple way to model the elimination of debt bias in our framework is setting the corporate tax rate to zero[12]. Furthermore, since we have separately identified the debt bias and the debt shifting effect in the econometric model, we can parse the different implications of these channels on systemic risk. Specifically, we do so by assuming three hypothetical reform scenarios.

Case (a): coordinated reform. In this case we assume that all countries eliminate the favourable tax treatment of debt with respect to equity. Consequently, the predicted change in the outcome variables is:

$$\triangle \hat{\lambda}_i^{(\boldsymbol{a})} = \Phi\left(\boldsymbol{x}^{(a)}\boldsymbol{\beta}\right)|_{tax_i=0,\, average\ tax_i=0} - \Phi(\boldsymbol{x\beta})$$

[12] In our stylised setting, we do not discuss the alternative modalities of establishing tax neutrality between debt and equity. For a critical discussion, see e.g. Fatica *et al.* (2013).

where $\Phi(.)$ is the normal cumulative distribution function, and $\boldsymbol{x}^{(\boldsymbol{a})}$ are the same covariates in the econometric model ($\boldsymbol{x}$), except for the tax variables. The coordinated tax reform assumes that all countries implement the reform simultaneously. Thus, the counterfactual imposes that both the host country tax and the average tax rate of the group in model (1) are driven to zero.

Case (b): uncoordinated reform. In this case we assume that all countries but the host country of bank i implement the reform. Naturally, this will artificially eliminate the channel of international debt shifting, leaving only the domestic debt bias effect of corporate taxes. The predicted change in the outcome variables is:

$$\triangle\, \hat{\lambda}_i^{(\boldsymbol{b})} = \Phi\left(\boldsymbol{x}^{(\boldsymbol{b})}\boldsymbol{\beta}\right)|_{\,average\ tax_i=0} - \Phi(\boldsymbol{x}\boldsymbol{\beta})$$

where the counterfactual probability function is calculated by imposing $average\ tax_i = 0$.

Case (c): unilateral reform. As the mirror image of the previous case, in this scenario we assume that only the host country of bank i implements the reform. As a consequence, while the debt bias is eliminated, international debt shifting towards countries where interest payments are still deductible will be taking place. Likewise, asset riskiness would increase in the host country accordingly. The predicted change in the two outcome variables is thus:

$$\triangle\, \hat{\lambda}_i^{(\boldsymbol{c})} = \Phi\left(\boldsymbol{x}^{(\boldsymbol{c})}\boldsymbol{\beta}\right)|_{\,tax_i=0} - \Phi(\boldsymbol{x}\boldsymbol{\beta})$$

where the counterfactual probability function is calculated by imposing $tax_i = 0$.

4.2 The micro-simulation model

To evaluate the systemic risk implications of tax reforms that eliminate the favourable tax treatment of debt over equity we use a microsimulation model for banking losses, which is referred to as SYMBOL (SYstemic Model of Bank Originated Losses). The model, which fits within the Basel framework for banks' minimum capital requirements, been recently used to quantitatively assess the impacts of regulatory reforms in Europe, including the complete safety-net set up after the crisis, i.e. enhanced Basel III capital rules, the bail-in tool and the resolution funds (De Lisa *et al*., 2012; Benczur *et al*., 2017). In the model framework, financial stability is evaluated in terms of the losses materializing in the event of a severe financial crisis. More specifically, our focus is on excess losses, i.e. those losses that cannot be absorbed due to exhaustion of the ad hoc safety nets, as will be made clear below.

We evaluate the impact of hypothetical reforms, namely the abolition of the interest deductibility under the corporate income tax implemented with different degrees of coordination among countries, by comparing simulated contingent liabilities conditional on a crisis event taking place in two different scenarios: *i*) the baseline, with observed balance sheet data; *ii*) the counterfactual post-reform scenario, where banks' capital structures and asset risk have been adjusted following the hypothetical tax reforms. In this way, we obtain two sets of aggregate excess losses generated in the national banking systems. In the context of our exercise, we refer to any reduction in such losses as the benefits of the tax reforms. By its very nature, our exercise is limited to assessing this particular benefit, while potential effects spilling over to the real economy and macroeconomic variables are not considered here[13].

The SYMBOL model uses publicly available balance sheet data of banks in the EU to estimate the joint distribution of bank losses at EU level, in a way that is fully consistent with the regulatory architecture governing the banking sector, i.e. the Basel risk assessment framework. The loss distribution of an individual bank depends on an estimated (average) implied obligor probability of default (IOPD) in each bank's portfolio. In turn, the IOPD is a function of an adjusted risk-weighted asset density. Thus, as a first step of the model simulations, the average IOPD is obtained via numerical inversion of the Basel formula for credit risk and using balance sheet data on the risk weight of assets and total assets[14]. Then, correlated bank losses are generated via Monte Carlo simulations using the Basel Internal Rating Based (IRB) function (see Basel Committee on Banking Supervision, 2013; Vasicek, 2002; Merton, 1974)[15]. The correlation exists either as a consequence of the banks' exposure to common borrowers or, more generally, to a particular common factor, such as the business cycle. Based on the matrix of correlated losses, failure of a bank is determined by comparing the size of simulated losses and the regulatory capital available to absorb the shocks.

More formally, the output of the model is a matrix of losses, $L_{n,i}$, where *n* denotes a simulation run and *i* indicates the bank. Let us denote the expected loss for bank *i* by EL_i. After provisions, capital is the first source to absorb unexpected losses. In this framework, bank *i* is assumed to be insolvent when simulated unexpected losses $\left(L_{n,i} - EL_i\right)$ exhaust all available capital, K_i, or, otherwise said, when it has positive excess losses (*ExcL*):

[13] Likewise, we do not consider the first-round public finance impacts of eliminating the tax advantage of debt.

[14] For the purpose of the simulation exercise, capital and risk weighted assets have been adjusted by using the correction coefficients provided by the Basel III monitoring exercise (Quantitative Impact Study, QIS) run by the European Banking Authority (EBA, Basel III monitoring exercise, 2015) and (EBA, CRD IV–CRR/Basel III monitoring exercise report, 2015). These adjustments aim to better represent the level and quality of capital and the proper calculation of risk. Hence, they would decrease capital and increase RWA. These correction coefficients change year by year. For 2014 we have used the value reported in Table A1 in the Appendix.

[15] The loss distribution is simulated under a number of assumptions, namely: i) implicitly, the model is based on the implicit assumption that the Basel IRB formula adequately represents (credit) risks that banks are exposed to; ii) all risks are assimilated to credit risk, and no other risk categories (e.g. market, liquidity or counterparty risks) are explicitly considered as potential trigger of a default event; iii) all events happen at the same time, i.e. there is no sequencing and cascading in the simulated events.

$$Failure \equiv ExcL_{n,i} - EL_i - K_i > 0.$$

Furthermore, consistent with the Basel rules on the level of minimum capital under which a bank is considered viable and actual recapitalization interventions by public authorities in the past crisis, recapitalization needs up to 10.5 percent of risk-weighted assets are also considered. Formally, a bank is considered undercapitalized when:

$$K_i - \left(L_{n,i} - EL_i\right) < 0.105 \cdot RWA_i.$$

All in all, the entries in the matrix of excess losses plus recapitalization needs look like:

$$ExcLR_{n,i} = \max\left\{L_{n,i} - EL_i - K_i + 0.105 \cdot RWA_i; 0\right\}.$$

Throughout the rest of the paper, we refer to losses as the losses in excess of capital plus recapitalization needs ($ExcRL_{n,i}$). Figure 1 provides a graphical representation of the distribution of losses for an individual bank. The white area shows the different loss absorption mechanisms at work at the bank level, i.e. provisions, minimum capital requirements (MCR) and a capital buffer (or excess capital, EC) that normally banks keep in excess of the regulatory minimum. Thus, the actual level of capital held by each bank determines the failure event as defined above, which occurs in the light grey area. Expectedly, 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. Operationally, we consider the case of a systemic crisis event, generating losses of the same order of magnitude of the losses incurred by the EU banking system in the period 2008-2012. If data as 2009 are considered this corresponds, roughly, to the 99.95th quantile of the unconditional EU28 aggregate distribution of losses in excess of capital plus recapitalization needs. Thus, a loss distribution with 99.95% Value at Risk (VaR) is adopted throughout in the simulations of the different scenarios[16]. Aggregate losses are obtained by summing losses in excess of capital plus potential recapitalization needs of all distressed banks in the system (i.e. both failed and undercapitalised banks) in each simulation run.

[Figure 2 here]

We perform our quantitative exercise for the whole EU28 banking sector. Running the model for small and large countries together allows one to reduce the potential numerical instability of the simulations. Losses produced in individual countries are then extracted from the whole

[16] To smooth out uncertainty due to different losses realization we use a Hodrick-Prescott (HP) filter and we compute the 99.95th percentile on the smoothed HP trend.

sample simulations. As an additional working hypothesis, we assume that full bail-out prevents the spreading of contagion through the interbank market, so as to rule out contagion effects[17].

5. Results

What are the implications for systemic risk of the different tax reform scenarios? In the next step of our analysis, we answer this question using the microsimulation model for banking losses described in the previous section. Specifically, we run the model for the baseline scenario with observed balance sheet data and for the counterfactual scenarios where banks' balance sheets are adjusted following the elimination of the tax subsidy to debt. We adopt different assumptions with respect to the number of countries implementing the reform, giving rise to three alternative scenarios, detailed in section 4.1. As a first step, to calculate the counterfactual debt ratios and risk-weighted asset densities, we obtain the predicted changes for these variables in the different scenarios. We use 2014 – the last year in our econometric sample – as the reference year for this exercise. Also, we focus on the country-specific results for the six major European banking sector – Germany, France, Spain, Italy, the United Kingdom and the Netherlands. Figure 2 shows the results in terms of national banking sector losses as a percentage of total assets obtained via microsimulation. The dark blue bars depict the losses in the baseline case, which, by construction, represent the outcome in the hypothetical event of a severe banking crisis taking place at the end of 2014. Simulated losses in the baseline scenario when actual balance sheet data are used range from 0.4 percent of total assets in the United Kingdom to 1.3 percent in Germany[18].

In the case of a coordinated elimination of the favourable tax treatment of debt, by assumption all countries would establish neutrality between debt and equity finance. The gains from coordinated tax reforms stem from the combined elimination of the two channels through which taxation affects debt and asset risk. On one hand, the reform in the host country leads local banks to decrease their debt ratios, ceteris paribus. On the other hand, the fact that debt loses its tax advantage in all other locations eliminates the incentives for shifting debt and risk across borders, and indirectly favour the accumulation of debt in the host country, all other things being equal. According to our econometric results, the former effect predominates over the latter, leading to a decrease in debt ratios compared to the baseline in all reforming

[17] In this way, we can focus on the spillovers generated by tax policy, not on those arising from network effects in the banking system.

[18] Excess losses incorporate recapitalization to 10.5 percent of risk-weighted assets (see section 4.2). The relatively high value for Germany might be due to the fact that, by considering only banking groups, we underestimate the riskiness of other banking sectors where standalone banks are more numerous.

countries. However, we expect the risk-weighted asset density to increase. Indeed, since banks are better capitalized after the tax reform, scope is created for them to increase the riskiness of the asset side of their balance sheet, for given capital requirements. The net effect on systemic risk is ultimately an empirical question. In our simulations, a coordinated elimination of the tax subsidy to debt reduces systemic losses with respect to the baseline, as depicted by the light blue bars in Figure 2. Overall, the impact on capital structure predominates over the increased riskiness on the asset side. The net effect is an improvement in financial stability, with a reduction in losses that is substantial particularly in high-tax countries.

[Figure 2 here]

Let us now suppose that the elimination of the debt bias takes place in an uncoordinated fashion. We define this scenario as a situation in which all countries, except the host country, establish tax neutrality between debt and equity finance. In our stylised setup, this is equivalent to eliminating the channel of international debt and risk shifting for each multinational bank affiliate, while local corporate taxes would still favour debt over equity. Thus, as a consequence of the foreign tax reforms, debt ratios of banks in the non-reforming countries increase. At the same time, however, banks in the non-reforming country would decrease the riskiness of their loan portfolios. Accordingly, excess losses increase with respect to the baseline in all countries, with the exception of France where the impact of lower riskiness on the asset side predominates. The light grey bars in Figure 2 give a visual representation of the results.

Finally, we consider the case of unilateral elimination of the tax bias in favour of debt. Specifically, we assume that the reform is implemented only in the host country, while all the other countries still keep a tax advantage for debt. As a mirror image of the previous scenario, taking up debt in the host jurisdiction becomes comparatively less advantageous. However, the channel of international shifting is still at play. Therefore, debt ratios in the reforming country decrease more markedly than in the case of coordinated reforms, since in this case debt can still be profitably reallocated across national borders within the banking group. All in all, the debt ratios in the host country decrease significantly compared to the baseline case, while the opposite occurs for the risk weight of assets. The individual country gain in terms of lower losses is substantial in comparison to the baseline case. In this case, excess losses for the national banking sectors vary from 0.3% to 0.7% of total assets.

From the individual country perspective, a unilateral tax reform is clearly preferable. However, this is not necessarily so at the aggregate level. In Figure 3 we plot the reduction in aggregate losses with respect to the baseline in the different reform scenarios. As is apparent, naturally unilateral tax reforms reduce only marginally the aggregate cost of a bank crisis with respect to the baseline case (dark blue bars). By contrast, uncoordinated and coordinated reforms significantly reduce aggregate systemic losses. However, the benefits of coordinated reforms are larger in all cases considered.

[Figure 3 here]

Next, we investigate whether and how the distribution of losses across countries changes in the different reform scenarios, conditional on the different aggregated values depicted in Figure 3 above. Table 7 reports the share of losses in each of the countries, considered in turn. The contribution of the different countries to aggregate losses when tax reforms are coordinated resembles that of the baseline case. Uncoordinated reforms determine a sizable increase in the contribution of the individual countries to losses. The increase is significantly less marked for France. However, that country still accounts for more than half total post-reform losses. At the other extreme, in general, unilateral reforms decrease significantly the loss share of the individual countries with respect to the baseline. The contribution remains rather stable in the Netherlands and the United Kingdom.

[Table 7 here]

6. Discussion

The results from the microsimulation exercise highlight the benefits of tax reform coordination in terms of financial stability. A few comments are in order with respect to the model simulations, concerning our working assumptions and findings. First, importantly, the counterfactual bank balance sheets used to simulate the losses under different reform scenarios are obtained by applying the marginal effects from the fractional regression model, under the assumption that the banks do not change the size of their balance sheet. Thus, we assuming that the elimination of the favourable treatment of debt would only change the composition of banks' balance sheets. At any rate, accounting for adjustment to asset riskiness allows us to take a cautious stance and avoid over-estimating the reduction in systemic losses. Intuitively, the fact that lower debt ratios trigger at the same time an increase in asset portfolio risk implies a reduction in the actual gains to financial stability, as highlighted in Langedijk *et al*. (2015). In general, we deliberately do not over-emphasize the absolute level of the losses obtained in the different scenarios, but rather focus on the changes in the comparison across scenarios.

Second, our proxy for systemic risk in excess losses, i.e. banking losses that would fall on economic actors external to the banking sector. In other words, depending on the regulatory framework in place, they would be borne by banks' creditors and depositors by taking a loss on their holdings, or eventually translate into contingent liabilities for the government. We remain silent on this specific aspect. In particular, we do not consider the complete safety-net set up in EU legislation to absorb banking losses in addition to enhanced Basel III capital rules, such as the bail-in tool and the resolution funds analysed in Benczur et al. (2017). The rationale behind this choice is indeed to isolate the effects on systemic risk of removing the tax bias towards debt finance. At any rate, our results have clear implications for social welfare.

Third, a word of caution is in order when it comes to our measure for asset risk. As is well-known, risk-weighted assets do not necessarily reflect actual portfolio risk in an adequate way. On one hand, the weights are defined by regulation for broad categories of assets. On the other hand, given their pivotal role in defining minimum capital requirements, risk-weighted assets are prone to manipulation by banks, particularly by the largest intermediaries that make use of internal risk models (Mariathasan and Merrouche, 2014). If this is the case, then the predicted changes in the risk weight of assets would not fully match the change in true portfolio risk following corporate tax reforms. However, in spite of these drawbacks, regulatory risk-weighted assets are still widely used in the banking literature to assess banks' response to financial regulations and policy change (Keen and de Mooij, 2016). Moreover, the measure is fully consistent with our microsimulation model.

Admittedly, our framework is very stylised. A complete characterization of banks' debt dynamics would require a fully-fledged model of bank behaviour, accompanied, on the empirical side, by more detailed data on the structure of multinational banks' financing. In this respect, internal capital markets represent an important element Egger *et al*. (2014). In fact, total debt conflates internal and external borrowing, which are likely to react differently to changes in the after-tax cost of funds (Desai *et al.*, 2004). In particular, Buettner and Wamser (2009), and more recently Reiter (2017), highlight the role of internal capital markets as a channel for profit shifting. Borrowing from affiliates located in low-tax countries and lending to affiliates located in high-tax countries will allow the latter to reduce profits by deducting interest payments, which are then taxed as earnings in the low-tax country. Disentangling whether and to what extent internal debt is used for profit shifting or whether allocation of debt within multinational banks reflects the conventional tax shelter of debt finance will improve our understanding of the existing empirical evidence on the tax-sensitivity of capital structure. However, the data at hand does not allow for an empirical investigation of this type.

7. Conclusions

By granting a rebate to interest payments while taxing the return to equity, corporate income tax systems typically encourage the use of debt rather than equity finance. This incentive grows as the corporate tax rate rises, so high corporate taxes are expected to be associated with greater corporate indebtedness. At the same time, however, bank regulation on minimum capital requirements, as in the Basel framework, create dependency between bank leverage and risk. In this paper we investigate the impact of corporate taxation on capital structure and asset risk choices of banking groups in Europe. Further, applying the framework put forward in Langedijk *et al*. (2015), we evaluate the systemic risk implications of establishing tax neutrality between debt and equity finance. We disentangle two channels through which corporate taxes affect leverage due to the deductibility of interest payments: i) the standard debt bias effect, which encourages the use of debt because of the level of local taxation; ii) the debt shifting effect, which allows multinational groups to minimize the cost of debt by taking advantage of international tax differences. The impact on asset risk is reversed, given the incentive to shift risk between the liability and the asset side of the balance sheet under minimum capital requirements. Using bank balance sheet data from Bankscope, we find evidence of both effects for multinational banks in Europe during the crisis and post-crisis period. We then evaluate the effects of a complete elimination of the favourable tax treatment of debt on financial stability, quantified as the systemic losses in the event of a severe banking crisis. We show that the degree of coordination in implementing the tax reform matters, both at national and at aggregate levels. Indeed, national tax reforms generate spillovers through the cross-border activities of multinational banks. In particular, a coordinated elimination of the tax bias towards debt would result in a significant reduction of aggregate losses. By contrast, unilateral tax reforms, while beneficial for the reforming country, indirectly increase systemic risk in the countries where equity finance is still penalised by the tax system.

Our findings point to a significant gain in terms of financial stability from tax harmonization aimed at creating a level playing field between debt and equity finance. Indirectly, they highlight the benefits of coordinated initiatives such as the Common Consolidated Corporate Tax Base, which introduces an allowance for corporate equity that makes increases in equity deductible from the taxable base.

References

Aghion, P. and Bolton, P. (1989). The Financial Structure of the Firm and the Problem of Control. *European Economic Review*, 33:286-293.

Basel Committee on Banking Supervision, 2010 [rev 2011]. A Global Regulatory Framework for More Resilient Banks and Banking Systems.

Basel Committee on Banking Supervision, 2013. Revised Basel III Leverage Ratio Framework and Disclosure Requirements.

Bellucci, A., Fatica, S., Heyndrickx, W., Kvedaras, V., and Pagano, A. (2017), The Impact of Financial Sector Taxes on Systemic Risk: Bank levies in Europe, mimeo, European Commission – Joint Research Centre.

Benczur, P., Cannas, G., Cariboni, J., Di Girolamo, F., Maccaferri, S., and Petracco Giudici, M. (2017). Evaluating the effectiveness of the new EU bank regulatory framework: A farewell to bail-out? *Journal of Financial Stability*, 33, 207-223.

Bovenberg, L., Cnossen, S. and de Mooij, R. (2003). Introduction: Tax Coordination in the European Union". *International Tax and Public Finance*, 10: 619-624.

Buettner, T. and Wamser, G. (2013). Internal Debt and Multinational Profit Shifting: Empirical Evidence From Firm-Level Panel Data. *National Tax Journal*, 66(1): 63-95.

Cameron, A. C. and Miller, D.L. (2015). A Practitioner's guide to cluster-robust inference. *Journal of Human Resources*, 50(2): 317-372.

Cerutti, E., and Dell'Ariccia, G. (2007). How banks go abroad: Branches or subsidiaries? *Journal of Banking and Finance*, 31, 1669–1692.

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

De Lisa, R., S. Zedda, F. Vallascas, F. Campolongo and M. Marchesi (2011). Modeling deposit insurance scheme losses in a Basel 2 framework, *Journal of Financial Services Research*, 40(3).

De Mooij, R. A. and Hebous, S. (2018). Curbing Corporate Debt Bias: Do Limitations to Interest Deductibility Work? *Journal of Banking and Finance*, forthcoming.

De Mooij, R. A. and Keen, M. (2016). Debt, taxes, and banks. *Journal of Money, Credit and Banking*, 48(1): 5–33.

De Mooij, R., Keen, M. and Orihara, M. (2014). Taxation, bank leverage, and financial crises, in de Mooij, R. and Nicodème, G. (eds.) *Taxation and regulation of the financial sector*, MIT Press.

Desai, M. A., Foley, C. F., & Hines, J. R. (2004). A multinational perspective on capital structure choice and internal capital markets. *Journal of Finance*, 59: 2451–2488.

Devereux, M. P. (2014). Two new bank taxes: Why and what will be the effects?, in de Mooij, R. and Nicodème, G. (eds.) *Taxation and regulation of the financial sector*, MIT Press.

Dischinger, M., Knoll, B., and Riedel, N. (2014). There is no place like home: The profitability gap between headquarters and their foreign subsidiaries. *Journal of Economics & Management Strategy,* 23(2): 369-395.

Egger, P., Keuschnigg, C., Merlo, V. and Wamser, G. (2014). Corporate Taxes, Internal Borrowing, and the Lending Capacity within Multinational Firms. *American Economic Journal: Economic Policy,* 6(2): 54-93.

European Banking Authority (2015). CRD IV–CRR/Basel III monitoring exercise report, London.

European Commission (2015). Tax Reforms in EU Member States: 2015 Report, Taxation paper No 58, European Commission, Brussels.

Fatica, S., Hemmelgarn, T. and Nicodème, G. (2013). The Debt-Equity Tax Bias: Consequences and Solutions. *Reflets et perspectives de la vie économique*, 1, 5-18.

Feyen, E. and del Mazo, I. G. (2013). European Bank Deleveraging and Global Credit Conditions Implications of a Multi-Year Process on Long-Term Finance and Beyond. World Bank Policy Research Working Paper 6388.

Frank, M.Z. & Goyal, V.K. (2007). Capital structure decisions: which factors are reliably important? *Financial Management*, 38, 1–37.

Gropp, R. & Heider, F. (2009). The Determinants of Bank Capital Structure. Review of Finance, 14 (4): 587-622.

Gu, G., de Mooij, R., and Poghosyan, T. (2015). Taxation and leverage in international banking. *International Tax and Public Finance*, 22(2): 177-200.

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

Heckemeyer, J.H. and de Mooij, R. (2013). Taxation and Corporate Debt: Are Banks any Different? IMF Working Paper 13/221.

Heider, F. and Ljungqvist A. (2015). As certain as debt and taxes: Estimating the tax sensitivity of leverage from state tax changes. *Journal of Financial Economics,* 118(3): 684-712.

Hemmelgarn, T. and Teichmann, D. (2014). Tax reforms and the capital structure of banks. *International Tax and Public Finance,* 21(4): 645-693.

Horvath, B. L. (2013). The impact of taxation on bank leverage and asset risk. CentER Discussion Paper, 2013-076

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

Koehn, M., and Santomero, A.M. (1980). Regulation of bank capital and portfolio risk. *Journal of Finance*, 35:1235-1250.

La Leslé, V. and Avramova, S. (2012). Revisiting risk-weighted assets - Why Do RWAs Differ Across Countries and What Can Be Done About It? IMF Working Papers 12/90, International Monetary Fund.

Langedijk, S. N., Nicodème, G., Pagano A. and Rossi A. (2015). Debt Bias in Corporate Income Taxation and the Costs of Banking Crises. CEPR Discussion Paper, 10616.

MacKie-Mason, J. (1990). Do taxes affect corporate financing decisions? *Journal of Finance,* 45(5): 1471–1493.

Mariathasan, M. and Merrouche, O., (2014). The Manipulation of Basel Risk-Weights. *Journal of Financial Intermediation*, 23(3): 300-321.

Merton, R. (1974). On the pricing of corporate debt: the risk structure of interest rates. *Journal of Finance*, 29: 449-470.

Merz, J., and Overesch, M. (2016). Profit shifting and tax response of multinational banks. *Journal of Banking and Finance*, 68: 57-68.

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.

Papke, L.E. and Wooldridge, J.M. (2008). Panel data methods for fractional response variables with an application to test pass rates. *Journal of Econometrics*, 145: 121-133.

Petersen, M. (2009). Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches. *The Review of Financial Studies,* 22(1): 435–480.

Rajan, R.G., and Zingales, L. (1995). What do we know about capital structure? Some evidence from international data. *Journal of Finance,* 50: 1421–1460.

Reiter, F. (2017). Avoiding Taxes: Banks' Use of Internal Debt, mimeo, University of Munich.

Roe, M.J. and Tröge, M. (2017). Containing Systemic Risk by Taxing Banks Properly, ECGI Working Paper Series in Law, Working Paper N° 317/2016

Schepens, G. (2016). Taxes and bank capital structure. *Journal of Financial Economics,* 120(3): 585-600.

Titman, S. and R. Wessels (1988). The determinants of capital structure choice. *Journal of Finance* 43(1), 1–19.

Vasicek, O.A., 2002. Loan portfolio value. *Risk*.

ZEW (2017). Effective tax rates in an enlarged European Union. Final Report 2016 - Project for the EU Commission TAXUD/2013/CC/120.

Annex 1

Table A1: QIS adjustment factors for 2014 used in the SYMBOL model

	RWA				Capital			
2014	**G-SIIs**	**G1**	**Medium G2**	**Small G2**	**G-SIIs**	**G1**	**Medium G2**	**Small G2**
	1	1.007	1.006	1	0.87	0.9	0.93	0.92

Tables and figures

Table 1: Distribution of banks by ownership status and country

Country	Parent banks	National subsidiaries	Foreign subsidiaries by home country	Foreign subsidiaries by host country
AT	10	29	25	7
BE	4	7	17	5
BG	0	1	0	7
CY	1	0	1	2
CZ	1	0	1	11
DE	17	42	25	26
DK	4	7	4	3
EE	0	0	0	2
ES	10	19	15	8
FI	0	4	0	2
FR	10	97	48	6
GB	7	32	9	13
GR	4	1	10	0
HR	0	0	0	1
HU	2	4	3	7
IE	1	5	3	6
IT	19	45	26	7
LT	0	0	0	3
LU	0	2	1	38
LV	1	0	1	2
MT	0	1	0	4
NL	5	7	13	4
PL	1	1	1	23
PT	4	5	3	7
RO	0	0	0	11
SE	4	8	13	1
SI	1	1	1	6
SK	0	0	0	8
Total	*106*	*318*	*220*	*220*

Table 2: Sample descriptive statistics

	Obs.	*mean*	*st. dev.*	*25th percentile*	*median*	*75th percentile*
Debt-to-assets ratio	2,573	0.905	0.110	0.896	0.925	0.948
RWA-density	1,553	0.514	0.208	0.378	0.529	0.665
Host country tax	2,573	0.270	0.062	0.240	0.265	0.340
Average tax (asset-weighted)	2,573	0.224	0.106	0.213	0.259	0.337
Parent dummy	2,573	0.157	0.364	0.170	0.207	0.259
Assets (logs)	2,573	9.370	3.093	8.132	9.899	11.301
Profitability	2,573	0.004	0.032	0.001	0.005	0.010
Asset growth	2,573	0.060	0.345	-0.041	0.020	0.089
Collateral	2,573	0.206	0.179	0.049	0.136	0.285
GDP growth	2,573	0.002	0.028	-0.008	0.007	0.020
Inflation	2,573	0.017	0.012	0.009	0.015	0.025
State aid to banking sector	2,573	0.001	0.002	0.000	0.001	0.002
Exposure to bank levy	2,573	0.423	0.494	0.000	0.000	1.000

Table 3. Determinants of bank debt ratios

	Local tax	Baseline	Country fixed effects	OLS
	(1)	(2)	(3)	(4)
Host country tax	0.310***	0.292***	0.344***	0.304***
	(0.065)	(0.066)	(0.120)	(0.084)
Weighted average tax		-0.219***	-0.194***	-0.181**
		(0.062)	(0.061)	(0.081)
Parent dummy	-0.010	-0.043***	-0.042***	-0.038***
	(0.008)	(0.010)	(0.010)	(0.012)
Size	0.007***	0.005***	0.006***	0.007**
	(0.002)	(0.002)	(0.002)	(0.003)
Asset growth	0.023**	0.024***	0.025***	0.024**
	(0.009)	(0.009)	(0.009)	(0.009)
Profitability	0.035	0.040	0.041	0.091
	(0.128)	(0.128)	(0.114)	(0.272)
Collateral	0.035	0.031	0.027	0.032
	(0.032)	(0.032)	(0.027)	(0.040)
GDP growth	-0.054	-0.045	-0.033	0.011
	(0.133)	(0.130)	(0.067)	(0.173)
Inflation	-0.414*	-0.378*	-0.281*	-0.350
	(0.222)	(0.218)	(0.144)	(0.273)
State aid to banking sector	2.024*	1.848*	1.998**	1.816
	(1.063)	(1.302)	(0.941)	(1.168)
Exposure to bank levy	0.010	0.009	0.002	0.010
	(0.008)	(0.008)	(0.004)	(0.010)
Year dummies	x	x	x	x
Group dummies	x	x	x	x
Country dummies			x	

Notes: columns (1)-(3) report the average marginal effects from a probit fractional response model for bank debt ratios estimated by pooled quasi-maximum likelihood. Column (4) reports the coefficient estimate from a linear regression model estimated with OLS. The number of observations is 2,573 (Number of banks: 515; number of groups: 133). Heteroscedasticity-robust standard errors, clustered at the bank affiliate level, are reported in parentheses. In the specifications (1)-(3) standard errors are obtained with the delta method. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Determinants of bank debt ratios – robustness checks

	Capital-tight	Capital-abundant	Always profitable	Only foreign subsidiaries & parents	Only multinational groups
	(1)	(2)	(3)	(4)	(5)
Host country tax	0.222***	0.308***	0.275***	0.252***	0.286***
	(0.030)	(0.116)	(0.066)	(0.055)	(0.068)
Weighted average tax	-0.092***	-0.292*	-0.239***	-0.198**	-0.179***
	(0.024)	(0.157)	(0.062)	(0.095)	(0.068)
Parent dummy	-0.012**	-0.036	-0.042***	-0.027	-0.025*
	(0.005)	(0.029)	(0.010)	(0.020)	(0.013)
Size	0.002***	0.009***	0.006***	0.004***	0.005**
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)
Asset growth	0.010***	0.026**	0.024**	0.011*	0.028**
	(0.003)	(0.012)	(0.009)	(0.006)	(0.012)
Profitability	-0.167***	0.174*	0.015	-0.301***	0.081
	(0.060)	(0.103)	(0.143)	(0.100)	(0.124)
Collateral	0.032***	-0.033	0.030	0.027	0.020
	(0.011)	(0.048)	(0.033)	(0.026)	(0.036)
GDP growth	-0.091*	0.396	-0.039	-0.019	-0.057
	(0.048)	(0.246)	(0.133)	(0.077)	(0.138)
Inflation	-0.136	0.092	-0.291	-0.052	-0.341
	(0.112)	(0.332)	(0.220)	(0.243)	(0.239)
State aid to banking sector	0.324	3.876	1.869*	1.717	1.526
	(0.594)	(2.466)	(1.807)	(1.104)	(1.105)
Exposure to bank levy	-0.003	0.019	0.008	0.006	0.011
	(0.003)	(0.012)	(0.008)	(0.007)	(0.009)
Year dummies	x	x	x	x	x
Banking group dummies	x	x	x	x	x
Observations	1,286	1,287	2,470	1,340	2,035
Number of banks	346	350	489	277	397
Number of banking groups	115	108	129	113	67

Notes: the table reports the average marginal effects from a probit fractional response model for bank debt ratios estimated by pooled quasi-maximum likelihood. Heteroscedasticity-robust standard errors, clustered at the bank affiliate level and obtained with the delta method, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Determinants of RWA densities

	Baseline	Capital-tight banks	Capital-abundant banks	Only foreign subsidiaries & parents	Only multinational groups
	(1)	(2)	(3)	(4)	(5)
Host country tax	-0.901***	-0.777***	-0.919***	-0.480	-0.812***
	(0.239)	(0.253)	(0.330)	(0.305)	(0.251)
Weighted average tax	0.776***	1.080***	0.442*	0.928***	1.045***
	(0.175)	(0.182)	(0.265)	(0.268)	(0.221)
Parent dummy	0.038	0.154***	-0.056	0.006	0.025
	(0.031)	(0.033)	(0.050)	(0.055)	(0.044)
Size	0.015***	0.001	0.014**	0.010	0.016***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Asset growth	-0.060***	-0.046***	-0.070**	-0.061***	-0.086***
	(0.018)	(0.015)	(0.027)	(0.021)	(0.024)
Profitability	0.084	0.526	-0.082	0.236	0.103
	(0.228)	(0.564)	(0.182)	(0.298)	(0.242)
Collateral	-0.195**	-0.225***	-0.154	-0.313***	-0.178*
	(0.082)	(0.068)	(0.141)	(0.076)	(0.095)
GDP growth	0.215	-0.037	0.912	-0.154	0.160
	(0.310)	(0.303)	(0.596)	(0.308)	(0.334)
Inflation	0.338	0.641	0.497	0.758	0.274
	(0.682)	(0.743)	(0.932)	(0.661)	(0.750)
State aid to banking sector	4.739	3.353	3.733	8.574**	6.556
	(3.159)	(5.242)	(3.336)	(3.523)	(3.381)
Exposure to bank levy	0.007	-0.001	-0.011	0.007	0.013
	(0.019)	(0.022)	(0.028)	(0.018)	(0.021)
Year dummies	x	x	x	x	x
Banking group dummies	x	x	x	x	x
Observations	1,553	855	698	939	1,129

Notes: the table reports the average marginal effects from a probit fractional response model for bank RWA densities estimated by pooled quasi-maximum likelihood. Heteroscedasticity-robust standard errors, clustered at the bank affiliate level and obtained with the delta method, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Taxes and marginal effects by country

Country	Host country tax	Weighted tax	Debt-to-asset ratio			RWA density		
			Average predicted value	M.E. of host country tax	M.E. of weighted tax	Average predicted value	M.E. of host country tax	M.E. of weighted tax
AT	0.250	0.175	0.910	0.280	-0.210	0.506	-0.899	0.775
BE	0.340	0.185	0.931	0.227	-0.170	0.433	-0.886	0.764
BG	0.100	0.240	0.840	0.425	-0.318	0.684	-0.801	0.690
CY	0.107	0.168	0.865	0.379	-0.284	0.627	-0.853	0.735
CZ	0.192	0.241	0.876	0.356	-0.267	0.608	-0.866	0.746
DE	0.265	0.189	0.911	0.277	-0.207	0.503	-0.899	0.775
DK	0.249	0.139	0.917	0.263	-0.197	0.479	-0.898	0.774
EE	0.210	0.236	0.883	0.340	-0.255	0.588	-0.877	0.756
ES	0.223	0.182	0.900	0.302	-0.226	0.535	-0.896	0.772
FI	0.243	0.140	0.915	0.267	-0.200	0.485	-0.898	0.774
FR	0.356	0.318	0.909	0.281	-0.210	0.521	-0.898	0.774
GB	0.248	0.164	0.912	0.276	-0.207	0.499	-0.899	0.775
GR	0.265	0.061	0.935	0.217	-0.162	0.405	-0.873	0.752
HU	0.189	0.219	0.880	0.346	-0.259	0.594	-0.874	0.753
IE	0.125	0.174	0.870	0.368	-0.276	0.616	-0.861	0.742
IT	0.276	0.206	0.911	0.278	-0.208	0.506	-0.899	0.775
LT	0.156	0.209	0.871	0.365	-0.273	0.615	-0.861	0.742
LU	0.289	0.261	0.902	0.297	-0.223	0.537	-0.895	0.772
LV	0.150	0.197	0.872	0.363	-0.272	0.611	-0.864	0.745
MT	0.350	0.259	0.920	0.256	-0.192	0.481	-0.898	0.774
NL	0.252	0.148	0.916	0.265	-0.199	0.483	-0.898	0.774
PL	0.190	0.276	0.865	0.377	-0.282	0.635	-0.847	0.730
PT	0.300	0.203	0.918	0.261	-0.195	0.482	-0.898	0.774
RO	0.160	0.230	0.867	0.374	-0.280	0.627	-0.853	0.735
SE	0.249	0.157	0.913	0.272	-0.204	0.493	-0.899	0.775
SI	0.188	0.211	0.882	0.342	-0.257	0.588	-0.877	0.756
SK	0.208	0.239	0.882	0.343	-0.257	0.592	-0.875	0.754

Notes: average values by country. The predicted debt-to-asset ratios and the associated marginal effects are obtained from model (2) in Table 3 (2,573 observations). The predicted RWA densities and the associated marginal effects are obtained from model (1) in Table 5 (1,553 observations). They are evaluated at the country-specific means of the tax variables and overall sample means of the other explanatory variables.

Table 7. Share of aggregate losses (in %)

		Elimination of favorable tax treatment of debt		
	Baseline	*coordinated*	*uncoordinated*	*unilateral*
DE	22.95	19.79	35.97	10.19
ES	6.91	3.37	14.64	1.26
FR	41.62	43.22	51.81	21.61
IT	6.15	4.17	12.24	0.87
NL	9.78	13.92	17.82	7.50
GB	12.58	15.53	24.63	8.11

Note: the table reports the shares of aggregate losses realized in the different countries under the different reform scenarios.

Figure 1 Individual bank loss probability distribution

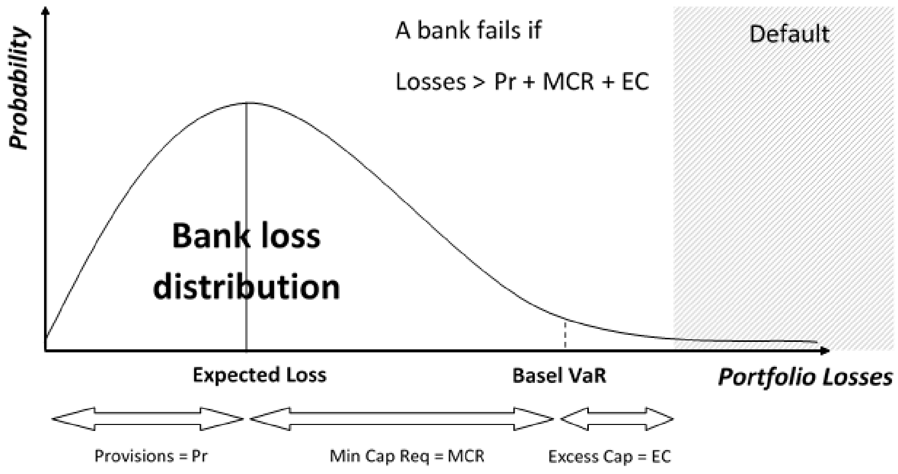

Figure 2. Losses in the national banking systems (as % of tot assets) for different reform scenarios

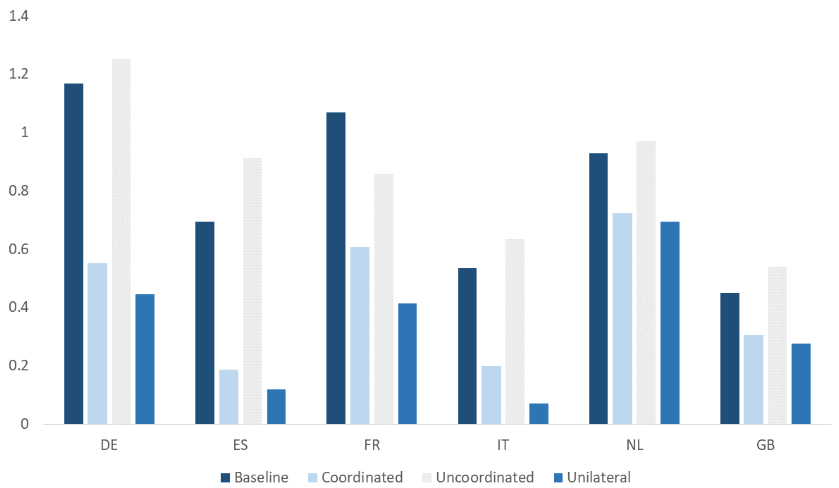

Figure 3. Reduction in aggregate losses (as % of tot assets) with respect to baseline for different reform scenarios