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Taxation, Bank Leverage, and Financial Crises

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Abstract

That most corporate tax systems favor debt over equity finance is now widely recognized as, potentially, amplifying risks to financial stability. This paper makes a first attempt to explore, empirically, the link between this tax bias and the probability of financial crisis. It finds that greater tax bias is associated with significantly higher aggregate bank leverage, and that this in turn is associated with a significantly greater chance of crisis. The implication is that tax bias makes crises much more likely, and, conversely, that the welfare gains from policies to alleviate it can be substantial—far greater than previous studies, which have ignored financial stability considerations, suggest.

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I. INTRODUCTION

The onset of the financial crisis of 2008 quickly prompted many assessments of the role that taxation might have played.¹ Their consensus was clear, but vague: tax distortions did not trigger the crisis, but may have increased vulnerability to financial crises. Prominent among the reasons given for this was ‘debt bias’: the tendency toward excess leverage induced, in almost all countries, by the deductibility against corporate taxation of interest payments but not of the return to equity.² By encouraging firms to finance themselves by debt rather than equity, this might have made them more vulnerable to shocks and so increased both the likelihood and intensity of financial crises. The point applies in principle to all firms, but is a particular concern in relation to financial institutions; and these are the focus here.

This potential link from tax design to financial crises is now widely recognized. But analysis has not progressed beyond metaphor and speculation. Shackelford, Shaviro, and Slemrod (2010, p. 784), for instance, stress “the possibility that the tax biases served...as extra gasoline intensifying the explosion once other causes lit the match”, and the European Commission that “The welfare costs related to debt bias might not be negligible [because] excessive debt levels increase the probability of default” (European Commission, 2011; p. 7), with both the ‘might’ and the ‘not negligible’ leaving much doubt and imprecision.

This paper aims to provide a first attempt to establish and quantify an empirical link between the tax incentives that encourage financial institutions (more precisely, banks, the group for which we have data) to finance themselves by debt rather than equity and the likelihood of financial crises erupting; and then to try to quantify the welfare gains that policies to address this bias might consequently yield.

The approach is to combine two elements in a causal chain. The first is that between the statutory corporate tax rate and banks’ leverage. This has received substantial attention in relation to nonfinancial firms,³ but very little in relation to the financial sector. Keen and De Mooij (2011), however, show that for banks too a higher corporate tax rate, amplifying the tax advantage of debt over equity finance, should in principle lead to higher levels of leverage; the presence of capital regulations does not affect the usual tax bias applying, so long as it is privately optimal for banks to hold some buffer over regulatory requirements (as they generally do). Empirically too, Keen and de Mooij (2012) find that, for a large cross-country panel of banks, tax effects on leverage are significant—and, on average, about as

¹ Including IMF (2009a); Lloyd (2009); Slemrod (2009); Shackelford, Shaviro and Slemrod (2010); and Hemmelgarn and Nicodeme (2010). See also the contributions in Arachi and Alworth (2012).

² De Mooij (2012) provides an overview of debt bias and possible policy responses to it.

³ See for instance the meta-analyses of De Mooij (2011) and Feld, Heckemeyer, and Overesch (2011).

large as for nonfinancial institutions. These effects are very much smaller, they also find, for the largest banks, which generally account for the vast bulk of all bank assets. One task in this paper is to explore these findings further, using data now available to extend coverage into the crisis period that began in 2008—enabling a comparison of tax impacts pre- and post-onset—and applying the same estimation strategy to country-level data for the OECD.

Importantly, the finding that tax distortions to leverage are small for the larger banks, which are massively larger than the rest, does not mean that the welfare impact of tax distortions is in aggregate negligible: even small changes in the leverage of very large banks could have a large impact on the likelihood of their distress or failure, and hence on the likelihood of financial crisis.

This is where the second link in the causal chain explored here comes in: that between the aggregate leverage of the financial sector and the probability of financial crisis.⁴ We estimate such a relationship for OECD countries, applying the estimation strategy of Barrell et al. (2010) and Kato, Kobayashi, and Saita (2010) but, in contrast to these earlier studies, capturing data on the recent financial crisis from Laeven and Valencia (2010). The results suggest sizeable and highly nonlinear effects of aggregate bank leverage on the probability of financial crisis.

Combining the results from these two estimating equations enables simple calculations of the impact of a variety of tax reforms on the likelihood of financial crisis. Linking this, in turn, with estimates of the output loss that is historically associated with such crises gives some rough sense of the potential welfare gains from policies that mitigate debt bias in the financial sector. Putting aside the overarching debate as to the proper roles of taxation and regulation in addressing the potential for excess leverage in the financial sector,⁵ we consider three tax reforms that would reduce the tax incentive to debt finance: a cut in the corporate tax rate; adoption of an Allowance for Corporate Equity form of corporate tax (which would in principle eliminate debt bias); and a ‘bank levy’ of broadly the kind that a dozen or so countries have introduced since the crisis.⁶

All this gives a very different perspective on the nature and possible magnitude of the welfare costs associated with debt bias. Previous work, which has not reflected considerations of financial stability, has concluded that these are small: Gordon (2010)

⁴ There is evidence too that higher levels of leverage amplify output losses when crises occur, but this aspect is not explored here.

⁵ See for instance Keen (2011a, b); Devereux (2013); and Coulter, Mayer, and Vickers (2013).

⁶ Estimates of the kind reported here could in principle also be used to inform the calibration of corrective taxes on bank liabilities along the line analyzed by Acharya et al. (2010) and Keen (2011b).

estimates the total efficiency loss from debt bias in the U.S. to be less than 1 percent of corporate income tax (CIT) revenue and concludes that: “tax distortions from corporate financial policy are not an important consideration when setting tax policy”; Weichenrieder and Klautke (2008) put the marginal welfare loss from debt bias somewhat higher, but still only at 0.06–0.16 percent of the capital stock. The question here is whether considerations of financial stability imply much higher welfare losses—and the conclusion will be that it seems they do.

The next section of the paper sets out our methodology and data (more details on the latter being in Appendix 1). Section III presents estimation results and Section IV reports simulations of the impact of the three reforms on the likelihood of a crisis and expected output. Section V concludes.

II. METHODOLOGY AND DATA

This section sets out the steps of the methodology sketched above: estimating the impact of the CIT rate on banks’ leverage (subsection A); estimating the effect of bank leverage ratios on the probability of a systemic banking crisis (subsection B); and combining the two to explore the relationship between taxation and the likelihood of crisis (subsection C).

A. The Effect of Taxation on Leverage

The effect of the CIT rate on banks’ leverage is estimated using both individual bank balance sheet data and aggregate country-level data for the banking sector as a whole.

Bank-level data

These data are taken from Bankscope and include 82 countries for the period 2001 to 2011. They are similar to those used by Keen and De Mooij (2012), but here we use a slightly longer time series, which allows a distinction between pre- and post-crisis periods. Details and summary statistics are in Appendix 1.

Following Keen and De Mooij (2012), the microdata are used to estimate dynamic panel regressions of the form:⁷

$$lev_{it} = \alpha + \beta_0 lev_{it-1} + \beta_1 tax_{it} + \beta_2' X_{it} + \alpha_i + u_t + \epsilon_{it} \quad (1)$$

⁷ The dynamic equation is estimated using the system GMM estimator of Arellano and Bover (1995) and Blundell and Bond (1998) to address both inconsistencies arising from correlation of the lagged dependent variable with the fixed effects and the weak instrument problem due persistence of taxes. The between-estimator uses OLS.

where i identifies an individual bank, t the year, lev_{it} is the bank's leverage ratio for bank i in year t , tax_{it} is the statutory corporate income tax (CIT) rate bank i faces in year t , \mathbf{X}_{it} is a vector of controls (including total bank assets and its square, bank profitability measured by the return on assets (ROA), GDP growth, the inflation rate, and aggregate savings), and α_i and u_t are, respectively, bank- and time-fixed effects.⁸ The lagged dependent variable allows for sluggish response. Attention focuses on the parameter β_1 , which measures the contemporaneous response of bank leverage to the tax rate (the expectation being that $\beta_1 > 0$, as a higher tax rate increases the value of interest deductibility) and on $\beta_1/(1 - \beta_0)$, which captures the long-term run tax effect. Putting aside sluggish adjustment and focusing on the long-term relationship between taxes and leverage, results are also reported for the between-estimator:

$$\overline{lev}_i = \alpha + \gamma_1 \overline{tax}_{it} + \gamma_2' \overline{\mathbf{X}}_i + \epsilon_i \quad (2)$$

where now γ_1 reflects the long-run tax effect of the CIT rate on banks' leverage, and the bar indicates a mean over time. As discussed below, some allowance is made for heterogeneity by running (1) and (2) separately for distinct subsets of banks.

Since the available evidence, and that developed below, links the likelihood of financial crisis to measures of overall leverage in the financial sector, some way is needed to aggregate the tax effects on individual banks' leverage into effects on aggregate leverage. This requires identifying any significant sources of heterogeneity in individual banks' responses. Keen and De Mooij (2012) explore various forms of heterogeneity by estimating a second-order polynomial with interactions of bank characteristics and the tax effect on leverage. Their results suggest that responses differ only, but substantially, with bank size: large banks (which also tend to be more highly leveraged) are less responsive to tax than small banks. This is important at the macro level, because large banks generally account for a very large share of total banking assets in a country. That large banks are less tax-responsive than small may reflect a 'too-big-to-fail' status that lowers their cost of debt finance, inducing them to become more highly leveraged and leaving less scope for tax effects. To allow for differences in effects by bank size, we split the sample of bank-years into five groups, according to asset size, as reported in Table 1. Group 1, for instance, contains the 85 percent of bank-year observations with the lowest levels of assets (responses within finer partitions of this group giving very similar results), which account for only 13.4 percent of total assets. The largest 2.5 percent, in contrast, account for nearly two-thirds.

⁸ The regressions do not explicitly control for regulatory variables, but these are likely to be largely captured by the bank fixed effects. Keen and De Mooij (2012) include capital requirements in their regression and find that, although they matter, they do not negate the impact of taxes on leverage.

Table 1. Partition of Banks by Size

Group	1	2	3	4	5
Percentile (in asset)	0-85%	85-90%	90-95%	95 – 97.5%	97.5-100%
Asset share ¹	13.4%	4.6%	8.6%	8.7%	64.7%

¹ The aggregate of assets of banks in the respective group, divided by aggregate assets of all banks.

Effects of taxation on aggregate bank leverage are thus estimated by running separate regressions (1) or (2) for each of the size categories in Table 1, and then using asset shares to calculate a weighted average effect, which approximates that on aggregate bank leverage.

Country-level data

The aggregated financial data come from *OECD Banking Statistics*, covering 29 countries over 2001–09. Other macro level control variables (used also in the bank-level regressions above), such as GDP growth, the inflation rate and aggregate savings, are taken from the IMF *World Economic Outlook*. Details and summary statistics are again in Appendix 1.

The estimating equations are as in (1) and (2), but with i now identifying countries rather than banks. The controls include the same macro variables as in the micro specifications, along with the average return on assets held by banks.⁹

B. The Effect of Leverage on the Probability of Banking Crisis

Our approach to estimating the impact of bank leverage ratios on the probability of a banking crisis follows Barrell et al. (2010) and Kato, Kobayashi, and Saita (2010),¹⁰ but differs in using not the data on banking crisis constructed by Laeven and Valencia (2008) but the updated data of Laeven and Valencia (2010), which includes information up to 2009 and so encompasses the start of the current crisis.¹¹ These data identify “systemic banking crises,” defined as an event in which there are both (i) significant signs of financial distress (bank

⁹ Aggregating the micro-level specification would imply that the product of banks’ aggregate assets and a Herfindahl index of their concentration should also be included. In the absence of data, however, these are not captured by the macro regressions.

¹⁰ Some studies have used alternative indicators to explore similar relationships. For instance, Ratnovski and Huang (2009) explore the effect of capital ratios on stock price declines of large banks; IMF (2009b) analyzes the impact of alternative indicators of bank capital ratios on the likelihood of governmental intervention. Neither study finds robust significant effects.

¹¹ Laeven and Valencia (2012) provide a further update of their database, with information up to 2011. There are no countries, however, for which a crisis began in 2010 or 2011, and the banking data from the OECD that we use are in any event only available up to 2009.

runs, bank losses, bank liquidation); and (ii) significant policy interventions in banking (liquidity support, bank restructuring, nationalizations, guarantees, asset purchases, deposit freeze, bank holiday). Overall, they report eight OECD countries (and events) that meet the condition for a financial crisis. Laeven and Valencia (2010) also define events of “borderline systemic banking crisis,” which occur when (i) and (ii) are judged to be almost met: this wider definition adds an additional seven events.¹² In the empirics, we assume that the banking crises last for two years.¹³

These data on the occurrence of crises are combined with aggregated balance sheet data for banks provided in *OECD Banking Statistics*. The resulting sample covers 29 countries from 2000 to 2009. Details are in Appendix 1.

As in Barrell et al. (2010) and Kato, Kobayashi, and Saita (2010), we estimate the logit model:

$$\log [C_{it}/(1 - C_{it})] = \alpha + \delta_1 lev_{i,t} + \delta_2' \mathbf{Z}_{i,t} + u_{it} \quad (3)$$

where $C_{it} = 1$ if there is a systemic banking crisis (results being reported separately with and without borderline cases) and $C_{it} = 0$ otherwise. The main parameter of interest is δ_1 , giving the impact on the odds of a crisis of a marginal increase in aggregate leverage; the expectation is that $\delta_1 > 0$. Drawing on previous results, the vector of controls \mathbf{Z} includes the current account balance (in percent of nominal GDP) and two measures of bank liquidity (in percent of total assets): one includes variables on the asset side (such as cash, balances with the central bank and securities); the other includes variables on the liability side (such as customer deposits). Equation (3) is estimated both by OLS and, to allow for possible correlation between lev and the error u , using as instruments the controls in the macro-level version of equation (1); that is, using in (3) not actual leverage but its predicted value from the leverage equation.

The two sets of regressions—for tax effects on leverage and leverage effects on crisis—are estimated separately: there is no apparent loss of efficiency in doing so since, estimating them as a system, the null of no contemporaneous correlation between the ϵ_{it} and the u_{it} cannot be rejected.

¹² The crisis events refer to the United States in 2007 and Austria, Belgium, Denmark, Germany, Ireland, Luxembourg, and the Netherlands in 2008. The borderline cases refer to France, Greece, Hungary, Portugal, Slovenia, Spain, and Sweden in 2008. Other crisis events identified in Laeven and Valencia (2010), including for instance the United Kingdom are not part of our dataset.

¹³ Second crisis year observations are therefore not independent and are eliminated from the sample in doing regressions.

C. Simulating Tax Effects on the Probability of Crisis

The ultimate objective of the exercise is to simulate the impact of tax changes on the probability of a crisis. For this, we shall simply combine various point estimates from the two sets of regressions just described. An alternative approach would be to simply substitute from the country-level version of (1) into (3) and so include the CIT rate directly as a regressor in modeling the probability of crisis. Doing so, the tax rate proves insignificant. This approach is problematic, however, for two reasons. First, the corporate tax rate might affect the probability of a crisis other than through an impact on bank leverage; one result reported below has the CIT rate appearing with a negative coefficient (which would tend to offset the positive effect expected through the leverage route), though the effect is not significant. The second difficulty is that the reduced form approach requires the additional identifying assumption, beyond those needed for the separate regressions, that $E[\mathbf{Z}\epsilon] = 0$, so that the controls in the crisis regression are independent of the shock in the leverage equation. But it is not hard to think of reasons why this might fail: a shock to asset prices, for instance, might affect not only banks' leverage but also their liquidity.

III. RESULTS

This section presents estimation results on the impact of the CIT rate on leverage (subsection A) and the effect of leverage on the probability of a banking crisis (subsection B).

A. The Effect of Taxation on Leverage

Bank-level data

The results of estimating (1) and (2) using bank-level data are presented in Table 2. Columns (1) and (2) use the dynamic specification of equation (1); columns (3)–(8) use the between-estimator of equation (2). In column (1), “tax (short-term)” refers to β_1 and “tax (long-term)” refers to $\beta_1/(1 - \beta_0)$. Since about two-thirds of the observations are for U.S. banks, which may differ from others in ways not fully captured by fixed effects (for example in the extent of off-balance sheet activities), results are reported, in even-numbered columns, when these are excluded. The sample is further divided to explore the potential difference between the pre- and post-crisis periods: columns (1) – (4) use all years available, columns (5) and (6) use only years 2001–07, and columns (7) and (8) use only 2008–11.

Table 2. Effect of Tax on Leverage: Bank-level Data¹

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Leverage	0.67***	0.74***						
	(0.08)	(0.13)						
tax (short-term)	0.08***	0.21						
	(0.03)	(0.03)						
tax (long-term)	0.25***	0.21***	0.31***	0.17***	0.17***	0.18***	0.30***	0.14***
	(0.05)	(0.05)	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)
log of asset	0.05**	0.05*	0.17***	0.16***	0.18***	0.14***	0.14***	0.17***
	(0.03)	(0.03)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
squared log of asset	-0.00**	-0.00*	-0.01***	-0.01***	-0.01***	-0.00***	-0.00***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ROA	-0.24***	-0.26***	-0.29***	-0.12***	-0.17***	-0.20***	-0.47***	-0.31***
	(0.03)	(0.09)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.05)
GDP growth	0.09**	0.01	0.06	-0.53***	0.57***	-0.09	-0.51***	-0.81***
	(0.03)	(0.05)	(0.07)	(0.09)	(0.09)	(0.11)	(0.06)	(0.08)
inflation	-0.14***	-0.09	-0.63***	-0.47***	-0.90***	-0.50***	-0.51***	-0.36***
	(0.04)	(0.07)	(0.04)	(0.05)	(0.05)	(0.06)	(0.04)	(0.05)
saving rate	0.00	0.03	0.10***	0.27***	0.06***	0.27***	0.17***	0.24***
	(0.01)	(0.04)	(0.02)	(0.03)	(0.02)	(0.04)	(0.02)	(0.03)
R2			0.28	0.36	0.24	0.33	0.30	0.39
Observations	106,649	33,933	120,481	39,712	74,852	23,956	45,629	15,756
Arellano-Bond AR1	0.00	0.00						
Arellano-Bond AR2	0.04	0.21						
Hansen P-value	0.51	0.09						
US included?	Yes	No	Yes	No	Yes	No	Yes	No
year	01-11	01-11	01-11	01-11	01-07	01-07	08-11	08-11

¹ Dependent variable is bank leverage, defined as total liabilities divided by total assets. Dynamic regressions (1) and (2) in the text are estimated with system GMM, with a maximum number of lags of two. Standard errors (between brackets) are heteroskedasticity-robust and clustered within countries. The between estimators (3) - (8) are estimated by OLS. Tax (short-term) refers to β_1 in equation (1) and tax (long-term) refers to $\beta_1/(1 - \beta_0)$ in equation (1) and γ_1 in equation (2). Standard error on long-term impact are calculated by delta method. The rate of return on assets (ROA) is defined as the ratio of profit before tax to total assets. *, **, *** denotes significance at the 10, 5, and 1 percent level.

Consistent with theoretical prediction and the results of Keen and De Mooij (2012), the picture that emerges is of a strong positive association between the CIT rate and bank leverage: most notably, the long-run coefficient is significant at the 1 percent level in all specifications. The long-run marginal impact lies between 0.14 and 0.31 and is similar between the dynamic and static specifications. The impact is also quite robust across different settings. Removing U.S. banks from the sample (the even-numbered columns) typically gives somewhat smaller coefficients. Comparing columns (5) and (6) with (7) and (8) suggests, perhaps surprisingly, only minor differences between the periods before and after the onset of the 2008 financial crisis. The controls are generally significant and with plausible sign: larger banks are able to borrow more; more profitable banks have access to relatively cheap retention finance; high savings are largely allocated at the margin, to deposits; and high inflation may reduce willingness to hold assets with low nominal returns. The R^2 for the between-estimator ranges from 0.24 to 0.39. For the dynamic specification, the Arellano-Bond AR(2) statistic suggests that second-order serial correlation might be problematic in the first column. The Hansen statistic in columns (1) and (2) does not reject (at 5 percent) the null that the instruments are valid.

Table 3 reports estimated tax effects when the sample of banks is divided by size into the five groups of Table 1. The underlying regressions include the same control variables as in Table 2, use all years and banks, and use either the dynamic specification or the between-estimator; so the results are comparable to those in columns (1) and (3) of Table 2. Tax effects decrease almost monotonically in banks' size, which is again consistent with Keen and De Mooij (2012). Indeed, with the dynamic-GMM estimator the marginal coefficient is 0.26 (and highly significant) for the smallest banks, but only 0.08 (and insignificant) for the largest. The between-estimator shows even more pronounced differences, with a coefficient of 0.36 for the smallest banks and -0.01 for the largest. Significance also drops with size, although less so for the between-estimator, where most results remain significant, including for larger banks.

Treating asset shares as exogenous, an unbiased estimator of the effect of the CIT on aggregate financial leverage is given by the asset-weighted average of the marginal coefficients in Table 3. This gives implied aggregate tax-responsiveness of 0.11 for the GMM estimators and 0.08 for the between estimates—quite a narrow range.¹⁴

¹⁴ With the further (and not entirely plausible) assumption that the estimated coefficients are independent across size groups, the standard error of the estimated aggregate effect is $(\sum var(\hat{\beta}_i)(\omega_i)^2)^{1/2}$. This gives t-values of 0.53 and 1.91 for, respectively, the dynamic and between estimators; thus only between estimate is significant, and only at 10 percent.

Table 3. Estimated Tax Effect on Bank Leverage for Alternative Size Groups¹

Percentile (in asset)	0-85	85-90	90-95	95 – 97.5	Top 2.5 pct
Asset share	13.4	4.6	8.6	8.7	64.7
<i>Dynamic GMM estimator (long-term impact)</i>					
Marginal impact coefficient	0.26***	0.17***	0.61	0.73	0.08
T-value	4.68	3.74	0.53	0.63	0.26
<i>Between estimator</i>					
Marginal impact coefficient	0.36***	0.17***	0.15***	0.09***	-0.01
T-value	16.00	5.66	5.60	2.66	-0.24

¹ Estimates as in specifications (1) and (3) of Table 2 for alternative size groups as in Table 1. *** denotes significance at 1 percent.

Country-level data

Table 4 reports results using country-level data. Again, we remove U.S. banks in the even-numbered columns. Columns (1) and (2) use all years, while columns (3) and (4) are for 2001–06 and columns (5) and (6) for 2007–09.

Table 4. Effect of Tax on Leverage: Country-level Data¹

	(1)	(2)	(3)	(4)	(5)	(6)
tax (long-term)	0.04*	0.06***	0.03	0.04**	0.02	0.09*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.06)	(0.05)
ROA	-1.77***	-1.75***	-2.15***	-2.09***	-1.16***	-1.16***
	(0.19)	(0.20)	(0.23)	(0.23)	(0.41)	(0.39)
GDP growth	0.09	0.09	0.09	0.08	0.14	0.13
	(0.08)	(0.08)	(0.08)	(0.08)	(0.12)	(0.12)
inflation	-0.15***	-0.15***	-0.18***	-0.17***	-0.16	-0.15
	(0.03)	(0.02)	(0.03)	(0.03)	(0.12)	(0.12)
saving rate	0.13***	0.11***	0.12***	0.12***	0.11***	0.07*
	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)
R2	0.50	0.51	0.54	0.53	0.44	0.52
Observations	253	244	199	192	54	52
US included?	Yes	No	Yes	No	Yes	No
year	01-11	01-11	01-07	01-07	08-09	08-09

¹ Dependent variable is bank leverage in percent of total bank assets. Standard errors are heteroskedasticity-robust but not clustered. Tax (long-term) is the coefficient on the CIT rate. The rate of return on assets (ROA) is defined as the ratio of profit before tax to total assets. *, **, *** denote significance at the 10, 5, and 1 percent level.

Like the bank-level data, the country-level data suggest that the CIT exerts a positive impact on the aggregate leverage ratio of banks. The statistical significance of the effect varies between models, however, from being significant at 1 percent level in column (2) to statistically insignificant in columns (3) and (5). Perhaps surprisingly, there is no systematic difference in tax effects before and after the financial crisis. The R^2 ranges from 0.44 to 0.54. Removing U.S. banks from the sample leads to larger estimated tax effects, the opposite of the finding for country-level data. In the full sample, the marginal impact of the CIT rate is 0.04 (column (1)); excluding U.S. banks, it increases to 0.06 (column (2)). This is close to but somewhat lower from the simulated aggregate impact from the bank-level estimates in Table 3. In the simulations below, and taking account too of the results for the bank-level data, we report results for tax effects on aggregate leverage in the range of 0.04–0.15.

B. The Effect of Leverage on the Probability of Banking Crisis

Table 5 presents estimation results for the logit model of equation (3), exploring the impact of bank leverage on the odds of a financial crisis. Columns (1)–(4) present results from simple OLS regressions, while column (5) instruments leverage by its predicted value from the macro regression in column (1) of Table 4. Columns (1), (2), (3), and (5) count as crisis events both the “systemic” and the “borderline systemic” banking crises reported in Laeven and Valencia (2010), while column (4) counts only the former. Column (2) includes the CIT rate as an explanatory variable; column (3) excludes the U.S.¹⁵

The effect of leverage on the probability of crisis is positive in all columns of Table 5, but significant only under the broader characterization of crises (i.e., not in column (4)). Excluding the U.S. increases the impact and significance of the leverage variable. This positive impact of leverage on the probability of banking crisis is consistent with previous studies (Barrell et al., 2010; Kato, Kobayashi, and Saita, 2010). Other control variables have expected signs—lower bank liquidity on the liability side and higher current account deficits are significantly associated with higher probability of crisis—though liquidity on the asset side is generally insignificant. As mentioned above, the CIT rate enters with a negative but insignificant coefficient.

¹⁵ Adding the tax variable changes very little when added to columns (3)–(5); using lags for the independent variables reduces the significance of the leverage variable.

Table 5. Effect of Leverage on the Odds Ratio of a Banking Crisis¹

	(1)	(2)	(3)	(4)	(5)
Leverage	31.47** (13.66)	31.58** (13.76)	40.19*** (14.60)	42.42 (32.03)	139.27*** (49.52)
Tax		-2.40 (4.22)			
Liquid assets	-1.19 (3.58)	-1.61 (3.33)	-1.26 (3.98)	-2.36 (5.09)	1.56 (4.91)
Liquid liability	-4.82** (1.99)	-4.48** (1.96)	-5.39** (2.23)	-3.96* (2.25)	-5.63*** (2.41)
Current Accounts	-14.36*** (5.24)	-13.03** (5.30)	-15.59*** (5.87)	-2.97 (4.42)	-30.18*** (9.01)
Number of obs.	240	240	231	240	240
Crisis/border	both	both	both	crisis	Both
U.S. included?	yes	yes	No	Yes	Yes
Estimator	OLS	OLS	OLS	OLS	IV
R-squared	0.14	0.14	0.18	0.13	0.30

¹ Dependent variable is the odds ratio of a banking crisis (logit). Standard errors are heteroskedasticity-robust and clustered within countries. Columns (1)-(4) use OLS and column (5) instruments leverage by its predicted value from column (1) of Table 4. 'Crisis/border' indicates, respectively, whether observations are used for both the systemic and the borderline systemic banking crises or for only systemic banking crises.

To interpret the size of the leverage coefficient in Table 5, we transform it into a marginal impact on the probability of crisis. Since the logit model is nonlinear, the impact of a change in the leverage ratio on the probability of a financial crisis depends on the initial leverage ratio. Table 6 reports the simulated marginal impact (that is, the impact of one percentage point change in the leverage ratio on the probability of crisis, measured in percent) for alternative values of the initial bank leverage ratio, based on columns (1) and (5) of Table 5. All variables other than leverage are evaluated at their means. For comparison, the last two columns show the comparable marginal impact coefficients reported in Barrell et al. (2010) and Kato, Kobayashi, and Saita (2010).

Table 6. Marginal Impact of Leverage on the Probability of Banking Crisis¹

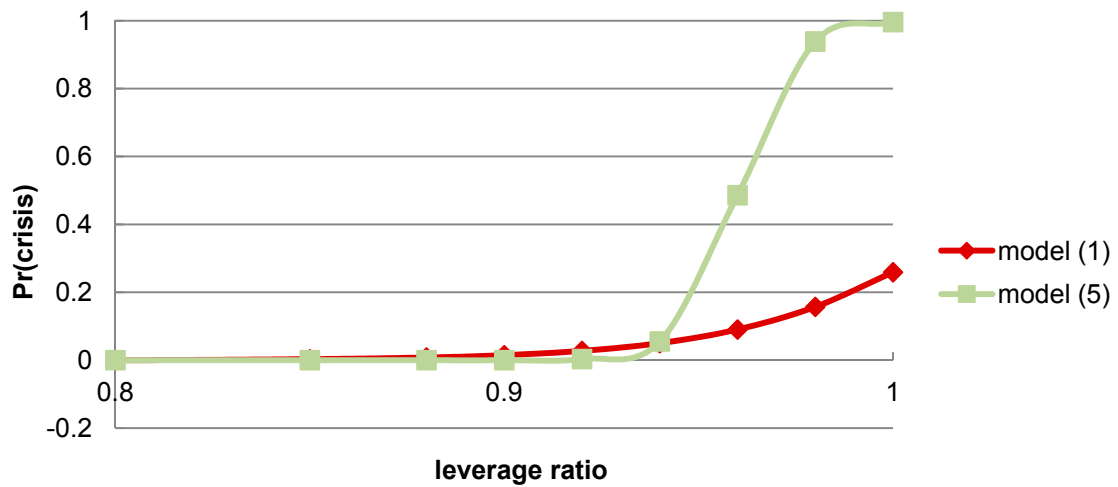
Initial leverage (percent)	(1)	(5)	Barrell et al.	Kato et al.
88	0.3	0.0	1.7	0.6
90	0.5	0.0	2.7	1.1
92	0.9	0.5	4.3	1.9
94	1.5	7.3	6.9	3.2
96	2.6	34.8	n.a.	n.a.

¹ Column labels (1) and (5) refer to regressions in columns (1) and (5) of Table 5. Marginal impacts are measured in percent.

Clearly, the marginal impact of bank leverage on the probability of a crisis increases rapidly, and increasingly rapidly, at higher levels of leverage. Taking the specification of column (1) from Table 5, for instance, at initial leverage of 88 percent—which is the mean leverage in the micro sample—a 1 percentage point increase in leverage increases the likelihood of a crisis by 0.3 percentage points; evaluated at an initial leverage ratio of 94 percent—close to the median in the macro sample—it increases the likelihood of crisis by 1.5 percentage points, around five times as much; and when leverage is initially 96 percent—as in many of the countries that experienced a crisis—the impact is an increased chance of crisis of 2.6 points. The implied effects at higher leverage ratios are even much stronger in the specification of column (5) of Table 5. At the same time, according to this specification the marginal impact is negligible at a leverage ratio of 0.88. Hence, the marginal impact coefficient in column (5) is considerably more convex in the leverage ratio than it is in column (1). While our results are not out of line with those of Barrell et al. (2010) and Kato et al. (2010), they suggest that the marginal impact of leverage on the probability of crisis is small at low levels of leverage, but larger and possibly much larger at high levels of leverage.

Figure 1 shows the implied, highly nonlinear relationship between the initial leverage ratio and the probability of crisis, using the results from Table 5. (Loosely, Figure 1 thus shows the integral of the marginal impacts reported in Table 6). While the likelihood of crisis is essentially independent of leverage while this remains below 90 percent or just above, the chances of a crisis increase rapidly, and increasing fast, at higher leverage.

Figure 1. Relationship between Initial Leverage and the Probability of Banking Crisis



IV. POLICY SIMULATIONS

The results of the previous section established two links in the chain described in the introduction: between the CIT rate and aggregate leverage in the banking sector; and between that aggregate leverage and the probability of a financial crisis. The first part of this section puts together the two links to infer a relationship between the CIT rate and the chances of crisis. The second explores the implied welfare gains from a variety of policies to mitigate the debt bias in banks' financing decisions.

Taxation and the likelihood of a banking crisis

The result in the previous section suggest that a 1 percentage point reduction in the CIT rate reduces the aggregate leverage ratio of banks by somewhere between 0.08 and 0.11 percentage points—though slightly smaller when inferred from macro data, so that we consider a range between 0.04 and 0.15; and that the impact of a marginal increase in leverage on the likelihood of crisis depends quite sensitively on its initial level. Taking this range of values for tax responsiveness and illustrative initial leverage ratios of 90, 93, and 96 percent (respectively, the level prevalent in some the low-leveraged countries in the sample, the mean in our sample, and a level prevalent in some of the high-leveraged crisis countries before the 2008 crisis), Table 7 combines these values to arrive at the implied increase in the probability of crisis associated with a 1 percentage point increase in the statutory CIT rate, using the two sets of estimated relationships as in Table 6 (corresponding to columns (1) and (5) of Table 5).

Table 7. Marginal Impact of Tax on the Probability of Banking Crisis

	Assumed marginal impact on leverage		
	0.04	0.08	0.15
Initial leverage at:	Estimates of column (1) in Table 6		
90 percent	0.02	0.04	0.07
93 percent	0.04	0.09	0.17
96 percent	0.10	0.21	0.39
Initial leverage at:	Estimates of column (5) in Table 6		
90 percent	0.00	0.00	0.01
93 percent	0.08	0.16	0.29
96 percent	1.39	2.78	5.22

Bearing in mind that a 1 point change in the CIT rate is quite a modest change, the effects are by no means inconsiderable, at least at high initial leverage ratios. For instance, at an aggregate leverage in the banking sector of 96 percent, increasing the corporate tax rate from 25 to 26 percent would increase the likelihood of crisis by between 0.1 and 0.39 points using the estimate from column (1) of Table 6, and by between 1.39 and 5.22 points using that from column (5) of Table 6. And this is so, it should be stressed, even though the tax-responsiveness of larger banks is low. If the initial leverage ratio is low, however, the effects are quite modest: at an aggregate leverage in the financial sector of 90 percent, a higher corporate tax rate raises the likelihood of a crisis hardly at all.

Welfare gains from policies to reduce debt bias in the financial sector

The link between taxation and the risk of crisis established above enables an assessment of three policies that would reduce the tax incentive for banks to finance themselves by debt rather than equity:

- ***A 10-point cut in the CIT rate.*** Given the convexity of the relationship between leverage and the changes of crisis, the effect of this more substantial reform is not simply ten times that in Table 7 (but, in general, rather less). The simulations reported below (for all reforms) take account of this nonlinearity by extrapolating a series of small changes.
- ***A ‘bank tax’ of 10 basis points.*** Since the crisis, 13 or so countries have introduced some form of levy on banks. While these differ in significant ways, the most typical form—broadly along the lines of the Financial Stability Contribution proposed by IMF (2010)—is a charge on liabilities other than insured deposits. For instance, the U.K. has implemented a levy of 7.8 basis points (10.5 basis points from January

2013) on short-term nonsecured liabilities. Such a charge is modeled here by transforming it into an equivalent tax on the flow of interest payments: assuming an interest rate of 4 percent, a bank levy of 10 basis points corresponds to a tax on interest of 2.5 percent ($=10/400$); so is modeled as a reduction in the CIT rate of 2.5 percent.

- ***An ‘Allowance for Corporate Equity’ (ACE) form of corporate tax.*** By providing a deduction for the normal return to equity, this in principle eliminates the corporate-level tax bias toward debt finance.¹⁶ It is in this respect equivalent, given the deductibility of interest, to reducing the corporate tax rate to zero. We simulate this reform as a 28-point reduction in the CIT rate, this being the mean value of the CIT rate in our panel.

The implications of these reforms for aggregate leverage are readily estimated using the results above. We suppose, as before, that a 1 percentage point reduction in the CIT rate reduces banks’ aggregate leverage by somewhere between 0.04 and 0.15. This means, for instance, that the bank levy of 10 bp would reduce financial leverage by between 0.1 and 0.4 percentage points, for example from 93 percent to 92.9 or 92.6. Eliminating debt bias altogether with an ACE would reduce leverage by 2.2 percentage points under what we shall take to be the central estimate of 0.08: say, from 93 to 90.8; with the upper bound estimate of 0.15, leverage would fall by 4.2 percentage points.

These leverage effects can then be translated into impacts on the likelihood of crisis along the lines of Table 7. To give some sense of the welfare implications, Table 8 transforms these implied changes in crisis probabilities into expected effects on output, which will in turn depend, for the reasons discussed above, on the initial level of leverage.¹⁷ Laeven and Valencia (2010) report that the mean output loss of a financial crisis, measured as the cumulative loss in GDP relative to the pre-crisis trend over a four-year period, averaged 23 percent over the period 1970–2009. Multiplying the change in crisis probability associated with the three policy reforms by this expected output loss of 23 percent gives an annual expected GDP gain associated with that policy reform.¹⁸ Table 8 reports such estimates for

¹⁶ Further discussion of the ACE is in De Mooij (2012), and evidence of its impact in practice, which does tend to suggest some impact on leverage, is reviewed in Klemm (2007). There are, it should be noted, other forms of corporate tax which would also eliminate debt bias, such as a comprehensive business income tax (CBIT) — which would simply deny interest deductibility—or the ‘R+F’ cash flow tax of the Meade Committee (1978). These though tend to raise particular difficulties, practical or political, in their application to the financial sector: the CBIT, for instance, would presumably exempt interest received, so largely eliminating any tax liability for traditional banks.

¹⁷ This approach simplifies in ignoring the revenue implications of the various reforms, as would be appropriate if revenue could be raised and disposed of in lump sum fashion.

¹⁸ While a case could be made for discounting these losses, since they accrue over time, acting in the opposite direction is that the approach here also ignores the losses that undoubtedly occur beyond the four-year horizon.

three alternative assumptions on tax-responsiveness of leverage, two of the initial levels of leverage in Table 7 (93 and 96 percent), and using the same two estimates of the impact of leverage on the likelihood of crises as before (from columns (1) and (5) of Table 6).

Table 8. Simulated 4-year Cumulative Expected Output Gain of Three Tax Reforms ¹

	(1)	(2)	(3)	(1)	(2)	(3)
	CIT cut	Bank Levy	ACE	CIT cut	Bank Levy	ACE
<i>Initial leverage ratio 93 percent of assets</i>						
	Impact of leverage Col (1)			Impact of leverage Col (5)		
Tax impact 0.04	0.1	0.0	0.3	0.2	0.1	0.4
Tax impact 0.08	0.2	0.1	0.5	0.3	0.1	0.4
Tax impact 0.15	0.3	0.1	0.7	0.4	0.2	0.5
<i>Initial leverage ratio 96 percent of assets</i>						
	Impact of leverage Col (1)			Impact of leverage Col (5)		
Tax impact 0.04	0.2	0.1	0.6	3.2	0.8	8.1
Tax impact 0.08	0.5	0.1	1.1	6.1	1.6	11.9
Tax impact 0.15	0.8	0.2	1.6	9.9	3.0	13.3

¹ 'CIT cut' refers to 10 percentage point reduction in the CIT rate; 'Bank Levy' refers to 10 basis point bank levy on all liabilities (2.5 percent lower debt bias); and 'ACE' refers to allowance for corporate equity to neutralize debt bias (assuming an initial 28 percent CIT).

Table 8 shows that the implied welfare impact of tax reforms that ease debt bias in the financial sector can be substantial. For instance, taking the central estimate for the tax impact on bank leverage of 0.08, eliminating debt bias through an ACE gives an expected GDP gain of between 0.5 and 11.9 percent. This is a large range, but both numbers are far larger than the very small deadweight losses reported in the literature for nonfinancial firms—and indeed large by the normal standards of tax analysis. The implication is that the most important social costs of debt bias likely originate not from the Harberger triangles previous discussion have focused on but from the impact on financial sector risks, especially in countries where leverage ratios are already high.

Of the three reforms, it is the ACE that gives the largest gains—which is as one would expect, since it alone entirely eliminates the debt bias. The impact of a 10-point CIT cut, however, can also be sizeable, but again especially at higher leverage ratios: at an aggregate bank leverage ratio of 93 percent, it is estimated to yield a cumulative expected GDP gain

over 4 years of between 0.1 and 0.4 percent; at leverage of 96 percent, this effect may go up to 9.9 percent. The bank levy of 10 basis points however—a rate at the upper end of those observed in practice—has much smaller effects, except when both tax responsiveness and initial leverage are high: even so, the estimated gain in expected GDP can rise to 3 percent.

These results raise more questions for policy design that can be addressed here. Prominent among these is whether, given the wider revenue loss they would otherwise imply, a reduced corporate tax rate and, more particularly, an ACE, could be applied only to the financial sector, where the welfare gains appear greatest. Clearly, applying differential corporate tax treatment to different sectors brings its own risk of creating avoidance opportunities and distortions of a kind not addressed here—for which reason it is usually considered bad policy. Perhaps the particularly tight regulations to which the financial sector is subject could substantially mitigate these risks (of nonfinancial activities, for instance, being conducted through financial institutions). If, however, sectoral differentiation through the corporate tax is ruled out—and no doubt the suggestion of lighter corporate taxation in the financial sector could be politically problematic—the implication would seem to be that a corrective case could be made for bank levies at substantially higher rates than at present.

V. CONCLUSION

The analysis here is in several respects simplistic and limited. In particular, we have not uncovered a direct link between tax incentives favoring debt finance and the probability of financial crisis. But the evidence presented here does suggest the real possibility of such a connection. If debt bias leads to higher aggregate bank leverage than would otherwise be the case—and it seems that it does—and if higher aggregate bank leverage makes financial crisis more likely—and it seems that it does—then debt bias increases the chances of financial crisis. This, in turn, can imply welfare gains from mitigating debt bias far higher than the small amounts found in previous work: noticeably more, in some of the calculations reported here, than 1 percent of GDP. Regulation, of course, has historically had the dominant role in addressing such problems of excess leverage in the financial sector, and the higher and tighter capital requirements of Basel III should to some degree reduce the welfare costs of debt bias. How much comfort is taken from this will depend on one's evaluation of these reforms. What the evidence assembled here suggests, however, is that the tax incentive encouraging banks to use debt finance is not just an inelegant inconsistency with regulations intended to do the exact opposite, but a potential risk to be recognized, and, as need be, addressed, in the pursuit of financial stability.

Appendix 1. Data

This appendix describes the data used in the exercises above. We first discuss the bank-level data used in the regressions for bank leverage, then the country-level data used for both the macro leverage regression and the crisis regression.

A. Bank-level Data

The data collection process for individual banks is similar to that in Keen and De Mooij (2012). We take individual banks' balance sheet from Bankscope, constructed by Bureau van Dijk, worldwide CIT rate data from KPMG's corporate and indirect tax survey 2011, and country level control variables from the IMF *World Economic Outlook*. Our observations consist of active commercial banks, savings banks, and cooperative banks. We use data from unconsolidated balance sheets. Our final observations contain data from 82 countries between 2001 and 2011. This is two years longer than in Keen and De Mooij (2012). We drop observations for which leverage exceeds unity. We keep observations when all the variables in Table A1 are available. The number of total bank-year observations is 120,481. The number of banks is 13,356 and the panel is unbalanced. Note that 80,769 observations (67 percent among the total observations) are for U.S. banks. Table A1 reports summary statistics.

Table A1. Summary Statistics of Data in the Leverage Regression using Micro Data

	N	mean	median	std. dev.	min	max
leverage	120481	0.881	0.904	0.096	0.071	1.000
tax	120481	0.367	0.400	0.055	0.000	0.421
log of asset	120481	12.210	12.041	1.570	2.477	21.567
squared log of asset	120481	151.560	144.995	39.842	6.133	465.147
ROA	120481	0.010	0.009	0.040	-3.148	3.154
GDP growth	120481	0.017	0.019	0.027	-0.177	0.183
inflation	120481	0.027	0.022	0.025	-0.035	1.087
saving rate	120481	0.174	0.152	0.058	-0.041	0.535

Variables are defined as follows. 'Leverage' is the individual banks' total liabilities divided by total assets. The mean leverage is 0.881. This is similar to the value in Keen and De Mooij (2012), suggesting that banks' overall capital structures had not changed greatly since the onset of the financial crisis. 'Tax' refers to statutory CIT rate, the sample average of which is 36.7 percent. If we exclude U.S. banks, the mean and median tax rates are 0.322 and 0.332, respectively. The average log of total assets is 12.210, implying an average asset value of 1.35 billion U.S. dollars. The rate of return on assets (ROA) is defined as the ratio of profit before tax to total assets. The average value of ROA is 1 percent, with considerable variation

ranging from -314.8 percent and 315.4 percent. The mean GDP growth rate, inflation rate, and saving rate are, respectively, 1.7 percent, 2.7 percent, 17.4 percent.

B. Country-level data

Aggregated balance sheet data of the country's banks from the *OECD Banking Statistics* are used to construct leverage and liquidity measures. Data on current account balance are from the *IMF World Economic Outlook*. Other variables such as GDP growth rate are collected as explained in the previous subsection. Coverage is between 2001 and 2009, which is a shorter period than those for micro level data, reflecting the unavailability of aggregated banks' financial information for 2010 and 2011. For most countries, information is available on the aggregated balance sheet of all banks. Four countries (Greece, Hungary, Portugal, and Turkey) report their balance sheets separately for commercial banks, saving banks, and co-operative banks; for these, we aggregate across these three kinds of banks. Only observations for which all the variables in Table A2 are available are retained, giving a sample of 29 countries with 253 observations.

Table A2. Summary Statistics of Data in the Regressions using Macro Data

	N	mean	median	std. dev.	min	max
leverage	253	0.930	0.934	0.024	0.862	0.973
asset liquidity	253	0.238	0.233	0.088	0.087	0.512
liability liquidity	253	0.536	0.518	0.161	0.218	0.956
current account balance	253	-0.007	-0.008	0.062	-0.159	0.164
tax	253	0.286	0.290	0.069	0.125	0.421
ROA	253	0.009	0.009	0.008	-0.048	0.031
GDP growth	253	0.023	0.026	0.033	-0.143	0.105
inflation	253	0.032	0.025	0.049	-0.026	0.685
saving rate	253	0.219	0.222	0.056	0.051	0.404

Following Barrell et al. (2010) and Kato, Kobayashi, and Saita (2010), we define variables as follows. 'Asset liquidity' is measured as cash and balances with the central banks plus securities divided by assets; 'liability liquidity' is measured as consumer deposit divided by assets; current account balance is measured as current account divided by nominal GDP. Other variables are defined in the same way as with the micro data.

Note that the mean leverage ratio in Table A2 is higher than in Table A1. This is because large banks tend to be more highly leveraged than small banks and account for a large share of total assets in a country. The average tax rate in Table A2 is lower than that in Table A1; this is because many of bank-year observations in Table A1 refer to countries with a high CIT rate (such as U.S., Japan, and Germany), which thus carry a much larger weight in the average of Table A1 than in that of Table A2.

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