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Interactions between bank levies and corporate taxes: How is bank leverage affected?

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Non-technical summary

Research Question

After the global financial crisis many European countries introduced regulatory bank levies, the goal being to internalize banks' contribution to systemic risk. Bank levies provide incentives for banks to reduce leverage, as they are typically designed as a tax on liabilities. At the same time corporate income taxation makes funding through debt more attractive, because interest on debt is tax-deductible in most countries while return on equity is not. The goal of this paper is to investigate how bank leverage is affected by the introduction of bank levies depending on corporate income tax rates.

Contribution

By providing evidence regarding the impact of bank levies on bank behavior conditional on corporate income taxation, we contribute to the assessment of regulatory reforms and potential interaction effects like the European Banking Union using bank levies to fund the Single Resolution Fund. Given the crucial role of bank leverage in the global financial crisis, a better understanding of the impact of bank levies on banks' capital structure also yields valuable implications for financial stability. In addition, our analysis bridges and thus contributes to two strands of the literature considering the individual effects of bank levies and corporate income taxes (CIT) on banks' capital structure.

Results

First, we confirm findings from previous literature. Banks in countries where a levy is introduced, such that debt financing becomes more expensive, show lower leverage than banks not subject to a levy. Second, in countries with higher CIT rates, an introduction of a bank levy reduces leverage less than in countries with lower tax rates. Third, in those countries with the most elevated tax rates, the positive incentives of bank levies on capitalization are not large enough to counteract the debt bias of taxation; the effect of a bank levy turns statistically insignificant. In a broader context, our results imply that before introducing new regulation to target a specific outcome, regulators should take possible interaction effects with (non-) regulatory measures. Otherwise, regulatory effectiveness cannot be guaranteed.

Nichttechnische Zusammenfassung

Fragestellung

Nach der globalen Finanzkrise führten viele europäische Länder Bankenabgaben ein. Diese Abgaben zielen darauf ab, dass Banken ihren Beitrag zum systematischen Risiko internalisieren. Da sie häufig als Abgabe auf Verbindlichkeiten ausgestaltet sind, haben Banken folglich einen Anreiz ihre Verschuldung zu reduzieren. Gleichzeitig kann die Bevorzugung von Fremdkapitalkosten bei der Einkommensbesteuerung von Unternehmen zu einer höheren Verschuldungsquote führen. Im Gegensatz zu Gewinnausschüttungen an Anteilseigner sind Zinsaufwendungen für Fremdkapital in den meisten Ländern steuerlich abzugsfähig. Das Papier untersucht inwieweit der Verschuldungsgrad der Banken - abhängig vom Unternehmenssteuersatz eines Landes - von der Einführung einer Bankenabgabe beeinflusst wird.

Beitrag

Die Analyse zeigt, dass eine Bankenabgabe in Abhängigkeit des Unternehmenssteuersatzes unterschiedliche Auswirkungen auf den Verschuldungsgrad von Banken entfalten kann. Ein besseres Verständnis dieses Zusammenhangs ist sowohl aus Finanzstabilitätssicht als auch für den einheitlichen Abwicklungsmechanismus von Bedeutung, welcher ebenfalls durch eine Bankenabgabe finanziert wird. Zudem trägt die Analyse zur bestehenden Literatur bei, indem sie zwei bisher getrennte Literaturstränge verknüpft.

Ergebnisse

Unsere Ergebnisse bestätigen zunächst die Erkenntnisse aus vorherigen Studien. Banken in Ländern, welche eine Bankenabgabe eingeführt haben, zeigen eine geringere Verschuldungsquote (VQ) als Banken in Ländern ohne Bankenabgabe. Zudem zeigt sich, dass in Ländern mit höheren Unternehmenssteuersätzen die Einführung einer Bankenabgabe die VQ in einem geringeren Maße reduziert, als in Ländern mit niedrigeren Steuersätzen. In den betrachteten Ländern mit den höchsten Steuersätzen ist der positive Effekt der Bankenabgabe auf die Kapitalisierung der Banken nicht groß genug, um den entgegengesetzt wirkenden Steuervorteil der Verschuldung auszugleichen. Die Ergebnisse weisen also darauf hin, dass die Beachtung von Wechselwirkungen mit (nicht-) regulatorischen Maßnahmen von großer Bedeutung ist, um die Effektivität neuer Regulierungsmaßnahmen zu gewährleisten.

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Abstract

Regulatory bank levies set incentives for banks to reduce leverage. At the same time, corporate income taxation makes funding through debt more attractive. In this paper, we explore how regulatory levies affect bank capital structure, depending on corporate income taxation. Based on bank balance sheet data from 2006 to 2014 for a panel of EU-banks, our analysis yields three main results: The introduction of bank levies leads to lower leverage as liabilities become more expensive. This effect is weaker the more elevated corporate income taxes are. In countries charging very high corporate income taxes, the incentives of bank levies to reduce leverage turn insignificant. Thus, bank levies can counteract the debt bias of taxation only partially.

Keywords: Bank levies, debt bias of taxation, bank capital structure

JEL classification: G21, G28, L51.

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1 Motivation

Regulatory bank levies provide incentives for banks to reduce leverage, as they are typically designed as a tax on liabilities. At the same time, corporate income taxation makes funding through debt more attractive, because interest on debt is tax-deductible in most countries while return on equity is not. In this paper, we ask how effective regulatory bank levies are in reducing bank leverage, depending on the corporate income tax (CIT) rate. Moreover, we study how the design of bank levies affects their impact upon leverage. As the European Banking Union also uses bank levies to finance the Single Resolution Fund, evidence regarding the impact of bank levies on bank behavior conditional on the corporate tax environment contributes to the assessment of such regulatory reforms.

The literature shows that corporate income taxes affect bank capital structure (De Mooij and Keen, 2016) and that banks exposed to regulatory levies strengthen capitalization (Célérier, Kick, and Ongena, 2018; Devereux, Johannesen, and Vella, 2019). However, empirical evidence on the interaction effects between regulatory and corporate taxes is so far missing. Against the background of the evaluation of changes in banking regulations and potential interactions between different policy interventions (FSB, 2017), this paper aims at filling this gap. Our goal is to investigate what role regulatory bank levies play in counteracting the debt bias of taxation. A better understanding of the impact of bank levies on bank capital structure, depending on corporate taxation, is crucial given that the debt bias of taxation is shown to not only increase leverage of both non-financial and financial firms, but also the probability of systemic banking crises (De Mooij, Keen, and Orihara, 2013).

In the aftermath of the global financial crisis, many European countries introduced regulatory levies, the goal being to internalize banks' contribution to systemic risk. On the one hand, bank levies are aimed at establishing funds to finance the restructuring and resolution of banks in distress. On the other hand, banks' funding composition

should be influenced by taxing non-deposit liabilities of banks, thereby setting an incentive for lower leverage and funding risk. Given the opposite incentives for higher bank leverage that result from corporate taxation, the goal of this paper is to better understand the interaction effects between regulatory and corporate taxes, thus understanding the consequences for the effectiveness of bank levies as a tool to increase financial stability through a less risky bank capital structure.

Using bank-level balance sheet data for EU-countries over the 2006 – 2014 period, we investigate how bank leverage is affected by the introduction of regulatory levies, depending on CIT rates. The regression analysis yields three key insights. First, we confirm findings from previous literature (Célérier et al., 2018; Devereux et al., 2019) that the direct effect of bank levies on leverage is negative and statistically significant. Banks in countries where a levy is introduced, such that debt funding becomes more expensive, show lower leverage than banks that are not subject to a levy. Second, higher CIT rates mitigate the leverage-reducing effect of bank levies. In countries with higher CIT rates, an introduction of a bank levy reduces leverage less than in countries with lower tax rates. At the average CIT rate (30.2%), introducing a bank levy reduces leverage by 0.4 percentage points. The equity-to-assets ratio, in turn, increases by 4% for the average bank. For the countries with the lowest CIT rates in the sample (10%), the corresponding marginal effect on leverage amounts to minus 3 percentage points and hence to a rise in the equity ratio of about 30% for the average bank. Third, and lastly, for the most elevated CIT rates, the positive incentives of bank levies on capitalization are not large enough to counteract the debt bias of taxation. Indeed, the effect of a bank levy turns statistically insignificant in high-corporate income tax countries, such that the goal of fostering financial stability through lower leverage cannot be fulfilled by the regulatory tax.

Our analysis bridges and, thus, contributes to two strands of the literature. A first set of related studies deals with the implications of the introduction of regulatory bank levies since the global financial crisis. Exploiting variation in bank levies in the

European Union (EU) across countries, banks and time, Devereux et al. (2019) present empirical evidence that banks exposed to regulatory levies increase their equity ratio, thus reducing funding risk. At the same time, portfolio risk is shown to increase. Concentrating on different bank-level outcome variables, Buch, Hilberg, and Tonzer (2016) show that loan supply and deposit rates were, on average, not significantly affected by the introduction of the bank levy in Germany. However, the most affected banks reduced loan supply and deposit rates while raising lending rates. An increase in lending rates is also found after the introduction of the Hungarian levy by Capelle-Blancard and Havrylchyk (2017). For a sample of EU banks, Kogler (2019) finds that banks pass the levies through to customers via higher lending rates while keeping deposit rates constant. This effect is weaker for the well-capitalized banks that are less exposed to the levies.[1] Our analysis differs from these studies as we focus, besides the direct impact of levies on bank leverage, on the interactions between bank levies and the CIT.

A second strand of literature investigates the relationship between corporate income taxation and leverage. As summarized in a meta-study by Feld, Heckemeyer, and Overesch (2013), the design of the corporate tax system is an important determinant of non-financial firms' capital structure. Typically, tax systems incentivize leveraging since interest paid on debt is tax-deductible whereas the return on equity is not. To lower their tax burden, firms tilt their capital structure more toward debt than they would in the absence of this tax bias in advantage of debt. The positive effect of the CIT on leverage is well established in the literature.[2] Findings by Heider and Ljungqvist (2015) suggest asymmetric effects of tax rates on leverage: U.S. firms' leverage responds to tax increases, but not to tax cuts.

[1] Kogler (2019) discusses theoretically the interaction effects between corporate taxation and levies for the pass-through of bank levies to customers in terms of lending rate increases. If the levy payment is not tax deductible, as in Germany or the UK, the pass-through is expected to be stronger than in countries where the levy payment can be deducted so that double taxation is prevented.

[2] For an overview, see Bremus and Huber (2016). Another but less related strand of literature analyzes whether and how much corporate income taxes are shifted to customers (see e.g. Banerji, Chronopoulos, Sobiech, and Wilson (2017) or Capelle-Blancard and Havrylchyk (2014)) and how securitization is affected by the CIT (Gong, Hu, and Ligthart, 2015).

As banks face different funding decisions than non-financial firms and are subject to regulatory capital requirements, they were typically excluded from the analysis of capital structures pre-crisis. Yet, Gropp and Heider (2010) show that, as long as banks hold more capital than required by regulation, the drivers of capital structure are similar for financial and non-financial firms. Still, banks tend to be more leveraged than non-financial firms. Berg and Gider (2017) find that this difference is largely explained by lower asset side risk of banks due to diversification.

Regarding the role of CIT for bank capital structure, a small but growing literature concludes that the debt bias of taxation also affects financial firms. Comparing the tax sensitivity of banks' and non-banks' capital structure, Heckemeyer and De Mooij (2017) find similar values for both groups of firms. However, the tax sensitivity differs across firm size and leverage. While larger and capital-tight banks react less to tax changes, the relationship between tax rates and the size of non-banks is found to be U-shaped. De Mooij and Keen (2016) argue that capital buffers that are typically above regulatory capital requirements leave scope for taxes to affect bank leverage. Based on bank balance sheet data for 82 countries, they confirm that banks' reaction to taxation is, on average, similar to that of non-financial firms and that large banks are less tax-sensitive than small ones.[3] Related studies for the United States (Milonas, 2018; Schandlbauer, 2017) confirm a significant impact of tax changes on bank leverage, which differs across bank characteristics like capitalization and size. Using Italian data, Gambacorta, Ricotti, Sundaresan, and Wang (2017) provide evidence that banks reduce leverage following tax reductions and that non-deposit liabilities decline more than deposits. Focusing on the capital structure of multinational banks, Gu, de Mooij, and Poghosyan (2015) show that the debt bias of taxation also affects bank subsidiaries and that international tax differences lead to debt shifting to countries with high taxes.

Shifting the focus from CIT to the effects of bank levies and of "Allowances for Corporate Equity" (ACE), Célérier et al. (2018) find that tax reforms that make leverage

[3]Hemmelgarn and Teichmann (2014) find smaller, but also statistically significant, effects of CIT-changes on bank leverage.

more expensive increase bank capitalization, while simultaneously promoting lending. Regarding tax reforms, they exploit, on the one hand, that several countries have reduced the tax discrimination against equity by allowing for a deduction of a notional interest rate for equity through ACEs, while others have not. On the other hand, they also exploit the introduction of bank levies that increase the total cost of capital, since liabilities are taxed, thus becoming more expensive. In a similar vein, Schepens (2016) presents evidence that the capitalization of Belgian banks significantly increased after implementation of an ACE in 2006.

While the discussed studies analyze the effects of CIT and of regulatory taxes separately, we contribute to the literature by estimating the effects of introducing bank levies, depending on CIT rates. By examining the interaction effects between regulatory and corporate income taxes, we aim at gauging how far bank levies can counteract the debt bias of taxation. The remainder of the paper is structured as follows. In the following Section 2, we explain the theoretical link between bank leverage and taxes, both corporate income taxes and bank levies. Section 3 describes both the data used and its sources as well as our empirical model specification. We discuss the regression results and several robustness tests in Section 4, while Section 5 concludes and presents potential policy implications.

2 Bank leverage and taxes

Both corporate income taxes and bank levies are related to bank leverage. The expenses of bank levies that are designed as a tax on liabilities typically increase with the amount of wholesale funding and leverage:[4]

$$Bank\ levy\ expenses = Levy\ rate * (Total\ liabilities - Customer\ deposits - Equity) \tag{1}$$

[4]See Appendix B for a detailed overview on which countries use wholesale liabilities as a tax base for their bank levy and Section 3.2 for more information on the data.

Consequently, the cost of debt (or: leverage) increases, making debt funding less attractive. Bank levies target exclusively the financial sector, especially credit institutions. In the aftermath of the global financial crisis, bank levies were introduced as an instrument to establish resolution funds to finance the resolution and restructuring of banks in distress (e.g. Cyprus, Germany, Latvia, and Sweden). In addition, countries opting for a bank levy that taxes wholesale funding aimed at reducing systemic risk by providing incentives for banks to shift from an over-reliance on short-term interbank financing to more stable funding sources such as customer deposits and equity capital (Kogler, 2019). Along these lines, Devereux et al. (2019) present a theoretical model of bank leverage, a tax on liabilities, and bank capital requirements where banks maximize the expected return to shareholders by choosing, among others, the optimal level of total debt (or leverage, as the amount of total assets is kept fixed for simplicity). In that framework, banks react to an increase in the tax on debt by reducing leverage. Similarly, in the model by Keen (2018), optimal leverage falls the higher the levy is, since the cost of leverage increases. These considerations lead to our first testable hypothesis:

Hypothesis 1: *A bank levy on debt incentivizes banks to reduce leverage.*

In contrast to bank levies, corporate income taxes are a general instrument targeting the non-financial as well as the financial sector. The main objective is to generate revenues for the public sector. Given that interest payments on debt are tax deductible, expenses due to corporate income taxes amount to

$$\begin{aligned} &CIT\ expenses = CIT\ rate * \\ &(Net\ income\ before\ taxes\ \&\ interest - Interest\ payments\ on\ debt). \end{aligned} \tag{2}$$

There is no explicit aim to target the behavior of taxed entities as concerns their capital structure. Nevertheless the empirical and theoretical literature documents that higher CIT rates set incentives for both non-financial firms and banks to increase leverage in order to lower tax expenses (Feld et al., 2013; Gropp and Heider, 2010;

De Mooij and Keen, 2016; Langedijk, Nicodème, Pagano, and Rossi, 2015). This debt bias of taxation results from the fact that interest rate costs for external debt are generally tax deductible, and thereby reduce the taxable net income of a company, whereas interest on equity is not.

As shown in the model of corporate income taxes and bank leverage presented by De Mooij and Keen (2016), if banks optimally choose total debt in a world with capital requirements, they borrow up to the point where the expected cost of violating the capital requirement equals the tax advantage of debt. The model implies that higher tax rates result in banks increasing their optimal amount of debt. The marginal tax benefit of debt increases in the corporate income tax rate, thus increasing the optimal level of debt if tax rates rise. We can thus form the second hypothesis:

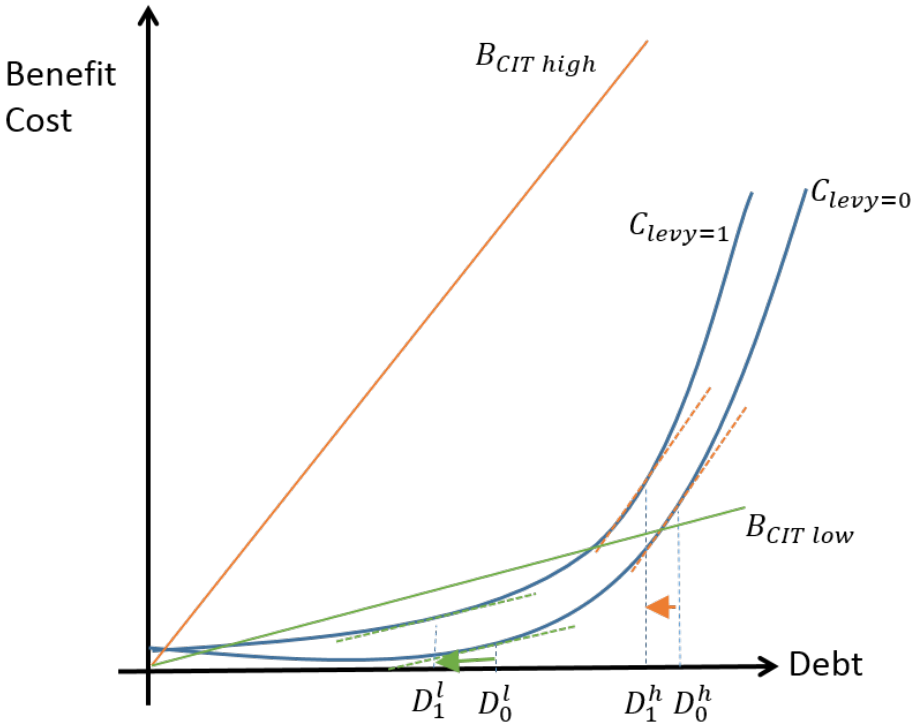
Hypothesis 2: *Bank leverage is higher the more elevated corporate income tax rates are.*

Due to opposing effects of corporate income tax rates and bank levies on leverage, the question arises of whether there is an interconnection between corporate income taxes, bank levies and bank leverage. If this is the case, it bears important policy implications. In particular, considering the case that the leverage-reducing effect of a bank levy taxing wholesale funding interacts reversely with the debt bias of taxation of the corporate income tax. In such a context, the effectiveness of the regulatory policy instrument cannot be guaranteed.

According to the trade-off theory of debt, firms choose the optimal debt level such that the marginal benefit of debt equals the marginal cost of debt (see e.g. Feld et al. 2013, Graham 2003, Heider and Ljungqvist 2015). The value of the tax shield of debt and hence the benefit of debt increases in the CIT. The cost of debt is generally modeled as an increasing, non-linear function of debt that mirrors, e.g., bankruptcy cost. As argued above, the cost of debt rises once a levy on bank debt is introduced. Following Heider and Ljungqvist (2015), Figure 1 illustrates the optimal choice of debt according to the trade-off theory. When comparing the reduction in optimal leverage in response

Figure 1: Changes in optimal leverage at different CIT rates

This figure illustrates optimal leverage according to the trade-off theory of debt. Following the illustration by Heider and Ljungqvist (2015), we posit that the benefit of debt positively depends upon the CIT and it linearly increases in debt ($B = CIT \cdot r_d D$). The cost of debt increases with debt in a non-linear way ($C = a + bD + cD^2$). If a bank levy is introduced ($levy = 1$), the cost of debt is higher for each level of debt compared to the case without a levy ($levy = 0$). Firms increase debt up to the point where the marginal benefit of debt equals the marginal cost of debt. D_1^l (D_1^h) denotes optimal debt if a levy is in place and the CIT rate is low (high), whereas D_0^l (D_0^h) is optimal debt if there is no levy and the CIT rate is low (high). Source: Own illustration.



to a bank levy if the CIT is high to the reduction in leverage when the CIT is low, it appears that firms adjust leverage *less* in response to a levy in countries where the CIT is high (and hence optimal leverage is high) compared to firms in countries where the CIT is low (and hence optimal leverage is lower). Thus, we suspect that the negative effect of bank levies on leverage is potentially smaller the higher the prevailing CIT rate is:

Hypothesis 3: *The leverage-reducing effect of bank levies is counteracted by the size of the corporate income tax rate.*

In what follows, we empirically analyze the nexus between regulatory and corporate taxation and its effect on bank leverage.

3 Data and methodology

In order to shed light on the effect of bank levies on leverage, depending on the prevailing CIT, we construct a linked micro-macro dataset that connects bank balance sheet variables with country-level information on the introduction and design of bank levies, as well as CIT rates. The baseline sample covers 2,767 banks in 27 EU-countries over the 2006 – 2014 period, which yields 10,755 bank-year observations. The sample period ends in 2014 because, since 2015, banks in EU member states participating in the European Banking Union must make levy contributions to the Single Resolution Fund. We next describe our dataset and some key features of the variables of interest, before discussing our estimation and identification strategy.

3.1 Bank-level data

Annual balance sheet and income statements for banks in 27 EU member states were obtained from Bankscope by Bureau van Dijk for the 2006 – 2014 period.[5] In order to clean the data from misreporting and outliers, we apply several standard screens. We eliminate bank observations if negative or zero values of equity, assets, liabilities or loans are reported or when the loans-to-assets or the equity-to-assets ratio exceeds one. Further, only banks with at least three observations across the sample period are kept. Following De Mooij and Keen (2016) and Kogler (2019), we consider unconsolidated accounts that end at national borders and to which national tax rates and in general also regulatory bank levies apply. That is, we include observations with Bankscope consolidation codes U1 (unconsolidated statement with no consolidated companion) and U2 (unconsolidated statement with a consolidated companion). In terms of bank business models, our baseline sample includes bank holdings and holding companies, commercial banks, cooperative banks, and savings banks. In order to prevent outliers from affecting our results, we winsorize all bank-level variables at the top and bottom

[5] We do not cover all 28 EU-countries as Croatian banks do not report all control variables included in the regression equation and, therefore, drop out of the sample.

1%-percentile.[6]

Following the banking literature, our dependent variable, leverage of bank i in year t, is defined as liabilities divided by total assets (Berg and Gider, 2017; Gropp and Heider, 2010; Gu et al., 2015). Figure 2 illustrates that at the sample median, leverage has followed a slight upward trend between 2007 and 2013, with the highly leveraged banks (75th percentile) showing a rather stable leverage ratio, while leverage trended upwards for lower-leverage banks (25th percentile).[7] The standard bank-level control variables that gauge bank size, profitability, and risk are also sourced from Bankscope. Appendix A provides a detailed data description of all variables used in the regression analysis. Table 1 reports summary statistics for our baseline regression sample. The sample mean of bank leverage, as measured by total liabilities to total assets, is 90%, varying between 16 and 98%.[8] Regarding the unconditional correlations between the bank-level variables included in the regression model below, Table 2 reveals that leverage is higher for larger banks and lower for more profitable banks in our sample.

3.2 Country-level data

Information on bank levies for our sample period, like the year of the introduction and the tax base, is taken from Devereux et al. (2019) and double-checked with the ECB's Macroprudential Policies Evaluation Database by Budnik and Kleibl (2018). We also verify whether countries have implemented a bank levy in those years not covered by Devereux et al. (2019). Detailed information on the data source by country is provided in Appendix B.

[6]To assure that our regression results are not driven by the choice of this cutoff, we checked the robustness of our baseline results to winsorizing at the 5%-percentile. The main results remain robust.

[7]ECB-data for the leverage of monetary financial institutions in the euro area, however, shows a slight downward trend. This difference in the evolution of leverage may be due to different classifications of equity and capital & reserves in Bankscope compared to the ECB-data and due to different countries sampled. Moreover, data coverage in Bankscope might not fully coincide with the information available to the ECB. When (i) excluding GIIPS countries or (ii) looking at non-euro area countries only, leverage of the median bank in our sample decreases.

[8]Note that the equity positions used to calculate the leverage ratio and regulatory capital differ such that they are not directly comparable. For example, given that some risk weights are less than one, risk-weighted assets are smaller than total assets.

Figure 2: Evolution of bank leverage

This figure illustrates the evolution of bank leverage as measured by total liabilities to total assets (in %) for the sample median as well as the 25th and 75th percentile. Source: Bankscope, own calculations.

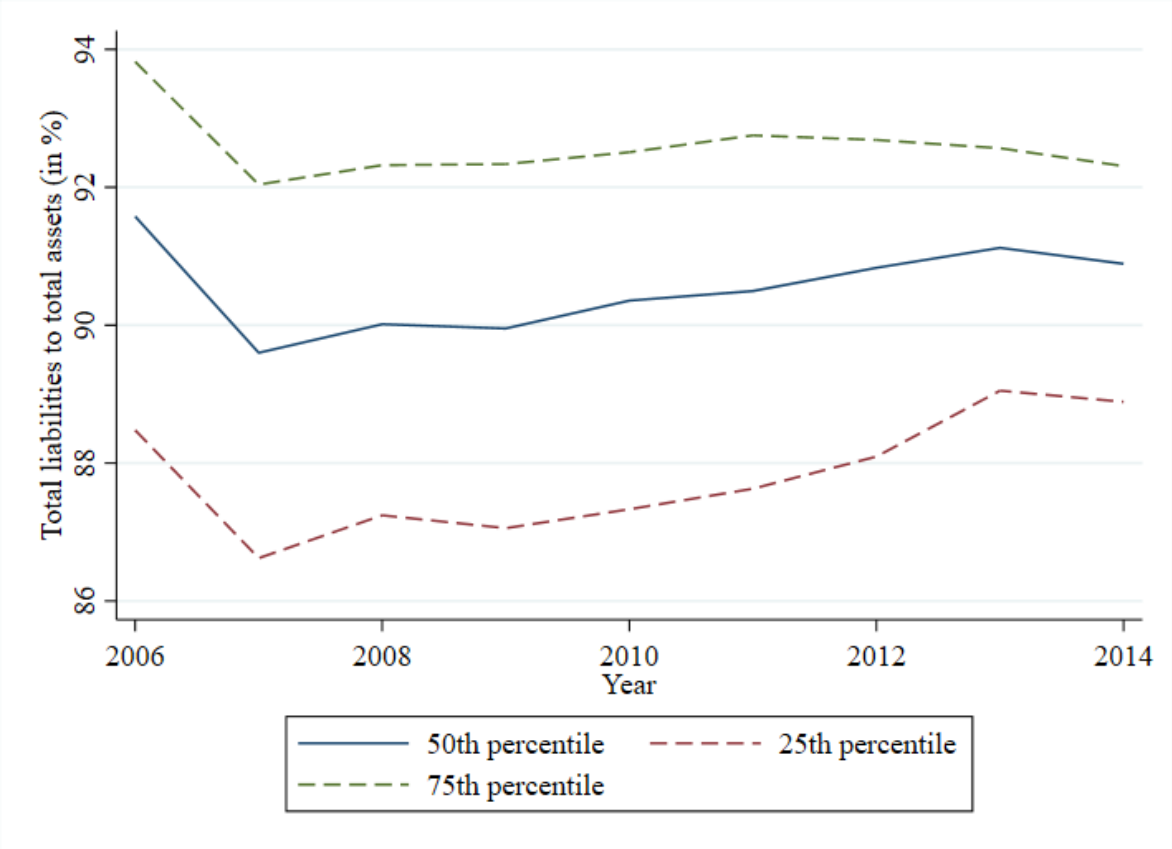


Table 1: Descriptive statistics

These descriptive statistics are based on the baseline regression sample (Table 5, column 1). The sample period spans 2006-2014. Source: See data description in Appendix A.

	Obs	Mean	SD	Median	Min	Max
Bank-level variables						
Total liabilities to total assets (in %)	10,755	89.58	5.87	90.69	16.04	98.00
Lag of ln(total assets)	10,755	6.96	1.81	6.70	3.44	12.36
Lag of return on assets (in %)	10,755	0.75	1.06	0.78	-4.28	5.56
Lag of impaired loans (in %)	10,755	6.82	6.45	4.96	0.10	39.04
Country-level variables						
Bank levy (0/1 dummy)	10,755	0.42	0.49	0.00	0.00	1.00
Corporate tax rate (in %)	10,755	30.18	5.10	30.94	10.00	40.36
GDP growth (in %)	10,755	0.10	2.44	0.59	-14.81	11.62
Inflation (in %)	10,755	1.78	1.27	1.60	-1.71	15.24
Supervisory forbearance discretion (0-4)	10,755	1.31	1.03	1.00	0.00	4.00
Factors mitigating moral hazard (0-4)	10,755	1.79	0.55	2.00	0.00	3.00

Table 2: Cross-correlations

This table shows correlation coefficients between the variables used in the regression models. The sample period spans 2006-2014. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Source: See data description in Appendix A.

	Total liabilities to total assets (in %)	Bank levy (0/1 dummy)	Corporate tax rate (in %)	GDP growth (in %)	Inflation (in %)	Lag of ln(total assets)	Lag of return on assets (in %)	Lag of impaired loans (in %)	Supervisory forbearance discretion (0-4)	Factors mitigating moral hazard (0-4)
Total liabilities to total assets (in %)	1									
Bank levy (0/1 dummy)	0.05*	1								
Corporate tax rate (in %)	0.07*	-0.01	1							
GDP growth (in %)	0.02	0.26*	-0.06*	1						
Inflation (in %)	-0.02*	-0.25*	-0.13*	0.06*	1					
Lag of ln(total assets)	0.23*	-0.05*	-0.01	0.06*	0.02*	1				
Lag of return on assets (in %)	-0.13*	0.12*	0.11*	0.11*	0.05*	-0.05*	1			
Lag of impaired loans (in %)	-0.14*	-0.21*	-0.21*	-0.09*	-0.04*	-0.12*	-0.34*	1		
Supervisory forbearance discretion (0-4)	-0.16*	-0.33*	0.05*	-0.06*	0.05*	0.16*	-0.01	0.02	1	
Factors mitigating moral hazard (0-4)	0.16*	-0.09*	0.44*	-0.09*	-0.04*	-0.03*	0.04*	0.03*	-0.26*	1

In our baseline regressions, we include 27 EU-countries and construct a dichotomous variable that equals one if a bank levy is in place in a given country and year, and zero otherwise. Appendix B contains detailed information on the countries that implemented the levy, the implementation year, and the tax base. The majority of countries implemented a levy in 2011, while others adopted it earlier or later. As shown in Table 3, prior to 2009, no banks included in our sample were subject to a levy, whereas in 2011, about one-third of the banks had to pay levies. The share of affected banks increased to 73% at the end of our sample period. The timing is in line with the start of policy discussion about the implementation of levies to finance restructuring funds and internalize banks' contribution to systemic risk after the financial crisis (IMF, 2010). Table 3 reveals that the number of banks covered in our sample significantly increases across time. This is predominantly due to the improving coverage of the non-performing loans ratio used as a control variable for bank risk.

Among the 17 countries that have introduced a bank levy within our sample period, the majority implemented the levy design as suggested by the IMF (2010), namely as

Table 3: Distribution of bank observations by years

This table presents the number and fraction of banks in the baseline sample that are subject to a levy and the ones that are not by sample year. Source: Own calculations.

	Number of bank observations			Share of bank observations with levy	
Year	without levy	with levy	total	by year	accumulated
2006	248	0	248	0%	0%
2007	748	0	748	0%	0%
2008	836	0	836	0%	0%
2009	893	59	952	6%	2%
2010	914	64	978	7%	3%
2011	674	351	1,025	34%	10%
2012	692	803	1,495	54%	20%
2013	667	1,544	2,211	70%	33%
2014	609	1,653	2,262	73%	42%
Total	6,281	4,474	10,755		

a tax on liabilities (i.e. total assets less equity) minus deposits. With this levy design, all non-deposit liabilities are taxed, thus making leverage more expensive. Appendix B reveals that there are, however, seven European countries that chose different levy designs.[9] In Hungary and Slovenia, for example, the levy is paid on total assets, whereas in France the minimum equity requirement is used as the tax base. Given the heterogeneity of the design of levies and the resulting differences in incentives set for capital structure, we restrict the "treatment group" in further regression exercises to the countries that impose the standard "liabilities minus deposits (L – D)" design.[10]

Information on corporate income taxes is obtained from the Oxford Centre of Business Taxation.[11] The corporate income tax rate for country c in year t is computed as the sum of the federal tax rate and the local tax rate taking into account surcharge and deductibility of local taxes. As shown by the summary statistics in Table 1, while the average CIT in our sample is 30%, the range of tax rates varies quite substantially between 10% (Bulgaria, Cyprus) and 40% (Spain). This variation is useful in the following empirical analysis as it helps identify the differential effects of regulatory bank

[9] Poland only implemented a levy in 2016.

[10] See Kogler (2019) for a description of different levy designs in Europe.

[11] `https://www.sbs.ox.ac.uk/faculty-research/tax/publications/data`; missing information for Latvia, Lithuania, Malta and Cyprus is added from Devereux et al. (2019) and KPMG (2014).

levies depending on the existing CIT. At the country level, Table 4 reveals that the majority of countries experienced changes in the CIT rate across the sample period, and these changes happen both in countries with and without a bank levy. The set of countries where a levy has been introduced contains both core and periphery European countries showing alternating corporate tax rates. Overall, the set of countries introducing a levy is relatively diverse as concerns the size and pattern of the corporate income tax rate, such that our analysis should not be driven by a selected group of countries.

Table 4: Summary statistics of corporate income taxes by country

This table shows summary statistics of corporate income tax (CIT) rates (in %) for each sample country and the period 2006-2014. Next to basic statistics, it is shown whether a country has an average CIT rate larger than the sample median of 31% (=1), whether a country (written in bold) has introduced a levy (=1) and whether both a levy and a high CIT rate (=1) can be found. Source: See data description in Appendix A and B.

	Mean	Std. Dev.	Min	Max	CIT > 31%	Levy	Levy & CIT > 31%
Austria	25.00	0.00	25.00	25.00	0	1	0
Belgium	33.99	0.00	33.99	33.99	1	1	1
Bulgaria	10.00	0.00	10.00	10.00	0	0	0
Cyprus	10.56	1.10	10.00	12.50	0	1	0
Czech Republic	20.44	2.13	19.00	24.00	0	0	0
Denmark	25.28	1.03	24.50	28.00	0	0	0
Estonia	21.33	0.71	21.00	23.00	0	0	0
Finland	24.50	2.60	20.00	26.00	0	1	0
France	35.20	1.27	34.43	38.00	1	1	1
Germany	31.91	2.88	30.95	39.60	1	1	1
Greece	24.89	2.37	20.00	29.00	0	0	0
Hungary	20.72	1.27	17.36	21.36	0	1	0
Ireland	12.50	0.00	12.50	12.50	0	1	0
Italy	32.29	2.84	30.33	37.25	1	0	0
Latvia	15.00	0.00	15.00	15.00	0	1	0
Lithuania	15.00	0.00	15.00	15.00	0	0	0
Luxembourg	29.12	0.44	28.59	29.63	0	0	0
Malta	35.00	0.00	35.00	35.00	1	0	0
Netherlands	25.73	1.47	25.00	29.60	0	1	0
Poland	19.00	0.00	19.00	19.00	0	0	0
Portugal	29.06	1.10	28.00	31.50	0	1	0
Romania	16.00	0.00	16.00	16.00	0	1	0
Slovakia	19.78	1.56	19.00	23.00	0	1	0
Slovenia	20.33	2.74	17.00	25.00	0	1	0
Spain	36.31	1.76	35.25	40.37	1	1	1
Sweden	25.91	2.35	22.00	28.00	0	1	0
United Kingdom	27.44	2.60	23.00	30.00	0	1	0

Further country-level control variables, like GDP growth and inflation or regulatory variables, come from sources such as the International Financial Statistics or Barth,

Lin, Ma, Seade, and Song (2013). Appendix A contains a detailed description of variables and sources.

3.3 Regression model

In order to analyze how the introduction of bank levies affects bank capital structure, depending on the prevailing CIT, we estimate the following regression equation

$$\begin{aligned} LA_{ict} = \alpha_i + \gamma_t + \beta_1 Levy_{ct} + \beta_2 CIT_{ct} + \beta_3 Levy_{ct} * CIT_{ct} \\ + \beta_4 X_{ict-1} + \beta_5 Y_{ct} + \epsilon_{ict} \end{aligned} \tag{3}$$

using a panel fixed-effects estimator. The dependent variable, bank leverage of bank i in country c at time t, is defined as the ratio of liabilities (total assets minus equity) to total assets (LA_{ict}). The main explanatory variables of interest are $Levy_{ct}$, a dummy variable that equals one if a bank levy is in place in country c at time t, and CIT_{ct}, the corporate income tax rate in country c at time t. Capturing bank levies by a country-specific dummy variable is a very crude proxy and ignores that some countries implement different levy designs and exclude, for example, small banks from the levy. Thus, in Section 4.2, we assess in more detail the role of the levy design and, in further robustness tests, we account for the role of bank size.

Based on theoretical considerations and empirical results from previous literature, we expect the direct effect of a bank levy on leverage, β_1, to be negative, whereas the direct effect of CIT, β_2, is supposed to be positive. The total effect of bank levies on leverage, depending on the CIT, is given by $\beta_1 + \beta_3 * CIT$. To investigate how effective bank levies are at counteracting the debt bias of taxation, our coefficient of interest is β_3, i.e. the interaction effect between the bank levy and the corporate income tax rate. Supposed that leverage is lower for banks that are affected by a levy relative to banks that are not ($\beta_1 < 0$), then the larger and positive β_3 is, the more the leverage-reducing effect from the levy is mitigated with higher CIT rates.

The vector X_{ict-1} contains bank characteristics, all lagged by one year to account for potential simultaneity concerns.[12] Following the literature on bank capital structure and taxation (Devereux et al., 2019; De Mooij and Keen, 2016), we include the log of total assets (in million USD) and the square of the log of total assets to control for bank size and for the fact that large banks display higher leverage, the return on assets (in %) to measure profitability, and the ratio of non-performing loans to gross loans (in %) as a measure of bank risk. The term Y_{ct} summarizes annual GDP growth, inflation, and regulatory variables, that is, country-level controls. Common time trends in the data are accounted for by including yearly time dummies (γ_t). To control for unobserved time-invariant bank characteristics, all regression models include a set of bank fixed effects (α_i). Given that banks in our sample do no switch countries, the bank fixed effects also account for all time-invariant factors at the country level. Thereby, we can test whether banks subject to a levy changed their leverage compared to banks not affected by a levy with similar bank-level and country-level characteristics. Robust standard errors are clustered at the bank level.

For our identification of effects, we exploit variation in the introduction of bank levies across countries and time. Importantly, during our sample period, changes in bank capital regulation, like the stepwise implementation of Basel III that started in 2013, also affected the choice of bank capital structure. As we control for observed and unobserved bank and country characteristics, it is nevertheless reasonable to suppose that two otherwise similar banks – one located in an EU-country that introduced a levy and the other located in an EU country without levies – are affected similarly by regulatory and institutional changes at the EU-level. Indeed, the World Bank Regulation and Supervision Survey (2019),[13] which contains data for the years from 2011 onwards, reveals that for the European sample, there is very little heterogeneity of capital requirements across countries implying that time fixed effects are a useful control. Furthermore, as we outline below, most changes become only effective after 2014. Still,

[12] Due to the fact that we lag the control variables by one period, our estimation covers the dependent variable for the years 2006-2014 and links it to bank-level control variables based on 2005-2013.

[13] https://www.worldbank.org/en/research/brief/BRSS

we account for changes in capital requirements and for differences in capitalization at the bank level in robustness tests in Section 4.4. To control for the fact that existing regulatory standards are enforced differently across EU-countries and that differences in the strength of moral hazards can impact leverage, we add two variables reflecting banking regulation in country c at time t, namely supervisory forbearance discretion and various factors mitigating moral hazard. Potential concerns about endogeneity are discussed in Section 4.3.

4 Regression results

This section discusses estimation results for the baseline sample including bank observations from EU-countries, using banks from those countries that introduced a levy as the treatment group and the remaining banks as the control group. We then limit the sample to countries with a more homogenous levy design, before testing the robustness of our findings with respect to additional changes in the sample composition. Finally, we test the sensitivity of our results to changes in the Basel regulatory regime as well as individual banks' level of capital.

4.1 Determinants of bank leverage

Table 5 reports the regression results from estimating Equation 3. Confirming previous findings from the literature, the results point to a negative effect of levies on bank leverage, while leverage is positively related to CIT rates. On the one hand, banks in countries that introduced bank levies reduce leverage relative to other banks, given that most countries implement a levy scheme making debt funding more expensive. On the other hand, banks facing higher CIT rates have higher liabilities to assets ratios due to the debt bias of taxation. The estimated interaction effect between regulatory and corporate taxes, β_3, is positive: This finding suggests that if a country introduces a bank levy, higher CIT rates mitigate the leverage-reducing effect of the levy.

Table 5: Determinants of bank leverage

This table shows regression results based on the empirical specification of Equation (3) for a sample of European banks. The estimation period covers 2006-2014. The dependent variable is total liabilities relative to total assets (in %). Bank levy is a country-level dummy variable that is one if a bank levy is in place and zero otherwise. Corporate tax rate is a continuous variable, also defined at the country level. Bank-level controls are included with a lag and standard errors are clustered at the bank level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	Total liabilities to total assets$_t$			
Bank levy$_t$		-0.496	-0.723**	-4.340***
		(0.330)	(0.338)	(0.882)
Corporate tax rate$_t$			0.190***	0.111**
			(0.043)	(0.043)
Corporate tax rate$_t$ * Bank levy$_t$				0.129***
				(0.027)
GDP growth$_t$	0.029	0.045	0.073*	0.094**
	(0.043)	(0.041)	(0.040)	(0.041)
Inflation$_t$	0.132*	0.142*	0.132*	0.065
	(0.073)	(0.074)	(0.075)	(0.072)
Ln total assets$_{t-1}$	7.118***	6.993***	7.472***	7.652***
	(1.773)	(1.741)	(1.762)	(1.769)
Ln total assets$^2_{t-1}$	-0.220**	-0.215**	-0.249**	-0.260**
	(0.102)	(0.100)	(0.101)	(0.102)
Return on assets$_{t-1}$	-0.293***	-0.290***	-0.285***	-0.296***
	(0.062)	(0.061)	(0.062)	(0.063)
Impaired loans$_{t-1}$	-0.002	-0.004	-0.001	0.003
	(0.019)	(0.019)	(0.019)	(0.019)
Supervisory forbearance discretion$_t$	-0.365***	-0.270	-0.431**	-0.607***
	(0.138)	(0.182)	(0.179)	(0.187)
Various factors mitigating moral hazard$_t$	0.454	0.396	0.381	0.373
	(0.371)	(0.352)	(0.357)	(0.341)
Time fixed effects	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Number of observations	10,755	10,755	10,755	10,755
R-squared	0.075	0.076	0.080	0.086
Number of banks	2,767	2,767	2,767	2,767

The estimated direct effect of the bank levy dummy in column 4 implies that for banks in countries with a levy in place, the liabilities to assets ratio is 4.3 percentage points lower than for the other banks, on average, if $CIT = 0$. Given the sample mean of 89.6%, this corresponds to a reduction in leverage of about 5% at the sample mean. Regarding the coefficient on CIT, we find that an increase in the CIT rate of one standard deviation (5.1 pp) translates into an increase in leverage of 0.6 percentage

points if no levy is in place ($Levy = 0$).[14] When it comes to the total marginal effect of bank levies, depending on the CIT, the estimated coefficients suggest that at the sample mean of the CIT (30.2%), the introduction of a bank levy reduces (increases) bank leverage (bank equity) by 0.4 percentage points. For the equity to assets ratio of the average bank (10.4%), in turn, this means an increase by around 4%. From a financial stability perspective, higher capital buffers in response to the introduction of a levy increase the distance to default in case of idiosyncratic or systemic shocks resulting into balance sheet losses.[15] For the countries with the lowest CIT rates in the sample (10%), the corresponding marginal effect on leverage amounts to minus 3 percentage points. This is reflected in a significant rise in the ratio of equity to assets of about 30% for the average bank. For comparison: Overall, the average equity to assets ratio of euro area banks increased by 36% between 2009 and 2014. In contrast, the marginal effect on leverage of introducing a bank levy is weakly positive for the maximum observed CIT rate (40.4%).

Figure 3a shows the whole range of marginal effects of bank levies on leverage, depending on CIT rates based on Table 5, column 4. It illustrates that the leverage-reducing effect of bank levies is most pronounced for banks in countries with low CIT rates. The higher the CIT rate, the smaller the favorable effect – from a regulatory perspective – of bank levies becomes. For the highest CIT rates in our sample, the sign of the effect changes. This positive but only weakly statistically significant marginal effect is mainly driven by the comparison of French and Spanish banks (subject to levies) with Italian banks (no levy). All three countries have high CIT rates and the positive effect of the levies is plausible, since the tax base in France and Spain is minimum equity requirements and deposits, respectively, rather than non-deposit liabilities. Thus, the baseline model points into an important direction for further analysis, namely that interaction effects between bank levies and CIT rates vary with the design of the bank levy.

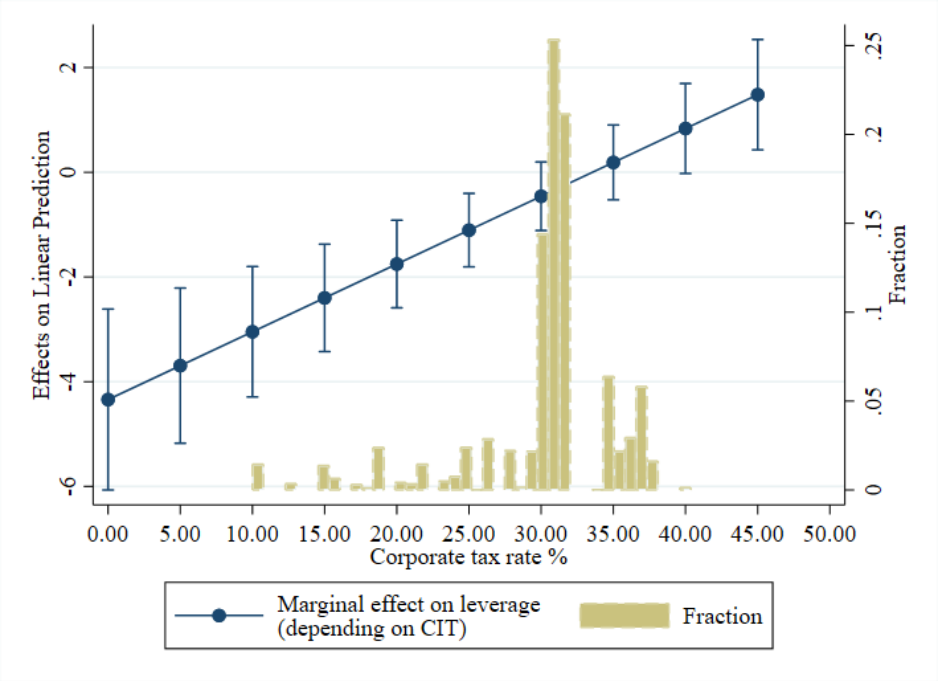
[14] The estimates are in line with De Mooij and Keen (2016) and Devereux et al. (2019).

[15] The link between banks' capital ratios and bank risk is also discussed by, e.g., Nguyen, Nguyen, and Nguyen (2019), BCBS (2019), Hogan (2015).

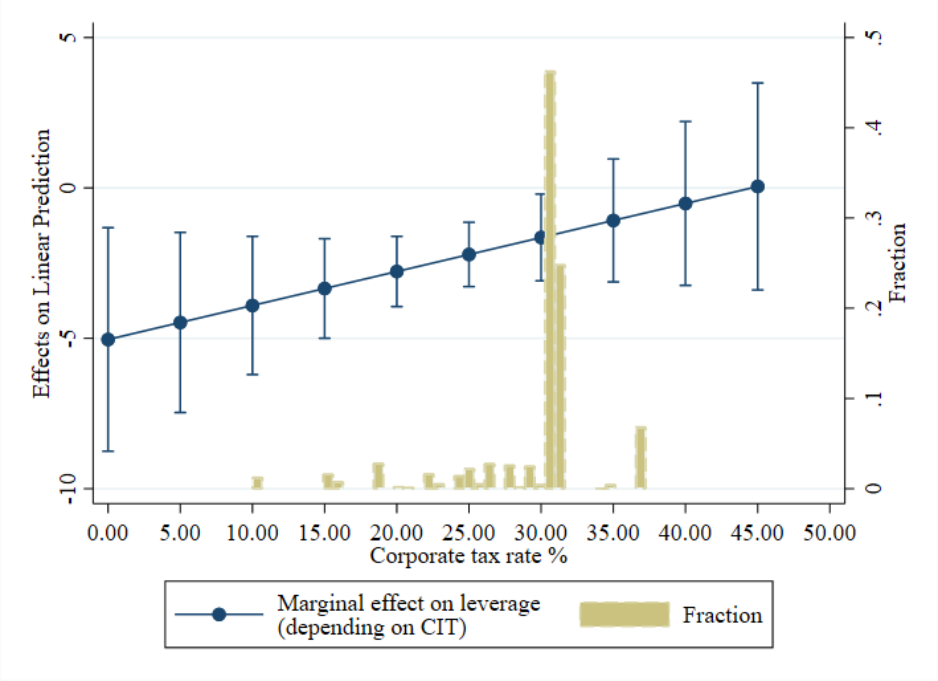
Figure 3: Marginal effects

This figure plots the marginal effects of levies (bank levy = 1 versus bank levy = 0) on bank leverage for the different observations of corporate income taxes (left hand side). On the right hand side, the fraction of observations for the histogram of corporate income taxes can be read. While subplot (a) shows the marginal effects for the entire country sample, subplot (b) summarizes the findings for the sample including countries where "liabilities minus deposits (L-D)" is the tax base of the levy. Source: Own calculations.

(a) Whole sample



(b) L-D sample



The estimated coefficients on the control variables are in line with the related literature. Bank leverage increases with bank size, but this effect levels off and turns negative for the largest banks. Higher profitability allows banks to accumulate equity, such that leverage declines. Bank risk, as measured by the ratio of non-performing loans to gross loans, inflation, and institutions mitigating moral hazard, do not seem to systematically affect leverage, whereas leverage tends to be higher during booms but lower in countries where supervisors have less discretion if banks violate the laws (higher values of the variable "supervisory forbearance discretion").

To rule out pre-event trends and to investigate how leverage evolves after the introduction of bank levies, we study the dynamics of leverage relative to the introduction of a bank levy. Following Beck, Levine, and Levkov (2010), we define dummies that equal zero except for one year before or after the introduction of the levy in a country. We consider four years pre-introduction given that our sample starts in 2006 and most countries start implementing the levy in 2010/11. The post-event window spans three years given that our sample ends in 2014. Leverage is then regressed on this set of dummies, as well as on bank and year fixed effects. Standard errors are clustered at the bank level. Figure 4 shows that pre-introduction no significant trend in leverage emerges. Immediately after the levy introduction, we find significant effects revealing a downward trend in leverage.

Figure 5 illustrates the dynamics of leverage around the introduction of a bank levy separately for banks in countries with CIT rates below and above the sample median. In both cases, there is no clear trend in leverage before the introduction of a bank levy. Post-implementation, though, the dynamic effects corroborate that banks reduce leverage in response to a levy in countries where CIT rates are low, whereas the leverage-reducing effect is insignificant in high-tax countries.

Figure 4: Dynamic effects of the introduction of a bank levy on leverage

This figure shows the impact of the introduction of bank levies on bank leverage measured as the percentage share of total liabilities in total assets (LA_{ict}) for a 7-year window. We consider potential effects four years before the introduction of a levy up to three years after, given that our sample period spans 2006 – 2014 and most countries introduced bank levies in 2010/11. Dashed lines represent 95-percent confidence intervals, adjusted for clustering at the bank level, circles represent point estimates from a regression of bank leverage on a set of binary variables: $ln(LA_{ict}) = \alpha_i + \gamma_t + \beta_1 Levy_{ct}^{-4} + \cdots + \beta_7 Levy_{ct}^{3} + \epsilon_{ict}$ where $Levy_{ct}^{-j}$ equals one j years prior to the introduction of a levy, and $Levy_{ct}^{j}$ is one j years thereafter. By leaving out the year of the introduction of the levy itself, we estimate its dynamic effects relative to the year of the introduction. Source: Own calculations following Beck et al. (2010).

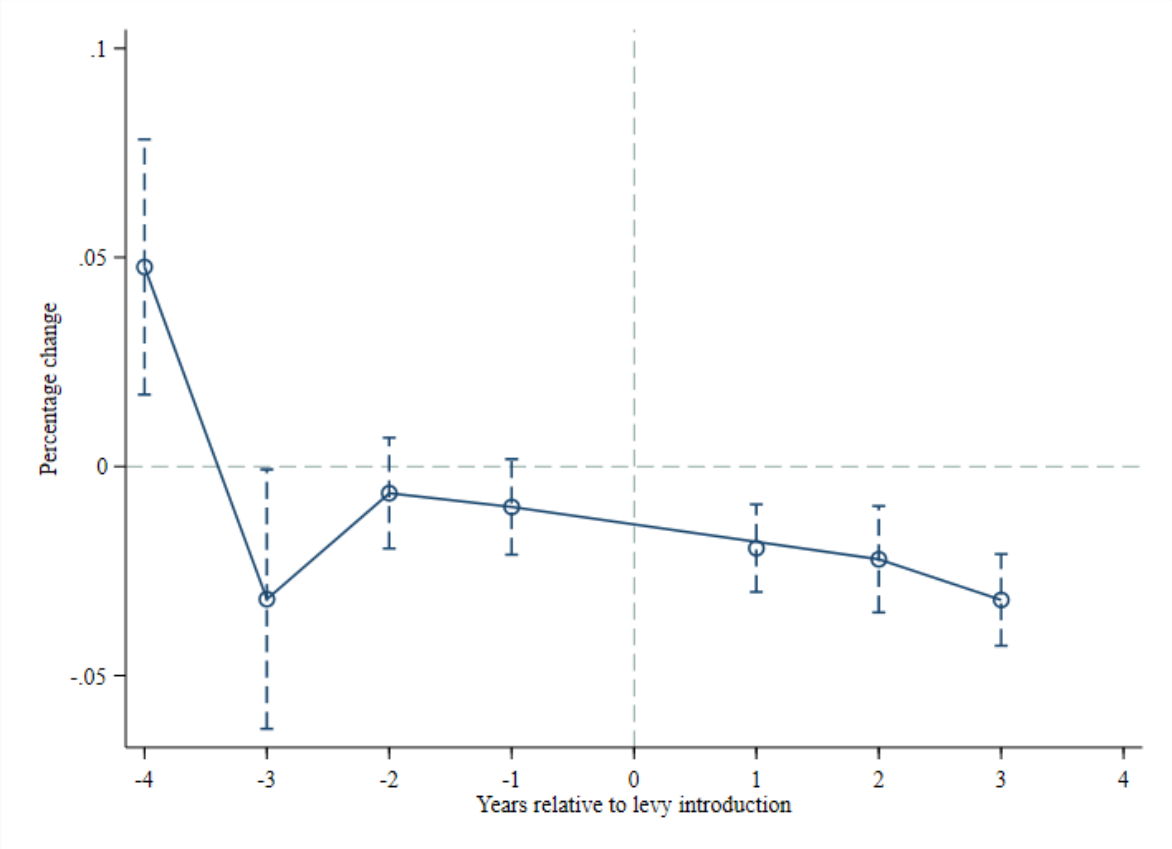
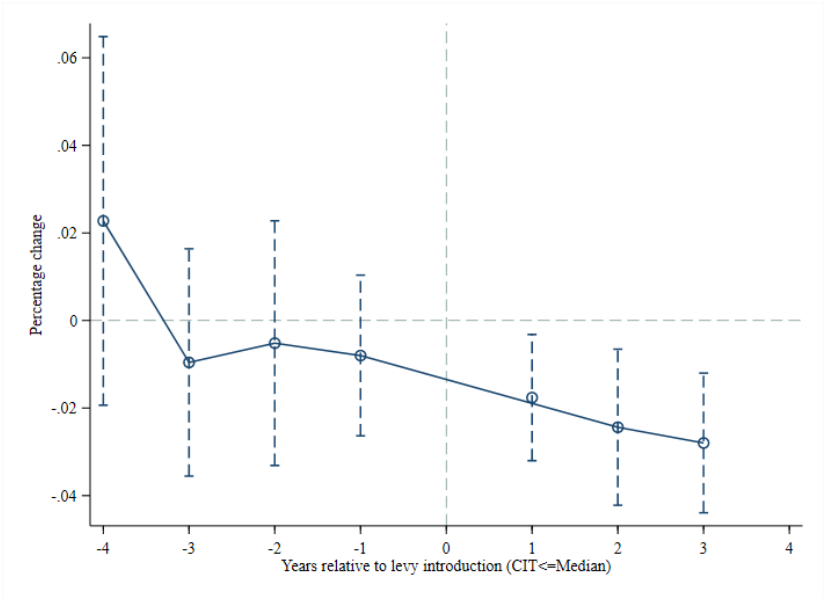


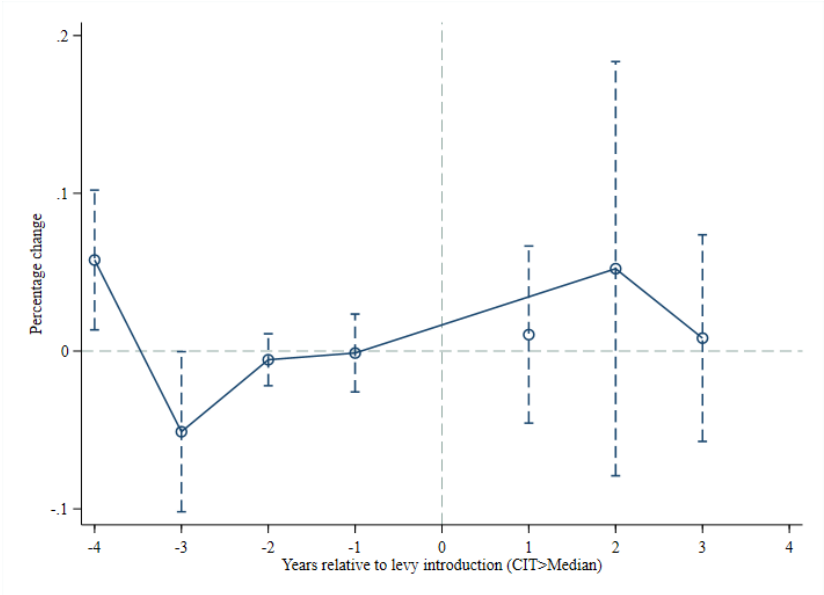
Figure 5: Dynamic effects of a bank levy for low- and high-CIT countries

This figure shows the impact of the introduction of bank levies on bank leverage (LA_{ict}) measured as the percentage share of total liabilities in total assets for a 7-year window. We consider potential effects four years before the introduction of a levy up to three years after, given that our sample period spans 2006 – 2014 and most countries introduced bank levies in 2010/11. Dashed lines represent 95-percent confidence intervals, adjusted for clustering at the bank level, circles represent point estimates from a regression of bank leverage on a set of binary variables: $ln(LA_{ict}) = \alpha_i + \gamma_t + \beta_1(Levy_{ct})^{-4} + \cdots + \beta_7(Levy_{ct})^3 + \epsilon_{ict}$ where $Levy_{ct}^{-j}$ equals one j years prior to the introduction of a levy, and $Levy_{ct}^{j}$ is one j years thereafter. The sample is split into banks located in countries c with a CIT rate in t equal to or below the sample median (panel a) and above the sample median (panel b). By leaving out the year of the introduction of the levy itself, we estimate its dynamic effects relative to the year of the introduction. Source: Own calculations following Beck et al. (2010).

(a) CIT rate below median



(b) CIT rate above median



4.2 The importance of the levy design

Since the design of bank levies differs across countries, in a next step, we split the regression sample according to the tax base of the levy. For those banks subject to a levy designed as a liabilities tax (L-D), theory predicts a negative link with leverage as a liabilities tax makes debt financing more expensive (Devereux et al., 2019). However, for banks affected by levies with a different tax base, like risk-weighted or total assets (Finland, Hungary, Slovenia), deposits (Cyprus, Ireland, Spain), or minimum capital requirements (France), the impact on leverage is not clear. To account for different levy regimes, we exclude, for example, bank observations of those countries that implemented a levy but did not design it as a liabilities tax over the whole sample period (compare also Appendix B).

The estimation results in Table 6 reveal that our baseline results are driven by banks subject to a levy in the form of a liabilities tax.[16] In countries where the levy design is not focused on making debt funding more expensive, levies do not promote a more stable bank capital structure by significantly reducing leverage, no matter how low or high the corporate tax rates are (columns 3 – 5). When focusing on countries with a liabilities tax (column 2), the leverage-reducing direct effect of the bank levy becomes stronger and the positive effects of CIT and of the interaction term between the levy and CIT on leverage remain. Even if, on average, the interaction term looses statistical significance, bank levies significantly reduce leverage unless CIT rates are very high: Figure 3b illustrates the marginal effect of a levy on bank liabilities on leverage, depending on the corporate income tax rate. Compared to Figure 3a, the estimations exclude all countries implementing a levy with a tax base other than liabilities minus deposits. It confirms the previous finding that bank levies reduce leverage more, the lower CIT rates are and, hence, the lower the debt bias of taxation is. However, in countries with high CIT rates, bank levies cannot be proven to be an effective tool for positively influencing capitalization. Their marginal effect is statistically insignificant

[16] Note that the sample size varies in this setup by construction, since we analyze different subgroups of countries depending on the design of the tax base of the levy.

Table 6: Determinants of bank leverage, depending on levy design

This table shows regression results based on the empirical specification of Equation (3). The estimation period covers 2006-2014. The dependent variable is total liabilities relative to total assets (in %). Bank levy is a country-level dummy variable that is one if a bank levy is in place and zero otherwise. Corporate tax rate is a continuous variable, also defined at the country level. Column 1 repeats the baseline results from Table 5, column 4. Columns 2-5 show the estimates for subgroups with regard to the levy design. The estimation sample covers countries with the respective levy tax base and countries that never implemented a levy. Bank-level controls are included with a lag and standard errors are clustered at the bank level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)
	Baseline	Tax base: L-D	Tax base: RWA or minimum equity requ.	Tax base: deposits	Tax base: total assets
Bank levy$_t$	-4.340***	-5.039***	-2.201	-1.302	3.330
	(0.882)	(1.896)	(4.455)	(1.297)	(6.928)
Corporate tax rate$_t$	0.111**	0.188***	-0.072	0.011	-0.174**
	(0.043)	(0.065)	(0.049)	(0.099)	(0.069)
Corporate tax rate$_t$ * Bank levy$_t$	0.129***	0.113	0.087	0.003	-0.168
	(0.027)	(0.078)	(0.130)	(0.040)	(0.350)
GDP growth$_t$	0.094**	0.116***	0.045	0.203**	0.056
	(0.041)	(0.044)	(0.034)	(0.084)	(0.039)
Inflation$_t$	0.065	0.093	0.197***	-0.309*	0.175**
	(0.072)	(0.066)	(0.075)	(0.184)	(0.074)
Ln total assets$_{t-1}$	7.652***	7.724***	6.579***	6.489***	6.417***
	(1.769)	(1.803)	(1.463)	(1.680)	(1.580)
Ln total assets$^2_{t-1}$	-0.260**	-0.235**	-0.225**	-0.198*	-0.194*
	(0.102)	(0.102)	(0.089)	(0.113)	(0.099)
Return on assets$_{t-1}$	-0.296***	-0.226***	-0.262***	-0.267***	-0.285***
	(0.063)	(0.064)	(0.069)	(0.077)	(0.075)
Impaired loans$_{t-1}$	0.003	0.002	0.021	0.014	0.013
	(0.019)	(0.021)	(0.020)	(0.024)	(0.021)
Supervisory forbearance discretion$_t$	-0.607***	-0.708***	-0.588***	-1.641***	-0.561***
	(0.187)	(0.177)	(0.187)	(0.459)	(0.183)
Various factors mitigating moral hazard$_t$	0.373	0.578	0.012	-0.826	0.386
	(0.341)	(0.364)	(0.375)	(0.670)	(0.436)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	10,755	9,165	6,224	5,454	5,212
R-squared	0.086	0.168	0.178	0.102	0.216
Number of banks	2,767	2,448	1,017	936	850

in these cases. Thus, the leverage-reducing effect of bank levies is more pronounced for the L-D design, i.e. for pure liabilities taxes. Our findings that bank levies only matter less in countries with a high CIT rate and that the effect of levies is stronger for countries implementing the L-D-design strengthen the argument brought forward in the related literature that bank levies reduce leverage through increased costs of debt (e.g. Célérier et al. (2018)).

In terms of economic significance, the estimated effects of the levy for the L-D-sample are – unsurprisingly – a bit larger compared to the effects for the full sample including all levy types: Table 6, column 2 reveals that leverage is 5 percentage points lower in countries with a liabilities tax in place. For those countries with the lowest CIT rates in the sample (10%), a levy leads to a reduction in leverage of 3.9 percentage points, whereas under the highest CIT rates (37%), a tax on liabilities still somewhat mitigates leverage (-0.9 percentage points relative to banks not subject to a levy). Thus, when comparing the results from Tables 5 and 6, it appears that bank levies that are designed as a tax on liabilities are more efficient in incentivizing a more stable bank funding structure, even for higher CIT rates.

Overall, the estimation results point to a favorable effect of bank levies on capitalization and this is the more so, the smaller the debt bias of taxation. For very high CIT rates, the resulting incentives for debt financing exceed the incentives from the bank levy to reduce leverage, such that the overall effect of the levies turns insignificant in these countries. Not surprisingly, the strengths of the levy-effect and, hence, its effectiveness to foster financial stability through lower leverage depends on levy design.

4.3 Potential sources of endogeneity

Regarding potential endogeneity issues, one could be concerned about reverse causality, meaning that high bank leverage drives the introduction of bank levies. However, this would imply a positive link between leverage and the introduction of bank levies, whereas we find a negative relationship between the two variables. Thus, our estimates would be biased downwards, such that they reflect a conservative estimate of the effect of levies on leverage if we do not fully control for reverse causality. Additionally, many countries did not primarily aim at influencing bank capital structure with the introduction of bank levies, but rather at filling bank resolution and restructuring funds. Lastly, we consider leverage at the bank level but control for the introduction of the levy at the country level. This approach lowers concerns about reverse causality

as individual banks might not drive the outcome of the regulatory process.

A further concern could be related to anticipation effects. For example, anticipating the introduction of bank levies, banks might, pre-introduction, lower leverage ratios in order to reduce regulatory costs. However, as bank levies were introduced quickly in most countries after first political discussion (see Section 3.2) and partially refer to balance sheets of years preceding the introduction (see e.g. Buch et al. (2016), Devereux et al. (2019)), it is unlikely that banks already adjusted their capital structure before the introduction. Again, such anticipatory adjustments would rather bias our results downwards because we would underestimate the full decline in leverage.

Finally, with respect to confounding factors that influenced bank capital structure at the same time as levies, we control for a large set of potential candidates. Disruptions due to the financial crisis, the European sovereign debt crisis, and expansionary monetary policy affecting all banks alike are captured by time fixed effects. Country-level macroeconomic developments, which obviously differed across the sample countries, and differences in the stance of regulation in the banking sector are controlled for by including a corresponding set of variables and country-level regulatory controls as described above.

As a response to the financial crisis, the regulatory framework has been reformed substantially with potential effects on banks' capital structure. However, our sample ends in 2014, whereas regulatory changes with respect to capital and liquidity requirements under Basel III were subsequently phased-in. Also, as concerns the establishment of the European Banking Union - one of the key regulatory changes in Europe after the financial and sovereign debt crisis - Koetter, Krause, and Tonzer (2019) show that many countries are delaying the implementation of the directives underlying the implementation of the European Banking Union into national law. Still, we control for different regulatory regimes and variation in individual banks' level of capital in robustness checks.

4.4 Robustness tests

We run several robustness checks in order to test the sensitivity of our results with respect to the timing and limits of bank levies (Table 7). Moreover, we analyze the sensitivity of our results to bank capital regulation (Table 8).

We first assess whether changes in the levy rate, the timing of the levy introduction, and the included banks and countries impact on our findings. Table 7 reveals that our baseline results (Table 5, column 4) are driven by banks in countries with an increasing levy rate over time (column 2) and by banks that were subject to bank levies early on (2012 or earlier, columns 3 - 4).[17] The latter result might reflect that levies have been most effective in countries implementing them relatively quickly after first political discussions such that banks could not adjust *ex ante*.

To test whether the composition of banks and countries matters for our results, we account for the fact that in many countries, smaller banks face exemptions from the levy. For the four countries which have an explicit lower limit on the tax base, namely Austria (1 billion Euros), Germany (300 million Euros), the Netherlands (20 billion Euros), and the UK (20 billion Pounds), we use the Bankscope data to calculate the tax base as closely as possible. We then exclude those banks from the sample that fall below the respective limit and hence do not have to pay a levy. The results remain robust (Table 7, column 5) - only the magnitude of the coefficients slightly changes. Alternatively, we adjust the levy dummy and set it to zero for those banks falling below the limit while including them in the sample (column 6). The coefficients stay highly significant but again change slightly in magnitude.

[17] Sweden increased its levy rate in 2011 from 0.018% of non-deposit liabilities to 0.036%. Austria, Cyprus, France, Hungary, Latvia, and the United Kingdom also increased their levy rates (Budnik and Kleibl, 2018).

Table 7: Robustness checks, timing and limits

This table shows regression results based on the empirical specification of Equation (3). The estimation period covers 2006-2014 if not indicated otherwise. The dependent variable is total liabilities relative to total assets (in %). Bank levy is a country-level dummy variable that is one if a bank levy is in place and zero otherwise. Corporate tax rate is a continuous variable, also defined at the country level. For comparison, the baseline results from Table 5 are reported in column 1. Column 2 restricts the sample to banks in countries increasing the levy rate over time, while columns 3-4 present results for subsamples of countries that introduced levies relatively early. Column 5 excludes banks in Austria, Germany, the Netherlands and the United Kingdom that fall below the tax base limit. In column 6, the levy variable is set to zero for banks in countries that implemented a levy but which fall under the lower limit of the tax base. Column 7 adds a triple interaction with a size indicator being one if a bank has a mean value of total assets larger than the country mean and zero otherwise. All models include bank-level and country-level controls, as well as bank and time fixed effects. Bank-level controls are included with a lag and standard errors are clustered at the bank level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) Baseline	(2) Progressive levy	(3) Levy introduced 2011 or earlier	(4) Levy introduced 2012 or earlier	(5) Tax base limit (AT, DE, NL, UK)	(6) Levy=0 for banks under tax base limit	(7) Interaction with bank size indicator
Bank levy$_t$	-4.340***	-7.035***	-4.246***	-4.242***	-3.956***		-4.753***
	(0.882)	(1.348)	(0.921)	(0.875)	(0.839)		(1.204)
Corporate tax rate$_t$	0.111**	0.114***	0.102**	0.102**	0.077*	0.110**	0.115**
	(0.043)	(0.044)	(0.045)	(0.044)	(0.040)	(0.043)	(0.048)
Corporate tax rate$_t$ * Bank levy$_t$	0.129***	0.207***	0.115***	0.116***	0.129***		0.142***
	(0.027)	(0.039)	(0.028)	(0.027)	(0.027)		(0.036)
Corporate tax rate$_t$ * Bank levy$_t$ * Large bank							-0.039
							(0.048)
Corporate tax rate$_t$ * Large bank							-0.045
							(0.063)
Bank levy$_t$ * Large bank							1.316
							(1.670)
Bank levy$_{t,tax\ base\ adjusted}$						-3.318***	
						(0.904)	
Corporate tax rate$_t$ * Bank levy$_{t,tax\ base\ adjusted}$						0.108***	
						(0.029)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	10,755	7,142	10,382	10,453	8,377	10,755	10,755
R-squared	0.086	0.171	0.136	0.135	0.077	0.082	0.086
Number of banks	2,767	1,193	2,657	2,672	1,681	2,767	2,767

As a more sophisticated test for the role of smaller versus larger banks across countries, we add a triple interaction term of the bank levy, the corporate tax rate and an indicator variable being one for large banks and zero otherwise. The indicator variable is defined at the country level to account for country-specific designs of levies. It turns one if a bank has an average value of total assets that is larger than the country mean. Results show that large banks do not respond differently than smaller banks (column 7) - the coefficient of the triple interaction term is statistically insignificant.

Second, we extend our tests to capture different regulatory regimes (Table 8). Excluding the year 2014 (column 2), a year in which the banking sector regulation changed considerably, e.g., because of the introduction of important pillars and directives of the European Banking Union, does not affect our main result. To control more specifically for differences in capital regulation across countries, we use information by Cerutti, Correa, Fiorentino, and Segalla (2016); Cerutti, Claessens, and Laeven (2017) on changes in capital requirements, on the existence of a countercyclical capital buffer, and on the existence of a systemic capital surcharge. These different controls for capital regulation are separately included in the regression model. Furthermore, to capture overall changes in regulation, we add a more general index capturing macroprudential regulation (column 6), with higher values indicating that a higher number of different macroprudential tools is in place. While Basel III was only slowly phased in in 2013/14, it could still be the case that individual countries changed their macroprudential regulation in response to the financial crisis of 2007/08 and increased regulatory tightness.

Table 8: Robustness checks, capital regulation

This table shows regression results based on the empirical specification of Equation (3). The estimation period covers 2006-2014 if not indicated otherwise. The dependent variable is total liabilities relative to total assets (in %). Bank levy is a country-level dummy variable that is one if a bank levy is in place and zero otherwise. Corporate tax rate is a continuous variable, also defined at the country level. For comparison, the baseline results from Table 5 are reported in column 1. Column 2 excludes the year 2014. Columns 3-6 add controls for regulatory changes. Column 7 adds a triple interaction with an equity indicator being one if a bank has a mean value of the equity ratio larger than the sample mean and zero otherwise. In column 8, we add interactions of bank group and time fixed effects to the baseline model. Bank groups are based on the quartiles of bank equity ratios. All models include bank-level and country-level controls, as well as bank and time fixed effects. Bank-level controls are included with a lag and standard errors are clustered at the bank level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Baseline	Until 2013	Change in capital requ.	Countercyclical capital buffer	Systemic capital surcharge	Macroprudential index	Interaction with equity indicator	With bank group-time FE
Bank levy$_t$	-4.340***	-4.119***	-4.910***	-4.049***	-4.341***	-4.157***	-2.134***	-1.844***
	(0.882)	(0.861)	(1.031)	(0.878)	(0.882)	(0.928)	(0.745)	(0.608)
Corporate tax rate$_t$	0.111**	0.074*	0.091**	0.088**	0.111**	0.111**	0.088**	0.139***
	(0.043)	(0.045)	(0.044)	(0.042)	(0.043)	(0.043)	(0.036)	(0.039)
Corporate tax rate$_t$ * Bank levy$_t$	0.129***	0.131***	0.147***	0.120***	0.129***	0.126***	0.073***	0.059***
	(0.027)	(0.029)	(0.032)	(0.028)	(0.027)	(0.028)	(0.026)	(0.019)
ΔCapital requirement$_t$			-0.230					
			(0.182)					
Countercyclical capital buffer$_t$				-1.236*				
				(0.683)				
Systemic capital surcharge$_t$					-0.274			
					(0.753)			
Macroprudential index$_t$						-0.155		
						(0.177)		
Bank levy$_t$ * High equity							-4.825**	
							(2.079)	
Corporate tax rate$_t$ * High equity							0.029	
							(0.039)	
Corporate tax rate$_t$ * Bank levy$_t$ * High equity							0.126**	
							(0.062)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank group-time fixed effects	No	No	No	No	No	No	No	Yes
Number of observations	10,755	8,493	10,694	10,755	10,755	10,755	10,755	10,755
R-squared	0.086	0.083	0.087	0.087	0.086	0.086	0.090	0.247
Number of banks	2,767	2,577	2,753	2,767	2,767	2,767	2,767	2,767

The results presented in columns 3 - 6 remain remarkably robust, while tighter capital or macroprudential regulation stand in a negative relationship with the total liabilities to assets ratio. However, only the coefficient of the variable indicating that a countercyclical capital buffer is in place shows a significant and negative coefficient.[18] The reason for the robustness of our results when adding controls for capital regulation is most likely that capital regulation was applied quite uniformly across European countries and is thus captured by time fixed effects. Moreover, Basel III was slowly phased-in only at the very end of our sample period. Hence, significant effects on leverage might only be seen in the following years.

To control for differences in capitalization at the bank level, we created an indicator variable that takes on a value of one for all banks that have an average equity ratio larger than the sample mean and zero otherwise. This indicator captures whether a bank is less capital constrained compared to the sample mean (and thus less under pressure once capital regulation is tightened). In Table 8, column 7, we add a triple interaction of our interaction term of interest ($CIT_t * Levy_t$) and the "high equity" indicator. For "low equity" banks, we find significant results similar to the baseline case. Comparing results to "high equity banks", the coefficient of the triple interaction term is significantly positive implying that banks with an equity ratio above the sample mean show a different sensitivity than banks with lower equity ratios.

As before, the leverage reducing effect of the bank levy is lower with higher corporate income taxes. This is the more so for banks with higher equity ratios. Thereby, the total effect of the bank levy on leverage is close to zero for banks with a low equity ratio for an average CIT rate of 30% and approximately minus one for banks with a high equity ratio. Hence, banks with an equity ratio above the sample mean are more responsive to bank levies, which is similar to the result by Devereux et al. (2019) that low-risk banks increase equity ratios more than high risk banks in response to a levy. One potential reason could be that safer banks, i.e. those with a higher equity ratio,

[18] The insignificance of the coefficients of these variables is in line with Gropp and Heider (2010) who find that capital regulation is not that important when it comes to banks' capital structure.

find it easier to adjust to new regulation by deleveraging as raising capital is less costly than for risky banks.

Since adjustments in leverage due to changes in financial regulations or responses to the global financial crisis may have been heterogeneous across banks with different capitalization, we follow Devereux et al. (2019) and Kogler (2019) and account for bank group-specific time trends. For that goal, dummy variables are computed for each quartile of the equity ratio for the entire sample and are then interacted with year dummies (column 8). Adding these bank group-time fixed effects does not affect the sign or statistical significance of the baseline results, but reduces the size of the coefficient on the bank levy dummy as well as the coefficient on the interaction with the CIT rate.

Appendix C provides additional estimations to test the sensitivity of our results with respect to model specification. Table C1 shows the results for different years and alternative tax measures included. Controlling for the former is especially important considering that our sample includes a non-crisis period, the financial and sovereign debt crisis episode, and a period characterized by the re-regulation of the European banking sector with potentially different underlying dynamics in the banking system. When splitting the sample into different time periods to rule out that unobserved common factors drive our result, it appears that the results are statistically significant for the period after 2007 (column 2) and for the subperiods 2010-13 (column 3). Yet, the size of the estimated coefficients of the bank levy dummy and of the interaction term with the CIT rate is smaller (in absolute terms) in more recent years when compared to the baseline result.

To mitigate concerns about confounding dynamics over time or coefficients picking up specific group effects, we test the sensitivity of our main result to including the average CIT rates (column 4). Given that CIT rates tend to be changed in small steps and our sample period spans less than ten years, the average still provides useful

information at the country level.[19] The main result of the positive interaction between the CIT rate and the bank levy dummy variable remains intact. To verify whether the definition of the CIT variable drives our results, we control for the magnitude of alternative tax rates. In column 5, we include a proxy for the effective tax rate at the bank level which is the ratio of tax expenses to pre-tax profits. In column 6, we control for the implicit tax rate on corporate income at the country level as obtained from the European Commission.[20] Banks which had a higher effective tax burden relative to profits in the previous period are more likely to increase leverage. Similarly, if implicit tax rates on corporate income have been high in the past, banks in such countries tend to have higher levels of leverage. These additional results might suggest that in countries with more demanding tax regimes, banks try to compensate reduced margins by a higher equity multiplier.

Table C2 groups further robustness tests. Regarding bank business models, public ownership of banks, as identified from BankFocus for the year 2018, does not seem to affect the results (column 2). Public banks do not respond significantly differently compared to private banks. Furthermore, we assess whether the dynamics of interest differ for non-GIIPS and GIIPS countries by including a triple interaction term between the CIT, the levy and an indicator variable being one if a bank is located in a GIIPS country and zero otherwise (column 3). The coefficients of interest remain significant with the expected sign whereas we do not find that GIIPS countries respond differently. If we exclude banks classified as holdings from the sample, the results remain robust, too (column 4). Our main results also remain intact when adding country-level or bank-level controls to the model, like GDP per capita or the pre-tax profit ratio (columns 5-6). Clustering standard errors at the country level instead of at the bank level reduces statistical significance somewhat. Still, the interaction effect between bank levies and

[19]Because banks do not change countries, the average CIT rate at the country level is captured by bank fixed effects, so that only the coefficients of the bank levy variable and the interaction term are estimated.

[20]The European Commission provides data on these tax rates that express aggregate tax revenues as a percentage of the potential tax base for each field (labor, consumption, capital). See: `https://ec.europa.eu/taxation_customs/sites/taxation/files/implicit-tax-rates.xlsx`

the corporate income tax rate remains statistically significant at the 5%-level.

5 Conclusion

The goal of this paper is to analyze how the introduction of bank levies can reduce leverage of European banks, depending on the prevailing corporate income tax (CIT) rate. While corporate income taxes introduce a debt bias, bank levies can have less clear effects on banks' capital structure if, for example, equity is excluded from the tax base. Given substantial changes in the regulatory framework in Europe, including the introduction of a European bank levy to finance the Single Resolution Fund, understanding such interaction effects among regulatory and corporate income taxes is of utmost importance.

Our analysis reveals that bank levies promote a more stable bank capital structure with potentially positive effects for financial stability. However, this favorable effect is weaker, the higher the CIT rate that a bank is subject to and, hence, the stronger the debt bias of taxation. For EU-countries charging very high CIT rates, the leverage-reducing effect of bank levies is considerably lower because the incentives to use debt financing that result from the CIT system mitigate the opposite incentives set by the levies. Thus, there are non-negligible interaction effects between regulatory taxes and corporate taxes that should be taken into consideration when thinking about the goals and effectiveness of changes in one tax or the other.

We also show that the effectiveness of the levies as a tool to decrease leverage depends crucially upon levy design. Again, the leverage-reducing effect of bank levies taxing liabilities weakens with a higher debt bias of taxation. Not surprisingly, bank levies that tax bank liabilities reduce leverage, whereas levies with different tax bases like total assets, deposits, or minimum equity requirements do not show systematic effects upon bank capital structure. The latter tax schemes, hence, tend to serve primarily the goal of filling resolution funds only. Our analysis reveals that, ceteris paribus, a

reduction of systemic risk due to less wholesale financing and a better capital base is most likely in case bank levies target the liability side and are implemented in an environment of limited debt bias of taxation.

This result has the important policy implication that financial regulators should also have an eye on the specific design of regulatory levies and the interaction with other taxation schemes. In a broader context, our results imply that before introducing new regulation to target a specific outcome in banks' behavior, regulators have to assess possible interaction effects with (non-)regulatory measures that are found to impact the targeted variable. Otherwise, high regulatory effectiveness cannot be guaranteed.

Appendix A Data description

Variable	Description	Source
Bank-specific variables		
Total liabilities to total assets (in %)	Total liabilities relative to total assets	Bankscope
Ln total assets	Log of total assets (in US$ million)	Bankscope
Return on assets (in %)	Operating profit relative to average assets	Bankscope
Impaired loans (in %)	Impaired loans relative to gross loans	Bankscope
Taxes to pre-tax profits (in %)	Taxes relative to pre-tax profits	Bankscope
Pre-tax profit to assets (in %)	Pre-tax profit relative to total assets	Bankscope
Large bank (0/1)	Dummy variable that is 1 if the bank's mean total assets exceed the country average	Bankscope
High equity (0/1)	Dummy variable that is 1 if the bank's mean equity exceeds the sample mean	Bankscope
Government bank (0/1)	Dummy variable that is 1 if the bank is nationally owned by the state in 2018	Bankscope Ownership Module
Country-specific variables		
Bank levy (0/1 dummy)	Dummy variable that is 1 if a bank levy is in place and 0 otherwise	Based on Devereux et al. (2019), ECB's Macroprudential Policies Evaluation Database by Budnik and Kleibl (2018), Kogler (2019), Twarowska (2016), Ernst and Young (2016)
Bank levy tax base: L-D (0/1 dummy)	Dummy variable that is 1 if the bank levy in place uses the difference of liabilities (=total assets - equity) and deposits as tax base to calculate the levy	
Bank levy tax base: deposit based (0/1 dummy)	Dummy variable that is 1 if the bank levy in place uses deposits as tax base to calculate the levy	
Bank levy tax base: RWA or minimum equity requirement (0/1 dummy)	Dummy variable that is 1 if the bank levy in place uses risk-weighted assets or minimum equity requirements as tax base to calculate the levy	
Bank levy tax base: total assets (0/1 dummy)	Dummy variable that is 1 if the bank levy in place uses total assets as tax base to calculate the levy	
Increasing levy rate (0/1 dummy)	Dummy variable that is 1 if the bank levy rate was increased after the introduction	ECB's Macroprudential Policies Evaluation Database by Budnik and Kleibl (2018)
Corporate tax rate (in %)	Sum of federal tax rate, local tax rate taking into account surcharge and deductibility of local taxes	Oxford University Centre for Business Taxation, KPMG (2014), Devereux et al. (2019)
GDP growth (in %)	Annual growth of GDP	International Financial Statistics, IMF
Inflation (in %)	Annual inflation rate	
Supervisory forbearance discretion (0-4)	Whether the supervisory authorities may engage in forbearance when confronted with violations of laws and regulation or other imprudent behavior (0-4, higher values indicate less supervisory discretion)	Barth et al. (2013)
Factors mitigating moral hazard (0-4)	The degree to which moral hazard exists (0-4, higher values indicate greater mitigation of moral hazard)	Barth et al. (2013)

Variable	Description	Source
GIIPS (0/1 dummy)	Dummy variable that is 1 if the country is GR, IE, IT, PT or ES	
ΔCapital requirement (0/1 dummy)	Dummy variable that is 1 if the country changes capital requirements in a year	Cerutti et al. (2016)
Countercyclical capital buffer (0/1 dummy)	Dummy variable that is 1 if the country has a countercyclical capital buffer	Cerutti et al. (2017)
Systemic capital surcharge (0/1 dummy)	Dummy variable that is 1 if the country has a systemic capital surcharge	Cerutti et al. (2017)
Macroprudential index (0/1 dummy)	Index summing macroprudential regulation in place (0-12)	Cerutti et al. (2017)
Implicit tax rate on corporate income (in %)	Implicit tax rate on corporate income	OECD
GDP per capita (in trillion USD)	GDP per capita (current values)	International Financial Statistics, IMF

Appendix B Country sample and tax base

This table presents the country samples depending on the tax base applied for the levy. Countries in **bold font** are those that introduced a levy, while the other countries did not have a levy in place during our sample period (2006 – 2014). In the second column, the L-D sample is shown including only countries in which the tax base is "Liabilities (=total assets – equity) – deposits (L-D)" and countries without a levy. The third column shows the year when the levy was implemented. The broad definition of the tax base is indicated in the fourth column. The final column shows the source of the information in those cases we draw on information beyond the one provided in Devereux et al. (2019) and the ECB's Macroprudential Policies Evaluation Database by Budnik and Kleibl (2018).

Baseline sample	*L-D sample*	*Implementation*	*Tax base*	*Source (if additional to:* Devereux et al. (2019); Budnik and Kleibl (2018))
Austria	**Austria**	**2011**	**L-D**	
Belgium	**Belgium**	**2012**	**L-D**	
Bulgaria	Bulgaria	No levy	No levy	
Cyprus	-	**2011**	**Deposits**	
Czech Republic	Czech Republic	No levy	No levy	
Denmark	Denmark	No levy	No levy	
Estonia	Estonia	No levy	No levy	
Finland	-	**2013**	**Risk-weighted assets**	Twarowska (2016)
France	-	**2011**	**Minimum equity requirement**	
Germany	**Germany**	**2011**	**L-D**	
Greece	Greece	No levy	No levy	
Hungary	-	**2010**	**Total assets**	
Ireland	-	**2014**	**Deposits**	
Italy	Italy	No levy	No levy	
Latvia	**Latvia**	**2011**	**L-D**	
Lithuania	Lithuania	No levy	No levy	
Luxembourg	Luxembourg	No levy	No levy	
Malta	Malta	No levy	No levy	
Netherlands	**Netherlands**	**2012**	**L-D**	
Poland	Poland	No levy	No levy	
Portugal	**Portugal**	**2011**	**L-D**	
Romania	**Romania**	**2011**	**L-D**	
Slovakia	**Slovakia**	**2012**	**L-D**	
Slovenia	-	**2011**	**Total assets**	
Spain	-	**2014**	**Deposits**	http://www.elexica.com/en/legal-topics/tax/09-spain-new-tax-on-bank-deposits
Sweden	**Sweden**	**2009**	**L-D**	
United Kingdom	**United Kingdom**	**2011**	**L-D**	

Appendix C Additional robustness checks

Table C1: Robustness checks, model specification I

This table shows regression results based on the empirical specification of Equation (3). The dependent variable is total liabilities relative to total assets (in %). Bank levy is a country-level dummy variable that is one if a bank levy is in place and zero otherwise. Corporate tax rate is a continuous variable, also defined at the country level. For column 1 and columns 4-6, the estimation period covers the years 2006-2014. Columns 2-3 show estimates for alternative sample periods. Column 4 interacts the bank levy with the average corporate income tax at the country level. Column 5 adds as a control the tax to pre-tax profit ratio and column 6 adds the countries' implicit tax rate on corporate income. All models include bank-level and country-level controls, as well as bank and time fixed effects. Bank-level controls are included with a lag and standard errors are clustered at the bank level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	After 2007	2010 till 2013	Average CIT rate	Control: Tax/Pre-tax profit	Control: Implicit tax rate
Bank levy$_t$	-4.340***	-2.909***	-1.993**	-3.447***	-3.829***	-3.963***
	(0.882)	(0.874)	(0.930)	(0.860)	(0.828)	(0.858)
Corporate tax rate$_t$	0.111**	0.329***	0.257**		0.135***	0.129***
	(0.043)	(0.080)	(0.119)		(0.042)	(0.045)
Corporate tax rate$_t$ * Bank levy$_t$	0.129***	0.082***	0.080***		0.113***	0.109***
	(0.027)	(0.028)	(0.026)		(0.026)	(0.028)
Avg. corporate tax rate * Bank levy$_t$				0.102***		
				(0.028)		
Taxes to pre-tax profits$_{t-1}$					0.006***	
					(0.002)	
Implicit tax rate on corporate income$_t$						0.036*
						(0.020)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	10,755	9,759	5,709	10,755	10,531	10,714
R-squared	0.086	0.080	0.045	0.079	0.086	0.089
Number of banks	2,767	2,723	2,461	2,767	2,741	2,760

Table C2: Robustness checks, model specification II

This table shows regression results based on the empirical specification of Equation (3). The estimation period covers the years 2006-2014. The dependent variable is total liabilities relative to total assets (in %). Bank levy is a country-level dummy variable that is one if a bank levy is in place and zero otherwise. Corporate tax rate is a continuous variable, also defined at the country level. Column 2 includes a triple interaction with government ownership, column 3 with a GIIPS indicator. In column 4, bank holdings are excluded. Columns 5 and 6 add controls. All models include bank-level and country-level controls, as well as bank and time fixed effects. Bank-level controls are included with a lag and standard errors are clustered at the bank level (excluding the last column). ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Baseline	Interaction with state ownership indicator	Interaction with GIIPS indicator	W/o bank holdings	Control: GDP per capita	Control: Pre-tax profit ratio	Std. err. clustered at country level
Bank levy$_t$	-4.340***	-4.300***	-1.889**	-4.369***	-3.501***	-4.384***	-4.340**
	(0.882)	(0.925)	(0.920)	(0.888)	(0.869)	(0.877)	(1.643)
Corporate tax rate$_t$	0.111**	0.139***	0.379***	0.112**	0.091**	0.110**	0.111
	(0.043)	(0.043)	(0.086)	(0.044)	(0.042)	(0.043)	(0.106)
Corporate tax rate$_t$ * Bank levy$_t$	0.129***	0.129***	0.063*	0.130***	0.104***	0.130***	0.129**
	(0.027)	(0.028)	(0.034)	(0.028)	(0.028)	(0.027)	(0.054)
Corporate tax rate$_t$ * Bank levy$_t$ * Government bank		0.248					
		(0.154)					
Bank levy$_t$ * Government bank		-5.577					
		(4.218)					
Corporate tax rate$_t$ * Government bank		-0.165					
		(0.229)					
Corporate tax rate$_t$* Bank levy$_t$ * GIIPS			0.248				
			(0.154)				
Bank levy$_t$ * GIIPS			-5.577				
			(4.218)				
Corporate tax rate$_t$ * GIIPS			-0.165				
			(0.229)				
GDP per capita$_t$					-0.173***		
					(0.035)		
Pre-tax profit to assets$_{t-1}$						-0.244***	
						(0.081)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	10,755	10,477	10,755	10,729	10,755	10,755	10,755
R-squared	0.086	0.087	0.095	0.086	0.092	0.087	0.086
Number of banks	2,767	2,686	2,767	2,761	2,767	2,767	2,767

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