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Evidence from European bank levies*

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Abstract

In the wake of the financial crisis, a number of countries have introduced levies on bank borrowing with the aim of reducing risk in the financial sector. This paper studies the behavioral responses to the bank levies and evaluates the policy. We find that the levies induced banks to borrow less but also to hold more risky assets. The reduction in funding risk clearly dominates for banks with high capital ratios but is exactly offset by the increase in portfolio risk for banks with low capital ratios. This suggests that while the levies have reduced the total risk of relatively safe banks, they have done nothing to curb the risk of relatively risky banks, which presumably pose the greatest threat to financial stability.

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1 Introduction

Excessive risk-taking by financial institutions is widely regarded as the main cause of the global financial crisis in 2007-2008 (Diamond and Rajan, 2009; Brunnermeier, 2009). Prior to the crisis, banks invested heavily in mortgage-backed securities, the risk of which was grossly underestimated, while at the same time relying increasingly on short-term borrowing for funding. As real estate markets weakened and losses on mortgage-backed securities mounted, the equity capital of many banks was quickly wiped out and uncertainty about the solvency of counterparts caused money markets to freeze (Gorton and Metrick, 2012; Shin, 2009). To avoid a collapse of the entire financial system, governments intervened by providing banks with credit lines, loan guarantees and new capital (Laeven and Valencia, 2013). While the collapse was avoided at a staggering cost, the crisis nevertheless spread to the real economy where firms suffered from the ensuing decline in lending by troubled banks (Ivashina and Scharfstein, 2010; Santos, 2011; Chodorow-Reich, 2013).

By making it painfully clear that distressed banks can impose very significant costs on tax payers, other banks and non-financial firms, the financial crisis has revived an old debate about government intervention in the financial sector. Many scholars have argued in favor of tightening capital requirements (e.g. Admati et al., 2010; Hart and Zingales, 2011). This stance is supported by the theoretical arguments that banks with more capital have more incentives to monitor borrowers (Allen, Carletti and Marquez, 2011) and less incentives to invest in excessively risky assets (Acharya, Mehran and Thakor, 2011) and by empirical analysis showing that banks with more capital generally fare better during a financial crisis (Berger and Bouwman, 2013; Beltratti and Stulz, 2012). In response to the crisis, the Basel capital requirements, the cornerstone of international financial regulation, have indeed been strengthened moderately.

Recognizing that externalities can be addressed with taxation as well as regulation, a number of countries, including the UK and Germany, have introduced a new type of bank levy proposed by the IMF (2010). The bank levies typically fall directly on bank borrowing and have a clear Pigouvian rationale: given that the social cost of bank distress exceeds the private cost, there is scope for a corrective tax on the types of bank funding that increase the risk of distress. By raising the cost of borrowed funds, the levies are

designed to increase stability in the financial sector by inducing banks to rely more on own capital. Some levies have more elaborate features, most of which can be rationalized within a Pigouvian framework. In the UK and Netherlands, for instance, short-term borrowing is taxed at a higher rate than long-term borrowing since the former involve a larger refinancing risk than the latter (Perotti and Suarez, 2011). In Germany and other countries, the levy rate structure is progressive presumably reflecting that the external cost of bank failure is higher for large banks than for small banks.

This paper studies how banks responded to the levies with the ultimate aim of assessing whether the levies have been successful in reducing risk in the financial sector. We draw on detailed information from the financial reports of more than 5,000 European banks and exploit that the adoption of bank levies constitutes a rich natural experiment with several types of variation. First, 11 countries in the European Union ("EU") adopted levies over the period 2009-2011 while the remaining 16 countries did not. Second, levy rates vary substantially *between countries* that have adopted a levy. Third, marginal levy rates vary *within countries* both in the cross-sectional dimension due to progressivity in the rate structure and in the time dimension due to rate changes. We exploit all these types of variation in a panel model that spans the period 2008-2011. The model includes standard determinants of capital structure at the bank and country levels as well as bank fixed effects to capture the permanent components of capital structure (Lemmon, Roberts and Zender, 2008).

Our first main finding is that bank levies had a statistically and economically significant effect on banks' funding choices. Specifically, our results suggest that banks raised their equity-asset ratio by 1 to 1.5 percentage points on average in response to the levies. This holds in a range of different specifications and is robust to the inclusion of region-specific, bank-size specific and equity-ratio specific non-linear time trends where identification effectively derives from comparisons of banks within the same region, of the same approximate size and with the same approximate equity-asset ratio. The causal interpretation of the estimates is further supported by the finding that banks affected by the levies had the same pre-levy trends in equity-asset ratios as other banks and by a placebo test on a sample of large non-financial firms.

These results suggest that bank levies can be quite successful in reducing banks'

funding risk. The banks in our sample initially had an equity-asset ratio of around 0.13, so the benchmark estimate of 0.015 suggests that bank levies caused an increase in the equity-asset ratio of an average bank of more than 10%. Importantly, we find that the increase in equity-asset ratios is driven by an increase in the stock of equity rather than a decrease in the stock of assets. This matters for policy purposes if there are concerns that banks may respond to the levies by slashing lending to households and non-financial firms to the detriment of the real economy.

Our second main finding is that bank levies, despite changing directly only the incentives underlying banks' funding choices, also had an effect on banks' portfolio choices. Specifically, we find that banks changed their portfolio of assets in response to the levies so as to increase the average regulatory risk weight by around 3%. We argue that this is likely to be the result of an unintended interaction with financial regulation, which imposes a minimum ratio of bank capital to *risk-weighted* assets. Hence, to the extent that banks raise more capital because of the levies, they are also able to increase the risk of their assets while still complying with the regulatory capital requirements.

These results suggest that the bank levies, which are designed to reduce the risk of the financial sector, actually lead to an increase in banks' portfolio risk. This result relates to a classical theoretical literature on risk shifting, which shows that when regulators limit banks' funding risk by imposing capital requirements, banks optimally undo the effect on their total risk, at least partly and sometimes more than fully, by taking on more portfolio risk (Koehn and Santomero, 1980; Kim and Santomero, 1988). It also relates to recent theoretical analysis of the interaction between banking regulation and taxation (Keen, 2011).

An important limitation of these results is our crude measurement of portfolio risk. While it is well-known that regulatory risk weights are imperfect measures of portfolio risk (Hellwig, 2010), they are frequently used in the literature (e.g. Jacques and Nigro, 1997; Rime, 2001; Keen and de Mooij, 2012) and have been shown to correlate with outcomes such as the share of non-performing loans and bank failure (Avery and Berger, 1991). Regardless of their correlation with true portfolio risk, regulatory risk weights are perfectly suited to detect portfolio changes in response to the bank levies if, as we argue, the levies affect portfolio choices through an interaction with regulation.

Our third set of findings concern the heterogeneity in banks' responses to the bank levies. We show that while banks with a high initial level of capital increased their equity-asset ratio most in response to the levies, only banks with a low initial level of capital increased the risk of their assets. The latter finding supports the interpretation that the indirect effect of levies on portfolio choices is due to the interaction with financial regulation, which is more likely to be a binding constraint for banks with low levels of capital.

These results suggest that the intended behavioral response, the decrease in funding risk, was largest in relatively safe banks whereas the unintended response, the increase in portfolio risk, occurred only in relatively risky banks. This seems to imply that the levies were more successful in reducing total risk in initially safe banks than in initially risky banks. We obtain this result directly by using the ratio of regulatory capital to risk-weighted assets, which captures both funding risk (in the numerator) and portfolio risk (in the denominator), as a measure of total risk. We find that the effect of the levies on this measure was significantly positive for banks with a high initial level of capital and precisely zero for banks with a low initial level of capital.

The main contribution of the paper is to evaluate a new type of government intervention in the financial markets: levies on bank borrowing have already been introduced in important banking centers such as the U.K. and Germany with the aim of enhancing financial stability and are currently under consideration in many other countries including the U.S. Our assessment of the levies is somewhat mixed: there is evidence that banks have reduced funding risk considerably in response to the levies, but it also appears that some banks have undone the effect on total risk by taking on more portfolio risk. Specifically, the levies seem to have reduced risk in the relatively safe banks while there are no signs that they have curbed risk in the relatively risky banks, which presumably pose the greatest threat to financial stability.

The remainder of the paper is structured in the following way. Section 2 provides background information about the bank levies; Section 3 sets out a brief conceptual framework linking funding and portfolio risk and analyzing the impact of a bank levy; Section 4 describes the data; Section 5 presents the results; and Section 6 concludes.

2 The bank levies

In the wake of the financial crisis, the IMF promoted levies on the risky part of bank funding as a tool to increase revenue collection from the financial sector while at the same time contributing to financial stability by incentivizing banks to adopt less risky capital structures. Bank levies of some form have been adopted in a number of countries and are still under consideration in many others. In the US, for instance, the Financial Crisis Responsibility Fee was first proposed by the Obama Administration in 2010 and is included in its budget proposal for 2014.

Table 1 describes key characteristics of the 14 bank levies that had been implemented in the EU by the end of 2012.[1] The most common levy design adopted by 11 countries (Austria, Belgium, Cyprus, Germany, Netherlands, Latvia, Portugal, Romania, Slovakia, Sweden and the UK) taxes some measure of bank liabilities. While the levies are conceptually very similar, some variation exists. First, most of the levies fall on total liabilities net of customer deposits that are guaranteed under a deposit insurance scheme, but two countries (Cyprus and Portugal) include insured deposits in the levy base. Second, most levies treat short-term and long-term liabilities symmetrically, but two countries (UK and the Netherlands) apply a reduced rate to liabilities with a maturity exceeding one year. Third, most of the levies apply a flat rate, but four countries (Austria, Germany, Netherlands and the UK) have a progressive rate structure where small banks are taxed at lower rates than large banks or not taxed at all. Finally, the UK rules have several provisions that narrow the taxable base, which are not found in other countries: most notably, they allow for the netting of gross assets and liabilities against the same counterpart and grant a deduction for highly liquid assets.

Table 1 around here

Most of these departures from the general principle of a flat levy on bank borrowing can be rationalized within a Pigouvian framework: provided that the deposit insurance is correctly priced, there is no rationale for additional taxes on insured deposits; long-term liabilities reduce the exposure to volatile money markets and thus the risk of distress;

[1] The Table captures only the most important features of the bank levies. More details are provided in the Online Data Appendix.

and the distress of large banks is likely to be associated with disproportionately large externalities due to their systemic role. One feature of the Austrian levy, however, seems to be motivated mostly by other considerations: the levies paid by Austrian banks in 2011-2013 were made with reference to the balance sheet in 2010, presumably to enhance the predictability of the government revenue to be raised by the levy. The fact that the law was passed very close to year-end in 2010 effectively eliminates the scope for behavioral responses to the levy during our sample period.

Three countries (France, Hungary and Slovenia) have adopted bank levies that are conceptually quite different from the design described above. In France, the taxable base is the minimum amount of capital necessary to comply with the regulatory requirements. In Hungary, the bank levy falls on total assets net of inter-bank lending. In Slovenia, the taxable base is total assets with no deductions, however, the levy is not due if either the level of lending to the non-financial sector or the growth in lending to the non-financial sector exceeds a threshold. It is not immediately clear how we should expect these three levies to affect banks' funding and portfolio choices. None of them directly change the incentives underlying funding choices and while one should expect the French levy to cause a decrease in portfolio risk, this is not obvious for the Hungarian and Slovenian levies. Because of these ambiguities, most of our empirical analysis omits the French, Hungarian and Slovenian banks from the sample and focuses on the 10 bank levies that fall on a similar and well-defined measure of bank liabilities.

It is important to note that several other policy initiatives aiming to enhance stability in the financial sector may directly and indirectly have affected banks' funding and portfolio choices. First, the new international framework for financial regulation, Basel III, to be phased in from 2013 will increase the minimum capital requirements in terms of risk-weighted assets and introduce a minimum leverage ratio in terms of total consolidated assets. It is likely that banks anticipating future regulatory requirements started adopting their capital structure already during our period of analysis. Note, however, that bank capital requirements are regulated at the EU level, hence it seems safe to assume that two otherwise similar banks located in two different countries within the EU were affected similarly by the regulatory changes. Second, in the aftermath of the financial crisis many governments intervened in the banking sector by providing distressed

banks with new equity and by guaranteeing their debt to third parties. In the countries most adversely affected by the crisis, these measures were very significant in size. In Ireland, for instance, government equity injections accumulated to around 4% of total bank assets over the period 2008-2011 and government guarantees of bank debt peaked at around 20% of total bank assets in 2009 (European Commission, 2012).

3 Conceptual Framework

We argued loosely in the introduction that a levy on bank liabilities should be expected to affect not only banks' funding choices but also their portfolio choices because of the interaction with bank regulation. To illustrate this mechanism, we develop a simple model of bank behavior in the presence of regulation and a bank levy. The model draws on Keen and de Mooij (2012), but extends it along several dimensions, notably by treating both funding and portfolio structure as fully endogenous outcomes. The model is not intended to capture all the complex channels through which a levy may affect bank choices and therefore makes a number of simplifying assumptions to focus on the channel that we believe is key, the interaction between the levy and bank regulation.[2]

A bank raises funds equal to 1, of which a fraction E_0 is in the form of equity and the remaining fraction L is in the form of debt. The bank invests a proportion α of its funds into risky assets with an uncertain, but on average positive, return $\theta - 1$, and the remaining proportion $1 - \alpha$ into a risk-free asset rate with a return that we normalize to zero. The cumulative distribution function of θ is $F(\theta)$. A bank levy at rate T is levied on L. Shareholders have limited liability. Abstracting from a potential regulatory penalty described below, the value of the equity of the bank after one period is therefore:

$$E = \max\{\alpha\theta + (1-\alpha) - L(1 + R(L) + T), 0\} \tag{1}$$

Inside the bracket, the first two terms are the values of the two types of assets, the third term is the liability to the lenders and the tax liability. If this is negative, then the bank defaults, and the shareholders receive zero. Lenders charge an interest rate of R. We

[2] A richer version of the model incorporating an endogenous risk premium on debt and equity is available on request.

assume that creditors of the bank are fully insured depositors. However, we also assume that the bank is large enough to exert some market power. As a result, it may need to increase the interest rate that it pays to depositors in order to borrow more. We capture this by making the interest rate a function of borrowing, $R_L > 0$. To simplify here, we assume that this relationship is linear, so that $R_{LL} = 0$; this is not crucial.

At the end of the period, the value of risk-weighted assets is $\alpha\theta$. The Basel regulatory requirement is that the ratio of equity to risk-weighted assets exceeds the minimum value, denoted B; that is:

$$\frac{E}{\alpha\theta} \succeq B \tag{2}$$

Given the initial choice of debt and the asset portfolio, the bank will fail to meet the Basel requirement if the realized value of the risky assets θ is below a cut-off value, θ^B given by:

$$\theta^B = \frac{1}{1-B}\left\{1 - \frac{1 - L(1 + R(L) + T)}{\alpha}\right\} \tag{3}$$

In the event of not meeting the Basel requirement, the bank faces a penalty P proportional to the shortfall in equity. Letting E^B denote the amount of equity that satisfies the Basel requirement, the penalty amounts to:[3]

$$P = c(E^B - E) = c\alpha(\theta^B - \theta) \tag{4}$$

where c is the penalty rate. The penalty reduces the value of E so that default occurs if:

$$\alpha\theta + (1 - \alpha) - L(1 + R(L) + T) - c\alpha(\theta^B - \theta) < 0$$

Given the initial choice of debt and risk, the bank will default if the rate of return on risky assets is below a cut-off value, θ^D given by

$$\theta^D = \frac{(1 - B + c)}{(1 - B)(1 + c)}\left\{1 - \frac{1 - L(1 + R(L) + T)}{\alpha}\right\} \tag{5}$$

Note that $\theta^D < \theta^B$ so that there is a range of realizations of θ where the bank fails to meet the Basel requirement but does not default.

[3]In practice, a bank could lose its licence to operate if it fails to meet the regulatory constraint. The penalty here is a more general proxy of the cost.

The bank makes funding and portfolio choices to maximize the return to the shareholders. It is convenient to express this as the expected value of equity at the end of the period, net of the potential penalty, and also net of the opportunity cost of equity finance, ρ. In principle, ρ reflects the risk inherent in owning the bank's equity; however we simplify by assuming that it is fixed. Hence, the bank chooses L and α to maximize:

$$\begin{aligned} W &= \int_{\theta^D}^{\infty} \{\alpha\theta + (1-\alpha) - L(1+R(L)+T))\} f(\theta)d\theta \\ &\quad - \int_{\theta^D}^{\theta^B} c\alpha(\theta^B - \theta) f(\theta)d\theta - (1+\rho)(1-L) \end{aligned} \tag{6}$$

The derivatives of W with respect to L and α can be stated as:

$$W_L = \rho - (R + T + LR_L) \int_{\theta^D}^{\infty} f(\theta)d\theta - c\alpha\theta_L^B \int_{\theta^D}^{\theta^B} f(\theta)d\theta \tag{7}$$

and

$$W_\alpha = \int_{\theta^D}^{\infty} (\theta - 1) f(\theta)d\theta - \int_{\theta^D}^{\theta^B} c(\theta^B - \theta + \alpha\theta_\alpha^B) f(\theta)d\theta \tag{8}$$

where $\theta_L^B > 0$ and $\theta_\alpha^B > 0$ are derivatives of θ^B with respect to L and α respectively.

It follows from (7) that a small increase in leverage changes the return to the shareholders through two channels: it affects funding costs by reducing the opportunity cost of equity finance by ρ (first term) while at the same time increasing the cost of debt finance by $R + T + LR_L$ in all states of the world where the bank does not go bankrupt (second term). It also adds to the penalty in all the states of the world where equity falls short of the Basel requirement but the bank does not go bankrupt (third term). Likewise, (8) shows that a small increase in asset risk changes W through two channels: it increases the expected return to assets (first term) but also adds to the penalty in all the states of the world where equity falls short of the Basel requirement but the bank does not go bankrupt (second term). Based on these insights, it is relatively straightforward to show how a bank levy shapes banks' optimal funding and portfolio choices:

Proposition 1 *A levy on bank debt induces banks to reduce its leverage ($dL/dT < 0$) and increase its asset risk ($d\alpha/dL > 0$)*

Proof. See the Appendix ■

Intuitively, if R is low, a bank can lower its funding costs by relying more on debt financing. It can also raise its expected investment return by investing more in risky assets. In the presence of bank regulation, however, banks balance these positive effects of risk-taking with a negative effect in the form of a higher penalty in the states of the world where equity falls short of the Basel requirement. When a levy on bank liabilities is introduced, the cost saving associated with debt financing is lowered, which induces the bank to rely less on debt and more on equity. This, in turn, implies that there are fewer states of the world in which the banks does not meet the Basel requirement and, hence, a lower marginal cost of increasing portfolio risk. In the new optimum, the bank therefore takes less funding risk and more portfolio risk.

While the model does not explicitly account for bank heterogeneity, it is fairly obvious that the mechanism we have modeled, by which a bank levy causes banks to increase portfolio risk, only applies to banks that are effectively constrained by the Basel requirement. If a bank, for reasons outside the model, initially has so much equity that the risk of violating the Basel requirement were zero, a further reduction in debt financing in response to a bank levy does not change the marginal costs and benefits of portfolio risk. We therefore conjecture that the positive effect of the bank levy on portfolio risk is larger for banks that are initially closer to the Basel constraint.

4 Data and measurement

Our main source of data is *Bankscope*, which contains information on balance sheets, income statements and regulatory reports taken from banks' annual reports. Table 2 summarizes balance sheet and regulatory information for the full sample of 5,087 banks from 27 European countries for the time period 2008-2011. As shown in column (2), the main source of funding for the average bank in the sample was customer deposits, which accounted for around 53% of total assets, whereas deposits from other banks accounted for around 17% and equity accounted for around 13%.[4] The average bank lent around 53% of its funds to customers, around 16% to other banks and held around 21% in

[4]While *equity/assets* falls between zero and one for the vast majority of banks, it takes very large negative values in the few cases where liabilities are very large relative to assets. To avoid that these extreme observations have an excessively large impact on our results, we exclude banks for which there are observations of equity/assets below -1. This reduces the sample by 31 observations.

securities. Finally, the average bank reported a regulatory capital ratio of around 16% and an average regulatory risk weight of assets of around 59%.[5] Note that not all banks publish regulatory information, hence the number of observations drops considerably when we move from balance sheet information to regulatory measures. Only around 60% of the banks in our sample disclose information about their regulatory capital ratio in their financial statements and only about 40% additionally report the stock of regulatory capital, which is required to back out the average risk weight.

Table 2 around here

We also report variable means separately for four subsamples. The key distinction in our empirical analysis is between banks that are subject to a levy and banks that are not. We therefore split the bank sample on whether the home country introduced a bank levy at some point during the period 2008-2012. As reported in columns (4)-(7), banks in levy countries and non-levy countries are reasonably comparable in terms of observable characteristics although banks in levy countries are somewhat larger, rely slightly more on deposits and less on long-term borrowing for financing and have somewhat riskier assets than banks in other countries. Moreover, an important endeavor of the paper is to investigate whether bank responses to the levies correlated with the extent to which they were constrained by regulation. For this purpose we split the sample on whether the ratio of regulatory capital to risk-weighted assets was above or below the sample median in 2008. As reported in columns (8)-(11), banks with high regulatory capital ratios were a lot smaller, relied more on equity and had slightly less risky assets than banks with low regulatory capital ratios.

The dependent variables are formed on the basis of these data. Our measure of funding risk is the ratio of equity to total assets both measured at book value. For several reasons, book values are more appropriate than the market values for our purposes. First, we would like our measure of funding risk to depend on the funding structure but not on the portfolio structure. While the book value of equity is unaffected by portfolio choices,

[5] In few cases, the average risk weight exceeds one; in the most extreme cases by several orders of magnitude. To avoid that these observations, which are necessarily due to errors in the financial reports, affect the results, we exclude banks for which there are observations of the average risk weight above 1. This reduces the sample by around 200 observations.

at least until these choices give rise to gains or losses, the market value of equity is likely to reflect all types of risk. Second, we are ultimately interested in active responses to the bank levies, such as share issues and changes in dividend policy, and we would therefore like to purge our measure of funding risk from the influence of other factors to the greatest extent possible. This suggests that book values are more suitable than market values, because the latter but not the former are affected by changes in expectations about future income and costs. One example of this mechanism is the bank levies themselves, which represent future costs for the banks and may therefore mechanically drive down the market value of equity holding banks' funding and portfolio choices constant.

Our measure of portfolio risk is the ratio of risk-weighted assets to total assets or, equivalently, the average regulatory risk weight of assets. It is well-known that regulatory risk weights are far from perfect measures of true portfolio risk. Since the adoption of the Basel II agreement, many banks have relied on their own estimates of the risk of assets and some commentators have expressed concern that the use of internal risk models have allowed banks to effectively circumvent the regulatory capital requirements by understating portfolio risk (e.g. Haldane, 2013). Despite their weaknesses, regulatory risk weights are probably the best available measure of portfolio risk and have been used extensively in the literature on bank responses to financial regulation (e.g. Rime, 2001) and taxation (Keen and de Mooij, 2012). Moreover, since the risk weights correspond precisely to the regulatory definition of portfolio risk, it is exactly this measure that should change if banks whose risk taking is effectively constrained by the regulatory capital requirements shift risk from the liability side of their balance sheet to the asset side in response to the levies.

Our measure of total risk is the ratio of regulatory capital to risk-weighted assets. This ratio captures both funding risk and portfolio risk and is the key variable used by financial regulators to assess the risk of individual banks. By incorporating the regulatory risk weights, it obviously suffers from the same measurement problems as the risk weights themselves.

The main explanatory variables concern the bank levies. Combining hand collected information from national legal texts, a survey by KPMG (2012) and other notes by professional tax advisers in the relevant countries, we have created a comprehensive

database with detailed information on the bank levies, which is available in the Online Data Appendix.[6] Drawing on this database, we construct two variables that capture the incentives facing banks. First, we construct a dummy variable for the existence of a bank levy at the country-year level. This variable is useful for policy evaluation purposes because it allows us to estimate the *average* effect of the levies that have been implemented on the outcomes of interest. Since we are interested in behavioral responses to the levies and the Austrian levy was effectively retroactive for 2011-2013, we code the dummy variable zero for this country. Second, we construct a measure of the marginal levy rate, which we define as the additional levy cost associated with a unit increase in taxable liabilities, at the bank-year level. In principle, this measure fully captures the within-country and between-country variation in marginal incentives across banks and allows us to directly estimate the tax responsiveness of the outcomes of interest. To construct the variable, we estimate the levy base for each individual bank and year on the basis of the balance sheet information and the legal definition of the levy base and identify the marginal levy rate applying to a base of that size. Details on the construction of marginal levy rates are available in the Online Data Appendix.

Finally, we employ a number of country-level and bank-level control variables including (i) inflation rates and real GDP growth rates from Eurostat; (ii) statutory corporate tax rates collected from the OECD Tax Database and the KPMG Corporate and Indirect Tax Survey 2011; (iii) information on government recapitalizations of distressed banks and government guarantees of bank debt from the European Commission (2012); and (iv) a list of the European banks faced with temporary additional capital requirements from the European Banking Authority (2011). These data are all available and documented in the Online Data Appendix.

[6] Available at the webpage: www.nielsjohannesen.net.

5 Results

5.1 Funding risk

We first explore the effect of bank levies on funding risk by estimating the extent to which the levies induced banks to rely more on equity funding. As a first step, we estimate the following baseline model:

$$\left(\frac{Equity}{Assets}\right)_{ict} = \alpha + \beta levy_{ict} + \gamma_{ic} + \theta_t + \phi \mathbf{X}_{ict} + \psi \mathbf{Z}_{ct} + \epsilon_{it} \tag{9}$$

where γ_{ic} denotes bank fixed effects, θ_t denotes time fixed effects and $\mathbf{X}_{ict}$ and $\mathbf{Z}_{ct}$ are vectors of bank-level and country-level control variables respectively. Bank fixed effects absorb all cross-sectional variation so that identification of the levy variable only derives from *changes* in the dependent variable. Time fixed effects absorb factors common to all banks such as changes in EU-level bank regulation. Unless stated otherwise, the sample includes all banks in the 27 EU countries except France, Hungary and Slovenia and the sample period is 2008-2011. Coefficients are reported with robust standard errors clustered at the bank level.

Table 3 reports results from this baseline model. As shown in column (1), the simplest specification with no control variables yields a highly significant estimate of β suggesting that bank levies on average raised equity-asset ratios by around 1.8 percentage points. The estimates are slightly lower but qualitatively unchanged when control variables are introduced. Columns (2) and (3) show that adding country-level covariates produces an estimate of around 1.6 percentage points while further adding bank-level covariates lowers the estimate to around 1.5 percentage points. Whereas country-level covariates are often insignificant and difficult to interpret, bank-level covariates are statistically significant and intuitive. The negative coefficient on assets (conditional on bank fixed effects) suggests that expansions of bank balance sheets tend to be financed with debt, which implies an erosion of the equity ratio. This is consistent with the findings in Adrian and Shin (2010). The positive coefficient on profitability reflects that profits in a given financial year mechanically translate into retained earnings on the end-of-year balance sheet and thus, everything else equal, increase the equity-asset ratio (at least until the profits are possibly paid out as dividends in the course of the following financial year).

Table 3 around here

Columns (4)–(6) show that the positive effect of levies on the equity-asset ratio remains when using the estimated marginal levy rate as explanatory variable. The estimated coefficient is highly significant across the three specifications. The coefficient in column (6) of around 0.26 suggests that banks subject to the UK marginal levy rate of 0.075% on average increased their equity-asset ratios by around 2 percentage points relative to banks subject to a zero marginal levy rate.

It is conceivable that the baseline results are driven by other shocks, which had a significant impact on bank capital structure and which were correlated with the implementation of levies. We address this concern in a number of robustness tests reported in Table 4.

First, there were several other governments interventions in the banking sector than the bank levies during the sample period. We attempt to control directly for those by augmenting the model with the following four variables: (i) cumulative government spending on bank recapitalizations measured as a fraction of total bank assets (European Commission, 2012); (ii) government guarantees of bank borrowing measured as a fraction of total bank assets; (iii) the share of bank assets invested in trading securities, which became subject to increased capital coverage requirements in 2011 and; (iv) a dummy variable coded one for banks that temporarily became subject to stricter capital requirements in 2011 (European Banking Authority, 2011). Column (1) reports the coefficients on the levy dummy (panel A) and the marginal levy rate (panel B) in two regressions that add controls for these government interventions to the baseline model. The coefficient on the levy measures is virtually unchanged compared to the baseline estimates.

Table 4 around here

Second, if the sovereign debt crisis in Greece, Portugal, Spain and Italy caused banks in Southern Europe to suffer greater losses than banks in other regions and if governments in Southern Europe were less likely to adopt bank levies than governments in other regions, this could cause a positive correlation between bank levies and equity ratios. We

control non-parametrically for regional shocks by including *region-specific time dummies* in the model. We define five geographical regions, each of which includes at least one country that has introduced a levy and at least one country that has not, and augment the model with interactions between region dummies and time dummies.[7] Note that in this specification, identification of the levy variables derives exclusively from within-region comparisons of banks that were subject to a levy and banks that were not. Column (2) shows that the effect of the bank levies is robust to region-specific non-linear time trends.

Third, small banks and large banks exhibit significant differences in funding and portfolio structure, hence banks of different sizes may have been exposed differently to the sovereign debt crisis and other major shocks to the financial sector during the sample period. If exposure to bank levies also correlates with size, for instance because of progressive levy rate structures or because countries with larger banks were more likely to adopt a bank levy, the baseline model produces biased estimates. We control for shocks correlating with bank size by including *bank size-specific time dummies* in the model: for each decile in the distribution of bank size in 2008 we construct a dummy and add its interactions with the time dummies to the baseline model. Column (3) shows that the estimated effect of the levies are almost unaffected.

Fourth, it is plausible that highly leveraged banks faced a strong market pressure to reduce leverage in the wake of the financial crisis. If countries with more leveraged banks were also more likely to adopt a bank levy, the baseline model would produce biased estimates. Analogous to the procedure applied above, we control for factors affecting banks with different leverage differentially by including *equity ratio-specific time dummies* in the model: for each decile in the distribution of equity-asset ratios in 2008 we construct a dummy and include its interactions with the time dummies in the baseline model. Column (4) shows that the coefficients on the levy variables hardly change. Fifth, column (5) shows that the bank levies remain economically and statistically significant when simultaneously including controls for other government interventions as well as region-specific, bank size-specific and equity ratio-specific time dummies.

[7] *Eastern Europe* is Poland, Estonia, Latvia, Lithuania, Czech Republic, Slovakia, Slovenia, Hungary, Romania and Bulgaria; *Southern Europe* is Spain, Portugal, Greece, Italy, Cyprus and Malta; *Northern Europe* is Denmark, Sweden and Finland; *Central Europe* is Austria, Germany, Netherlands, Belgium, France and Luxembourg; and the *British Isles* is the UK and Ireland.

Another possible concern is that the levy variables may pick up pre-existing differential trends in equity ratios. If banks hit by a levy were for some reason on different trajectories than other banks, this could show up in the estimated effects of the levies. To address this concern, we first construct a dummy variable for banks facing a positive marginal levy rate as well as three dummy variables indicating one year, two years and three years before marginal levy rate turned positive. We then estimate the baseline model with these variables.[8] As illustrated in Figure 1, the coefficients on the pre-levy dummies are small and insignificant suggesting that the pre-levy trend in equity-asset ratios did not differ between banks that were hit by a levy and those that were not.

Figure 1 around here

Finally, we conduct two placebo tests and report the results in Table 5. First, we estimate the effect of bank levies on the equity-asset ratios of non-banks.[9] If the estimated effect on banks were driven by unobserved shocks at the country-level, e.g. an increased supply of equity capital or pressure from investors to reduce leverage, it should be expected that such shocks would affect non-banks similarly. Columns (1)-(2) show that in the sample of non-banks, the effect of levies is small and insignificant in the baseline model and even negative when additional controls are introduced. Second, we estimate the effect of the Austrian, French, Hungarian and Slovene bank levies, which did not create an incentive to rely more on equity funding. If our results were driven by unobserved characteristics of countries that chose to adopt bank levies rather than the changed incentives created by the levies themselves, we should expect to find an effect on Austrian, French, Hungarian and Slovene banks similar to that on banks facing a levy on bank borrowing. We thus estimate the baseline model on a sample that includes banks in Austria, France, Hungary and Slovenia as well as banks in countries that did not introduce a levy. Columns (3)-(4) show that the coefficient on the levy dummy is small and insignificant in the baseline model and almost exactly zero when additional

[8] The sample period is extended to 2004-2011 to allow all levies to contribute to the identification of the pre-levy trends

[9] The sample is drawn from the database *Amadeus* and consists of the largest firms in the EU with the size threshold chosen so as to roughly match the number of observations of the bank sample.

controls are introduced.

Table 5 around here

We have conducted a number of other robustness tests, which are not included here due to space constraints (reported in the "Reviewer Appendix"). For instance, the positive effect of levies on equity ratios is robust to including the lagged dependent variable on the right hand side; to estimating the model in first differences; and to instrumenting the marginal levy rate, which is strictly speaking endogenous in countries with progressive levy rates, with the marginal levy rate that would have applied if banks had the exact same balance sheet as before the levies were introduced.[10]

5.2 Portfolio risk and total risk

While an increase in the equity-asset ratio is clearly an important objective of the bank levies, it is a concern that the levies may interact with regulation so as to induce banks to increase portfolio risk as highlighted by the conceptual framework.

To test whether bank levies have an effect on portfolio risk, we estimate the baseline model with the average regulatory risk weight as dependent variable. Table 6 reports the results. Columns (1)-(2) show that the levies had a highly significant effect on portfolio risk regardless of which of the levy measures is used. Column (1) suggests that the average bank changed its portfolio when a bank levy was introduced with the result that the average risk weight increased by around 2 percentage points. The average value of the risk variable in the sample is around 0.60 so the estimate implies an increase in risk weights of around 3%. Column (2) shows that these results survive when using the marginal levy rate as explanatory variable. The coefficient of around 0.5 suggests that the UK bank levy induced banks subject to the top marginal levy rate of 0.075% to increase the average risk weight of their assets by around 3.7 percentage points.

Table 6 around here

So far, our results have shown that bank levies were associated with a reduction in

[10] This is essentially the procedure applied by Gruber and Saez, 2002 in the context of personal income taxation.

funding risk and an increase in portfolio risk. To estimate the net effect of these two responses on total risk, we estimate (9) with the regulatory capital ratio as dependent variable. Columns (3)-(4) show that the effect of the levies on capital ratios is positive and statistically significant regardless of which of the levy measures is used. This suggests that the levies had a net positive impact on the robustness of the average bank. Specifically, column (3) suggests that the average bank increased its regulatory capital ratio by 0.8 percentage points, which corresponds to an increase of around 5%, when a bank levy was introduced. Column (4) suggests that a UK bank subject to the top marginal levy rate of 0.075% increased its regulatory capital ratio by around 1 percentage point in response to the levy.

5.3 Heterogeneity in responses

In the two previous sections, we estimated the effect of the bank levies on the funding and portfolio choices of an *average* bank. However, if the incentive for risk shifting works through the regulatory capital requirement, as argued above, this effect should be much stronger for banks that are effectively constrained by this requirement.

We test these hypotheses by constructing separate dummy variables for banks with a ratio of regulatory capital to risk-weighted assets below the median ("low capital") and above the median ("high capital") respectively. We then introduce interactions between these two dummy variables and the levy measure into the model, which effectively allows the effect of bank levies to differ between the relatively "risky banks" and relatively "safe banks".

Two caveats apply. First, we cannot allow the dummy variables for regulatory capital to vary over time since this would make them endogenous to risk taking. Hence, we define the dummy variables in terms of regulatory capital ratios in 2008, which is exogenous to later changes in risk taking induced by the levies. Second, the initial regulatory capital ratio may itself be an important determinant of future changes in risk taking. This would be the case if, for instance, negative shocks to the regulatory capital ratio induce banks to reduce risk taking in future periods so as to return to their target regulatory capital ratio. We address this issue by introducing interactions between the two dummies for high and low regulatory capital and the time dummies. By conditioning the time trend

on the initial regulatory capital ratio, we ensure that identification effectively derives from comparisons of banks with approximately the same initial regulatory capital ratio of which some were hit by a bank levy and some were not.

Column (1) in Table 7 reports the results from applying the baseline model to each of the three outcome variables while allowing for heterogenous responses as described above. As expected, levies increase the equity-asset ratio for both types of banks, but the effect is considerably larger for "safe banks" than for "risky banks" regardless of whether the levy dummy (panel A) or the marginal levy rate (panel B) is used as explanatory variable. Also as expected, levies increase the average risk weight for "risky banks" but not nearly as much for "safe banks" (panels C and D). Finally, levies have a positive effect on the regulatory capital ratio for "safe banks" but not for "risky banks" (panels E and F).

Table 7 around here

The next columns explore the robustness of these results by introducing controls for other government interventions (column 2), region-specific non-linear time trends (column 3), bank size-specific non-linear time trends (column 4) and equity ratio-specific non-linear time trends (column 5) separately and jointly (column 6). All the patterns of heterogeneous responses described above are fairly robust to the extensions. First, the estimated effect of levies on equity-asset ratios is significant for "safe banks" and larger than for "risky banks" in all specifications except one where the effect is similarly sized (panel A - column 5). Second, the estimated effect of levies on average risk weights is significant for "risky banks" and larger than for "safe banks" in all specifications Finally, the estimated effect of levies on regulatory capital ratios is significant for "safe banks" and insignificant for "risky banks" in all specifications (only borderline significance in panel F - column 5-6).

5.4 Behavioral mechanisms

In section (5.1), we documented a robust positive effect of bank levies on equity-asset ratios. This section takes a closer look at the behavioral mechanisms through which the equity-asset ratios were affected and reports the results in Table 8.

For policy purposes, it is important whether the increase in the equity-asset ratio was

achieved by a substitution of debt funding for equity funding for a given level of assets or by a reduction in assets for a given level of equity. In the latter case, the adverse effects on the real economy could potentially be severe if the reduction in assets were driven by a contraction in lending to non-financial firms. To test which of the two possible channels is most empirically relevant, we estimate the baseline model where the dependent variable is the equity stock (in logs) and the asset stock (in logs) respectively. Columns (1)-(2) show that equity stocks increased significantly in response to the levies whereas columns (3)-(4) show that there was no significant effects on asset stocks.

Table 8 around here

Moreover, from the basic accounting definition of equity, it follows that there are three channels through which the stock of equity may have increased in response to the bank levies: (i) banks raised equity on the capital markets for instance through issues of new shares; (ii) banks reduced dividend payments to shareholders; (iii) banks earned larger profits. While the first two channels represent real changes in financial policy that are consistent with the change in incentives, it would be difficult to explain an effect of levies on profitability. Ideally, we would like to know how much each of the three channels contributed to the estimated increase in equity or, at least, how much of the total effect can be attributed to real changes in financial policy and how much is the effect of changes in profitability. Since we are unable to obtain good measures of share issues and dividend payments, we take an indirect approach: we first compute an adjusted measure of equity that only reflects active financial policy. In the starting year 2008, the adjusted equity measure equals actual equity whereas, in the years 2009-2011, it equals actual equity net of cumulated after-tax profits since 2008. By eliminating the mechanical effect of profits on equity, the adjusted equity measure only changes when banks raise equity and pay out dividends. We then estimate the baseline model using this adjusted equity measure. Columns (5)-(6) show that the effect of levies on adjusted equity is comparable to and in one case even slightly larger than the baseline results suggesting that the estimated increase in equity-asset ratios fully reflects changes in banks' financial policy.

6 Concluding remarks

In the wake of the financial crisis, a number of countries have introduced bank levies in an attempt to reduce risk in the financial sector. This paper has studied how the levies introduced by the countries of the EU affected banks' funding and portfolio choices with the ultimate aim of assessing whether the levies met this objective.

We first showed that the levies were associated with an average increase in equity-asset ratios of around 1 to 1.5 percentage points. The increase in the equity-asset ratio was shown to reflect active financial policy such as share issues and changes in dividend policy rather than a contraction of the balance. These findings suggest that levies are associated with a considerable reduction in banks' funding risk. We then showed that the levies caused a sizable increase in regulatory risk-weights for the average bank. These results suggest that banks may have responded to the levies by shifting risk from the liability side to the asset side of the balance sheet. For the average bank, however, the increase in portfolio risk is sufficiently small that the net effect of the levies is to reduce total risk.

Finally, we explored the heterogeneity in responses to the bank levies by splitting the sample into "risky banks" with a low initial regulatory capital ratio and "safe banks" with a high initial regulatory capital ratio. We found that while "safe banks" increased their equity-asset ratio most in response to the levies, *only* "risky banks" increased the risk of their assets so that while "safe banks" experienced a considerable reduction in total risk, there was no such effect for "risky banks". This is consistent with the conceptual framework that indicates that "risky banks", closer to being initially constrained by regulatory capital requirements, switch their risk from the funding side to the portfolio side in response to a tax on the funding side.

The results speak to current policy debates about banking regulation. The Basel III agreements introduce the requirement that the ratio of regulatory capital to assets (i.e. the leverage ratio) exceed a threshold of 3%. This complements the existing capital requirement with respect to the ratio of regulatory capital to risk-weighted assets. Our finding that funding risk and portfolio risk are substitutes suggests that the new minimum leverage ratio could be of limited value. It is true that highly leveraged banks may be forced to raise more equity to reach the minimum leverage ratio. However, to the extent

that the risk choices of these banks were initially constrained by the existing capital requirement, they are likely to take advantage of the room for additional portfolio risk created by the additional equity to leave total risk unaffected.

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7 Appendix

Proof of Proposition 1

Assuming $W_L = 0$ and $W_\alpha = 0$, then totally differentiating (7) and (8), and noting $W_{\alpha T} = 0$, implies

$$\begin{bmatrix} W_{LL} & W_{L\alpha} \\ W_{\alpha L} & W_{\alpha\alpha} \end{bmatrix} \begin{bmatrix} dL \\ d\alpha \end{bmatrix} = -dT \begin{bmatrix} W_{LT} \\ 0 \end{bmatrix} \tag{10}$$

and hence

$$\frac{dL}{dT} = -\frac{W_{\alpha\alpha}W_{LT}}{\Delta}; \frac{d\alpha}{dT} = \frac{W_{\alpha L}W_{LT}}{\Delta}. \tag{11}$$

where $\Delta = W_{LL}W_{\alpha\alpha} - W_{\alpha L}^2$. Substituting for θ^B and θ^D and their derivatives with respect to L and α, and rearranging, it is possible to derive the following expressions for the elements of (11).

$$W_{LL} = \frac{(1+R+T+LR_L)^2}{\alpha(1-B)^2} c\chi - 2R_L \int_{\theta^D}^{\infty} f(\theta)d\theta \tag{12}$$

$$W_{\alpha\alpha} = \frac{1-L(1+R+T)}{\alpha^2(1-B)} \left\{ \frac{1}{(1-B)} - \theta^B \right\} c\chi \tag{13}$$

$$W_{\alpha L} = \frac{1+R+T}{\alpha(1-B)} \left\{ \frac{1}{(1-B)} - \theta^B \right\} c\chi \tag{14}$$

$$W_{LT} = -\int_{\theta^D}^{\infty} f(\theta)d\theta < 0 \tag{15}$$

where

$$\chi = \frac{(1-B+c)^2}{(1+c)c} f(\theta^D) - f(\theta^B) \tag{16}$$

$1/(1-B) - \theta^B > 0$ if $L(1+R+T) < 1$. Assuming that L is sufficiently small for this to be true, then $\chi < 0$ is a sufficient condition for $W_{LL} < 0$, $W_{\alpha\alpha} < 0$, $W_{\alpha L} < 0$ and $\Delta > 0$, in which case Proposition 1 follows, and the second order conditions of the maximization hold.■

Table 1: Bank levies in the European Union

	Base	Rate structure in 2011*	Entry into force
LEVIES ON BANK BORROWING:			
Austria**	total liabilities net of equity and insured deposits	0.000% up to €1 billion 0.055% up to €20 billion 0.085% above €20 billion	2011
Belgium	total liabilities net of equity and insured deposits	0.035%	2012
Cyprus	total liabilities net of equity	0,090%	2011
Germany	total liabilities net of equity and insured deposits	0.000% up to €300 million 0.020% up to €10 billion 0.030% up to €100 billion 0.040% up to €200 billion 0.050% up to €300 billion 0.060% above €300 billion	2011
Latvia	total liabilities net of equity and insured deposits	0.036%	2011
Portugal	total liabilities net of equity and subordinated debt	0.050%	2011
Romania	total liabilities net of equity and insured deposits	0,100%	2011
Slovakia	total liabilities net of equity and insured deposits	0.400%	2012
Sweden	total liabilities net of equity and insured deposits	0.036%	2009
Netherlands	total liabilities net of equity and insured deposits	0.000% up to €20 billion 0,044% above €20 billion (half rate for long-term funding)	2012
UK	total liabilities net of equity and insured deposits but netting of gross assets and liabilities against the same counterpart and deduction for liquid assets	0.000% up to £20 billion 0.075% above £20 billion (half rate for long-term funding)	2011
OTHER LEVIES:			
France	minimal amount of own funds required to comply with coverage ratio	0.250%	2011
Hungary	total assets net of interbank loans	0.150% up to HUF 50 billion 0.530% above HUF 50 billion	2010
Slovenia***	Total assets	0.100%	2011

Notes: *2012 rates when this is the year of entry into force; ** Levy payments in 2011-2013 were a function of the balance sheet in 2010; ***Exceptions apply depending on the stock and growth of lending to non-banks

Table 2 : Summary statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		All banks		Levy		Non-levy		High capital		Low capital	
	Obs	Mean	S.d.	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Total Assets (euro million)	18131	17776	111022	12994	19975	5137	12212	5139	5228	5036	43257
Balance sheet components as share of total assets											
Customer deposits	18131	0.53	0.30	12994	0.55	5137	0.48	5139	0.63	5036	0.55
Deposits from banks	18131	0.17	0.22	12994	0.18	5137	0.14	5139	0.14	5036	0.17
Long term funding	18131	0.10	0.10	12994	0.06	5137	0.19	5139	0.09	5036	0.15
Other liabilities	18126	0.07	0.15	12989	0.07	5137	0.06	5139	0.04	5036	0.05
Equity	18126	0.13	0.00	12989	0.13	5137	0.12	5139	0.11	5036	0.07
Loans to customers	18131	0.53	0.26	12994	0.51	5137	0.60	5139	0.55	5036	0.63
Loans to banks	18131	0.16	0.19	12994	0.16	5137	0.15	5139	0.16	5036	0.11
Securities	18131	0.21	0.19	12994	0.22	5137	0.17	5139	0.23	5036	0.18
Other assets	18131	0.09	0.17	12994	0.10	5137	0.08	5139	0.06	5036	0.06
Regulatory measures											
Regulatory capital ratio	10175	0.17	0.08	6335	0.17	3840	0.17	5139	0.20	5036	0.13
Average risk weight	6997	0.59	0.18	3589	0.54	3408	0.64	3463	0.57	3534	0.61

Note: Columns (1)-(3) provide summary statistics for our full sample of banks for the sample period 2008-2011. Columns (4)-(7) report variable means for banks located in countries that did / did not introduce a bank levy during the period 2009-2012. Columns (8)-(11) report variable means for banks with a ratio of regulatory capital to risk-weighted assets above / below the sample median in 2008.

Table 3: Equity - baseline

	(1)	(2)	(3)	(4)	(5)	(6)
			Equity / Assets			
levy	0.0177***	0.0164***	0.0150***			
	(0.0019)	(0.0019)	(0.0015)			
marginal levy rate				0.1856***	0.2282***	0.2607***
				(0.0706)	(0.0684)	(0.0546)
log assets			-0.1174***			-0.1175***
			(0.0338)			(0.0337)
log assets squared			0.0020			0.0020
			(0.0024)			(0.0024)
profitability			0.0035***			0.0036***
			(0.0013)			(0.0013)
inflation		0.0023***	0.0015**		0.0026***	0.0018***
		(0.0009)	(0.0007)		(0.0009)	(0.0007)
gdp growth		0.0002	0.0006**		0.0006	0.0009***
		(0.0004)	(0.0003)		(0.0004)	(0.0003)
corporate tax rate		-0.2963	-0.0691		-0.5148***	-0.2803*
		(0.1944)	(0.1695)		(0.1913)	(0.1693)
dummy 2009	0.0040***	0.0114***	0.0139***	0.0040***	0.0140***	0.0162***
	(0.0011)	(0.0033)	(0.0029)	(0.0011)	(0.0034)	(0.0029)
dummy 2010	0.0054***	0.0086***	0.0119***	0.0058***	0.0085***	0.0120***
	(0.0013)	(0.0026)	(0.0021)	(0.0013)	(0.0026)	(0.0021)
dummy 2011	-0.0049***	-0.0044**	0.0057***	0.0035*	0.0017	0.0106***
	(0.0018)	(0.0019)	(0.0018)	(0.0019)	(0.0018)	(0.0018)
Observations	16,449	16,449	16,415	16,449	16,449	16,415
R-squared	0.0099	0.0116	0.2654	0.0036	0.0070	0.2620
Number of banks	4,572	4,572	4,568	4,572	4,572	4,568
bank fixed effects	YES	YES	YES	YES	YES	YES
time fixed effects	YES	YES	YES	YES	YES	YES

Note: The dependent variable is the ratio of book equity to assets; *levy* is a dummy variable at the country-year level taking the value one when there is a bank levy in place; *marginal levy rate* is an estimate at the bank-year level of the levy saving created by subsituting one unit of debt with one unit of equity; *log assets* is the log of assets; *log assets squared* is the log of assets squared; *profitability* is the ratio of pre-tax profits to assets; *inflation* is the rate of inflation at the country-year level; *gdp growth* is the rate of GDP growth at the country-year level; *corporate tax rate* is the corporate tax rate at the country-year level; *dummy 2009* is a dummy variable indicating that the year is 2009.

Table 4: Equity - robustness

	(1)	(2)	(3)	(4)	(5)
			Equity / Assets		
PANEL A					
levy	0.0151***	0.0146***	0.0147***	0.0145***	0.0103***
	(0.0015)	(0.0023)	(0.0014)	(0.0017)	(0.0023)
PANEL B					
marginal levy rate	0.2843***	0.1823***	0.2885***	0.2311***	0.1529***
	(0.0544)	(0.0592)	(0.0549)	(0.0537)	(0.0568)
Observations	16,218	16,415	15,819	15,844	15,819
Covariates, bank FE and time FE	YES	YES	YES	YES	YES
Controls for govt. interventions	YES	NO	NO	NO	YES
time fixed effects × region	NO	YES	NO	NO	YES
time fixed effects × size	NO	NO	YES	NO	YES
time fixed effects × equity ratio	NO	NO	NO	YES	YES

Note: The dependent variable is the ratio of book equity to assets; *levy* is a dummy variable at the country-year level taking the value one when there is a bank levy in place; *marginal levy rate* is an estimate at the bank-year level of the levy saving created by subsituting one unit of debt with one unit of equity; *controls for government interventions* include the value of government debt guarantees and recapitalization relative to bank assets and a dummy for intervention by the EU regulatory authorities; *region* indicates one of five regions in the EU; *size* indicates the 10 size deciles in 2008; *equity ratio* indicates the 10 equity ratio deciles in 2008. All equations include the variables: log assets: log assets squared, profitability, inflation, gdp growth and the corporate tax rate.

Table 5: Equity - placebo tests

	(1)	(2)	(3)	(4)
	Equity / Assets			
	Non-financial firms		Austrian, French, Slovene and Hungarian levies	
levy	0.0045	-0.0050	0.0052	-0.0001
	(0.0042)	(0.0059)	(0.0035)	(0.0030)
Observations	16,272	14,764	7,931	7,498
Covariates, bank FE and time FE	YES	YES	YES	YES
Controls for govt. interventions	NO	YES	NO	YES
time fixed effects × region	NO	YES	NO	YES
time fixed effects × size	NO	YES	NO	YES
time fixed effects × equity ratio	NO	YES	NO	YES

Note: The dependent variable is the ratio of book equity to assets; *levy* is a dummy variable at the country-year level taking the value one when there is a bank levy in place. All equations include the variables: log assets: log assets squared, profitability, inflation, gdp growth and the corporate tax rate. In columns (1)-(2), the sample consists of non-financial firms drawn from the Amadeus database so as to maintain the number of observation from each country as in the baseline regression. In columns (3)-(4), the consists of banks from countries with no levies as well as Austria, France, Slovenia and Hungary.

Table 6: Portfolio risk and regulatory capital ratio

	(1)	(2)	(3)	(4)
	Risk weighted assets /Assets		**Regulatory capital / Risk weighted assets**	
levy	0.0200***		0.0076***	
	(0.0038)		(0.0018)	
marginal levy rate		0.4951***		0.1425***
		(0.1268)		(0.0528)
log assets	-0.0437	-0.0428	-0.1419***	-0.1422***
	(0.0614)	(0.0607)	(0.0389)	(0.0389)
log assets squared	-0.0011	-0.0011	0.0051**	0.0051**
	(0.0035)	(0.0035)	(0.0023)	(0.0023)
profitability	-0.0440	-0.0315	0.4639***	0.4708***
	(0.1335)	(0.1342)	(0.1505)	(0.1501)
inflation	0.0008	0.0012	-0.0005	-0.0004
	(0.0014)	(0.0014)	(0.0006)	(0.0006)
gdp growth	-0.0006	-0.0004	-0.0003	-0.0001
	(0.0008)	(0.0008)	(0.0005)	(0.0005)
corporate tax rate	0.2590	0.1472	0.0210	-0.0042
	(0.3299)	(0.3283)	(0.1624)	(0.1648)
dummy 2009	-0.0127**	-0.0106*	0.0061*	0.0073**
	(0.0059)	(0.0059)	(0.0032)	(0.0032)
dummy 2010	-0.0165***	-0.0162***	0.0165***	0.0165***
	(0.0050)	(0.0050)	(0.0020)	(0.0020)
dummy 2011	-0.0347***	-0.0317***	0.0187***	0.0210***
	(0.0051)	(0.0048)	(0.0024)	(0.0022)
Observations	6,806	6,806	9,897	9,897
R-squared	0.0844	0.0828	0.1543	0.1524
Number of banks	2,225	2,225	3,026	3,026
Bank and time FE	YES	YES	YES	YES

Note: In columns (1-)-(2), the dependent variable is the ratio of risk-weighted assets to assets whereas in columns (3)-(4) it is the ratio of regulatory capital to risk weighted assets; *levy* is a dummy variable at the country-year level taking the value one when there is a bank levy in place; *marginal levy rate* is an estimate at the bank-year level of the levy saving created by subsituting one unit of debt with one unit of equity; *log assets* is the log of assets; *log assets squared* is the log of assets squared; *profitability* is the ratio of pre-tax profits to assets; *inflation* is the rate of inflation at the country-year level; *gdp growth* is the rate of GDP growth at the country-year level; *corporate tax rate* is the corporate tax rate at the country-year level; *dummy 2009* is a dummy variable indicating that the year is 2009.

Table 7: Heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A			**Equity / Assets**			
levy × low capital	0.012***	0.011***	0.007***	0.011***	0.010***	0.005***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
levy × high capital	0.017***	0.017***	0.012***	0.016***	0.009***	0.006**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
PANEL B						
marg. levy rate × low capital	0.190***	0.203***	0.060	0.201***	0.171***	0.086**
	(0.034)	(0.034)	(0.040)	(0.032)	(0.033)	(0.037)
marg. levy rate × high capital	0.424***	0.439***	0.236***	0.432***	0.201***	0.111
	(0.073)	(0.076)	(0.062)	(0.077)	(0.072)	(0.068)
Observations	9,897	9,822	9,897	9,695	9,708	9,695
PANEL C			**Risk weighted assets /Assets**			
levy × low capital	0.029***	0.027***	0.025***	0.028***	0.024***	0.022***
	(0.005)	(0.005)	(0.008)	(0.005)	(0.006)	(0.008)
levy × high capital	0.009	0.012**	0.004	0.012**	-0.003	-0.003
	(0.006)	(0.006)	(0.008)	(0.006)	(0.007)	(0.010)
PANEL D						
marg. levy rate × low capital	0.550***	0.564***	0.477**	0.553***	0.468**	0.452**
	(0.175)	(0.178)	(0.198)	(0.180)	(0.183)	(0.202)
marg. levy rate × high capital	0.340**	0.404**	0.163	0.414**	0.067	0.052
	(0.165)	(0.173)	(0.177)	(0.173)	(0.174)	(0.186)
Observations	6,753	6,691	6,753	6,594	6,603	6,594
PANEL E			**Regulatory capital / Risk weighted assets**			
levy × low capital	0.002	0.001	0.000	0.001	0.001	0.001
	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)
levy × high capital	0.014***	0.011***	0.013***	0.011***	0.013***	0.012**
	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.005)
PANEL F						
marg. levy rate × low capital	0.030	0.041	-0.045	0.024	0.013	0.010
	(0.052)	(0.050)	(0.065)	(0.054)	(0.061)	(0.062)
marg. levy rate × high capital	0.291***	0.244**	0.231**	0.231**	0.201*	0.196*
	(0.109)	(0.112)	(0.111)	(0.113)	(0.119)	(0.119)
Observations	9,897	9,822	9,897	9,695	9,708	9,695
Covariates, bank FE and time FE	YES	YES	YES	YES	YES	YES
Controls for govt. interventions	NO	YES	NO	NO	NO	YES
time fixed effects × region	NO	NO	YES	NO	NO	YES
time fixed effects × size	NO	NO	NO	YES	NO	YES
time fixed effects × equity ratio	NO	NO	NO	NO	YES	YES

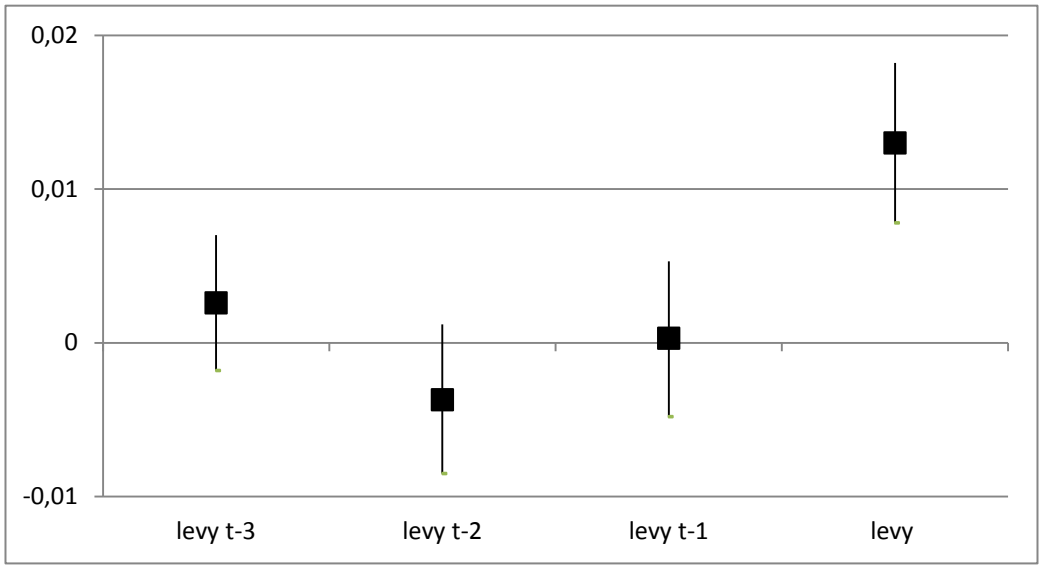
Note: In panels A-B the dependent variable is the ratio of book equity to assets; in panels B-C, it is the ratio of risk weighted assets to assets; in panels E-F, it is the ratio of regulatory capital to risk weighted assets; *levy* is a dummy indicating that a bank levy in place; *marginal levy rate* is an estimate of the levy saving created by subsituting one unit of debt with one unit of equity; *low capital* is a dummy for a regulatory capital ratio below the median in 2008; *high capital* is a dummy for a regulatory capital ratio above the median in 2008; *controls for government interventions* include the value of government debt guarantees and recapitalization relative to bank assets and a dummy for intervention by the EU regulatory authorities; *region* indicates one of five regions in the EU; *size* indicates the 10 size deciles in 2008; *equity ratio* indicates the 10 equity ratio deciles in 2008. All equations include the variables: *log assets, log assets squared* , *profitability* , *inflation* , *gdp growth* and the *corporate tax rate* .

Table 8: Mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)
	Log equity		**Log assets**		**Adjusted equity / Assets**	
levy	0.1419***		-0.0118		0.0142***	
	(0.0092)		(0.0113)		(0.0017)	
marginal levy rate		2.6960***		0.3809		0.2986***
		(0.4714)		(0.4048)		(0.0643)
Observations	16,347	16,347	16,420	16,420	15,653	15,653
Covariates, bank FE and time FE	YES	YES	YES	YES	YES	YES

Note: In columns (1)-(2), the dependent variable is the log of equity; in columns (3-(4) it is the log of assets; in columns (5)-(6), it is the ratio of equity to assets purged for the mechanical effect of profits since 2008; *levy* is a dummy variable at the country-year level taking the value one when there is a bank levy in place; *marginal levy rate* is an estimate at the bank-year level of the levy saving created by subsituting one unit of debt with one unit of equity; All equations include the variables: log assets: log assets squared, profitability, inflation, gdp growth, the corporate tax rate and time fixed dummies

Figure 1: Trend in equity-asset ratio for banks facing positive levy rates relative to general trend



Note: The figure shows the estimated coefficients and confidence intervals for an estimation of the baseline model where the variable *levy* take the value one in years where the bank is subject to a positive marginal levy rate; the variable $levy_{t-1}$ takes the value one in the year before the marginal levy rate turns positive and so on.

Reviewer Appendix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				OLS					IV	
	Equity / Assets				Δ(Equity / Assets)				Equity / Assets	
levy	0.0140***	0.0131***			0.0072***	0.0065***				
	(0.0014)	(0.0013)			(0.0018)	(0.0018)				
marginal levy rate			0.1741***	0.2580***			0.2054***	0.1907***	0.2284***	0.2772***
			(0.0585)	(0.0507)			(0.0620)	(0.0584)	(0.0621)	(0.0538)
equity /assets (lagged)	0.2354***	0.1334***	0.2384***	0.1353***						
	(0.0456)	(0.0357)	(0.0457)	(0.0357)						
log assets		-0.1042***		-0.1042***		-0.0414**		-0.0414**		-0.1175***
		(0.0316)		(0.0314)		(0.0203)		(0.0203)		(0.0036)
log assets squared		0.0014		0.0014		-0.0002		-0.0002		0.0020***
		(0.0022)		(0.0022)		(0.0013)		(0.0013)		(0.0003)
profitability		0.0033**		0.0034**		0.0044		0.0044		0.0036***
		(0.0014)		(0.0014)		(0.0039)		(0.0039)		(0.0008)
inflation		0.0011*		0.0014**		0.0007		0.0009		0.0018***
		(0.0006)		(0.0006)		(0.0008)		(0.0008)		(0.0005)
gdp growth		0.0008***		0.0011***		0.0017***		0.0018***		0.0009***
		(0.0003)		(0.0003)		(0.0005)		(0.0005)		(0.0003)
corporate tax rate		0.0109		-0.1835		0.4821***		0.3677**		-0.2848***
		(0.1491)		(0.1479)		(0.1806)		(0.1777)		(0.0993)
Observations	15,579	15,551	15,579	15,551	15,579	15,551	15,579	15,551	16,449	16,415
R-squared	0.0884	0.3025	0.0833	0.2993	0.0033	0.0394	0.0031	0.0393		
Number of banks	4,433	4,429	4,433	4,429	4,433	4,429	4,433	4,429	4,572	4,568
bank fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: In columns (1)-(4) and (9)-(10), the dependent variable is the ratio of equity to assets; in columns (5)-(8) it is the first-difference in the ratio of equity to assets; *levy* is a dummy variable at the country-year level taking the value one when there is a bank levy in place; *marginal levy rate* is an estimate at the bank-year level of the levy saving created by subsituting one unit of debt with one unit of equity; *log assets* is the log of assets; *log assets squared* is the log of assets squared; *profitability* is the ratio of pre-tax profits to assets; *inflation* is the rate of inflation at the country-year level; *gdp growth* is the rate of GDP growth at the country-year level; *corporate tax rate* is the corporate tax rate at the country-year level. In columns (9)-(10), the marginal levy rate is instrumented with the marginal levy rate that would have applied had the bank had the exact same balance sheet as in 2008.

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