On the Incidence of Bank Levies: Theory and Evidence

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Abstract

This paper studies the incidence of bank levies that were recently introduced in several European countries. Their main objective is to internalize the fiscal cost of banking crises. Using a variant of the Monti-Klein model, we predict that banks pass part of the tax burden onto borrowers by raising lending rates but that deposit rates usually do not respond to the levy. The magnitude of the pass-through depends on bank competition and capitalization. These predictions are tested and quantified using a panel dataset with balance sheet information of almost 3'000 EU banks: On average, we find that bank levies moderately raise lending rates and net interest margins but do not significantly affect deposit rates suggesting a pass-through to borrowers. Bank competition determines the magnitude of the pass-through: Increases of the lending rate are particularly large and economically significant in concentrated banking markets with a low intensity of competition. To a lesser extent, the capital structure of banks influences the incidence: Well capitalized banks are less exposed to the levy such that pass-through of the burden to customers is less pronounced or even vanishes.

JEL Classification: G21, G28, H22

1 Introduction

Banking crises are expensive: In addition to their severe impact on the real economy, they may involve large fiscal cost as a considerable amount of public funds is required for the stabilization of the banking sector. During the recent financial crisis, EU member states, for instance, incurred fiscal cost of bank recapitalization and asset relief (2008-13) of 4.9 percent of GDP (European Commission, 2014). In addition, government guarantees and liquidity assistance that 2009 reached a peak value of 6.9 percent of GDP were provided. However, the magnitude largely differs across countries: While fiscal cost were moderate in Germany or Austria, the UK incurred cost of recapitalization and guarantees worth 7.4 and 10.1 percent of GDP respectively. In Ireland, they even reached extreme values of 39.9 and 173.8 percent. Therefore, the G20 asked the IMF to prepare a report that studies the scope for special taxes on banks in order to raise a 'fair and substantial contribution from the financial sector'. Subsequently, 14 countries including Germany, France, Austria, and the United Kingdom introduced some sort of a bank levy. In the United States, President Obama's proposal of a 'Financial Crisis Responsibility Fee' is still being discussed but a soon implementation seems rather unlikely. The objective of a bank levy is to (i) raise revenue to (partly) cover the fiscal cost of banking crises thereby compensating governments and taxpayers

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for the provision of guarantees and bailouts and (ii), as a Pigovian tax, to internalize externalities associated with such guarantees thus reducing risk in the banking sector and complementing prudential regulation.

A key feature of every tax is its incidence: Do bank owners bear the burden themselves or do they pass it onto their customers by raising lending rates or lowering deposit rates? Higher lending rates and a contraction of the credit supply may turn out to be detrimental as they hamper firms' access to finance and limit their ability to invest thus slowing down economic growth. Slovik and Cournède (2011), for instance, estimate that a one percentage points increase of (long-term) lending rates reduces annual GDP growth by up to 0.4 percentage points in the Euro area. The corporate finance literature strongly suggests that small, innovative firms are most likely to be negatively affected as they have difficulties to substitute bank credit by other sources of funding. With banking reforms (e.g., Basel III, Banking Union) that tighten regulatory constraints and impose additional private cost on banks being implemented at the same time, potential adverse effects on the real economy might be amplified.

This paper contributes to the emerging literature on bank levies and their incidence by both theoretically and empirically investigating to what extent banks pass the tax burden onto customers. For that purpose, we develop a variant of the Monti-Klein model complemented by taxation and regulation, which yields testable predictions. This framework relates bank behavior to the competitive and regulatory environment of banks thereby carving out potential determinants of a pass-through. Subsequently, the model is confronted with the evidence: Using a cross-country panel dataset with balance sheet information from almost 3'000 EU banks, we estimate how the bank levy affects lending and deposit rates as well as net interest margins. To our knowledge, this is the first paper that provides cross-country evidence of the bank levy's incidence. We find that banks are able to shift part of the burden onto customers but the average effects are moderate: For example, lending rates and net interest margins with average values of 6 and 2.5 percent only rise by 0.13 and 0.04 percentage points respectively if a bank is taxed. The magnitude of the responses, however, critically depends on bank competition and, to a lesser extent, capitalization: In particular, the pass-through to borrowers is more pronounced and economically significant in highly concentrated markets where the levy raises lending rates by 0.3 to 0.4 percentage points.

The remainder of this paper is organized as follows: Section 2 provides an overview about the bank levies in Europe and section 3 reviews the related literature. Section 4 outlines the model and derives predictions about the incidence. These predictions are subsequently tested and quantified in section 5. Eventually, section 6 concludes.

2 Bank Levies

The IMF's report on financial sector taxation published 2010 examines the scope for special taxes levied on banks. A key element is the proposal of a bank levy, the so-called 'financial stability contribution': Its main objectives are (i) a contribution from the banking sector to compensate governments and taxpayers for the cost of guarantees and bailouts and (ii), as a Pigovian tax, the internalization of these fiscal cost to reduce the risk of future banking crises and to complement prudential regulation. The banks' failure to internalize such externalities can be partly attributed to the provision of implicit government guarantees for large, systemically important banks. This creates a funding benefit which makes the bank's funding cost less sensitive to its risk profile[1] thereby lowering the private cost of risk taking. Hence, the tax a bank pays should reflect its contribution to systemic risk and to all potential cost of a banking crisis. It is suggested that the tax is levied on the liability side of the bank's balance sheet[2] excluding capital and insured

[1]The funding benefit is well documented in the empirical literature; for evidence, see, for example Flannery and Sorescu (1996), Balasubramnian and Cyree (2011) or Acharya, Anginer, and Warburton (2013).

[2]This could also help mitigate the debt bias of corporate income taxation.

deposits[3]. The tax base may also include some off-balance sheet items such as derivatives. Ideally, the tax rate varies with the bank's contribution to systemic risk, which might, however, be difficult to implement at least at the beginning. Therefore, the IMF suggests a flat tax rate, which should reflect the funding benefit for large, systemically important banks due to implicit government guarantees: The IMF Staff (2010, p. 55) estimates that the benefit is between 10bp and 50bp with an average of 20bp. For the U.S., Acharya et al. (2013) find a benefit of 24bp on average (1990-2011) but substantially higher values during the crisis. For smaller, less risky banks, a lower rate may apply. The tax revenue could either accumulate a resolution fund or be used for the general budget. The former, however, requires the existence of a credible resolution mechanism in order to prevent moral hazard. In addition, the report also studies two other taxes on banks, which are, however, not at the core of our analysis: the financial activities tax and the financial transactions tax. The former is a substitute for the value added tax on financial services and should be levied on the sum of bank profits and remunerations; the latter is imposed on financial transactions and aims at reducing the risk of asset bubbles.

	Tax Base	Tax Rates	Exemptions	Use of Funds
Austria 1.1.2011	Total Liabilities	< EUR 20bn: 0.09%* > EUR 20bn: 0.11%	Equity, Insured Deposits Allowance: EUR 1bn Surcharge: 45% until 2017	Treasury
Belgium 1.1.2012	Total Liabilities	0.035%	Regulatory Capital, Insured Deposits	Resolution Fund
Germany 1.1.2011	Total Liabilities Derivatives	< EUR 10bn: 0.02% EUR 10bn-100bn: 0.03% EUR 100bn-200bn: 0.04% EUR 200bn-300bn: 0.05% > EUR 300bn: 0.06% Derivatives: 0.0003%	Equity, Insured Deposits Allowance: EUR 200mn Cap: 20% of Annual Net Income Minimum: 5%	Resolution Fund
France 1.1.2011	Regulatory Capital	0.5%	Allowance: EUR 500mn	Treasury
Hungary 27.9.2010	Total Assets	< HUF 50bn: 0.15% > HUF 50bn: 0.53%	Interbank Loans	Treasury
Netherlands 1.10.2012	Total Liabilities	0.044% (short-term) 0.022% (long-term	Equity (Tier 1+2), Insured Deposits Allowance: EUR 20bn	Treasury
Slovakia 1.1.2012	Total Liabilities	0.4%	Equity, Insured Deposits, Subord. Debt	
Sweden 30.12.2009	Liabilities and Provisions	0.044%	Subord. Debt, Selected Securities	Stability Fund
UK 1.1.2011	Total Liabilities	0.036% (short-term) 0.071% (long-term)	Equity (Tier 1), Insured Deposits, Liquid Assets Allowance: GBP 20bn	Treasury

*Until 2014: 0.055% (<EUR 20bn), 0.085% (>EUR 20bn), surcharge 25%

Sources: Devereux, Johannesen, and Vella (2015, Appendix), Keuschnigg and Kogler (2014, p.11)

Table 1: Bank Levies

Since 2009, 14 countries almost exclusively in the European Union have introduced a bank levy.[4] Table 1 summarizes bank levies currently in place in selected European countries.[5] Germany, the UK, and the Netherlands closely follow the IMF's concept of a financial stability contribution

[3]Insured deposits should be excluded to prevent double taxation due to deposit insurance premia, which are ideally risk-adjusted.

[4]See OECD (2013) for detailed information. Note that Australia and Greece had already imposed bank levies before; however, these levies had a different purpose and are not comparable with the IMF's recommendations.

[5]An extensive summary can be found in Devereux et al. (2015, Appendix) or OECD (2013).

whereas the levies in Hungary and France are fundamentally different. In general, they differ between countries in at least four aspects: First, most countries impose the levy on liabilities as suggested by the IMF. Usually, equity and insured deposits are exempt in order to tax the risky part of funds only and to prevent double taxation. In Germany, even all customer deposits are exempt but (like Austria previously) it also taxes off-balance sheet derivatives. Hungary, however, does not exempt equity and the tax base consists of total assets net of interbank loans, and the French levy is imposed on minimum regulatory bank capital. Second, the tax rate is flat (e.g., Belgium, Sweden), progressive (e.g., Austria, Germany, Hungary) or differs between short- and long-term liabilities (e.g., Netherlands, UK). In addition, some countries exempt small banks from the levy by an allowance because they are unlikely to benefit from implicit guarantees and their contribution to systemic risk is small or even negligible. This creates or reinforces a progressive schedule (e.g., Austria, Germany, Netherlands, UK). Third, the level of the tax rates reaches from values clearly below the IMF's suggestion of (at most) 20bp (e.g., Germany, UK, Sweden) to high values of 40 to 50bp (e.g., Hungary, Slovakia). Such a comparison may, however, be misleading given different the tax bases and allowances. Fourth, Belgium, Germany, and Sweden finance a bank resolution fund whereas all others allocate the revenue is allocated to the treasury.

Eventually, two further aspects of the levy need to be emphasized. First, its role in the tax system and its relation to the corporate income tax: The IMF suggests a levy that is fully deductible from the corporate income tax in order to avoid double taxation. However, Germany, the Netherlands, and the United Kingdom, for instance, do not allow for a deduction of the levy payments.[6] The second aspect is the timing: Most levies are forward-looking in the sense that they aim at reducing financial risk and covering the fiscal cost of future banking crises. Thus, they are imposed on current (or previous-year) balance sheets in order to induce the desired behavioral responses. In two countries the levy is backward-looking and imposed on past balance sheets: Austria (balance sheet 2010) and Hungary (balance sheet 2009). It appears that the primary goal is to cover the fiscal cost of the recent crisis. Since banks cannot reduce their (lump-sum) tax burden, behavioral adjustments are less likely[7] unless it is clear that this regime is temporary and the tax base will be changed to current liabilities in the foreseeable future.[8] Then, forward-looking banks may adjust their balance sheets and risk positions to reduce the future tax burden.

3 Literature

Since bank levies are quite novel taxes, the related literature is yet rather scarce. In general, this paper draws from two strands of the literature: First, the literature on the role of Pigovian taxes in banking, and second, the literature on bank-related tax incidence in general.

The analysis of Pigovian taxes in banking has been primarily theoretical: Keen (2011) studies their role in the internalization of two types of externalities associated with collapse and bailout of banks. He suggests a corrective tax on bank borrowing with marginal tax rates that sharply raise at low capital ratios. Perotti and Suarez (2011) explore to what extent a Pigovian tax can help internalize a bank's contribution to systemic risk associated with short-term funding: They find that a tax is superior to quantity-based regulation (e.g., funding ratios) if banks differ in lending opportunities but inferior if they differ in charter values and risk-taking incentives. De Nicoló, Gamba, and Lucchetta (2012) use a dynamic model to evaluate the welfare implications of capital and liquidity regulation as well as taxation. They conclude that a tax on short-term debt has inferior effects on efficiency and lending than the corporate income tax. Devereux et al. (2015) both theoretically and empirically examine how banks adjust capital structure and risk taking in

[6] See, Devereux et al. (2015, Appendix).

[7] This does not rule out price adjustments, e.g., raising lending rates or fees, if the bank has market power. Capelle-Blancard and Havrylchyk (2013a) find evidence for such behavior in Hungary.

[8] In Austria, the levy was imposed on the 2010 balance sheet for the years 2011 to 2013; from 2014 on, it is imposed on the previous year balance sheet.

response to a levy on liabilities: They find that banks indeed reduced their leverage but they also increased risk taking measured by the average risk weight. The latter is due to a mechanical effect as more equity increases the maximum risk-weighted assets of a bank, which then rather responds by raising asset risk instead of size. Schweikhard and Wahrenburg (2013) simulate the amount of (hypothetical) levy payments during the financial crisis and compare them to the funding benefit of systemically important banks due to government guarantees. They find that the levies achieve a partial internalization of systemic risk.

Few studies examine the incidence of bank levies. Weder di Mauro (2010) forecasts responses to the financial stability contribution suggested by the IMF: Using a stylized model of the bank's lending decision, she predicts that a levy of 10bp on liabilities raises the lending rate by about 7bp in case of a full pass-through; in an intermediate case, the increase of the lending rate is limited to 4bp. However, these forecasts assume an exogenous extent of the pass-through. Evidence is provided mostly at the country level: Buch, Hilberg, and Tonzer (2014) analyze the incidence of the German bank levy: Using a difference-in-difference approach that explores the variation between large banks that are taxed and small banks that are not, they find no evidence for effects on loan volumes, lending and deposit rates of an average bank. However, they find that banks with a large market share tend lower loan volumes and deposit rates and to increase lending rates and that large banks, which face a disproportionately higher tax burden due to the progressive tax schedule, reduce loan volume and deposit rates. Capelle-Blancard and Havrylchyk (2013a) find similar effects for the Hungarian bank levy where a pass-through (i.e., a unilateral increase of the lending rate) is likely if borrowers already have an ongoing borrowing relationship with a bank and can thus hardly switch to another bank. A problem of these studies is that the observation period is rather short, which may explain relatively moderate estimates. In the long run, one can, therefore, expect a more pronounced effect. We also build on the more extensive literature that analyzes the incidence of the corporate income tax in case of banks. The extent of the pass-through is usually identified by the increase of pre-tax profits or net interest margins. Demirgüç-Kunt and Huizinga (1999) find evidence that the tax is fully passed onto customers as net interest margins, for instance, increase one by one with the tax rate. In the same spirit, Demirgüç-Kunt and Huizinga (2001) find that the pre-tax profitability of international banks varies relatively little with domestic tax rates as they can exploit profit shifting opportunities such that the pass-through to customers is less pronounced. Furthermore, Albertazzi and Gambacorta (2010) show that corporate income taxes lower the loan volume and raise the lending rate such that banks can pass up to 90 percent of the tax burden onto borrowers. However, they find no effect on the deposit market. Chiorazzo and Milani (2011) estimate that European banks can pass through 45 percent of the tax burden in the short- and 80 percent in the long-run. In contrast, Capelle-Blancard and Havrylchyk (2013b) find no evidence for a pass-through when relying on a different measure of the bank's tax burden. Overall, the literature suggests that banks pass the corporate income tax onto customers, especially onto borrowers, but this finding is not robust to all specifications.

4 Theoretical Framework

This section develops a framework to study the impact of bank levies on loans and deposits and, more importantly, on the equilibrium interest rates. If the levy raises lending and lowers deposit rates, this is interpreted as a pass-through to borrowers and depositors respectively. For that purpose, we apply the Monti-Klein model complemented with regulation and taxation. This model is popular in the incidence literature and used, for example, by Albertazzi and Gambacorta (2010) and Capelle-Blancard and Havrylchyk (2013a). It goes back to Klein (1971) and Monti (1972) and is an industrial organization model of the banking industry; both oligopolistic and monopolistic

variants are common.[9] The Monti-Klein model captures the main determinants of banks' lending and borrowing decisions, in particular, bank competition that plays a crucial role for the tax incidence. Furthermore, its predictions can easily be confronted with empirical evidence. The model is, however, not without controversy: In the neoclassical tradition, the bank is primarily considered as a banking firm and frictions like information asymmetries or externalities are not captured. The well-known result that loan and deposit market are separable relies on restrictive assumptions (e.g., linear and separable cost function). Dermine (1986), for instance, shows that it is not robust to introducing bank failure risk. Since this paper focuses on the response of banks' interest rates to taxation, the Monti-Klein model is, nevertheless, an appropriate framework for this analysis. We first study the levy's incidence using a textbook variant of the Monti-Klein model to establish a benchmark. Subsequently, we extend the model and introduce risky lending and bank failure based on the approach of Dermine (1986). This extension allows for a more detailed analysis that also captures the risk dimension. The latter is particularly important because internalizing the fiscal cost of bank failure is the main rationale for the bank levy.

4.1 Monti-Klein Model with Taxation and Regulation

Suppose N identical banks indexed by $j = 1, ..., N$ compete for loans and deposits in a Cournot fashion; they face a downward-sloping inverse loan demand $r_L = r_L\left(\sum_{j=1}^{N} l_j\right)$ and an upward-sloping inverse deposit supply $r_D = r_D\left(\sum_{j=1}^{N} d_j\right)$. Each bank is owned and operated by a license holder with no private wealth (henceforth: bank owner). Bank i supplies credit l_i and is funded by deposits d_i and equity e_i. To raise equity, the bank owner promises a share ϕ_i of the bank's end-of-period value to outside shareholders; they elastically supply equity at a required return ρ reflecting their opportunity cost. In addition, the bank can borrow from the interbank or money market at a given interest rate r.[10] A bank's non-deposit liabilities m_i consist, for instance, of interbank and money market funding. Eventually, the bank incurs administrative cost associated with loans and deposits, which are described by the cost function $C(l_i, d_i)$ with $C_L > 0$ and $C_D > 0$. We make the standard assumption for the Monti-Klein model that the cost function is linear and separable: $C(l_i, d_i) = \gamma_L l_i + \gamma_D d_i$. The additive cost structure generates the typical result that the bank's problem is separable in loans and deposits. The bank's end-of-period equity value (profit) is:

$$\pi_i = (1 + r_L)l_i - (1 + r_D)d_i - (1 + r)m_i - (\gamma_L l_i + \gamma_D d_i) \tag{1}$$

Its objective is to maximize the value that can be appropriated by its owner. Therefore, it solves:

Program 1 *A bank chooses loans l_i, deposits d_i, equity e_i, and the share promised to outside equityholders ϕ_i to maximize the equity value appropriated by its owner*

$$\max_{l_i, d_i, m_i, e_i, \phi_i} (1 - \phi_i)\pi_i \tag{2}$$

subject to capital requirements

$$e_i \geq k l_i \tag{3}$$

the participation constraint of outside shareholders

$$\frac{\phi_i \pi_i}{e_i} = 1 + \rho \tag{4}$$

and the funding constraint

$$l_i + T_i = d_i + m_i + e_i \tag{5}$$

[9] For a more extensive discussion of the model, see Freixas and Rochet (2008, ch. 3).

[10] Suppose that r is determined either by the central bank or on the international capital market and taken as given by each bank. Therefore, the banks' individual positions do not need to sum up to zero.

where T_i denotes the bank's tax liability.

The constraints are interpreted as follows: Standard capital regulation, (3), requires a fraction $k \in [0,1]$ of loans to be financed with equity. In order to attract the latter, the bank needs to promise a sufficiently large value share ϕ_i (i.e., dividends) to outside equityholders such that the (gross) return on equity equals their opportunity cost $1+\rho$. This is captured by the participation constraint (4). Suppose that equity is privately costly and earns an excess return over debt: $\rho > r$. This is a typical assumption that can be justified, for instance, by the debt bias of the corporate income tax. Costly equity also ensures that the regulatory constraint binds and the bank does not raise more equity than necessary. Eventually, the bank's choices have to satisfy a funding constraint at the beginning of the period (5). In particular, the bank levy is paid upfront, which captures the forward-looking aspect of this tax.[11]
Substituting the three constraints and the definition of π_i into the objective function and using $L = \sum_{j=1}^{N} l_j$ and $D = \sum_{j=1}^{N} d_j$, one can compute the two first-order conditions with respect to loans and deposits:

$$r_L + r_L'(L)l_i - \tilde{\gamma}_L - (1+r)T_L = 0$$
$$r - [r_D + r_D'(D)d_i + \gamma_D + (1+r)T_D] = 0$$

T_L and T_D denote the partial derivatives of the tax liability with respect to l_i and d_i and $\tilde{\gamma}_L = \gamma_L + \rho k + r(1-k)$. These conditions require marginal revenue and cost of lending as well as marginal gains and cost of deposits to be equalized. Due to the oligopolistic market structure, the marginal revenue of loans and the marginal cost of deposits include a quantity and a price component. The marginal gains from deposit funding correspond to the opportunity cost of alternative funding, r.[12] The marginal cost of loans consist of the (weighted) cost of capital, the administrative cost, and the marginal tax burden; the marginal cost of deposits consist of the marginal deposit rate (quantity and price effect), the administrative cost, and the marginal tax burden. The tax burden is multiplied by the factor $1+r$ because the bank pays the levy upfront and thus incurs additional borrowing cost. In the symmetric Cournot-Nash equilibrium with $l_i = l = \frac{L}{N}$ and $d_i = d = \frac{D}{N}$, one obtains the typical Monti-Klein result:

$$\frac{r_L(L) - [\gamma_L + \rho k + r(1-k) + (1+r)T_L]}{r_L(L)} = \frac{1}{N\varepsilon_L} \tag{6}$$
$$\frac{r - [r_D(D) + \gamma_D + (1+r)T_D]}{r_D(D)} = \frac{1}{N\varepsilon_D} \tag{7}$$

This relies on the interest rate elasticities of loan demand, $\varepsilon_L = -\frac{1}{r_L'}\frac{r_L}{L} > 0$, and deposit supply, $\varepsilon_D = \frac{1}{r_D'}\frac{r_D}{D} > 0$, respectively. The Lerner index, that is, the relative difference between price and marginal cost, equals the inverse interest rate elasticity: Banks charge a markup on loans and a markdown on deposits (compared to its non-deposit funding cost) that is inversely related to elasticity and number of competitors, that is, to its market power. As a result, the lending rate exceeds the weighted cost of capital and the deposit rate falls short of the interbank rate (i.e., $r_L > r > r_D$). Note that lending and borrowing choices are separable as long as $T_{LD} = 0$; this a typical feature of the Monti-Klein model due to the assumption of a linear and separable cost function. Eventually, the conditions (6) and (7) entail two special cases: If $N \to \infty$, the perfect competition outcome is realized. Markup and markdown are zero and the interest rates equal the corresponding marginal cost. If $N = 1$, the outcome coincides with the monopoly.

[11] Note this assumption does not affect the incidence but it allows for a more realistic interpretation in a variant with bank risk (see section 4.2).
[12] The bank can substitute deposits for more expensive money market or equity funding.

4.1.1 A Benchmark: Taxing Liabilities

This section specifies the benchmark model of the bank levy, namely, a tax on liabilities. This variant suggested by the IMF has been adopted by most countries that introduced a bank levy including Germany, Austria, and the United Kingdom. Hence, we assume that the levy is imposed on the bank's total liabilities consisting of deposits d_i and non-deposit liabilities m_i. A uniform tax rate τ is applied such that the bank's tax liability is:

$$T_i = \tau[d_i + m_i]$$

Using capital requirement (3) and funding constraint (5), implies

$$T_i = \frac{\tau}{1-\tau}(1-k)l_i \tag{8}$$

such that the levy is *de facto* a function of loans only. Note that the upfront levy payment *ceteris paribus* induces the bank to raise additional funds (i.e., to increase its liabilities) that are, in turn, also subject to the levy. For notational convenience, one may define the effective levy rate $\tau^e \equiv \frac{\tau}{1-\tau}$. The partial derivatives of (8) are $T_L = \tau^e(1-k)$ and $T_D = 0$. Substituting in (6) and (7) yields the Monti-Klein conditions that characterize the symmetric Cournot-Nash equilibrium:

$$\frac{r_L(L) - [\gamma_L + \rho k + r(1-k) + (1+r)(1-k)\tau^e]}{r_L(L)} = \frac{1}{N\varepsilon_L} \tag{9}$$

$$\frac{r - [r_D(D) + \gamma_D]}{r_D(D)} = \frac{1}{N\varepsilon_D} \tag{10}$$

The incidence is related to the sensitivities of the equilibrium interest rates with respect to the levy. They are derived by differentiating (6) and (7).[13] As usual in the Monti-Klein model, we assume constant price elasticities ε_L and ε_D. This establishes:

Proposition 1 *The bank levy is passed onto borrowers as it lowers the loan supply, $\frac{\partial L}{\partial \tau} < 0$, and raises the lending rate:*

$$\frac{\partial r_L}{\partial \tau} = \frac{(1+r)(1-k)}{(1-\tau)^2\left(1 - \frac{1}{N\varepsilon_L}\right)} > 0 \tag{11}$$

The pass-through is stronger if the number of competitors is small and the loan demand inelastic and weaker if banks are well capitalized; it increases in the levy rate.
The bank levy is not passed onto depositors it neither affects deposits, $\frac{\partial D}{\partial \tau} = 0$, nor the deposit rate, $\frac{\partial r_D}{\partial \tau} = 0$.

Proof: See appendix A.2.

In general, the levy raises a the bank's funding cost[14] and thus its marginal cost of loans. Optimality requires an similar increase of its marginal revenue. The latter increases as banks reduce lending which leads to a higher lending rate given the downward-sloping loan demand. Therefore, part of the tax burden is passed onto banks' borrowers. The magnitude of the bank's response essentially depends on two factors: (i) market power and (ii) bank capitalization. First, market power or, more generally, the degree of concentration and competition in banking markets, is a key determinant of the magnitude of a pass-through: The increase of the lending rate is *ceteris paribus* stronger if a bank faces few competitors or an inelastic loan demand. Second, the capital structure determines the bank's exposure to a levy on liabilities such that a bank facing tighter capital requirements is less exposed to the levy, which may curb the increase of the lending rate.

[13] We assume that the levy rate is small enough such that the regulatory constraint is still binding (i.e., $\rho > r + (1+r)\tau^e$). Otherwise, banks would substitute equity for non-deposit liabilities.

[14] Note that this is due to the assumption of binding capital requirements; otherwise, substituting equity for debt would be possible.

This effect is purely mechanical. However, apart from influencing the bank's behavioral response to the bank levy, capital requirements have a positive direct effect on the lending rate.
The deposit rate is, in contrast, unaffected by the levy such that it is not passed onto depositors. Although banks may adjust[15] their liabilities as to satisfy the funding constraint, this only involves an adjustment of their non-deposit liabilities. Deposits are optimally chosen according to (10) and the levy does not change the cost of deposits relative to other sources of funding, which constitute the relevant reference point. This is an implication of the separability of loans and deposits. Intuitively, banks earn rents on deposits due to imperfect competition such that they prefer adjusting other balance sheet items if necessary.
The net interest margin (NIM) is a profitability ratio that prominently features in the incidence literature and that also plays a role in our empirical analysis. It measures the lending spread and is defined as net interest revenue divided by average interest-bearing assets. In our framework, the NIM is given by:

$$NIM = \frac{r_L l_i - r m_o - r_D d_i}{l_i} = r_L - r(1+\tau^e)(1-k) + \frac{(r-r_D)d_i}{l_i} \tag{12}$$

The NIM depends on both the interest rates and the composition of the balance sheet. Note that interest bearing assets consist of loans only. An increase of the NIM due to the levy is usually interpreted as a pass-through to customers. The partial derivative of (13) implies:

Corollary 1 *The bank levy raises the net interest margin:*

$$\frac{\partial NIM}{\partial \tau} = \frac{1-k}{(1-\tau)^2}\left[\frac{1+r}{1-\frac{1}{N\varepsilon_L}}\left(1+\frac{(r-r_D)D}{\frac{r_L L}{\varepsilon_L}}\right) - r\right] > 0$$

The effects of market power and capital structure on the pass-through can be of either sign.

Proof: Follows from differentiating (13) using $\frac{d}{l} = \frac{D}{L}$ in the symmetric equilibrium. Note that the first term in square brackets is always larger than r. *Q.E.D.*

The response of the net interest margin can be interpreted using its definition in (13): The levy (i) raises the lending rate and thus the net interest income (i.e., the numerator) and reduces bank lending (i.e., interest-bearing assets in the denominator) such that the combined effect is clearly positive.

4.1.2 Insured Deposits and Cash Holdings

This section adds two features to the benchmark model to illustrate possible mechanisms that make the deposit rate sensitive to the levy: (i) insured deposits and (ii) positive cash holdings. Deposits protected by a deposit insurance scheme are not subject to the bank levy in many countries due to double taxation risk: First of all, suppose a share β of a bank's deposits is insured, this usually represents the volume share of deposits below the coverage threshold (e.g., EUR 100'000). A bank takes β as given because it cannot fully control the exact amount savers deposit.[16] Whereas the exemption of insured deposits adds an additional feature of the levy to the model, cash holdings are a small but typical item of a bank's balance sheet: Suppose that the bank keeps a fraction $\alpha \in (0,1)$ of deposits in cash, for instance, due to reserve requirements. Importantly, cash yields no interest such that the marginal cost of deposits increase by $r\alpha$.[17] Moreover, the funding constraint (5) becomes $\alpha d_i + l_i + T_i = d_i + m_i + e_i$. Subtracting insured deposits βd_i from taxable liabilities

[15] There are two counteracting effects: Banks may reduce their funds because of the reduced loan supply or increase them to pay the upfront tax.

[16] However, the bank could influence β by offering different interest rates on insured and non-insured deposits. In the long run, strategic interest rate setting in response to the levy cannot be ruled out.

[17] Note that the bank's equity value changes to $\pi_i = (1+r_L)l_i + \alpha d_i - (1+r_D)d_i - (1+r)m_i - C(l_i, d_i)$.

yields the tax liability $T_i = \tau[m_i + (1-\beta)d_i]$. After substituting for m_i using the modified funding constraint, the tax liability is:

$$T_i = \frac{\tau}{1-\tau}[(1-k)l_i + (\alpha-\beta)d_i]$$

The partial derivatives are $T_L = \tau^e(1-k)$ and $T_D = \tau^e(\alpha-\beta)$. Replacing the partial derivatives in (6) and (7) yields the Monti-Klein conditions that characterize the symmetric equilibrium:

$$\frac{r_L(L) - [\gamma_L + \rho k + r(1-k) + (1+r)(1-k)\tau^e]}{r_L(L)} = \frac{1}{N\varepsilon_L} \tag{13}$$

$$\frac{r - [r_D(D) + r\alpha + \gamma_D + (1+r)(\alpha-\beta)\tau^e]}{r_D(D)} = \frac{1}{N\varepsilon_D} \tag{14}$$

Compared to the benchmark, the marginal cost of deposits may be higher due to the opportunity cost of holding cash or lower as additional deposits reduce the tax burden; the marginal cost of loans remain unchanged. Totally differentiating (13) and (14) yields:

Corollary 2 *The bank levy's effect on deposit rate is ambiguous:*

$$\frac{\partial r_D}{\partial \tau} = -\frac{(\alpha-\beta)(1+r)}{(1-\tau)^2\left(1+\frac{1}{N\varepsilon_D}\right)} \tag{15}$$

The sign depends on the relative magnitude of the share of insured deposits and the reserve requirements. The magnitude of the deposit rate's response negatively depends on market power. The levy raises the lending rate as shown by proposition 1.

Proof: Follows from differentiating (13) and (14). *Q.E.D.*

Whereas the pass-through to borrowers also prevails in case insured deposits are not taxed and banks hold cash, these features establish a link between bank levy and deposits: The exemption of insured deposits from the levy makes deposits a more attractive source of funding. Consequently, banks may substitute deposits that are only partly taxed for non-deposit liabilities that are fully taxed in order to reduce their tax burden. The higher deposit demand, in turn, raises the deposit rate such that depositors even benefit from the levy. While theoretically possible, there is little evidence that such an effect indeed exists. If deposits require cash holdings, in contrast, they extend the balance sheet thereby raising the contribution-relevant liabilities and the tax burden. Hence, banks respond to higher marginal cost by lowering their deposit demand and pass part of the burden onto depositors. Although the combined effect is, in principle, ambiguous, an increase is more likely because the (volume) share of insured deposits in total deposits is around 50 percent in the sample whereas reserve requirements rarely exceed five percent. In general, however, one may expect the response of the deposit rate (and the pass-through to depositors) to be less pronounced than the response of the lending rate and perhaps even insignificant. This can be explained by the counteracting mechanisms discussed above that may partly offset each other and by the relative stickiness of deposit rates that is a standard result of the Monti-Klein model and a phenomenon well-documented in the empirical literature. The latter also implies that, contrary to the lending rate, the deposit rate reacts less strongly if bank competition is intense: The reason for this asymmetry is that the bank is on the demand side and the quantity and price component of deposits' marginal cost are both positive. In case the bank's market power is strong, the price effect is large and the marginal cost already fall for a modest deposit rate reduction and quantity adjustment. This is consistent with the evidence that the relative stickiness of deposit rates increases with the level of market concentration (see, for example, Hannan and Berger (1991)).

4.1.3 Interaction with the Corporate Income Tax

Banks are not only subject to the bank levy but also to the corporate income tax (CIT): Assume that their profit defined as revenue minus cost is taxed with a flat tax rate t. Apart from their different purpose and tax base, bank levy and CIT differ as the former is forward-looking and *ex ante* levied on the balance sheet whereas the latter is *ex post* levied on bank profit. Depending on whether the initial levy payment T_i^L given by (8) is tax-deductible, a bank's CIT liability is:

$$T_i^C = t\left[r_L l_i - r m_i - r_D d_i - C(l_i, d_i) - \mathbb{1}_{\{ded\}}(1+r)T_i^L\right] \tag{16}$$

Note that the last term is nonzero only if the levy payment can be deducted from the CIT. This form of the CIT is characterized by the debt bias as the cost of equity are not tax-deductible. Using participation and funding constraint, (4) and (5), one can rewrite the bank's optimization problem:

$$\max_{l_i, d_i}(1+r_L)l_i - (1+r)(1-k)l_i + (r-r_D)d_i - C(l_i,d_i) - T_i^C - (1+r)T_i^L - (1+\rho)kl_i$$

The first-order conditions characterizing the symmetric equilibrium are as follows: Loans are determined according to

$$\frac{r_L(L) - \left[\gamma_L + \frac{\rho k}{1-t} + r(1-k) + \frac{(1+r)(1-k)\tau^e(1-\mathbb{1}_{\{ded\}}t)}{1-t}\right]}{r_L(L)} = \frac{1}{N\varepsilon_L} \tag{17}$$

whereas the choice of deposits is similar to (7) in the benchmark model. The CIT raises the marginal cost of loans due to (i) the debt bias that raises the cost of equity and (ii) potential double taxation with the bank levy. As a result, the CIT is only neutral and does not distort a bank's lending choice if the cost of equity and the levy payment can be deducted. In case the levy payment is deductible from the CIT, the incidence is unaffected; otherwise, the magnitude of the pass-through may differ because of double taxation. The levy payment is not deductible, for example, in Germany and the United Kingdom.Totally differentiating (17) yields:

Corollary 3 *If the levy payment is deductible from the CIT, the incidence is unaffected and the lending rate responds according to (11) in proposition 1. If the levy payment is not deductible, the pass-through to borrowers is stronger:*

$$\frac{\partial r_L}{\partial \tau} = \frac{(1+r)(1-k)}{(1-t)\left(1 - \frac{1}{N\varepsilon_L}\right)} > 0 \tag{18}$$

Proof: Follows from differentiating (17) and a comparison with (11). *Q.E.D.*

Since double taxation raises the effective tax burden, the CIT increases the magnitude of the response[18] thereby reinforcing the pass-through compared to the benchmark.

4.2 Monti-Klein Model with Bank Risk

This section adds bank failure to the Monti-Klein model as internalizing the fiscal cost of failure was the main reason for introducing bank levies. These cost arise due to explicit or implicit government guarantees for depositors. We adapt a variant with risky loans developed by Dermine (1986). To keep the analysis tractable, we now abstract from imperfect competition for deposits and focus on

[18] In addition, the CIT has a own direct effect on the lending rate even in the absence of bank levies due to the combination of debt bias and capital requirements; its effect on the deposit rate, in contrast, is tied to the levy and hinges on non-deductibility.

an elastic supply of deposits characterized by $r_D = r$ that rules out any pass-through to depositors. Although the reason for this modification is mainly technical, it is consistent with the results of the benchmark model that implies no response of the deposit rate to the levy. In addition, it provides an appropriate description of the current state of the economy that is, in turn, the background of our empirical analysis: In a low interest rate environment, a further reduction of deposit rates in order to shift the tax burden is difficult or even impossible. The deposit market is also likely to be more competitive than the loan market due to fewer frictions (e.g., no monitoring that is at the core of relationship banking) and the availability of many substitutes (e.g., cash, securities, mutual funds). Eventually, we normalize the administrative cost of loans and deposits to zero (i.e., $\gamma_L = \gamma_D = 0$). Banks are, therefore, indifferent between deposits and non-deposit liabilities as both are equally costly; the focus is on banks that only attract deposits but no other liabilities.
Following Dermine (1986) who builds on a model à la Jaffee and Modigliani (1969), borrowers invest in risky projects that yield a stochastic (gross) return A which is distributed according to some continuous, differentiable distribution function $F(A)$. Hence, he only repays the loan if the realized return exceeds the (gross) lending rate, $A > 1 + r_L$. Otherwise, the borrower defaults and his assets are transferred to the bank. Whether the bank itself is risky or not depends on the correlation of borrowers' returns: If they are uncorrelated, the loan portfolio is is perfectly diversified and the bank is safe. If there is some positive correlation, however, the bank may fail if too many of its loans perform poorly. As Dermine (1986), we focus on the second case and assume that returns are perfectly correlated, which could be interpreted as the bank lending to one large borrower or to borrowers that earn identical returns. More precisely, the bank fails if its assets fall short of its liabilities at the end of the period such that it cannot repay all deposits. The minimum realization of the stochastic loan return for which the bank remains solvent, A^*, is thus given by:

$$A^* l_i = (1 + r) d_i \tag{19}$$

As soon as the realized return is below A^*, the bank fails such that its failure probability is $F(A^*)$. Since government guarantees are the main rationale for bank levies, we focus on the case where they are indeed present: In particular, depositors rely on such guarantees and consider deposits as risk-free such that they just require the interest rate r without a risk premium. The bank's optimization problem is:

Program 2 *A bank chooses loans, deposits, equity and the share promised to outside equityholders to maximize its expected equity value*

$$\max_{l_i, d_i, e_i, \phi_i} (1 - \phi_i) \left[(1 - F(1 + r_L))(1 + r_L) l_i + \int_{A^*}^{1+r_L} A dF(A) l_i - (1 - F(A^*))(1 + r) d_i \right] \tag{20}$$

subject to capital requirement (3), investors' participation constraint (4), and the funding constraint

$$l_i + T_i = d_i + e_i$$

The integral captures the (expected) liquidation value of the borrowers assets transferred to the bank. The upfront levy payment captures the idea of a forward-looking tax in the sense that banks *ex ante* pay to cover the fiscal cost of a future failure or crisis. The tax base, bank liabilities, just consist of deposits such that the tax liability is $T_i = \tau d_i$. Using the funding constraint to eliminate d_i and $A^* = (1 + r)(1 + \tau^e)(1 - k)$ from (20), one can compute the first-order condition:

$$(1 - F(1 + r_L))[1 + r_L + r_L'(L) l_i] + \int_{A^*}^{1+r_L} A dF(A) - (1 - F(A^*))(1 + r)(1 + \tau^e)(1 - k) - (1 + \rho)k = 0$$

Again, loans are chosen as to equalize marginal revenue and cost. In the symmetric Nash equilib-

rium with $l_i = l = \frac{L}{N}$, bank loans are determined by:

$$\frac{r_L(L) - \int_{A^*}^{1+r_L} F(A)dA - \rho k - r(1-k) - (1+r)\tau^e(1-k)}{r_L(L)} = \frac{1 - F(1+r_L)}{N\varepsilon_L} \tag{21}$$

As in the baseline model, the Lerner index is inversely related to the interest rate elasticity of loan demand. The marginal cost include loan losses in case borrowers default; this is captured by the integral. Differentiating (21) yields:

Proposition 2 *The bank levy lowers the loan supply, $\frac{\partial L}{\partial \tau} < 0$ and raises the lending rate:*

$$\frac{\partial r_L}{\partial \tau} = \frac{(1 - F(A^*))(1-k)(1+r)}{(1-\tau)^2\left[(1 - F(1+r_L))\left(1 - \frac{1}{N\varepsilon_L}\right) + \frac{f(1+r_L)r_L}{N\varepsilon_L}\right]} > 0 \tag{22}$$

The pass-through is likely to be weaker if bank competition is intense but the effect of bank capitalization is ambiguous. The levy raises the net interest margin.

Proof: See appendix A.2.

Hence, the result that banks pass (part of the) tax burden onto borrowers also prevails in a model with risky loans and bank failure. It is likely that the pass-through is stronger in concentrated banking markets but no clear conclusion about the impact of bank capitalization can be made.
Based on these findings, one can also explore whether the bank levy is an effective instrument in the sense that it leads to an internalization of the fiscal cost of banking crises. For that purpose, we focus on how the levy affects the net fiscal cost of bank failure (FC). This measure equals the present value of the expected fiscal cost due to explicit or implicit guarantees for depositors net of tax revenue. Therefore, it captures both the risk of bank failure as well as the fiscal cost in case the bank fails. It is defined as:

$$FC = \frac{1}{1+r}\int_0^{A^*} [(1+r)d - Al]dF(A) - \tau d \tag{23}$$

The expected fiscal cost equal deposits $(1+r)d$ minus the realized value of bank loans Al that is transferred to the government in case of failure. Using the funding constraint to eliminate d yields:

$$FC = \frac{1}{1+r}\int_0^{A^*} [(1+r)(1-k)(1+\tau^e) - A]ldF(A) - \tau^e(1-k)l$$

Computing the partial derivative with respect to τ yields:

Corollary 4 *Introducing a bank levy reduces the net fiscal cost of bank failure*

$$\frac{\partial FC}{\partial \tau} = -\frac{(1 - F(A^*))(1-k)}{\frac{(1-\tau)^2 r_L}{N\varepsilon_L}}\left[\frac{\int_0^{A^*} F(A)dA - \tau^e(1+r)(1-k)}{(1 - F(1+r_L))\left(1 - \frac{1}{N\varepsilon_L}\right) + \frac{f(1+r_L)r_L}{N\varepsilon_L}} + \frac{r_L}{N\varepsilon_L}\right] \tag{24}$$

Proof: Follows from differentiating (23) using $\frac{\partial L}{\partial \tau}$ from proposition 2. *Q.E.D.*

Intuitively, raising the levy rate increases the tax revenue and the internalization reduces bank size, which is otherwise too large as banks fail to internalize all cost, such that the fiscal cost of providing a bailout are lower. The latter is inherently linked to the pass-through discussed above: Reducing the loan supply raises the lending rate due to the downward-sloping loan demand and, at the same time, banks are smaller such that fiscal cost of fulfilling guarantees towards depositors are lower. However, there are two additional, counteracting effects of a higher levy rate: First, the

smaller bank size reduces tax base and revenue, which is a typical Laffer property. Second, banks increase their liabilities in order to pay the tax upfront such that failure threshold A^* as well as failure probability $F(A^*)$ rise.[19] In general, the overall effect of raising the levy rate is ambiguous. However, one can see in (24) that it is unambiguously positive if the levy is introduced (i.e., the initial tax rate is $\tau = \tau^e = 0$ such that the negative term in square brackets vanishes) and the levy rate is low. Consequently, introducing a levy on bank liabilities can be an effective measure to internalize (part of) the fiscal cost of banking crises.

4.3 Predictions

The theoretical analysis implies that the levy raises lending rates and net interest margins and has no effect on the deposit rate. The key finding that banks pass part of the tax burden onto borrowers prevails in several extensions that complement the Monti-Klein model with additional features. A pass-through to depositors is, in contrast, unlikely because banks generally prefer adjusting non-deposit liabilities that yield no rent instead. Deposits might respond if they require cash holdings (e.g., due to reserve requirements) or if they are partly exempt from the levy such that banks might substitute deposits for other sources of funding. Nevertheless, the combined effect is ambiguous due to these counteracting mechanisms and weak due to the stickiness of deposit rates.
The magnitude of the pass-through crucially depends on two factors: First, a bank's market power, given by market concentration or interest rate elasticity, reinforces the increase of the lending rate but weakens the response of the deposit rate if there is any. This is a standard finding in the incidence literature and determines to what extent banks can pass the tax burden onto customers. Second, the bank's capital structure, influenced by regulation, determines its exposure to the levy. Since the levy is usually imposed on liabilities, more equity mechanically reduces the bank's tax burden and pass-through to borrowers. A potential pass-through to depositors is, however, unaffected. Consequently, the regulatory reforms (Basel III) currently being introduced may even mitigate adverse consequences of the levy for cost and supply of credit. However, this prediction only prevails in the benchmark model without risk of bank failure. The main theoretical predictions are summarized in table 4.3.

	Lending Rate	Deposit Rate	Net Interest Margin
Levy	+	none	+
Market Power	↑	(↓)	ambiguous
Equity Ratio	↓	(none)	ambiguous

Table 2: Theoretical Predictions

However, some of these predictions need to be treated with caution because of the model's limitations: First, it is static, which prevents a gradual adjustment of interest rates that is likely in reality as the bank can often not unilaterally change existing credit contracts. Thus, the levy will mainly affect new loan and deposit contracts. In addition, Austria initially imposed the levy on past balance sheets such that the bank's tax liability T_i is, in principle, unrelated to its current loans and deposits. In this case, the static first-order conditions, (6) and (7), imply that the bank's choices are unaffected ruling out any balance sheet adjustment. In a dynamic framework, banks would, nevertheless, react in order to lower their future tax burden. Second, capital requirements are binding, which can be explained by costly equity and small enough levy rates. However, it does not allow for a substitution of equity for debt and conflicts with Devereux et al. (2015), who find

[19] Note that this effect would prevail even if the tax is paid at the end of the period as the bank's obligations are then $(1+r)d+T$. Only the German model where a significantly lower levy has to be paid in case the bank makes a loss does not entail such a feature.

evidence that the levy indeed induces banks to lower their leverage. Third, the Monti-Klein model by construction establishes a fixed relation between quantity and price because interest rates are pinned down by a given inverse demand or supply function. Hence, separating price and quantity effects (e.g., raising lending rates without changing loan supply) is not possible.

5 Evidence

This section analyzes how EU banks respond to bank levies and to what extent they pass the tax burden onto their customers. It provides reduced-form tests of the theoretical predictions, which is a usual approach in related contributions such as Albertazzi and Gambacorta (2010) and Devereux et al. (2015). We employ a panel dataset from Bankscope with balance sheet data of 2'963 banks in the European Union between 2007 and 2012.[20]

5.1 Estimation Strategy

The empirical strategy closely follows Devereux et al. (2015) who use a similar dataset to estimate the impact of bank levies on capital structure and risk taking. The choice of the covariates is motivated by the theoretical analysis as well as by the bank-related incidence literature.

5.1.1 Baseline Model

The baseline model captures the average effect of the bank levy. The econometric specification is

$$y_{ijt} = \alpha_i + \gamma_t + \beta_1 levy_{ijt} + \varphi X_{ijt} + \epsilon_{ijt} \tag{25}$$

where y_{ijt} and $levy_{ijt}$ are outcome and main explanatory variable respectively. α_i and γ_t denote bank and time fixed effects and $\mathbf{X}_{ijt}$ the vector of controls. Bank fixed effects absorb all time-constant heterogeneity, time fixed effects all common shocks.

To capture the incidence, we estimate the levy's impact on three different outcome variables: net interest margin, lending rate, and deposit rate. In line with the literature, an increase (in case of the deposit rate a decrease) in response to the levy is interpreted as a pass-through. The net interest margin, NIM_{ijt}, defined as the ratio of net interest income to average interest-bearing assets is a common measure in the incidence literature and allows estimating the pass-through to customers by increasing the spread between lending and borrowing rates. Since bank interest rates are not directly available in the data, we approximate the average lending and deposit rate by two ratios: interest income on loans as a share of average loans, IIL_{ijt}, and interest expenses on customer deposits as a share of average deposits, IED_{ijt}. These ratios are imperfect measures of the interest rates a bank charges or pays: In particular, they do not allow distinguishing between old and new loans, different maturities or risk profiles. Since the levy was introduced on short notice and difficult to anticipate, it is likely that it mainly affects interest rates of new loans and deposits. Hence, the estimated effects on average interest rates are rather conservative.

The main explanatory variable $levy_{ijt}$ is captured by three proxies that exploit three sources of variation: First, some EU countries introduced a bank levy while others did not; second, in some countries that impose a levy not all banks are taxed, for example, in Germany, Austria, and the UK where small banks are exempt; third, banks face different marginal levy rates across and in some cases also within countries. The latter is due to the progressive schedule. Following Devereux et al. (2015), we first construct a dummy variable $levy1_{jt}$ that equals one if a bank is located in a country that imposes a levy in a certain year and zero otherwise. This measure defines the levy at the country-year level and captures its effect on interest rates and profitability of an average bank located in a levy country. However, the dummy variable might be affected by other

[20] This *de facto* captures the (post-)crisis period 2008-12 as several bank level variables are lagged.

country-year level variations such as changes in bank regulation, corporate taxation or government interventions in the banking sector that need to be controlled for. Second, we approximate each bank's contribution-relevant liabilities[21] using the levy information provided by Devereux et al. (2015). Based on this estimates, we create a dummy variable $levy2_{ijt}$ that equals one if both a bank levy is in place in the country and year and the bank's contribution-relevant liabilities are positive and exceed the allowance threshold defined in the tax law. Hence, this variable indicates whether a bank faces a positive marginal tax rate and is effectively taxed. Such a measure is also used by Buch et al. (2014) when analyzing the incidence of the German levy. Again following Devereux et al. (2015), we eventually calculate the marginal levy rate $levy3_{ijt}$ for each bank based on its contribution-relevant liabilities. In countries without an allowance, the bank-level measures are similar for all banks, and $levy1$ and $levy2$ coincide. Overall, the bank-level proxies are more informative and appear preferable to the country-level proxy. Recall, however, that the data do not include any information whether a bank is effectively taxed; we instead rely on a rough approximation of its contribution-relevant liabilities and infer from the tax schedule whether it is subject to the levy. Hence, the country-level levy measure provides a valuable robustness check.

The vector of controls $\mathbf{X}_{ijt}$ is, first of all, motivated by the Monti-Klein model: It includes the share of equity, $equity_{ijt}$, the non-interest expenditures divided by total assets as a proxy for the cost structure, $cost_{ijt}$, the interbank rate, $interbank_{jt}$, and the Herfindahl-Hirschman index HHI_{jt} as a measure of bank concentration. Moreover, the model also implies that the corporate income tax rate influences at least the lending choice due to the debt bias (see section 4.1.3); hence, the statutory tax rate, CIT_{jt}, is included. Additional controls are chosen in line with the incidence literature: We add the bank's size measured by the log of total assets squared, $assets_{ijt}$, which due to allowance and progressive tax rates determines whether a bank is taxed and how much it pays. Following Chiorazzo and Milani (2011), we rely on the squared values to capture possible non-linearities and to avoid interfering with other variables defined in terms of total assets. A potential concern is that increases in average lending and deposit rates do not reflect a pass-through to customers but higher risk premia as the levy induces banks take more risk. Devereux et al. (2015) find evidence for such a behavior. However, we approximated the lending rate by the bank's interest income (as a fraction of average loans), which only includes interest effectively paid. Since lending to riskier borrowers results in a larger fraction of non-performing loans, the average interest income *ex post* should not be affected provided that the lending rate accurately reflects the borrowers' risk profile.[22] Hence, changes in risk taking should not influence the bank's average interest income such that an increase indeed reflects a pass-through. Nevertheless, it is unlikely that both effects exactly cancel out each other given that the risk premium also accounts for loan losses in case the borrowers default. Therefore, we include a proxy for the risk of the bank's loan portfolio. While the average regulatory risk weight would be an appropriate measure, it can be computed only for a small subsample. Hence, we instead rely on the only measure available for the full sample, the loan loss reserves, $risk_{ijt}$. To account for different macroeconomic conditions that may affect bank behavior we add inflation, $infl_{jt}$, and the real growth rate of GDP, $growth_{jt}$. Since government interventions in the banking sector during and after the financial crisis partly overlap with the introduction of levies and likely influenced bank behavior, the variable $recap_{jt}$ that measures the fiscal cost of bank recapitalization as a share of GDP is also included. All bank-level stock variables are lagged by one period to avoid simultaneity.

The model (25) is estimated using OLS (within estimator); standard errors are clustered at the bank level and robust to cross-sectional heteroskedasticity and serial correlation. The main advantage of this method is that it controls for time-invariant, unobserved heterogeneity. In this context, one might think of the nature of the bank-borrower relationship: In case of a long-standing borrowing

[21] For the calculation of the contribution-relevant liabilities, refer to table 15.

[22] The lending rate is higher but the share of performing loans is smaller such that the *ex post* interest payments are unchanged.

relation, the lending rate is *ceteris paribus* lower due to low monitoring cost but, at the same time, it facilitates a pass-through of the levy because switching to another bank may be (prohibitively) costly for the borrower, which could be exploited by the bank. The bank-borrower relationship, in turn, depends on the bank's general strategy, expertise, and reputation, which is usually constant in the short- and medium-run. The key identifying assumption is strict exogeneity, which requires that the control variables - especially the main explanatory variable $levy_{ijt}$ - are uncorrelated with past, present, and future values of the time-varying errors ε_{ijt}:

$$E[\varepsilon_{ijs}|levy_{ijt}, X_{ijt}, \alpha_i, \gamma_t] = 0, \ \forall s = 1, .., t, .., T$$

If this assumption is not satisfied, the demeaned controls and errors are correlated resulting in inconsistent estimates. A concern regarding strict exogeneity is that banks might have anticipated the levy and already adjusted their balance sheets in advance. This adjustment prior to the levy's introduction would be part of the error term that is then correlated with future (i.e., post-introduction) values of the levy variable thereby violating strict exogeneity. However, the levy was introduced on rather short notice and in the same time frame in many countries (see section 2). In case of Germany, for instance, Buch et al. (2014) argue that there was substantial uncertainty about the levy's design and implementation and it was imposed in retrospect in the first year thereby making it difficult for banks to anticipate their precise exposure to the levy. Consequently, anticipation is unlikely especially in countries that introduced the levy 2011 or earlier. Moreover, the bank-level levy variables, $levy2$ and $levy3$, might be endogenous because they depend on bank characteristics due to allowances and progressive levy rates in some countries. This concern is addressed as a robustness check: We instrument these levy variables with a measure based on a bank's pre-levy balance sheets and obtain similar estimates than in the baseline fixed-effects model.

5.1.2 Heterogeneity in Responses

The theoretical analysis implies that the magnitude of the responses of average lending rate and net interest margin differs in at least two dimensions: market power and capital structure. Hence, we adjust the baseline specification and estimate two models that include interaction terms

$$y_{ijt} = \alpha_i + \gamma_t + \beta_1 levy_{ijt} + \beta_2 levy_{ijt} * mp_{ijt} + \varphi X_{ijt} + \epsilon_{ijt} \tag{26}$$

$$y_{ijt} = \alpha_i + \gamma_t + \beta_1 levy_{ijt} + \beta_2 levy_{ijt} * cap_{ijt} + \varphi X_{ijt} + \epsilon_{ijt} \tag{27}$$

mp_{ijt} and cap_{ijt} are measures for market power and capital structure respectively. Since theory highlights the importance of market concentration, we include the Herfindahl-Hirschman index HHI_{jt} as well as the branch density BD_{jt}. The former is a popular measure of bank concentration, it equals the sum of bank market shares squared. We rely on the HHI based on assets of the entire banking industry, which is provided by the ECB. We also use the branch density, that is, the number of bank branches per 10'000 inhabitants, as an additional concentration measure. In addition, we apply a bank-level measure of market power, namely, its market share, which is computed for banks in the sample based on loans, MS_{ji}. Interacting levy and market share may not be very meaningful because the degree of market power associated with a five percent market share, for example, differs between concentrated and fragmented loan markets. Therefore, we compute the quartiles of the market share distribution for each country and interact the levy with a dummy variable that equals one if the bank's market share is above the upper quartile (75th percentile). For example, this corresponds to a market share of at least 0.31% in Austria, 0.03% in Germany, 4.27% in the Netherlands, and 0.71% in the UK. Since one needs to compare market shares at a given point in time, we rely on the market share distribution in 2009, the year before the levy was introduced the first time. This also avoids endogeneity that might arise if quantity effects induced by the levy leads to changes in the market shares.

Similarly, to account for the effect of bank capitalization on the incidence, we interact the levy variable with a dummy variable that equals one if a bank's equity ratio is above the median. This corresponds to an equity ratio of at least 7.04 percent. Since the levy likely influences the capital structure, we rely on the equity distribution prior to its introduction (2009). As robustness checks, we also interact the levy variable with a dummy variable that equals one if the equity ratio was higher than the 75th percentile (i.e., 9.74%) and a dummy variable that equals one if the 2009 regulatory capital ratio exceeds the median.

5.2 Data and Measurement

We employ an unbalanced panel dataset that includes bank-level information of (at most) 2'963 banks from 24 European countries between 2007 and 2012. All 2012 EU member states except for France, Hungary, and Slovenia, which adapted a conceptually different levy, are included. The sample consists of 16'454 bank-year observations. Five different types of banks are represented: commercial banks (17.7% of all bank-year observations), savings banks (23.7%), cooperative banks (54.4%), real estate and mortgage banks (3.4%), and bank holdings and holding companies (0.8%). A list of variables, their definitions and sources is provided in table 13 in appendix B. The main source is *Bankscope*, a database provided by Bureau van Dijk that contains information on balance sheets and income statements of banks based on their annual reports. Since taxes are levied on single entity accounts, only unconsolidated financial statements (consolidation codes U1 or U2) are included.[23] This generally removes the problem that multinational banks pay levies in several countries as we have separate data of the parent bank and its foreign subsidiaries.[24] Bankscope is a popular source in the empirical banking literature and used in related papers like Devereux et al. (2015) and Chiorazzo and Milani (2011). Detailed information about bank levies is taken from Devereux et al. (2015), who provide hand-collected data about the levy's design (tax base, allowance, tax rates) in all relevant countries. Macroeconomic data (real growth and inflation rates) are taken from Eurostat and bank sector characteristics from the ECB Financial Structures Report. Data on interbank rates are taken from the OECD financial statistics or from national central banks[25]. Some adjustments of the sample were made: First, balance sheet data with closing date between April and September were excluded from the sample because they are not clearly attributable to a specific year; observations with closing date between January and March are attributed to the previous and observations with closing date between October and December to the current year. Second, all observations in a currency other than Euro were transformed into Euro. Third, inactive banks as well as banks with negative assets or equity were deleted.[26] Fourth, some variables including the outcomes are ratios typically expressed in terms of bank assets. They may take extreme values if the assets are small or misreported. Finally, the influence of such outliers is reduced by winsorizing all bank-level ratios[27] at the 2nd and 98th level.

The sample covers approximately 43 percent of all banks in the 24 countries. German and Italian banks are overrepresented accounting for 56% (18%) of sample versus 28% (11%) of existing banks in 2010.[28] Hence, it is likely that the results are partly driven by the German bank levy.

The summary statistics are provided in table 16 in appendix B for the full sample (1st column), for banks from countries that did or did not adopt a levy (2nd and 3rd column), and for banks taxed or not taxed according to the levy proxy $levy2$ (4th and 5th column). The statistics in the 4th and 5th column are calculated only for banks in countries that introduced a levy at some

[23] For the Netherlands and the UK, however, we rely on consolidated financial statements as the levy is imposed on the consolidated balance sheet of banking groups.

[24] However, foreign branches subject to a levy may be included in the unconsolidated data of the domestic bank.

[25] Information on interest rates from central banks for Bulgaria, Cyprus, Latvia, Lithuania, Malta, and Romania

[26] This might give rise to the survivorship bias if banks exit because they cannot pass through the levy. However, this is highly unlikely in the short run; recall that most countries introduced the levy not earlier than 2011 and the sample includes just two follow-up periods.

[27] The following variables are winsorized: IIL, IED, NIM, $equity$, $risk$, and $cost$.

[28] For a detailed composition of the sample, see table 14 in appendix B.

point in time. The average bank is characterized by an interest income on loans of 5.96 percent of average loans, interest expenses on deposits of 1.90 percent of average deposits and a net interest margin of 2.49 percent. Its total assets amount to approximately EUR 12.7bn, 8.38 percent of which are funded by equity. In general, banks located in levy countries charge higher lending rates (6.17% vs. 5.38%) and pay higher deposit rates than those in non-levy countries; they are also larger and funded by a smaller share of equity (7.58% vs. 10.47%). Within countries that adopted a levy, those banks subject to the levy are characterized by lower interest rate and profitability measures (e.g., NIM 2.21% vs. 2.52%) and are considerably larger (total assets of EUR 38.1bn vs. EUR 1.3bn). The latter is primarily due to the fact that small banks are exempt from the levy in countries such as Germany, Austria and the United Kingdom. The magnitude of the difference is, however, driven by the presence of a few very large British and Dutch banks, for which consolidated financial statements are used due to the legal definition of the tax base.

In order to construct the bank-level levy measures, one needs to approximate banks' contribution-relevant liabilities (i.e., the tax base) in those countries that exempt small banks from the levy or apply a progressive tax rate: Austria, Germany, the Netherlands, and the UK. The contribution-relevant liabilities are approximated according to the information provided by Devereux et al. (2015, appendix), a summary of the regulations in national tax laws. They usually equal the balance sheet total net of equity and insured deposits; in Germany, all consumer deposits are exempt. If only specific forms of bank capital (e.g., Tier 1 capital in the UK) are excluded, we subtract this item from the balance sheet total if available or replace it by total equity otherwise. Insured deposits, in turn, are calculated by multiplying a bank's customer deposits by the coverage ratio (i.e., the volume share of insured deposits in total deposits) in the country, which is provided by the EU Commission. Other excluded items are subtracted only if available. The bank-level levy proxy $levy2$ equals one if the current-year contribution-relevant liabilities exceed the allowance threshold. For Austria, this variable is determined based on the 2010 balance sheet.[29]

Eventually, table 3 summarizes the distribution of banks subject to the levy: In 2010, 79 out of 2949 banks in the sample were taxed as only Sweden introduced the levy already in this year. However, all Swedish banks were effectively taxed. The share of banks in countries that adopted the levy significantly increased in 2011 when 68 percent of all sample banks were located in countries that adopted a levy. However, only 22 percent effectively faced a levy as a large number of small banks was exempt from the levy. These shares slightly increased in 2012 as three additional countries (Belgium, Netherlands, and Slovakia) introduced a bank levy.

	Levy Country		Subject to Levy		
	Fraction	Banks	Fraction	Banks	Total Banks
2010	2.65	74	2.65	74	2791
2011	70.25	2017	22.19	637	2871
2012	72.18	2055	23.78	677	2847

Table 3: Banks Subject to Levy

5.3 Main Results

This section summarizes the main results, namely, the estimates of the baseline model (25) and of the heterogeneous responses models (26) and (27).

5.3.1 Baseline Model

Table 4 reports the coefficient estimates for regression (25). The dependent variable is interest income on loans/average loans in columns (1)-(3), interest expenses on deposits/average customer deposits in columns (4)-(6) and the net interest margin in columns (7)-(9). For each outcome variable, we run three regressions, using country- and bank-level levy dummies, $levy1$ and $levy2$,

[29] The detailed construction of the contribution-relevant liabilities is explained in table 15 in appendix B.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	IIL	IIL	IIL	IED	IED	IED	NIM	NIM	NIM
levy1	-0.0802			-0.1072			0.0900***		
	(0.0499)			(0.0818)			(0.0195)		
levy2		0.1308***			-0.0850			0.0434***	
		(0.0341)			(0.0921)			(0.0146)	
levy3			2.9318***			-0.7895			1.7436**
			(1.0382)			(0.5346)			(0.7205)
levy3^2									-3.9073**
									(1.8455)
cost	0.1028***	0.1135***	0.1115***	-0.0210	-0.0208	-0.0217	0.0778***	0.0705***	0.0698***
	(0.0237)	(0.0234)	(0.0234)	(0.0334)	(0.0333)	(0.0334)	(0.0106)	(0.0103)	(0.0103)
equity	0.0071	0.0016	0.0008	0.0116	0.0110	0.0108	0.0144**	0.0176***	0.0176***
	(0.0191)	(0.0179)	(0.0166)	(0.0163)	(0.0162)	(0.0161)	(0.0057)	(0.0056)	(0.0056)
assets	-0.0087	-0.0084	-0.0090	0.0105	0.0105	0.0104	-0.0125***	-0.0122***	-0.0123***
	(0.0117)	(0.0118)	(0.0117)	(0.0141)	(0.0141)	(0.0139)	(0.0028)	(0.0028)	(0.0028)
risk	0.0231	0.0402*	0.0344	-0.0484	-0.0466	-0.0462	-0.0023	-0.0042	-0.0050
	(0.0248)	(0.0240)	(0.0234)	(0.0597)	(0.0597)	(0.0596)	(0.0100)	(0.0102)	(0.0102)
interbank	0.3110***	0.2952***	0.3025***	0.2309***	0.2320***	0.2263***	0.0961***	0.1005***	0.1021***
	(0.0536)	(0.0547)	(0.0551)	(0.0511)	(0.0525)	(0.0496)	(0.0191)	(0.0191)	(0.0190)
infl	-0.0572*	-0.0529	-0.0555*	-0.0699**	-0.0702**	-0.0691*	0.0222*	0.0237*	0.0246**
	(0.0328)	(0.0331)	(0.0326)	(0.0353)	(0.0353)	(0.0354)	(0.0122)	(0.0121)	(0.0121)
growth	-0.0445***	-0.0580***	-0.0550***	-0.0226	-0.0233	-0.0265	-0.0055	-0.0004	-0.0003
	(0.0135)	(0.0125)	(0.0123)	(0.0205)	(0.0208)	(0.0188)	(0.0057)	(0.0053)	(0.0053)
CIT	0.0799**	0.0728**	0.0727**	0.1812***	0.1898***	0.1898***	0.0123	0.0139	0.0132
	(0.0339)	(0.0344)	(0.0343)	(0.0392)	(0.0396)	(0.0395)	(0.0163)	(0.0165)	(0.0165)
recap	-0.0237	-0.0227	-0.0251	0.0154	0.0156	0.0153	-0.0536***	-0.0580***	-0.0588***
	(0.0228)	(0.0220)	(0.0219)	(0.0413)	(0.0413)	(0.0415)	(0.0092)	(0.0097)	(0.0098)
HHI	-3.2290	-1.1678	-0.7613	1.4752	1.7051	2.4354	6.0618***	6.1014***	6.3189***
	(3.5276)	(3.5687)	(3.4424)	(3.6847)	(3.8059)	(3.5460)	(1.0608)	(1.0437)	(1.0825)
Constant	3.7750***	3.9754***	3.9813***	-3.4210***	-3.6568***	-3.6651***	1.7792***	1.6876***	1.7007***
	(1.1548)	(1.1666)	(1.1586)	(1.2349)	(1.2688)	(1.2667)	(0.4941)	(0.5039)	(0.5045)
Obs.	11848	11833	11833	4044	4044	4044	13366	13333	13333
No. banks	2604	2601	2601	948	948	948	2916	2910	2910
R^2	0.5893	0.5921	0.5925	0.4525	0.4524	0.4524	0.1001	0.0972	0.0975
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Dependent variable: interest income on loans/av. loans (1)-(3), interest expenses on deposits/av. customer deposits (4)-(6), net interest margin (7)-(9)
Clustered standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Baseline Regression

as well as the marginal tax rate $levy3$. Given the rather complex response of the NIM implied by theory, we also include the squared levy rate, $levy3^2$, in the corresponding regressions to account for potential non-linearities. The theoretical analysis suggests a positive coefficient of the levy variables on the average lending rate, IIL, and the net interest margin, NIM, and suggests no or only a weak and unclear response of the average deposit rate, IED.

First, the interest income on loans/average loans positively responds to the levy as soon as the bank is effectively taxed: The coefficient of the bank-level dummy $levy2$ is positive and significant and implies an increase of the average lending rate by roughly 0.13 percentage points. The coefficient of the marginal levy rate, $levy3$, suggests that if a bank faces, for instance, a 0.06 percentage points higher marginal levy rate (i.e., the top levy rate in Germany is doubled), the lending rate is 0.18 percentage points higher. The country-level variable $levy1$, in contrast, is insignificant. The positive estimates differ from Buch et al. (2014), which do not find any significant increases of lending rates in Germany. However, we use a cross-country sample with a longer time frame after the levy's introduction (two years instead of one), which makes a pass-through more likely.

Second, the results do not suggest that the average deposit rate, measured by interest expenses on deposits/average customer deposits, responds to the levy as the coefficients remain insignificant. This might be partly attributed to the reduced sample size compared to the previous estimations due to data availability. This result is fully consistent with the theoretical predictions and the evidence that deposit rates are relatively sticky.

Third, the coefficient estimates for the net interest margin (NIM) shown in columns (7)-(9) are positive and significant: When using the country-level proxy $levy1$, one finds that the NIM of banks located in a country that adopts a levy increases by 0.09 percentage points. The coefficient of $levy2$ also implies a positive but smaller increase of the NIM. The coefficients for the marginal levy rate have opposite signs hinting at a concave relation; an increase of the levy rate by 0.06 percentage points implies that the NIM rises by 0.09 percentage points. Therefore, the evidence supports the theoretical prediction that the spread between the bank's lending and borrowing rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Average Lending Rate (IIL)					
levy1	-0.3915***			0.6617***			-0.1055**		
	(0.0702)			(0.1835)			(0.0498)		
levy2		-0.1197**			0.6443***			0.1625**	
		(0.0610)			(0.1937)			(0.0674)	
levy3			-0.7957			7.5410*			6.5474***
			(2.4252)			(4.1094)			(2.2468)
levy3^2			-24.8453**			-10.0190			-8.6027
			(11.6091)			(8.2004)			(5.8577)
levy*mp	7.4634***	5.8691***	106.5442**	-0.1684***	-0.1214***	-0.6553	0.1017***	-0.0454	-2.6664
	(1.1027)	(1.3860)	(46.3994)	(0.0434)	(0.0446)	(0.6742)	(0.0354)	(0.0754)	(1.7879)
Obs.	11848	11833	11833	11848	11833	11833	11848	11833	11833
No. banks	2604	2601	2601	2604	2601	2601	2604	2601	2601
R^2	0.5928	0.5936	0.5931	0.5951	0.5969	0.5964	0.5897	0.5921	0.5929
				Net Interest Margin (NIM)					
levy1	0.0941***			0.0201			0.0822***		
	(0.0255)			(0.0649)			(0.0201)		
levy2		0.0448*			-0.2151***			-0.0093	
		(0.0235)			(0.0630)			(0.0322)	
levy3			1.0958			-2.5340*			1.4723
			(0.8391)			(1.4814)			(1.0561)
levy3^2			-6.1541			3.5002			-3.5272
			(5.0089)			(2.6504)			(2.2270)
levy*mp	-0.0960	-0.0319	12.6310	0.0109	0.0551***	0.5785**	0.0308**	0.0752**	0.3944
	(0.4774)	(0.5831)	(20.7948)	(0.0140)	(0.0140)	(0.2516)	(0.0125)	(0.0323)	(0.6351)
Obs.	13366	13333	13333	13366	13333	13333	13366	13333	13333
No. banks	2916	2910	2910	2916	2910	2910	2916	2910	2910
R^2	0.1001	0.0972	0.0976	0.0978	0.0979	0.0965	0.1004	0.0979	0.0976
mp		HHI			Branch Density			MS above 75th percentile	
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Clustered standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Heterogeneous Responses: Market Power

increases. The impact on the NIM is, however, weaker than the impact on the average lending rate, which may be explained by the fact that it also includes interest income on all assets and interest expenses on all liabilities not just on loans and deposits. Since the returns of assets like sovereign or corporate bonds, for example, are unlikely to react to a bank levy at least in the short run, the response of an average measure like the NIM is obviously less pronounced. Moreover, the response is influenced not just by price but as well by composition effects.

Consequently, the levy is passed onto borrowers and raises the spread between lending and borrowing rates as predicted by the model. Although the quantitative effects are not negligible, they are quite moderate given that average interest income on loans and net interest margin are 5.96 and 2.49 percent respectively such that one should not overemphasize their economic relevance.

5.3.2 Heterogeneity in Responses

The theoretical analysis suggests that the magnitude of the pass-through depends on market power and bank capitalization. Table 5 reports the coefficients of interest for regression (26) that includes interaction terms between levy variables and three proxies for market power: Herfindahl-Hirschman index, branch density, and the bank's (relative) market share. The analysis focuses on two outcomes: interest income on loans and net interest margin. We omit the estimations for interest expenses on deposits because the interaction terms are all insignificant as expected because neither theory nor the baseline regression (see table 4) imply any effect.

The upper section summarizes the results for the average lending rate: All three interaction terms of the levy proxies with the Herfindahl-Hirschman index are positive and significant (columns 1-3). Importantly, the overall effect strongly depends on the HHI and only reaches significance if market concentration is above average: Figure 1 illustrates the bank's average lending rate response if its marginal levy rate increases by 0.06 percentage points: $\beta_1 * 0.06 + \beta_1' * 0.06^2 + \beta_2 * 0.06 * HHI$. Recall that this scenario corresponds to doubling the top marginal levy rate in Germany. The left-hand panel illustrates the marginal effect (with the 95% confidence band), the right-hand panel

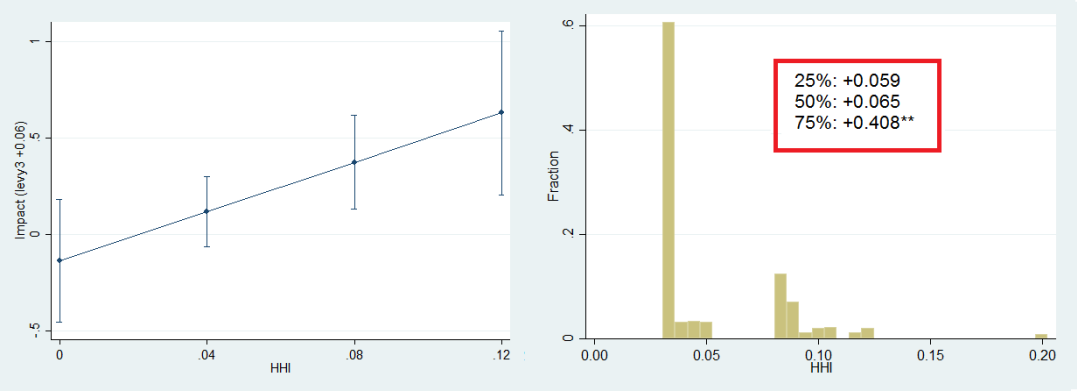

Figure 1: Heterogeneity: Lending Rate and HHI

the distribution[30] of the HHI. The effect is only significant as long as the HHI exceeds 0.045. For banks in countries at the 25th (e.g., Germany) or 50th percentile of the HHI distribution, one does not observe an increase of the average lending rate as the marginal effect is insignificant; for those located in a country at the 75th percentile (e.g., Romania), in contrast, the levy leads to an increase of 0.41 percentage points, which is economically relevant given an average lending rate of 5.96 percent and almost three times larger as the baseline response of 0.18 percentage points.

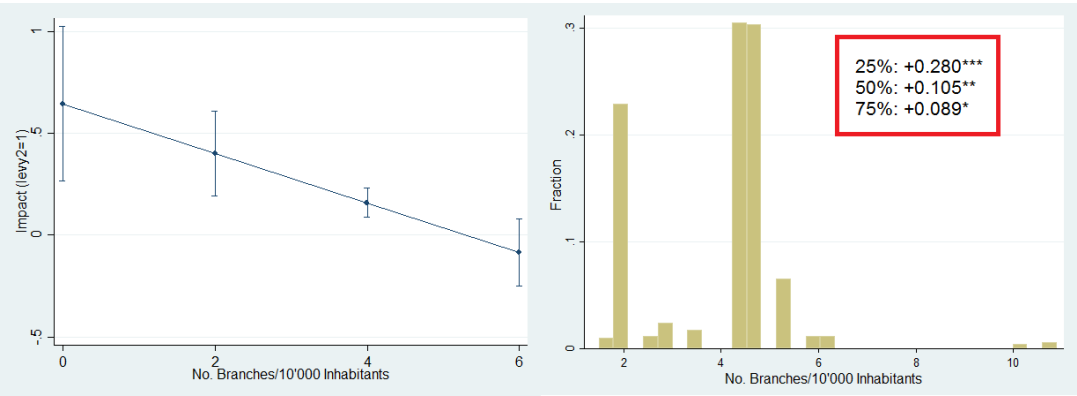

Figure 2: Heterogeneity: Lending Rate and Branch Density

Similar findings are obtained when measuring market power by the branch density (columns 4-6): The coefficients of the interaction terms are negative and significant in two out of three regressions. Figure 2 illustrates the increase of the average lending rate if a bank is subject to the levy (column 5): $\beta_1 + \beta_2 * BD$. It rises by 0.28 percentage points in a country at the 25th (Romania: 3 branches/10'000 inhabitants) and by 0.09 percentage points at the 75th percentile of the branch density distribution (Germany: 4.64 branches/10'000 inhabitants) respectively. In general, banks operating in countries with a branch density of more than 4.7 do not significantly increase lending rates when facing a positive marginal levy rate. While the incidence considerably varies with market concentration, a bank's individual market power, namely, its market share, seems to matter less as only one out of three coefficients (column 7) is positive while the others are insignificant. The evidence thus strongly supports the theoretical prediction that market power reinforces the pass-through to borrowers. More precisely, the pass-through of the levy burden to borrowers is sizable and statistically and economically significant in concentrated loan markets but rather modest on average (see section 5.3.1) and even insignificant in case of intense bank competition. In particular, industry-wide characteristics like concentration and the number of bank branches matter.

The lower section of table 5 reports the estimates for the net interest margin. Recall that coun-

[30] For the subsample of observations for which $levy3 \neq 0$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Average Lending Rate (IIL)					
levy1	-0.1012*			-0.0884*			-0.0463		
	(0.0523)			(0.0508)			(0.0524)		
levy2		0.0922***			0.1184***			0.0898**	
		(0.0341)			(0.0338)			(0.0396)	
levy3			4.4293**			5.8618***			4.3780**
			(1.8538)			(1.6865)			(2.0231)
levy3^2			-8.3420			-4.1785			-7.4000
			(6.1356)			(6.7620)			(6.0796)
levy*cap	0.0558*	0.1551*	1.5662	0.0580	0.1055	-3.4580*	-0.0533*	0.0715	0.9948
	(0.0337)	(0.0832)	(1.7080)	(0.0680)	(0.1251)	(2.0938)	(0.0279)	(0.0536)	(1.7012)
Obs.	11848	11833	11833	11848	11833	11833	11848	11833	11833
No. banks	2604	2601	2601	2604	2601	2601	2604	2601	2601
R^2	0.5894	0.5924	0.5927	0.5894	0.5922	0.5931	0.5894	0.5922	0.5927
				Net Interest Margin (NIM)					
levy1	0.1193***			0.1116***			0.1113***		
	(0.0193)			(0.0188)			(0.0204)		
levy2		0.0619***			0.0622***			0.0406**	
		(0.0137)			(0.0131)			(0.0179)	
levy3			2.1753***			2.0381***			1.9005***
			(0.6438)			(0.6528)			(0.6892)
levy3^2			-2.5536			-2.7593			-3.7318*
			(2.1856)			(2.1133)			(1.9920)
levy*cap	-0.0745***	-0.0701**	-1.2541*	-0.1458***	-0.1488***	-1.3764**	-0.0320***	0.0047	-0.2560
	(0.0149)	(0.0342)	(0.6593)	(0.0331)	(0.0576)	(0.6655)	(0.0122)	(0.0228)	(0.6218)
Obs.	13366	13333	13333	13366	13333	13333	13366	13333	13333
No. banks	2916	2910	2910	2916	2910	2910	2916	2910	2910
R^2	0.1024	0.0978	0.0980	0.1041	0.0987	0.0982	0.1005	0.0972	0.0975
cap	Above median			Above 75th percentile			Reg. Cap. above median		
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Clustered standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Heterogeneous Responses: Bank Capitalization

teracting price and composition effects do not allow for a clear theoretical prediction. Interacting the levy with the HHI yields insignificant coefficients whereas the those of the branch density are positive and significant in two out of three regressions (columns 5 and 6). The latter hints at a negative effect of concentration on the pass-through. The interaction terms of levy and the bank's market share are positive and significant two out of three specifications (columns 7 and 8). It implies, for example, that banks with a market share above (below) the 75th percentile increase the NIM by 0.11 (0.08) percentage points if they are located in a country that introduces the levy.

The second dimension is bank capitalization: Table 6 reports the coefficients of the interaction terms between the levy measures and a dummy variable that equals one if the (pre-levy) equity ratio is above the median (columns 1-3), a dummy variable that equals one if the equity ratio is above the 75th percentile (columns 4-6), and a dummy variable that equals one if the regulatory capital ratio is above the median (columns 7-9).

The results for average lending rate and net interest margin are reported in the upper and lower section respectively: Contrary to the prediction, the evidence is inconclusive about the impact of capitalization on the lending rate's response to the levy. However, it strongly implies that the increase of the net interest margin is less pronounced for well-capitalized banks as all interaction terms are negative and significant. Based on the coefficients, we compute the marginal effects of the levy for three scenarios: the bank is located in a country with a bank levy ($levy1 = 1$), the bank is effectively subject to a levy ($levy2 = 1$), and the bank faces a 0.06 higher marginal levy rate. The marginal effects are summarized in table 7: In general, banks with an initial equity ratio below the median, which corresponds to a equity ratio of at most 7.04%, raise the net interest margin by more than in the baseline regardless whether the levy is measured at the country- or at the bank level. The response of banks with an above median equity ratio is weaker or insignificant. In case of well capitalized banks with an equity ratio above the 75th percentile (i.e., capital ratio at least 9.74%) the pass-through completely vanishes. If a country introduces a bank levy (column 1), for example, a bank's net interest margin increases by 0.09 percentage points on average. If its equity ratio is below the median, the effect is more pronounced as the net interest margin increases by 0.12 percentage points. As soon as its equity ratio is above the median, however, the net interest

margin increases only by 0.05 percentage points and the effect vanishes in case the equity ratio is above the 75th percentile.

		(1)	(2)	(3)
Average		0.090***	0.043***	0.091**
Equity Ratio	below 50th	0.119***	0.062***	0.121***
	above 50th	0.048**	-0.008	0.046
	above 75th	-0.034	-0.087	0.030

Table 7: Heterogeneous Responses: NIM and Bank Capitalization

Overall, the empirical results imply that well capitalized banks do not pass the levy burden onto their customers and that the pass-through is particularly strong in case of poorly capitalized banks. The latter seems to drive the baseline result that the levy raises banks' net interest margins whereas the former may explain the relatively moderate average response.

5.4 Robustness Tests

This section provides several robustness tests: First, the concern that the bank-level levy measures might be endogenous as they depend on bank characteristics is addressed by estimating the baseline model using instruments for the levy variables. Second, we introduce differential time trends to capture shocks to specific groups of banks that are likely in the context of financial crisis and banking reform and may lead to biased estimates if correlated with the bank levy. Eventually, we estimate the baseline models in subsamples of different groups of banks; in particular, we study the incidence for Austria and Germany.

5.4.1 Instrumental Variables

A concern is that the bank-level levy variables, $levy2$ and $levy3$, are endogenous because, in some countries, balance sheet characteristics determine whether a bank is effectively taxed and which marginal levy rate is applied. Hence, a shock that affects both interest rate setting and balance sheet (i.e., tax base) might influence a bank's exposure to the levy such that the bank-level measure is correlated with the (time-varying) error. Nevertheless, only four countries in the sample[31] introduced a levy scheme with an allowance or tax rates that depend on bank size or maturity structure. In seven other countries, all banks are subject to the levy with a flat rate such that endogeneity problems specifically for the bank-level measures are unlikely. We address this issue by the following robustness check: Following a strategy applied by Gruber and Saez (2002) in the context of income taxation, Devereux et al. (2015) suggest to instrument the levy measure with a measure that would have prevailed if the bank's characteristics were exactly the same after the levy was introduced. We thus construct two bank-level instruments, a dummy variable whether the bank is taxed ($levy2'$) and the applied marginal levy rate ($levy3'$), based on the balance sheet in the year before the levy was introduced.The instrument is based on 2010 balance sheets, for Dutch banks on 2011 balance sheets. This instrument is unaffected by the levy and highly correlated with the actual levy variables.

Table 8 reports the coefficients of the model (25) where the variables $levy2$, $levy3$, and $levy3^2$ are instrumented: The coefficients in the lending rate and NIM regressions are positive and significant as in the baseline model estimated using OLS (table 4); while the impact of the bank-level levy dummy is also of similar magnitude, the estimates imply a slightly smaller impact of the marginal levy rate. The coefficients in the deposit rate regressions remain insignificant, which, in line with the theoretical predictions, suggests no pass-through to depositors. Consequently, the IV-estimates are qualitatively and quantitatively similar to those of the baseline fixed-effects model (table 4).

[31] Austria, Germany, the Netherlands, and the United Kingdom. The Austrian levy was effectively retroactive until 2014 (i.e., based on the 2010 balance sheet) such that our bank-level measures are not endogenous.

	(1)	(2)	(3)	(4)	(5)	(6)
	IIL	IIL	IED	IED	NIM	NIM
levy2	0.1282***		-0.1055		0.0508***	
	(0.0375)		(0.0918)		(0.0161)	
levy3		2.8398***		-0.8185		1.8695**
		(1.0463)		(0.5390)		(0.7510)
levy3^2						-4.2392**
						(1.9200)
Obs.	11724	11724	3980	3980	13220	13220
No. banks	2493	2493	884	884	2800	2800
R^2	0.5921	0.5925	0.4523	0.4524	0.0978	0.0982
Bank FE, Controls	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Dependent variable: interest income on loans/av. loans (1)-(2), interest expenses on deposits/av. customer deposits (3)-(4), net interest margin (5)-(6)
Clustered standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Robustness: IV Regressions

Furthermore, we examine the robustness of the heterogeneous responses model and focus on the role of market power for the levy's impact on the average lending rate as well as on the role of the capital structure for the impact on the net interest margin.[32] The coefficients of the model with instrumented bank-level levy variables are shown in table 9. The estimates do not largely differ from the fixed-effects models (tables 5 and 6).

	(1)	(2)	(3)	(4)	(5)	(6)
	Average Lending Rate (IIL): Market Power					
levy2	-0.1267*		0.6398***		0.1294	
	(0.0700)		(0.1980)		(0.0854)	
levy3		-2.0045		6.5070		4.8271*
		(2.7878)		(4.4760)		(2.5538)
levy3^2		-18.6590		-6.7838		-4.4231
		(12.5221)		(9.1096)		(6.5975)
levy*mp	5.4624***	96.3362*	-0.1249***	-0.7650	-0.0239	-2.4432
	(1.5413)	(50.3722)	(0.0448)	(0.6999)	(0.0905)	(1.9692)
Obs.	11724	11724	11724	11724	11724	11724
R^2	0.5936	0.5931	0.5969	0.5964	0.5921	0.5929
No. banks	2493	2493	2493	2493	2493	2493
mp	HHI		Branch Density		Market share	
	Net Interest Margin (NIM): Capitalization					
levy2	0.0680***		0.0716***		0.0486**	
	(0.0149)		(0.0147)		(0.0191)	
levy3		2.2945***		2.1790***		2.0515***
		(0.6716)		(0.6827)		(0.7144)
levy3^2		-2.9349		-3.0919		-4.0391*
		(2.2557)		(2.1751)		(2.0668)
levy*cap	-0.0652*	-1.2201*	-0.1563***	-1.4037**	0.0038	-0.2955
	(0.0374)	(0.6657)	(0.0588)	(0.6676)	(0.0243)	(0.6290)
Obs.	13220	13220	13220	13220	13220	13220
No. banks	2800	2800	2800	2800	2800	2800
R^2	0.0984	0.0986	0.0994	0.0988	0.0978	0.0982
cap	Above median		Above 75th percentile		Reg. Cap. above median	
Bank FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

IV estimation, clustered standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Robustness: Heterogeneous Responses

5.4.2 Specific Shocks

Another concern is that the results might be influenced by shocks which are correlated with banks' interest rate setting and coincide with the adoption of bank levies. In particular, shocks related to the financial crisis and the following policy responses and regulatory reforms might not be fully captured by the macroeconomic controls, the fiscal cost of bank recapitalization, and - since they may differ across countries - by the general time trend. Following Devereux et al. (2015), we estimate several variants of the baseline model (22) including differential time trends that capture

[32] Recall that the evidence is inconclusive about the impact of market power on the response of the NIM and about the impact of capitalization on the lending rate's response. It can be shown that this result does not change if the bank-level levy measures are instrumented.

specific shocks: First of all, banks in the Eurozone were more exposed to the Eurozone crisis then banks outside. Furthermore, the regulatory reforms considerably differ between Eurozone and Non-Eurozone countries due to the creation of a banking union (e.g., the single bank resolution fund).[33] If Eurozone countries are more likely to introduce bank levies, the observed effect may be biased. We include *Eurozone-specific time dummies* in the model which absorb all Eurozone-specific shocks; for that purpose, we construct a dummy variable that is one if the bank is located within the Eurozone and zero else and interact it with a time dummy. Second, the exposure to crisis and regulatory reforms differs between small and large banks; the latter are likely to be systemically important thus benefiting from implicit government guarantees during and facing tighter regulatory constraints after the crisis in the context of 'too-big-to-fail' policies. Evidence, for example by Flannery and Sorescu (1996) or Acharya et al. (2013), suggests that implicit government guarantees lower the bank's funding cost thereby mechanically increasing interest margins. In countries where large banks are more likely to be taxed due to allowance and progressive rates, the observed effect might be biased. Hence, we estimate a model with *size-specific time dummies* to control for size-specific shocks: For that purpose, a dummy variable for each decile of the total asset distribution in 2009 (i.e., the year prior to the introduction of the levy in the first country) is constructed and the interaction of time and size dummy is included in the regression. Compared to a standard general time trend, we also capture shocks to specific bank groups over time and identify the levy's effect by a comparison of banks of roughly similar size. Moreover, poorly capitalized banks are likely to face tighter regulatory constraints after the crisis, which may affect lending and interest rate setting, than well-capitalized banks. At the same time, they are more likely to be taxed (or to face a higher marginal tax rate) as equity is generally exempt from the levy. The observed effect might rather reflect the pass-through of higher compliance and recapitalization cost onto customers. We include *capitalization-specific time dummies* to control for capital-ratio specific shocks: For each decile of the equity ratio distribution in 2009, we construct a dummy variable and include the interaction of time and equity dummy in the regression. Thus, we estimate regression (25) and replace the general time trend by Eurozone-, size-, and capitalization-specific time trends respectively.

Table 10 reports the coefficient estimates: In general, the baseline results are robust to these specific shocks. The levy's positive impact on banks' interest income on loans to average loans, IIL, approximating its average lending rate prevails in all specifications when using the bank-level measures ($levy2$ and $levy3$). There are some minor quantitative differences: While including a size-specific time trends tends to increase the magnitude of the levy coefficients, Eurozone- and capital-ratio-specific trends are associated with slightly smaller coefficients. The result that the levy has no impact on interest expenses on deposits to average deposits, IED, fully prevails. Eventually, the increase of the net interest margin, NIM, fully prevails when using the country- or bank-level dummies and in two out of three specifications when using the marginal levy rate. The quantitative differences are again small: Compared to the baseline, including a size-specific (capital-ratio-specific) time trend leads to slightly larger (smaller) coefficients.

This robustness test supports the main findings of an increase of lending rate and net interest margin and no response of the deposit rate: Hence, the results do not appear to be driven by shocks to specific groups of banks related to financial and Eurozone crisis or to regulatory reforms.

[33] However, the last point is less relevant in our case as the banking union was still uncertain and its design rather vague at the end of our sample period in 2012. Hence, it is unlikely that banks already began adjusting lending choices and interest rate setting.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						Average Lending Rate (IIL)						
levy1	-0.0802	-0.0093	-0.0766	-0.0707								
	(0.0499)	(0.0530)	(0.0509)	(0.0601)								
levy2					0.1308***	0.0980***	0.1812***	0.1202***				
					(0.0341)	(0.0344)	(0.0541)	(0.0379)				
levy3									2.9318***	2.4720**	3.0859***	2.5111**
									(1.0382)	(1.2296)	(1.1930)	(1.1238)
Obs.	11848	11848	11611	11611	11833	11833	11599	11599	11833	11833	11599	11599
No. banks	2604	2604	2446	2446	2601	2601	2445	2445	2601	2601	2445	2445
R^2	0.5893	0.6021	0.5954	0.6156	0.5921	0.6049	0.5983	0.6185	0.5925	0.6053	0.5985	0.6187
						Average Deposit Rate (IED)						
levy1	-0.1072	-0.0505	-0.1304	-0.1161								
	(0.0818)	(0.0881)	(0.0939)	(0.0922)								
levy2					-0.0850	0.0053	-0.1165	-0.0996				
					(0.0921)	(0.0981)	(0.1095)	(0.1042)				
levy3									-0.7895	-0.7110	-0.8839	-0.9228
									(0.5346)	(0.4742)	(0.6002)	(0.5904)
Obs.	4044	4044	3937	3937	4044	4044	3937	3937	4044	4044	3937	3937
No. banks	948	948	877	877	948	948	877	877	948	948	877	877
R^2	0.4525	0.4625	0.4714	0.4659	0.4524	0.4624	0.4712	0.4657	0.4524	0.4626	0.4711	0.4657
						Net Interest Margin (NIM)						
levy1	0.0900***	0.1101***	0.0977***	0.0696***								
	(0.0195)	(0.0190)	(0.0189)	(0.0228)								
levy2					0.0434***	0.0404***	0.0641***	0.0253*				
					(0.0146)	(0.0141)	(0.0225)	(0.0145)				
levy3									1.7436**	1.3772*	2.3155**	0.7670
									(0.7205)	(0.7243)	(0.9617)	(0.7114)
$levy3^2$									-3.9073**	-3.5520*	-5.2716**	-1.3353
									(1.8455)	(1.8771)	(2.4214)	(1.8596)
Obs.	13366	13366	13069	13069	13333	13333	13043	13043	13333	13333	13043	13043
No. banks	2916	2916	2719	2719	2910	2910	2719	2719	2910	2910	2719	2719
R^2	0.1001	0.1063	0.1127	0.2310	0.0972	0.1019	0.1098	0.2295	0.0975	0.1018	0.1101	0.2295
Bank FE, Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO
Time x Euro FE	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO
Time x Size FE	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO
Time x Equity FE	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Robustness: Different Time Trends

5.4.3 Subsample Tests: Austria and Germany

The levy might not be perfectly comparable across countries especially if captured by a dummy variable (e.g., *levy*1 and *levy*2). Thus, we study the incidence at the country level; the focus is on Austria and Germany for two reasons: First, a sufficiently large subsample is available, and second, these countries adopted a levy scheme characterized by an allowance such that small banks are exempt (contribution-relevant liabilities below EUR 300m and EUR 1bn respectively) and progressive levy rates.[34] In Austria, the levy is retroactive for the relevant time frame as it is imposed on the 2010 balance sheet; however, the legislator decided and communicated that the tax base will be changed to past-year balance sheet from 2014 on.[35] For such a design, our static model implies no adjustment of balance sheet positions and interest rates because such a response cannot lower the current levy burden. As long as banks are forward-looking, they may nevertheless adjust their balance sheets in order to lower the future tax burden, which is associated with a pass-through such that we expect to usual responses to be present. Note that for Austria, we can only estimate the levy's impact on the NIM because the other outcomes are not reported for a sufficiently large subsample; for Germany, the interest income on loans as a proxy for the lending rate is also available.

	(1)	(2)	(3)	(4)	(5)	(6)
	Austria		Germany			
	NIM	NIM	NIM	NIM	IIL	IIL
levy2	0.1141**		0.0142		0.0971***	
	(0.0444)		(0.0133)		(0.0333)	
levy3		7.4707***		4.0790***		4.5056***
		(2.7634)		(1.1228)		(1.5498)
levy3^2		-94.0165**		-158.3303***		
		(41.7253)		(28.3029)		
Obs.	944	944	7653	7653	7626	7626
No. banks	212	212	1617	1617	1615	1615
R^2	0.1752	0.1762	0.2500	0.2513	0.6672	0.6672
F	19	18	155	142	658	658
Bank FE, Controls	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Clustered standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Controls only include bank-level variables: *assets*, *equity*, *cost*, *risk*

Table 11: Robustness: Austria and Germany

The levy coefficients are shown in table 11: We find that the bank levy has a positive effect on the NIM of Austrian banks (columns 1 and 2), which suggests that they pass the burden onto their customers. More precisely, the levy raises the NIM by almost 0.15 percentage points. Similarly, increasing the marginal levy rate by 0.06 percentage points leads to a 0.17 percentage points higher NIM. These responses are substantially larger than the baseline, cross-country estimates. For German banks, in contrast, we find no significant effect on the NIM. However, there is a positive effect on the average lending rates (columns 5 and 6) suggesting a pass-through of the burden to borrowers: If a bank is subject to the levy, its interest income increases by almost 0.09 percentage points. The latter is fully consistent with the heterogeneous responses regression especially when measuring market power by the branch density.

5.4.4 Subsample Tests: Others

We perform three additional robustness tests by estimating the baseline regression in subsamples that only include (i) banks from 14 western European (i.e., pre-2004 enlargement) member states, (ii) banks located within the Eurozone, and (iii) banks outside Belgium, the Netherlands and Slovakia. The first test is motivated by the fact that Western and Eastern European banking sectors substantially differ; the latter are, for instance, characterized by a larger share of subsidiaries of international banks. A study of the CIT incidence by Demirgüç-Kunt and Huizinga (2001) shows

[34] This ensures the bank-level levy measures are not captured with the general time trend.
[35] See § 2 Abs. 2 Stabilitätsabgabegesetz (BGBl I Nr. 111/2010).

that the profitability of international banks varies only little with domestic tax rates as they benefit from profit shifting opportunities. Given the small share of eastern European banks in the sample (less than 5%, see table 14), however, it is unlikely that this feature weakens the results. Making use of the fact that Eurozone banks face the same monetary policy, the second subsample test ensures that the results are not driven by different monetary policies. The third test addresses an endogeneity concern: It excludes banks from three countries that introduced the levy 2012. Since other countries adopted the levy earlier, anticipation and an adjustment of bank balance sheets seem more likely in these three countries. This would violate strict exogeneity.[36] However, the relevance of this concern should not be overstated as banks from these three countries account for less than two percent of the banks in the full sample. The results are summarized in table 12.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	IIL	IIL	IIL	IED	IED	IED	NIM	NIM	NIM
					EU15 Banks				
levy1	0.0187			0.0224			0.1173***		
	(0.0546)			(0.0969)			(0.0204)		
levy2		0.1419***			0.0106			0.0419***	
		(0.0341)			(0.1197)			(0.0139)	
levy3			6.9824***			0.5012			3.0204***
			(1.6302)			(3.0602)			(0.9066)
$levy3^2$									-33.5166*
									(19.1757)
Obs.	11382	11367	11367	3604	3604	3604	12867	12834	12834
No. banks	2471	2468	2468	817	817	817	2779	2773	2773
R^2	0.6168	0.6203	0.6207	0.5378	0.5378	0.5378	0.0988	0.0940	0.0944
					Eurozone Banks				
levy1	0.0635			-0.1486			0.1557***		
	(0.0592)			(0.1072)			(0.0196)		
levy2		0.1258***			-0.0499			0.0742***	
		(0.0329)			(0.1134)			(0.0132)	
levy3			3.5205***			-0.8980**			2.9408***
			(1.2185)			(0.3532)			(0.6076)
$levy3^2$									-6.6659***
									(1.6351)
Obs.	10847	10836	10836	3136	3136	3136	12309	12282	12282
No. banks	2361	2359	2359	724	724	724	2664	2659	2659
R^2	0.6164	0.6197	0.6207	0.4375	0.4371	0.4374	0.1001	0.0930	0.0932
					Banks outside BE, NL, SK				
levy1	-0.0767			-0.1292			0.0996***		
	(0.0480)			(0.0882)			(0.0211)		
levy2		0.1241***			-0.1216			0.0444***	
		(0.0346)			(0.0983)			(0.0152)	
levy3			4.1289**			-4.8477**			3.3463***
			(1.7115)			(2.0258)			(1.2137)
$levy3^2$									-31.6698
									(26.4596)
Obs.	11720	11706	11706	3935	3935	3935	13117	13085	13085
No. banks	2572	2569	2569	920	920	920	2856	2850	2850
R^2	0.5972	0.6000	0.5999	0.4585	0.4583	0.4596	0.1042	0.1007	0.1015
Bank FE, Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Dependent variable: interest income on loans/av. loans (1)-(3), interest expenses on deposits/av. customer deposits (4)-(6), net interest margin (7)-(9)
Clustered standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Robustness: Subsample Tests

The upper section reports the coefficients for the subsample of banks from EU14 countries (pre-enlargement member states excluding France). They are roughly similar and only slightly larger than for the entire sample such that the baseline results fully prevail and do not appear to be influenced by specific features of eastern European economies and banking sectors. The middle section shows the coefficients for Eurozone banks: While they are similar if the average lending rate is the outcome, they suggest an increase of the net interest margin by 0.07 to 0.15 percentage points instead of 0.04 to 0.09 percentage points. Hence, the pass-through is likely to be more pronounced

[36]Note that this problem is different from the endogeneity concern addressed by IV (section 5.4.1), which is that the levy may depend on bank characteristics. Anticipation would also make the country-level levy measure *levy*1 endogenous.

in the Eurozone. Eventually, the lower section reports the coefficients for a subsample excluding three countries that introduced the bank levy late: Again, the coefficients are of similar sign and magnitude as in the full sample; there are only few minor differences (columns 6 and 8). Overall, the baseline findings also prevail if regressions are performed in subsamples thus supporting the result that the levy moderately raises lending rates and net interest margins but does not trigger a clear response of the deposit rate.

6 Conclusion

This paper provides a theoretical and empirical analysis of the incidence of bank levies recently introduced in several EU countries following a proposal of the IMF. The focus is on how banks pass the burden of this novel tax onto their customers by adjusting interest rates. For that purpose, a variant of the Monti-Klein model, which characterizes lending and borrowing choices of a bank operating in imperfectly competitive markets, is applied. Theory predicts that the levy increases the lending rate and the net interest margin such that part of the tax burden is passed onto customers. The magnitude of the pass-through depends on bank competition and on bank capitalization. In a model variant with risky lending, it is shown that a bank levy indeed reduces the (net) fiscal cost of bank failure thus partly internalizing the externality. Importantly, this effect relies on a smaller bank size, which is, in turn, the very reason for higher lending rates. Subsequently, using a cross-country panel dataset with balance sheet information of almost 3'000 banks from 24 EU countries, we estimate the levy's impact on interest rates and bank profitability thereby quantifying the pass-through. The evidence suggests that the levy raises a bank's average lending rate and net interest margin: If a bank faces a positive marginal levy rate, for example, its interest income on loans (as a share of average loans) increases by 0.13 and the net interest margin by 0.04 percentage points. However, these effects are moderate given averages of 6 and 2.5 percent respectively. In particular, the increase of lending rates is considerably stronger and economically significant as its response is, depending on the detailed scenario, between 0.3 and 0.4 percentage points in concentrated loan markets. Eventually, there is evidence that the pass-through is less pronounced or even vanishes if the bank is well capitalized; this finding is only significant if measured by the net interest margin.

This paper contributes to the theoretical incidence literature by analyzing a novel tax and relating the magnitude of the pass-through to banking market characteristics. On the empirical side, it is, to my knowledge, the first paper that provides cross-country evidence about the levy's incidence, which allows for a more robust levy measurement by exploiting cross-country variation. In addition, the post-introduction period is slightly longer than in other recent studies such that effects which materialize with some delay are more likely to be captured.

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A Appendix: Theory

A.1 List of Notations

	VARIABLES
A	Stochastic Return, $A \sim F(A)$
D	Total Deposits
d	Deposits
e	Equity
L	Total Loans
l	Loans
m	Non-deposit Liabilities
	PARAMETERS
k	Capital Requirements
N	Number of Banks
r	Interbank Rate
t	Corporate Income Tax Rate
α	Reserve Requirements
β	Share of Exempt (Insured) Deposits
ϕ	Share of Outside Equity in Bank Profit
ρ	Required Return on Bank Equity
τ	Levy Rate
	FUNCTIONS
$C(D, L)$	Bank's Cost Function
$F(A)$	Distribution Function of Stochastic Return
r_D	Inverse Deposit Demand, Deposit Rate
r_L	Inverse Loan Demand, Lending Rate
	DEFINITIONS
T	Tax Liability
ε_D	Elasticity of Deposit Supply
ε_L	Elasticity of Loan Demand
π	Bank's Equity Value
τ^e	Effective Levy Rate, $\tau^e = \frac{\tau}{1-\tau}$

A.2 Proofs and Derivations

Proof of Proposition 1: The partial derivative of the loans supply L is obtained by differentiating (6):

$$\frac{\partial L}{\partial \tau} = \frac{(1+r)(1-k)}{(1-\tau)^2 r_L'(L)\left(1-\frac{1}{N\varepsilon_L}\right)} < 0 \tag{28}$$

Using $r_L = r_L(L)$ with $r_L'(L) < 0$ yields (11). The sensitivities of the response regarding N, ε_L and k follow from differentiating (11). The independence of deposits from the levy immediately follows from the equilibrium condition (7). $Q.E.D.$

Proof of Proposition 2: The sensitivities of the lending rate follows from differentiating (21) using $r_L = r_L(L)$. The second (partial) derivatives with respect to the number of competitors N and the capital share k are:

$$\frac{\partial^2 r_L}{\partial \tau \partial N} = -\frac{\frac{\partial r_L}{\partial \tau}\left[\frac{1-F(1+r_L)-f(1+r_L)r_L}{N^2\varepsilon_L} - \frac{\partial r_L}{\partial N}\left(f(1+r_L)\left(1-\frac{2}{N\varepsilon_L}\right) - \frac{f'(1+r_L)r_L}{N\varepsilon_L}\right)\right]}{(1-F(1+r_L))\left(1-\frac{1}{N\varepsilon_L}\right) + \frac{f(1+r_L)r_L}{N\varepsilon_L}}$$

$$\frac{\partial^2 r_L}{\partial \tau \partial k} = \frac{\frac{(1+r)[f(A^*)A^* - (1-F(A^*))]}{(1-\tau)^2} + \frac{\partial r_L}{\partial \tau}\frac{\partial r_L}{\partial k}\left[f(1+r_L)\left(1-\frac{2}{N\varepsilon_L}\right) - \frac{f'(1+r_L)r_L}{N\varepsilon_L}\right]}{(1-F(1+r_L))\left(1-\frac{1}{N\varepsilon_L}\right) + \frac{f(r_L)r_L}{N\varepsilon_L}}$$

Note that $\frac{\partial r_L}{\partial N} < 0$ and $\frac{\partial r_L}{\partial k} > 0$. It can be seen that the first expression is negative such that the pass-through decreases in N as long as

$$(1-F(1+r_L))^2\left(1-\frac{1}{N\varepsilon_L}\right) - \frac{f(1+r_L)^2 r_L^2}{N\varepsilon_L} - \frac{(1-F(1+r_L))f'(1+r_L)r_L^2}{N\varepsilon_L} > 0$$

which holds provided that the banking industry is sufficiently competitive. However, it is not possible to make any conclusion about the sign of $\frac{\partial^2 r_L}{\partial \tau \partial k}$ such that the impact of bank capitalization, which was negative in the benchmark model without risk, is ambiguous. Eventually, the net interest margin is defined as $NIM = r_L - \frac{rd}{l} = r_L - r(1+\tau^e)(1-k)$. Its derivative with respect to the levy is:

$$\frac{\partial NIM}{\partial \tau} = \frac{\partial r_L}{\partial \tau} - \frac{r(1-k)}{(1-\tau)^2} = \frac{1-k}{(1-\tau)^2}\left[\frac{(1-F(A^*))(1+r)}{(1-F(1+r_L))\left(1-\frac{1}{N\varepsilon_L}\right) + \frac{f(r_L)r_L}{N\varepsilon_L}} - r\right]$$

The expression is usually positive unless the term $\frac{f(r_L)r_L}{N\varepsilon_L}$ is very large. $Q.E.D.$

B Appendix: Evidence

Variable	Description	Source
IIL	Bank's interest income on loans/average loans	Bankscope
IED	Bank's interest expenses on deposits/average customer deposits	Bankscope
NIM	Bank's net interest margin	Bankscope *(data4018)*
levy1	Levy Dummy at country level	Devereux et al. (2015)
levy2	Levy Dummy at bank level	Author's calculations
levy3	Marginal levy rate (bank level)	Author's calculations
assets	(Log of) Total assets squared	Bankscope *(data2025)*
BD	Bank branches per 10'000 inhabitants	ECB
CIT	Corporate Income Tax Rate	Devereux et al. (2015)
covratio	Coverage ratio	EU Commission
cost	Bank's non-interest expenses/total assets	Bankscope *(data4021)*
equity	Bank's total equity/average assets	Bankscope *(data18165)*
growth	Growth rate of real GDP	ECB
HHI	Herfindahl-Hirschman index (based on assets)	ECB
infl	Inflation rate	ECB
interbank	Interbank or short-term interest rate*	OECD, National Central Banks
recap	Bank recapitalization (in % of GDP)	EU Commission
risk	Loan loss reserves/average loans	Bankscope *(data18220)*

*Eurozone: 3-months EURIBOR

Table 13: Definition of Variables

	Existing banks 2010		Banks in sample 2010	
	No.	Share	No.	Share
Austria	750	11.58	207	7.42
Belgium	48	0.74	23	0.82
Bulgaria	24	0.37	18	0.64
Cyprus	127	1.96	7	0.25
Czech Republic	36	0.56	15	0.54
Germany	1819	28.08	1570	56.25
Denmark	143	2.21	35	1.25
Estonia	7	0.11	3	0.11
Finland	318	4.91	11	0.39
Greece	36	0.56	8	0.29
Ireland	461	7.12	4	0.14
Italy	697	10.76	510	18.27
Lithuania	77	1.19	8	0.29
Luxembourg	118	1.82	40	1.43
Latvia	29	0.45	16	0.57
Malta	26	0.40	6	0.21
Netherlands	254	3.92	22	0.79
Poland	685	10.57	32	1.15
Portugal	133	2.05	21	0.75
Romania	33	0.51	13	0.47
Slovakia	15	0.23	9	0.32
Spain	255	3.94	86	3.08
Sweden	148	2.28	74	2.65
United Kingdom	239	3.69	53	1.90
TOTAL	6478		2791	

Source: ECB, Author's calculations

Table 14: Sample by Country

Country	Computation
Austria*	Bank's total liabilities *(data11750)* -Insured deposits *(data11550*coverage ratio)*
Germany	Bank's total liabilities *(data11750)* -Total customer deposits *(data11550)*
Netherlands	Bank's total liabilities and equity *(data11850)* -Regulatory Capital *(data30670)* or Common Equity *(data11800)* or Equity *(data11840)* -Insured deposits *(data11550*coverage ratio)*
United Kingdom	Bank's total liabilities and equity *(data11850)* -Tier 1 Equity *(data30660)* or Common Equity *(data11800)* or Equity *(data11840)* -Insured deposits *(data11550*coverage ratio)*

Based on: Devereux et al. (2015, Appendix), *2010 Balance sheet

Table 15: Contribution-Relevant Liabilities: Construction

	Full Sample			No Levy			Levy			Banks not taxed*			Banks taxed		
	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.
IIL	5.96	1.72	14171	5.38	1.96	3892	6.17	1.57	10279	6.28	1.40	6601	5.98	1.83	3677
IED	1.90	2.02	4840	1.70	1.90	3730	2.56	2.24	1110	2.74	2.28	201	2.52	2.23	909
NIM	2.49	0.81	16454	2.64	0.99	4571	2.43	0.72	11883	2.55	0.60	7741	2.21	0.87	4131
assets	12663	123372	16454	9072	47106	4571	14045	142182	11883	1240	9363	7741	38074	238979	4131
equity	8.38	4.01	16454	10.47	4.37	4571	7.58	3.56	11883	7.67	3.21	7741	7.39	4.12	4131
cost	2.64	1.25	16453	2.83	1.29	4571	2.57	1.22	11882	2.71	1.12	7741	2.30	1.35	4130
risk	0.34	0.55	16454	0.51	0.55	4571	0.27	0.54	11883	0.26	0.52	7741	0.31	0.57	4131
MS	0.89	4.75	15545	1.73	6.97	4284	0.57	3.50	11261	0.05	0.68	7262	1.51	5.69	3999
infl	2.14	1.22	16454	2.52	1.32	4571	1.99	1.15	11883						
growth	0.72	3.15	16454	-0.40	2.96	4571	1.16	3.12	11883						
CIT	29.39	4.47	16454	27.33	4.27	4571	30.18	4.30	11883						
recap	0.49	0.92	16454	0.32	1.27	4571	0.56	0.72	11883						
HHI	0.04	0.04	16454	0.05	0.05	4571	0.04	0.03	11883						
BD	4.85	1.26	16454	5.63	1.66	4571	4.55	0.90	11883						

In percent; assets in Mio. EUR, HHI normalized in unit interval

*Only banks located in countries that adopt levy

Table 16: Summary Statistics