Bank Tax and Deposit Competition: Evidence from U.S. State Taxes*

Alessio Galluzzi Xin Liu Guangqian Pan

Abstract

We use a novel dataset on bank-specific state income taxes in the United States to study how local bank tax shocks affect regional deposit markets. We find that banks lower deposit rates to pass on state tax burdens to depositors, especially in low-competition markets. Higher taxes also reduce competition permanently by deterring new entries. Tax incidence on depositors persists with weaker competition but does not spill over to bank branches in other states or non-taxable intermediaries within the state. Our model shows how banks pass through tax to depositors and how tax-induced competition changes magnify tax effects.

JEL Classification Codes: E43, G21, H22
Keywords: tax incidence, bank-specific state income taxes, bank competition, deposit channel, bank network

*Corresponding author: Alessio Galluzzi, The University of Sydney Business School, Room 520, Codrington Building (H69), The University of Sydney, NSW, 2006, Australia; phone: (+61)2-9114-2199 email: alessio.galluzzi@sydney.edu.au. Xin Liu is from the Australian National University, email: xin.liu@anu.edu.au. Guangqian Pan is from the University of Sydney, email: guangqian.pan@sydney.edu.au.
We thank Itay Goldstein, Thomas Matthys, Phong Ngo, and the participants of the Sydney Macro Reading Group, the University of Sydney and ANU seminar series, the 2022 FIRN Banking and Financial Stability Meeting, and the 2022 Workshop of the Australasian Macroeconomics Society for their helpful comments and suggestions. We thank Yupeng Lin for many early discussions and for sharing the dataset on state tax rates.

1 Introduction

Deposit-taking is an essential part of banking activities and financial market operations.[1] Volume-wise, deposits represent approximately three-quarters of all the funding for U.S. commercial banks (Hanson et al. (2015)). However, there is little micro evidence about the impact of local tax shocks on banks' deposit-taking and pricing. A key empirical challenge is that taxes are typically applied and reported at the bank level, which makes it difficult to identify regional tax shock exposure and banks' local response.

To address the issue, we merge a unique dataset of state-level bank-specific income taxes in the United States with detailed bank branch–level data over the period 2001–2014. Although they are previously understudied in the literature, state taxes are economically important for banks. On average, state tax expenses consist of more than 20% of U.S. banks' total domestic tax expenses.[2] Yet, banks have heterogeneous exposure to state taxes depending on the locations of their operating branches (see Table 1).

By exploring staggered state tax changes and branch-level price reactions, our stacked difference-in-differences (DID) estimates suggest that banks pass through their local tax shocks to local depositors. We then further scrutinize the mechanism by focusing on competition as the key pass-through driver. Local bank competition interacts both directly and indirectly with the tax changes and banks' tax incidence on depositors (see Figure 1). Through the direct channel, high local competition mitigates a bank's tax incidence. More importantly, through the indirect channel, a bank tax increase would tighten participation constraints for banks and weaken local competition by restricting new entries into the market. Consequently, tax increases erode local competition and further amplify banks' tax

[1]For instance, existing literature has extensively discussed deposits' role in financial fragility (Diamond and Dybvig (1983); Goldstein and Pauzner (2005)), monetary policy transmission (Drechsler et al. (2017); Wang et al. (2022)), bank value creation (Egan et al. (2022)), and retail stock market participation (Lin (2020)).

[2]Source: Call report items: RIAD4780 (Applicable U.S. federal income taxes) and RIAD4790 (Applicable state and local income taxes) between 1978 to 1996.

incidence to depositors.

Formally, we introduce a simple model of banking that is driven by the trade-off between deposits and equity capital as sources of funding for a bank's asset portfolio. Deposits are inexpensive and provide a tax shield, but they also increase leverage and make equity more costly. Because of this trade-off, taxes affect the marginal decision of a profit-maximizing bank. When competition is low, and the deposit supply is inelastic, banks pass on profit taxes to deposit rates. Furthermore, higher taxes decrease long-term bank profitability, discouraging market participation and reducing competition due to high entry barriers. The larger the entry barrier, the stronger this effect.

Empirically, our identification depends on two strategies. First, to mitigate the estimation biases in staggered DID setting as previous literature has discussed (e.g., Baker et al. (2022)), we adopt the stacked DID estimate following Cengiz et al. (2019). Specifically, we create a cohort for every large tax change event with a three-year before-and-after event window and exclude all branches with recent tax change exposure in the control group. Second, we explore the geographic discontinuity by pairing adjacent counties across the border of a tax-changing state. The close proximity of social-economic factors in those adjacent counties creates a quasi-experimental setting that allows us to establish the causal effects of state tax changes on deposit rate changes in the tax-changing state.

Following these two identification strategies, we first find strong evidence of bank tax pass-through to depositors. Our results suggest a negative relationship between state tax rate increases and local deposit rates. These effects are economically significant and long-lasting. A one percentage point increase in the bank income tax rate reduces the local deposit interest rate by four to five basis points. The tax incidence persists three years after the tax changes. We also find a negative relationship between state tax rate shocks and local deposit holdings, consistent with lower deposit rates. Our results are robust after controlling for adjacent counties, excluding multiple state tax changes, or including state personal income taxes. However, bank tax changes do not affect non-taxable financial institutions or banks' household loan products.

We also explore the effects of bank tax pass-through in non–tax-changing states. Our results remain consistent if we drop branches that could be indirectly affected by the tax change through the bank network. Furthermore, we find no evidence suggesting banks pass through state tax burdens to depositors outside of the tax-changing state. These findings show that banks only pass through local taxes to local depositors, even with the presence of branch networks across states. This is in line with the work of Butters et al. (2022), who find that local taxes are borne by local consumers.

To understand the key drivers of bank tax incidence, we further show that competition levels play a significant role in bank tax incidence as well. Specifically, the stacked triple difference estimators suggest the more competitive a banking market is, the less banks are able to pass their additional tax cost to their depositors. This is consistent with our direct channel mechanism suggesting competition constrains banks' tax incidence. Remarkably, the competition effect can negate any type of tax pass-through in high-competition areas, which is consistent with our model prediction suggesting that banks' tax incidence occurs when competition is low.

Last, we find that tax increases lead to weaker local competition. The weaker competition persists three years after the tax change. Consequently, this negative tax-induced competition change would further amplify the tax incidence (indirect channel). When separately examining the branch exit and entries after the state tax changes, we find the weaker competition is dominantly driven by fewer entries into the market. This confirms the entry barrier is the key to explaining the tax impact on deposit competition.

Related Literature

This paper relates to both theoretical and empirical discussions on tax incidence and tax pass-through. The seminal works of Harberger (1962) and Kotlikoff and Summers (1987) provide the theoretical background for the transmission mechanism of taxes into an economic system. Weyl and Fabinger (2013) further improve on the previous research by providing a framework of tax pass-through in a variety of competition scenarios. However, these models mostly focus on price taxes rather than profit taxes as in our paper. Finally, Chetty et al. (2009) provides a behavioral model of tax pass-through depending on how salient taxes are for consumers.

Previous empirical studies have explored the effect that changes in corporate income taxes have on firms' operations, such as labor markets (Suárez Serrato and Zidar (2016)) or airline competition (Hanlon et al. (2022)). In general, results are sparse, because a statistically significant effect of taxation is often incorrectly rejected (Hennessy et al. (2020)). Moreover, identification is challenging when effective tax rates decline even if the statutory rates remain unchanged (Dyreng et al. (2017)). On the topic of banking taxation, Carletti et al. (2021) exploit a change in the taxation of households' holdings of financial instruments to shock banks' balance sheets. A few studies explore the effect of bank-specific taxes that have been implemented in Europe (e.g., Albertazzi and Gambacorta (2010); Chiorazzo and Milani (2011); De Nicolo et al. (2012); Buch et al. (2016); De Mooij and Keen (2016); Capelle-Blancard and Havrylchyk (2017)). All of these papers provide a national or international comparison among the banks that are affected by the bank levy introduced within the European Union. Nevertheless, these bank-level pieces of evidence are mixed and depend on the types of taxes. Furthermore, Milonas (2018) and Schandlbauer (2017) use similar U.S. state tax changes to evaluate their impact on bank operations. Nevertheless, due to the lack of branch-level information in those two studies, they struggle to identify both the regional tax shock exposure and to capture local responses to the shocks. We are, to the best of our knowledge, the first to exploit the natural laboratory of U.S. state taxes to provide micro-level evidence of how bank tax influences local branches' deposit-taking activity.

This paper is also related to the literature discussing how national firms respond to local shocks (e.g., Adams and Williams (2019); DellaVigna and Gentzkow (2019); Fuest et al. (2018)). Butters et al. (2022) use store product–level data to show how national firms react to changes in local product taxes. They conclude that local taxes do not have any spillover effect on geographic areas that are not affected by the change. However, previous studies in the loan market show bank branches would indirectly react to shocks in other states via bank networks, even when they are not directly exposed to those shocks. For instance, Cortés and Strahan (2017) demonstrate how natural disasters can lead to a negative spillover in unaffected areas in the form of a credit reduction. Our paper finds that changes in state income taxes levied on banks have little spillover effects on the branches located in non–tax-changing states. This suggests that the type of a negative shock or the product type could matter to determining the presence of any spillover effect.

Another line of literature that our paper is related to discusses how competition could affect the firm pass-through of shocks (e.g., Alm et al. (2009); Belleflamme and Toulemonde (2018)). Although most of the literature believes that market power could affect the pass-through, the sign of the relationship is ambiguous and empirically mixed in different product markets. On the one hand, Drechsler et al. (2017) suggest that banks increase their deposit spread more and offer comparably lower deposit rates in concentrated markets to pass through the monetary policy shocks to depositors. On the other hand, when studying gas station pricing in Greece, Genakos and Pagliero (2022) show that the excise duty cost pass-through is bigger and faster in a more competitive market as opposed to a monopoly market. Cabral et al. (2018) study health insurance subsidies pass-through in the United States and find market power is important to determining the pass-through of the benefits shocks. The pass-through of subsidies to consumers is significantly lower in the least competitive markets than in the most competitive markets. In the deposit market, the pass-through decision is governed by the trade-off between deposits and equity capital as sources of funding for a bank's asset portfolio. As we will show in the theory model section, the predictions could go either way, depending on the elasticity of the deposit product and competition.

Finally, this work is connected to the large literature about the importance of deposit-taking activities in banking (e.g., Diamond and Dybvig (1983); Goldstein and Pauzner (2005); Berger and Bouwman (2009); Jiang et al. (2019); Egan et al. (2022)). For instance, Berlin and Mester (1999) analyze how banks generate liquidity and derive value from deposit creation. We relate to their work by studying how taxation affects the flow of deposits. Egan et al. (2017) and Hastings et al. (2017) focus on how competition affects banking activities. We show that taxation can directly change the competitive landscape in a county and, therefore, the banking services that are available. Lastly, Ben-David et al. (2017), Drechsler et al. (2017), and Drechsler et al. (2021) study different factors that could influence deposit interest rates. Our paper complements these works by proposing an indirect channel of tax incidence to the deposit interest rates through tax-induced competition changes. Unlike other shocks, tax change could permanently change the local deposit competition and cause long-term tax incidence costs for depositors.

The paper is organized as follows. Section 2 illustrates the data and its main features. Section 3 presents the theoretical model. Section 4 provides empirical evidence of the bank's tax incidence effect on depositors. Section 5 discusses the role of competition in bank tax incidence. Section 6 concludes.

2 Data and Background

In this section, we detail our data collection process and illustrate the patterns that emerge in the tax data. Table 2 shows the statistics summary of the key variables in our sample.

2.1 Data Sources

Tax rates. We use hand-collected state corporate income tax rates from the yearly editions of the State Tax Handbook and The Book of States, with additional information sourced from the Tax Foundation and the Tax Policy Center. We focus on income tax rates applicable to financial institutions or excise taxes based on income. This allows us to compile a yearly dataset between 2001 and 2014 of the corporate income tax rates in 45 states and Washington, D.C..[3] These taxes are generally paid in addition to federal taxes.[4]

Importantly, we can distinguish between the tax rates imposed on banks and those imposed on other corporate entities. We find that these tax rates can differ substantially. For instance, in 1999 Iowa taxed its banks at a 12% rate, while non-bank corporations were taxed at a much lower 5%. Figure 2 illustrates the average state tax rates on banks and the average state tax rates on banks from 2001 to 2014. We can find that not only are bank tax and non-bank tax different but there is also no clear co-movement pattern between these two tax rates.

Deposit rates. The deposit rate data come from RateWatch, which collects weekly information on deposits and loan rates at the branch level. We focus on the period between January 2001 and December 2014 to match the sample period of state tax rates data. We then merge the interest rates with the branch deposit information using the branch ID

[3]We exclude those states with non-income bank taxes (Texas) or zero corporate income tax rates (Nevada, South Dakota, Washington, Wyoming) in our sample period.

[4]Only Alabama, Iowa, Louisiana, Missouri and North Dakota allow federal income tax deductions in our sample period.

and bank financial information using the RSSD ID assigned to financial institutions by the Federal Reserve. Product-wise, we choose 12-month certificates of deposit with an account size of $10,000 ($10K 12-month CDs) because it is the most common form of time deposit. This deposit product is also risk free because it is fully covered by deposit insurance.

Summary of Deposits. We use the Summary of Deposits to retrieve information about the branches that appear in our interest rate data. We observe the geographic location and the deposit amounts. These data help us to evaluate the total deposit amount and estimate local bank competition at the county level.

Additional data. We collect additional bank information and county-level socioeconomic data as controls. We use the bank holding company level FR Y-9C filings to retrieve age, provisions per loan, return on assets, and total assets for the banks in our sample. We then use census data to retrieve county-level socioeconomic factors, such as local GDP, population, unemployment levels, median income, house prices, and the number of establishments. Table A1 shows detailed information on those variables.

2.2 Tax Data Summary

The tax data we collect present a number of interesting patterns. First, we illustrate that there is quite large variability in the tax rates that states impose on their banks. Figure 3 shows the different tax rates in 2011, which range from zero to approximately 10.8%. This is quite a substantial range if one considers that these taxes are usually applied on top of the standard federal tax rate. However, most of the states levy a relatively small tax, below the 7% rate.

Moreover, state tax rates change more often than federal rates. Figure 4 shows the number of branches in our sample that are affected by a tax change. Out of the approximately

7,000 branches that we follow in our sample, an average of 2,000 branches will experience a tax rate change on yearly basis. That is, a little less than 30% of the branches have to adapt to a new tax rate every year. This number is surprisingly stable over time, which suggests that tax interventions are frequent and not relegated to specific periods of time.

We must discuss how these tax rates affect branches in our sample because the lack of uniform regulation across states may affect the validity of our results.[5] First, we need to determine whether a financial institution is doing business or has a nexus with a given state. A state could impose income tax on a bank when the bank has: (1) a physical presence in the state, or (2) a non-physical/economic presence nexus in the state. The economic nexus standards are controversial and not universally adopted across states (Swain (2003)).[6] However, under the influential U.S. Supreme Court rulings in National Bellas Hess v. Department of Revenue, 386 U.S. 753, 87 S.Ct. 1389, 18 L.Ed. 2d 205 (1967) and Quill Corp. v. North Dakota, 504 U.S. 298, 112 S.Ct. 1904, 119 L. Ed. 2d 91 (1992), the physical presence test is considered an important test to determine state tax jurisdiction. Physical presence nexus conditions would include having an employee(s) working in the state, having tangible property in the states, or soliciting sales in the state.[7] In this paper, we use branch-level data, which indicates a bank branch's physical presence in a state, to determine whether the bank is subject to a state's jurisdiction for tax purposes.

Second, it is important to establish the tax base and the apportionment rules that dictate the portion of a bank's income subject to state tax. Most states use a mix of in-state property, payroll, and sales values compared to the total values of these factors to determine

[5]See Serether et al. (2011) for an extensive discussion on how state taxes apply to financial institutions and what questions are left open by the regulation.

[6]Due to the ongoing debate and the expansion of virtual sales, a state's capacity to charge tax for businesses without a physical presence has expanded in recent years, especially after the U.S. Supreme Court ruling in South Dakota v. Wayfair, Inc. 585 U.S. ___, 138 S. Ct. 2080, 201 L.Ed. 2d 403 (2018). In our analysis, the sample period ends in 2014, before which the physical presence test was the dominant approach to determining nexus.

[7]For instance, Washington's Department of Revenue lists these activities to establish physical presence nexus.

their tax base.[8] While accurately representing how these apportionment rules affect each bank in our sample is unfeasible, we believe that assuming apportionment is proportional to the branch presence in a state is a reasonable first-order approximation for the institutions in our sample.

3 Model

In this section, we propose a simple theoretical model to identify the main channels through which bank income taxes affect deposit provision and the competitive banking landscape.

3.1 General Intuition

We present a model that is fundamentally driven by the trade-off between deposits and equity capital as sources of funding for a bank's asset portfolio. Deposits entail a lower cost of funding, as they require a lower return. However, deposits also increase the bank's leverage and risk profile. Consequently, equity holders internalize the higher risk by demanding a higher return on equity.

Because of this trade-off, taxes affect the marginal decision of a profit-maximizing bank. When profit taxes increase, a bank has two options: it can either lower deposit rates and transfer some of the cost to depositors (tax incidence channel), or it can increase the deposit rates and funding to benefit from the tax shield (tax shield channel[9]).

[8] These factors are typically equally weighted, but some states have adopted a single-factor formula based solely on sales. This raises concerns that banks may optimize their structure to benefit from varying state taxes. However, this shift to a sales-only formula is a recent development and does not impact the banks in our sample.

[9] Tax benefits of debt financing have been extensively studied in the finance literature. Early seminal works of Modigliani and Miller (1958) and King (1974) show the tax shield of debt could impact the corporate capital structure. More recently, Schepens (2016) suggests one reason banks choose a limited equity ratio is the tax benefit of having debt. Once a tax shield for equity is introduced, banks have higher capital and an increase in common equity. In a more general setting, Heider and Ljungqvist (2015) study the staggered

Our findings suggest that banks choose tax incidence when they face lower competition and an inelastic deposit supply, because low competition makes the return on equity more sensitive to equity employed by the bank. Therefore, increasing deposits and the tax shield would not outweigh the additional equity cost. However, the inelastic deposit supply limits the potential cost of tax incidence for banks since banks will not lose too much cheap deposit funding when they lower deposit rates.

The long-term value of banks and the competitiveness of the market are also influenced by taxation. When profit taxes increase, after-tax profits and the value of banks decrease. Due to the high barriers to entry in banking, banks must be sufficiently profitable to participate in the market. As a result, higher taxes can lead to a less competitive market. This reduction in competition affects the deposit market, as there are fewer competitors for depositors to migrate to. Therefore, banks can pass on tax cost burdens by lowering deposit interest rates to a greater extent.

3.2 Model Details

We consider a market where N symmetric banks fund a fixed quantity of loans with a combination of deposits and equity. To raise deposits, banks compete à la Cournout on the deposit rate they offer their clients. We assume the inverse supply for deposits to be increasing, or

$$\frac{\partial r^d}{\partial D} > 0, \tag{1}$$

where r^d is the deposit rate, and D is the corresponding aggregate quantity of deposits.

Additionally, each bank $i = 1, ..., N$ can raise outside equity e_i at a return r^e from deep-pocketed investors. This return is determined by investors who take into account the bank's risk level based on the amount of equity it has chosen to raise. In other words, investors

state corporate income tax changes and show firms increase their leverage after tax increases.

understand that a bank with less capital is more vulnerable to negative shocks and will therefore demand a higher return. We assume that the return on equity is decreasing and concave in the individual bank equity, or

$$\frac{\partial r^e}{\partial e} < 0,\ \frac{\partial^2 r^e}{\partial (e)^2} < 0. \tag{2}$$

Because of these assumptions, the bank faces an endogenous leverage constraint that limits its ability to rely solely on deposits for funding. This is a common feature in banking models, where similar restrictions may be imposed by regulators or arise endogenously in models with limited banker commitment, such as Gertler and Karadi (2011) and Gertler and Kiyotaki (2015). We also assume that the return on equity is high enough when the bank is fully funded by equity (i.e., $r^e(\cdot) > r^d(\cdot)$) to avoid a corner solution with no deposits.

To close the bank balance sheet, we adopt a partial equilibrium approach by normalizing the aggregate quantity of loans to unity ($L = 1$) and fixing the associated loans interest rate r^ℓ. The loan rate can be interpreted as the expected return from a large portfolio of atomistic loans. This simplification allows us to emphasize the trade-off between funding through deposits and equity.[10] Then, the bank manager chooses the deposit rate r^d to maximize the inside value of equity

$$(1-\tau)\left(r^\ell \ell_i - r^d(D)\, d_i\right) - r^e(e_i)\, e_i, \tag{3}$$

subject to the balance sheet constraint

$$\ell_i = d_i + e_i, \tag{4}$$

where τ is the corporate income tax rate, $\ell_i = {}^1\!/_N$ is the portfolio of loans managed by

[10] One caveat with fixing loan interest rates is we block banks' choice of passing through the tax burdens to lenders. As we will show in the empirical section, we do not find any evidence that banks pass through tax burdens to borrowers and discuss the reasons. Here, our setting is equivalent to a perfectly elastic loan supply scenario.

the bank, and $d_i = {}^{D}/{}_{N}$ are the deposits at bank i. Moreover, we impose a participation constraint

$$(1-\tau)\left(r^{\ell}\ell_i - r^{d}(D)\,d_i\right) - r^{e}(e_i)\,e_i \geq V_c, \tag{5}$$

where V_c is the charter value of the bank. The charter value captures the barriers to entry into the banking market and therefore pins down the competition in the market.

3.3 Model Results

Imposing symmetry and the balance sheet constraint (4) returns the following first-order condition as a function of aggregate deposits

$$\underbrace{(1-\tau)\,r^{d}\left(1+\frac{1}{\epsilon^{d}}\right)}_{\text{Marginal cost of deposits}} = \underbrace{r^{e}\left(1+\frac{1}{\epsilon^{e}}\right)}_{\text{Marginal saving on equity}}, \tag{6}$$

where ϵ^d is the deposit supply elasticity and ϵ^e is the equity supply elasticity to the respective rates. The equation above highlights the trade-off between deposit and equity funding. At the optimal point, the bank's marginal costs are equal to the marginal benefits. The left-hand side is the marginal cost of deposit funding. Profit taxes provide a tax shield for debt costs, so the marginal cost of deposits is net of the tax shield. The right side is the marginal savings on equity from switching to deposits. Because the return on equity is decreasing and concave, the savings are small when equity is ample and progressively increases.

A change in the profit tax rate affects the marginal cost of deposits by modifying the tax shield. When taxes increase, the marginal cost of deposits decreases, all else being equal. As a result, a bank may choose to either increase its deposits (and decrease its equity) to benefit from the additional tax shield or increase its equity (and decrease its deposits) to reduce the marginal savings on equity. The following proposition examines which effect prevails:

Proposition 1. *Banks pass through their tax burden to depositors if and only if*

$$\frac{\partial r^e}{\partial r^d}\left(1+\frac{1}{\epsilon^e}\right)-\frac{r^e}{(\epsilon^e)^2}\frac{\partial \epsilon^e}{\partial r^d}>(1-\tau)\left(1+\frac{1}{\epsilon^d}-\frac{r^d}{(\epsilon^d)^2}\frac{\partial \epsilon^d}{\partial r^d}\right). \tag{7}$$

We call the region identified by this inequality the pass-through region, which is characterized by either low competition among banks or an inelastic supply of deposits.

The proof for all the propositions is in Appendix B. The left-hand side represents the change in marginal savings on equity with respect to the deposit rate, while the right-hand side represents the change in the marginal cost of deposits. Banks pass through their tax burden whenever the marginal savings on equity are more sensitive to the deposit rate. As taxes increase, banks in the model can only reprice deposits, which also affects the cost of equity. Thus, they alter deposit rates to offset the tax increase. Pass-through occurs when reducing equity costs saves more than the tax shield and profits lost by lowering deposit rates.

The proposition outlines two primary conditions for banks to pass on the tax burden. First, pass-through is more likely when competition is lower. This effect is embedded in the equity supply elasticity ϵ^e, which is proportional to the number of banks N.[11] When N is low, the return on equity is more sensitive to any reduction in equity. Therefore, increasing deposits and the tax shield would not outweigh the additional equity cost. As competition intensifies, the potential equity savings diminish, leaving only the tax shield effect for banks to exploit. Second, the pass-through region is larger the more inelastic the deposit supply is, because the marginal cost of deposits for banks is relatively constant when deposit supply is inelastic. Thus it is more effective to pass the tax increase to the sticky depositors while also lowering the marginal cost of equity as some depositors leave.

After establishing the conditions to achieve pass-through, we study how the market

[11]See equation (B.5) in Appendix (B.2).

conditions affect the tax pass-through to deposit interest rates:

Proposition 2. *Within the pass-through region, the magnitude of the pass-through is decreasing in the number of banks.*

This finding builds upon earlier results. The model illustrates a negative correlation between pass-through and competition, with the impact originating from equity market competition. With less competition, each bank becomes larger and requires more equity. As the amount of equity in each bank grows, so does the potential for savings on equity costs. This incentivizes banks to sacrifice some of the tax shield benefit in exchange for lower equity returns.

The final step is to determine how taxation affects competition:

Proposition 3. *Without barriers to entry (charter value equals zero), changes in taxation will not affect the bank's competition. With barriers to entry, a large enough tax increase decreases the number of banks that operate in the market. The higher the barrier, the more sensitive the market is to tax changes.*

Based on the participation constraint (5), the number of banks in equilibrium is limited by their profitability. In a market with no entry barriers, the outcome is full competition, where banks earn zero profits and profit taxes have no effect (tax irrelevant channel). However, if there is a positive entry barrier, the number of banks in equilibrium is finite and decreases as the entry barrier increases. Furthermore, higher taxation reduces bank profits, with a greater impact when there are fewer banks. This leads to two outcomes: first, a significant tax increase may reduce the number of banks in equilibrium; second, the effect of a tax increase is larger when the entry barrier is high due to the natural oligopoly it creates. As a result, a tax increase is more likely to generate an even less competitive market.

In this static model, we cannot distinguish between entry and exit. However, if we consider the franchise cost as a barrier to entry, it becomes evident that higher taxation reduces incentives for new entrants. For incumbents, entry costs are sunk and their participation decision is not affected by the tax change. In contrast, new entrants must consider entry costs in light of lower profits, reducing their incentives to enter the market.

4 Tax incidence

To test our model prediction and alternative hypotheses set forth in Section 3, we empirically examine the relationship between the bank tax rate change and the banks' deposit rates. First, we discuss our identification strategy using the stacked difference-in-difference approach in a quasi-experimental setting. Then, we present empirical evidence to establish a causal relationship between bank tax rate change and local bank branches' deposit rates.

4.1 Identification strategies

4.1.1 Stacked DID estimator

To establish a causal relationship between bank tax change and bank deposit rates, we use a quasi-experimental setting to explore deposit rate heterogeneity after staggered large bank tax increases across different states in the United States. Previous literature (e.g., Baker et al. (2022)) suggests without careful treatments, staggered difference-in-differences regression estimators could be biased. To address such bias, we follow Cengiz et al. (2019) to obtain stacked regression estimators. For each large bank tax increase event, we create a cohort sample that covers all bank branches within a [-3, 3] event window, i.e., from three years before the tax increase to three years after the tax increase. We exclude all branches that experienced another shock from our control group. Then, we examine whether bank branches that experience a large bank tax increase (treated group) will lower their deposit rates compared to bank branches doe not experience a large bank tax increase (control group) before and after the tax increase by estimating the following regression model:

$$Rate_{i,t} = \beta_0 + \beta_1 \times Post_{i,t} \times Treat_{i,t} + \beta_2 \times \Delta Nonbanktax_{s,t} + \beta_3 \times X_{b,t} + \beta_4 \times X_{c,t} + \tau_t + \tau_c + \epsilon_{i,t}, \tag{8}$$

where i, t, b, c, and s index branches, years, commercial banks, counties, and states, respectively. The dependent variable, $Rate_{i,t}$ is defined as branch i's deposit rate in year t. $Treat_{i,t}$ is a dummy variable that indicates whether the state experienced a tax change greater than two percentage points in the event window. $Post_{i,t}$ is a dummy variable that indicates whether there is already a large tax change. $\Delta Nonbanktax_{s,t}$ indicates the size of the non-bank corporate income tax change in state s from $t-1$ to year t. $X_{b,t}$ is the control variable related to the branch's parent commercial bank b in year t. $X_{c,t}$ is the control variable related to branch's located county c in year t. β_1, the coefficient of $Post_{i,t} \times Treat_{i,t}$, captures the impact of the bank tax change on bank branch deposit rate.

4.1.2 Geographic discontinuity

While we control for both county fixed effects and year fixed effects, one possible concern for the full sample DID analysis is that some unobserved time-varying regional factors may still affect local bank deposit rates but would not be captured in the above analysis. To address such concerns, we further explore the adjacent counties on the border of the treated and control states. Specifically, we create paired samples of adjacent counties in the treated and control states and repeat our DID analysis in the paired sample.

Figure 5 illustrates an example of these adjacent counties in Illinois and its neighboring states. In 2011, Illinois experienced a 2.2% increase in the bank tax rate while its neighboring states' bank taxes were unchanged three years before and three years after event window.

Our adjacent county analysis would compare the bank branches in the border counties of Illinois that experienced a large tax increase (dark blue counties in Figure 5a) and the bank branches in the border counties of its neighboring states that did not experience any tax changes in the cohort (light blue counties in Figure 5a). Those adjacent counties generally share similar demographics and socio-economic factors and create a novel setting to study the impacts of state policies via geographic discontinuity.

For instance, Figure 5b illustrates the bank branches located in an adjacent county pair: Cook County, Illinois and its neighbor county, Lake County, Indiana. Both counties belong to the Chicago Metropolitan Area and have similar socio-economic characteristics. For the 2011 Illinois tax change, we use all bank branches located in Cook County (highlighted in red) as the treated group and all bank branches located in Lake County (highlighted in green) as the control group. The stacked difference-in-difference estimators for the paired sample then would provide evidence of whether bank branches experiencing a large bank tax increase will lower their deposit rates compared to bank branches that do not experience a large bank tax increase but that have similar socio-economic characteristics.

One may be concerned that the control branches in adjacent counties could be indirectly affected by the tax changes in the treatment counties through cross-border deposit flows between those geographically close counties. Although we cannot rule out this potential bias, such cross-border deposit flows will cause the deposit rates in our control counties to move in the same direction as rate changes in our treatment counties. For instance, if a treatment county branch A lowers its deposit rate and causes a deposit outflow to a control county branch B, branch B will experience a positive supply shock in deposits and lower its deposit rate too. Therefore, this bias would only cause an underestimation of the tax incidence in the treatment group.

4.2 Empirical results

4.2.1 Baseline analysis

We examine whether bank branch deposit rates become lower after the state where the branch is located experiences a higher bank tax rate by estimating the following regression model in the bank branch panel sample:

$$\Delta Rate_{i,t} = \beta_0+\beta_1\times\Delta Banktax_{s,t}+\beta_2\times\Delta Nonbanktax_{s,t}+\beta_3\times X_{b,t}+\beta_4\times X_{c,t}+\tau_t+\tau_c+\epsilon_{i,t}, \quad (9)$$

where i, t, b, c, and s index branches, years, commercial banks, counties, and states, respectively. The dependent variable, $\Delta Rate_{i,t}$, is defined as the change of deposit rate from year $t-1$ to year t. $\Delta Banktax_{i,s}$ is the variable of interest that captures the change of bank tax rate from year $t-1$ to year t in state s. We define $\Delta Banktax_{i,s}$ using three measures: (1) bank tax change indicates the size of bank tax change in the state from $t-1$ to year t; (2) large change dummy is a dummy variable that indicates whether the state experienced a tax change greater than two percentage points; (3) large tax change indicates the size of tax change from year $t-1$ to year t when the tax change is greater than two percentage points.[12] $\Delta Nonbanktax_{i,s}$ indicates the size of the non-bank corporate income tax change in state s from $t-1$ to year t. $X_{b,t}$ is the control variable related to the branch's parent commercial bank b in year t. $X_{c,t}$ is the control variable related to branches located county c in year t. β_1, the coefficient of $\Delta Banktax_{i,s}$, captures the impact of a bank tax change on bank branch deposit rates.

Table 3, columns (1) to (6) present the results for branch-level deposit rates. Column (1) indicates that a one percentage point increase in the state bank tax rate would reduce the deposit rate offered by the bank branches located in the state by four basis points.

[12] All large bank tax changes in our sample are large tax increases.

Column (2) suggests the bank branch's deposit rate would decline by 12 basis points on average after they experience a tax increase greater than two percentage points. Column (3) indicates the effect of tax pass-through on the deposit rates is 32% stronger when the tax increase is greater than two percentage points. This is consistent with previous findings suggesting that firms are less responsive to small tax changes.[13] Consequently, we will only use tax changes that are greater than two percentage points for later analysis. In our full sample, some of the states changed both the bank tax rate and the non-bank tax rate. We drop those observations and repeat the analysis in columns (4) to (6). The results suggest bank pass-through becomes larger in this subsample. More importantly, when only the non-bank corporate income tax rate changes, the coefficient on non-bank tax changes becomes statistically insignificant and economically negligible.

We further examine whether county-level deposit amounts become lower after the state where the county is located experiences a higher bank tax rate. Table 3, columns (7) to (9) present the results for county-level deposit flows. Consistent with a lower deposit rate after the bank tax rate increases, the county would experience a deposit outflow when the local bank tax rate increases. The county deposit amount would decline by one percentage point after it experiences a one percentage point increase in the bank tax rate.

4.2.2 Stacked difference-in-difference results

Table 4 shows the stacked DID estimate results for deposit rates as we discussed in Section 4.1. Column (1) shows in the full sample, the treated bank branch's deposit rate would decline by eight basis points on average in the three years after they experience a tax increase greater than two percentage points compared to the group of control bank branches. The

[13] One potential reason for this unresponsiveness could be fixed adjustment costs for price changes, for example menu costs. Therefore, banks may not change their prices after small tax changes because it is not cost-efficient. Alternatively, federal income taxes are deductible in some states, which could also make banks less responsive to the state income tax changes.

tax incidence effect becomes six basis points when we use a paired adjacent counties sample in column (2), which is marginally smaller than the results in the full sample.

In our full sample, some of the states changed both bank and non-bank taxes. We drop those observations and repeat the analysis in column (3). The estimated pass-through becomes larger, and non-bank tax changes no longer affect deposit rates when there is no bank tax change. However, higher individual income taxes could lead to population outflows and further affect both deposit supply and loan demands in the tax-changing state. Thus, we further control for state personal income tax in column (4); the result is similar to column (1).

To further understand the dynamics of post-treatment effects of a tax increase in the treated group, we replace the *Post* dummy with post-treatment year dummies $Year_i$ in equation (8). The results of the dynamic tax effects are shown in column (5). The tax pass-through effect would be strongest in Year 0 and remain sizable up to Year 3. This suggests the tax change would have both transitory and permanent effects on the local bank deposit rates. As our model suggests, tax incidence on depositors persists due to the tax-induced weaker competition, which we will further discuss in Section 5.

Table 4, columns (6) and (7) show the DID estimate results for deposit flows at the county level. Consistent with the branch-level deposit rate results, the results suggest the treated counties would have a deposit outflow after they experience a tax increase greater than two percentage points and offer a lower deposit rate. The outflow is most significant in the first year of a tax change — a negative three percentage points difference in the deposit amount. Such deposit outflow would weaken in Year 1 and disappear after Year 2. Even with consistently lower deposit rates, local deposit outflows in tax-changing states are moderate and transitory. These findings are consistent with the previous findings suggesting deposits have low elasticity (Chiu et al. (2018); Karlan and Zinman (2018)).

4.2.3 Absence of spillover via bank network

More than one-third of branches in our sample are operated by banks that have branches in several states. Previous literature (e.g., Cortés and Strahan (2017)) has shown local shocks could be transmitted across states through bank networks. In our setting, when banks have branches across different states, they can potentially pass through the tax-change-state's tax burden via their network to non-tax-change state depositors. This could invalidate our previous analysis because our control branches in the sample might be indirectly affected by tax changes through the spillover effect.[14]

Figure 6 illustrates the potential spillover issue and our sample selection process to test the spillover effects. Branch B is in the non-tax-changing state, but it could potentially be exposed to local tax shocks via its parent bank, which also has a bank branch A in the tax-changing state. To address potential spillover bias, we drop all branches that have spillover exposure like branch B in the control group and repeat our analysis in Table 4. Columns (1) and (2) in Table 5 show our baseline results are robust in the absence of spillover effects.

In addition, we test the magnitude of spillover effects in the non-tax-change states sample only. If banks do pass through the state tax change to non-tax-changing states, we should observe a difference in deposit rates between branches that have spillover exposure (branch B) versus branches that do not have spillover exposure (branch C). Results of column (3) in Table 5 suggest there is no evidence banks pass through their state tax burdens outside of the tax-change state, which is consistent with Butters et al. (2022)'s findings.

[14]Although, such spillover effects would only lead to a downward bias to our estimation when the spillover effects on the control group and the changes in the treatment group move in the same direction. Hence, such spillover-induced bias will lead to an underestimation of local tax effects.

4.2.4 Placebo test: credit unions

One may still be concerned that the bank tax change is associated with other unobserved factors, for example a lax regulation of the financial market competition, which could explain our previous results. To test this possible explanation, we examine the effects of a bank tax rate change on credit unions' branch-level deposit rates. Credit union branches operate similarly to bank branches in taking deposits, except they are exempt from paying taxes because they are a not-for-profit financial institutions. If there are other unobserved non-tax factors that could affect a bank's deposit rates simultaneously with the state tax change, we expect these factors would affect a credit union's deposit rates in the same way. Hence, we replicate our analysis in Table 4 for credit union branch-level deposit rates as a placebo test and report the results in Table 6. The effects of tax changes on credit unions become much smaller in magnitude and statistically insignificant, which indicates credit unions' deposit rates are not affected by the bank tax changes in the sample. These placebo tests reaffirm that our results are not driven by any unobserved factors other than the regional bank tax rate change.

4.2.5 Cross-sectional analysis

We also conduct a cross-sectional analysis based on various bank and branch characteristics, including branch net interest margin, national bank, and bank profitability (see Table A2). Our baseline results in Table 4 still hold in this cross-section analysis. Suárez Serrato and Zidar (2016) suggest firms would bear some of the tax incidences to keep the location premium. In the content of branch banking, banks may choose to pass fewer tax burdens to depositors when they have a higher net interest margin (NIM) in the region. To test that, we examine whether the impact of a tax change would differ in branches with a high NIM versus branches with a low NIM. We calculate the branch-level net interest margin as the difference between the personal unsecured loan interest rate and the 12-month certificate of deposit interest rate. Table A2, column (1) reports the results. National banks might be better at managing local tax shocks than state banks via their branch network.[15] We compare national banks versus state banks in column (2). Hanlon et al. (2022) find a corporate income tax change would have asymmetric effects on firms depending on the firm's profitability. Specifically, they argue profitable firms would enjoy an immediate cash flow benefit after the tax cut, while firms with losses would only realize the benefit of the tax cut down the road. Therefore, profitable firms accelerate their market predation against their loss-making competitors. However, an immediate tax increase could constrain profit-making banks more than loss-making banks, which leads to higher pass-through for those banks. We compare the high-profit banks and low-profit banks in column (3) and find the opposite is true. High-profit banks tend to pass through fewer tax burdens to their clients than low-profit banks.

4.2.6 No pass-through to borrowers

In addition to passing through tax costs to depositors, banks could also pass through to borrowers by increasing loan rates (e.g., Kang et al. (2021)). To test banks' potential pass-through to their borrowers, we replicate our analysis in Table 4 for two consumer loan products: personal unsecured loans and 30-year fixed-rate mortgages, and we do not find any evidence that banks pass through to borrowers (see Table A3).

There are two potential reasons for asymmetric tax pass-through to loans and deposits. First, depositors could be less price sensitive than borrowers, which motivates banks to pass more tax burdens to depositors. Previous literature has shown the price elasticity for retail deposits and saving accounts are low in both developed countries and developing countries (Chiu et al. (2018); Karlan and Zinman (2018)). Banks' capacity to exercise their market

[15] We define a national bank as a bank that has branches in different states.

power in the retail deposit market could contribute to the low price sensitivity on deposits (Drechsler et al. (2021)). Second, banks could change their non-price loan contract terms after tax changes without adjusting loan prices. For instance, Han et al. (2015) suggests banks increase loan sales as the corporate income tax rate rises.

5 The role of deposit competition

Competition plays a central role in banking activities and financial stability (e.g., Carlson and Mitchener (2006); Egan et al. (2017); Drechsler et al. (2017)). In this section, we explore how local deposit competition affects banks' decisions to pass through their tax burdens to their depositors. First, we find high competition mitigates banks' tax incidence. Second, the empirical evidence supports our model prediction that a state bank tax increase erodes local deposit competition.

5.1 Pass-through with different degrees of competition

To further explore the effects of local competition on the banks' tax pass-through, we extend our stacked DID analysis in Table 4 by introducing the triple-interaction term among $Post_{i,t}$, $Tax_{i,t}$, and $Highcompetition_{i,t}$ and estimating the following difference-in-difference-in-difference (DDD) regression model:

$$\begin{aligned} Rate_{i,t} = \beta_0 + \beta_1 \times Post_{i,t} \times Treat_{i,t} \times Highcompetition_{i,t} + \beta_2 \times Post_{i,t} \times Treat_{i,t} \\ + \beta_3 \times \Delta Nonbanktax_{s,t} + \beta_4 \times X_{b,t} + \beta_5 \times X_{c,t} + \tau_t + \tau_c + \epsilon_{i,t}, \end{aligned} \tag{10}$$

where i, t, b, c, and s index branches, years, commercial banks, counties, and states, respectively. The dependent variable, $Rate_{i,t}$, is defined as the branch i's deposit rate in year t. $Treat_{i,t}$ is a dummy variable that indicates whether the state experienced a tax change greater than two percentage points in the cohort. $Post_{i,t}$ is a dummy variable that indicates whether there was already a large tax change. $Highcompetition_{i,t}$ is a dummy variable that indicates whether the county in which a bank branch is located has a Herfindahl-Hirschman index (HHI) level lower than the national average. $\Delta Nonbanktax_{s,t}$ indicates the size of the non-bank corporate income tax change in state s from $t-1$ to year t. $X_{b,t}$ is a control variable related to the branch's parent commercial bank b in year t. $X_{c,t}$ is a control variable related to a branch's located county c in year t. β_1, the coefficient of $Post_{i,t} \times Treat_{i,t} \times Highcompetition_{i,t}$ captures the difference between high-competition counties versus low-competition counties in the impact of post-bank tax change on treated bank branch deposit rates compared to the control group. β_2, the coefficient of $Post_{i,t} \times Treat_{i,t}$, captures the impact of the post-bank tax change on treated bank branch deposit rate in low-competition counties compared to the control group.

The results are shown in Table 7. Bank branches located in the counties with competition levels lower than the national median will offer deposit rates that are 12–13 basis points lower after they experience a tax increase greater than two percentage points, compared to the control group. Competition would significantly mitigate the tax incidence. Notably, in the adjacent counties sample, the coefficient of $Post_{i,t} \times Treat_{i,t} \times Highcompetition_{i,t}$ suggests that high competition would fully eliminate the bank's incentive to pass through the tax increase to depositors. This is likely because the adjacent county bank branches would serve as perfect substitutions for the treated bank branches when competition is high. Therefore, banks will not pass through their tax burdens when the market is close to perfect competition. This finding is consistent with Proposition 1 suggesting that banks' tax incidence only occurs when local competition is sufficiently low.

5.2 The effects of bank tax on local competition

To test Proposition 3, we explore how county-level bank competition changes after the state where the county is located experiences a large bank tax increase. We use the stacked DID approach discussed in the Section 4.1 and replace the dependent variables with four county-level measures of local competitions: (1) branch HHI is calculated as $\sum depositshare_{branch,i}^2 \times 10,000$, (2) bank HHI is calculated as $\sum depositshare_{bank,j}^2 \times 10,000$, (3) number of bank branches, and (4) number of commercial banks.

Table 8 shows the effects of bank tax changes on local competition. Consistent with our model prediction, local competition becomes weaker after a large bank tax increase in the state using all four measures of competition. Branch HHI will increase by 5% on average in the three years after a large tax increase. There will be three fewer bank branches or 0.6 fewer commercial banks in the county. When we explore the dynamic effect of bank tax on local competition, the results show the local competition changes are not transitory. Column (2) suggests the 5% increase in the county-level branch HHI persists up to three years after the state tax increases.[16]

Furthermore, Proposition 3 suggests that entry barriers are the key to explaining the bank tax's impact on deposit competition. Since charted value and branch establishment are sunk costs, we would expect tax change to affect the local bank competition through branch entry rather than exit. Incumbent banks that have already paid such costs would be less affected by the tax changes. However, new banks' entry would weigh on how the after-tax future profits could pay off the entry cost and bank income tax changes would play a more significant role in the entry decisions.

To further understand the source of competition changes in response to the state bank

[16] In the unshown results, we also use three other competition measures to analyze the dynamic effect of bank tax on local competition, and results are consistent as column (2).

tax rate change, we repeat the exercise in Table 8 for the county-level branch entry and exit separately. Table 9 shows the counties experiencing a large tax increase would have 3% fewer branches enter the local market, but there is no significant impact in exits.

6 Conclusion

In this paper, we utilize a novel dataset of bank-specific tax reforms at the U.S. state level. We exploit the plausibly exogenous variation in bank income tax rates to unpack the effects of tax incidence on the deposit rates. We find that an increase in income taxes is passed on to depositors in the form of lower interest rates. As such, local depositors respond with a reduction in the deposit growth rate. These effects are strongest in counties where bank branches face less competition. However, the tax pass-through is greatly reduced in areas with high bank competition. Furthermore, we find that taxation affects competition via restricting new entries in the years following a tax increase.

Our results suggest that local deposit competition is affected by local tax policy and, those tax-induced competition changes amplify banks' tax incidence. A profit tax increase will be at least partially paid by local depositors. Moreover, an increase in taxes dynamically reduces the level of competition, which may bring additional costs for the depositors in the following year. This is of particular importance for policymakers both at the state and federal levels who need to balance those unintended consequences with additional tax revenue when they want to increase bank taxes. We leave for future research an assessment of the trade-offs and a quantification of the dynamic tax incidence costs.

References

Adams, B. and K. R. Williams (2019). Zone pricing in retail oligopoly. *American Economic Journal: Microeconomics 11*(1), 124–56.

Albertazzi, U. and L. Gambacorta (2010). Bank profitability and taxation. *Journal of Banking & Finance 34*(11), 2801–2810.

Alm, J., E. Sennoga, and M. Skidmore (2009). Perfect competition, urbanization, and tax incidence in the retail gasoline market. *Economic Inquiry 47*(1), 118–134.

Baker, A. C., D. F. Larcker, and C. C. Wang (2022). How much should we trust staggered difference-in-differences estimates? *Journal of Financial Economics 144*(2), 370–395.

Belleflamme, P. and E. Toulemonde (2018). Tax incidence on competing two-sided platforms. *Journal of Public Economic Theory 20*(1), 9–21.

Ben-David, I., A. Palvia, and C. Spatt (2017). Banks' internal capital markets and deposit rates. *Journal of Financial and Quantitative Analysis 52*(5), 1797–1826.

Berger, A. N. and C. H. Bouwman (2009). Bank liquidity creation. *Review of Financial Studies 22*(9), 3779–3837.

Berlin, M. and L. J. Mester (1999). Deposits and relationship lending. *Review of Financial Studies 12*(3), 579–607.

Buch, C. M., B. Hilberg, and L. Tonzer (2016). Taxing banks: An evaluation of the German bank levy. *Journal of Banking & Finance 72*, 52–66.

Butters, R. A., D. W. Sacks, and B. Seo (2022). How do national firms respond to local cost shocks? *American Economic Review 112*(5), 1737–72.

Cabral, M., M. Geruso, and N. Mahoney (2018). Do larger health insurance subsidies benefit patients or producers? Evidence from Medicare Advantage. *American Economic Review 108*(8), 2048–87.

Capelle-Blancard, G. and O. Havrylchyk (2017). Incidence of bank levy and bank market power. *Review of Finance 21*(3), 1023–1046.

Carletti, E., F. De Marco, V. Ioannidou, and E. Sette (2021). Banks as patient lenders: Evidence from a tax reform. *Journal of Financial Economics 141*(1), 6–26.

Carlson, M. and K. J. Mitchener (2006). Branch banking, bank competition, and financial stability. *Journal of Money, Credit & Banking 38*(5), 1293–1329.

Cengiz, D., A. Dube, A. Lindner, and B. Zipperer (2019). The effect of minimum wages on low-wage jobs. *Quarterly Journal of Economics 134*(3), 1405–1454.

Chetty, R., A. Looney, and K. Kroft (2009). Salience and taxation: Theory and evidence. *American Economic Review 99*(4), 1145–77.

Chiorazzo, V. and C. Milani (2011). The impact of taxation on bank profits: Evidence from EU banks. *Journal of Banking & Finance 35*(12), 3202–3212.

Chiu, C.-W. J., J. Hill, et al. (2018). The rate elasticity of retail deposits in the United Kingdom: A macroeconomic investigation. *International Journal of Central Banking 14*(2), 113–158.

Cortés, K. R. and P. E. Strahan (2017). Tracing out capital flows: How financially integrated banks respond to natural disasters. *Journal of Financial Economics 125*(1), 182–199.

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

De Nicolo, M. G., M. A. Gamba, and M. Lucchetta (2012). *Capital regulation, liquidity requirements and taxation in a dynamic model of banking.* International Monetary Fund.

DellaVigna, S. and M. Gentzkow (2019). Uniform pricing in US retail chains. *Quarterly Journal of Economics 134*(4), 2011–2084.

Diamond, D. W. and P. H. Dybvig (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy 91*(3), 401–419.

Drechsler, I., A. Savov, and P. Schnabl (2017). The deposits channel of monetary policy. *Quarterly Journal of Economics 132*(4), 1819–1876.

Drechsler, I., A. Savov, and P. Schnabl (2021). Banking on deposits: Maturity transformation without interest rate risk. *Journal of Finance 76*(3), 1091–1143.

Dyreng, S. D., M. Hanlon, E. L. Maydew, and J. R. Thornock (2017). Changes in corporate effective tax rates over the past 25 years. *Journal of Financial Economics 124*(3), 441–463.

Egan, M., A. Hortaçsu, and G. Matvos (2017). Deposit competition and financial fragility: Evidence from the US banking sector. *American Economic Review 107*(1), 169–216.

Egan, M., S. Lewellen, and A. Sunderam (2022). The cross-section of bank value. *Review of Financial Studies 35*(5), 2101–2143.

Fuest, C., A. Peichl, and S. Siegloch (2018). Do higher corporate taxes reduce wages? Micro evidence from Germany. *American Economic Review 108*(2), 393–418.

Genakos, C. and M. Pagliero (2022). Competition and pass-through: Evidence from isolated markets. *American Economic Journal: Applied Economics 14*(4), 35–57.

Gertler, M. and P. Karadi (2011). A model of unconventional monetary policy. *Journal of Monetary Economics 58*, 17–34.

Gertler, M. and N. Kiyotaki (2015). Banking, liquidity, and bank runs in an infinite horizon economy. *American Economic Review 105*(7), 2011–43.

Goldstein, I. and A. Pauzner (2005). Demand–deposit contracts and the probability of bank runs. *Journal of Finance 60*(3), 1293–1327.

Han, J., K. Park, and G. Pennacchi (2015). Corporate taxes and securitization. *Journal of Finance 70*(3), 1287–1321.

Hanlon, M., N. Shroff, and R. Yoon (2022). Asymmetric effects of taxes on product market outcomes. *Available at SSRN 4121571*.

Hanson, S. G., A. Shleifer, J. C. Stein, and R. W. Vishny (2015). Banks as patient fixed-income investors. *Journal of Financial Economics 117*(3), 449–469.

Harberger, A. C. (1962). The incidence of the corporation income tax. *Journal of Political Economy 70*(3), 215–240.

Hastings, J., A. Hortaçsu, and C. Syverson (2017). Sales force and competition in financial product markets: The case of Mexico's social security privatization. *Econometrica 85*(6), 1723–1761.

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

Hennessy, C. A., A. Kasahara, and I. A. Strebulaev (2020). Empirical analysis of corporate tax reforms: What is the null and where did it come from? *Journal of Financial Economics 135*(3), 555–576.

Jiang, L., R. Levine, and C. Lin (2019). Competition and bank liquidity creation. *Journal of Financial and Quantitative Analysis 54*(2), 513–538.

Kang, Y., O. Z. Li, and Y. Lin (2021). Tax incidence in loan pricing. *Journal of Accounting and Economics 72*(1), 101418.

Karlan, D. and J. Zinman (2018). Price and control elasticities of demand for savings. *Journal of Development Economics 130*, 145–159.

King, M. A. (1974). Taxation and the cost of capital. *Review of Economic Studies 41*(1), 21–35.

Kotlikoff, L. J. and L. H. Summers (1987). Tax incidence. In *Handbook of Public Economics*, Volume 2, pp. 1043–1092. Elsevier.

Lin, L. (2020). Bank deposits and the stock market. *Review of Financial Studies 33*(6), 2622–2658.

Milonas, K. (2018). Bank taxes, leverage, and risk. *Journal of Financial Services Research 54*(2), 145–177.

Modigliani, F. and M. H. Miller (1958). The cost of capital, corporation finance and the theory of investment. *American Economic Review 48*(3), 261–297.

Schandlbauer, A. (2017). How do financial institutions react to a tax increase? *Journal of Financial Intermediation 30*, 86–106.

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

Serether, J. M., M. P. Eberle, and M. L. Colavito Jr (2011). Can you take this to the bank? State taxation of financial institutions. *State Tax Notes 59*, 717–724.

Suárez Serrato, J. C. and O. Zidar (2016). Who benefits from state corporate tax cuts? A local labor markets approach with heterogeneous firms. *American Economic Review 106*(9), 2582–2624.

Swain, J. A. (2003). State sales and use tax jurisdiction: An economic nexus standard for the twenty-first century. *Georgia Law Review 38*, 343.

Wang, Y., T. M. Whited, Y. Wu, and K. Xiao (2022). Bank market power and monetary policy transmission: Evidence from a structural estimation. *Journal of Finance 77*(4), 2093–2141.

Weyl, E. G. and M. Fabinger (2013). Pass-through as an economic tool: Principles of incidence under imperfect competition. *Journal of Political Economy 121*(3), 528–583.

Figure 1: Direct and indirect roles of bank competition in tax incidence

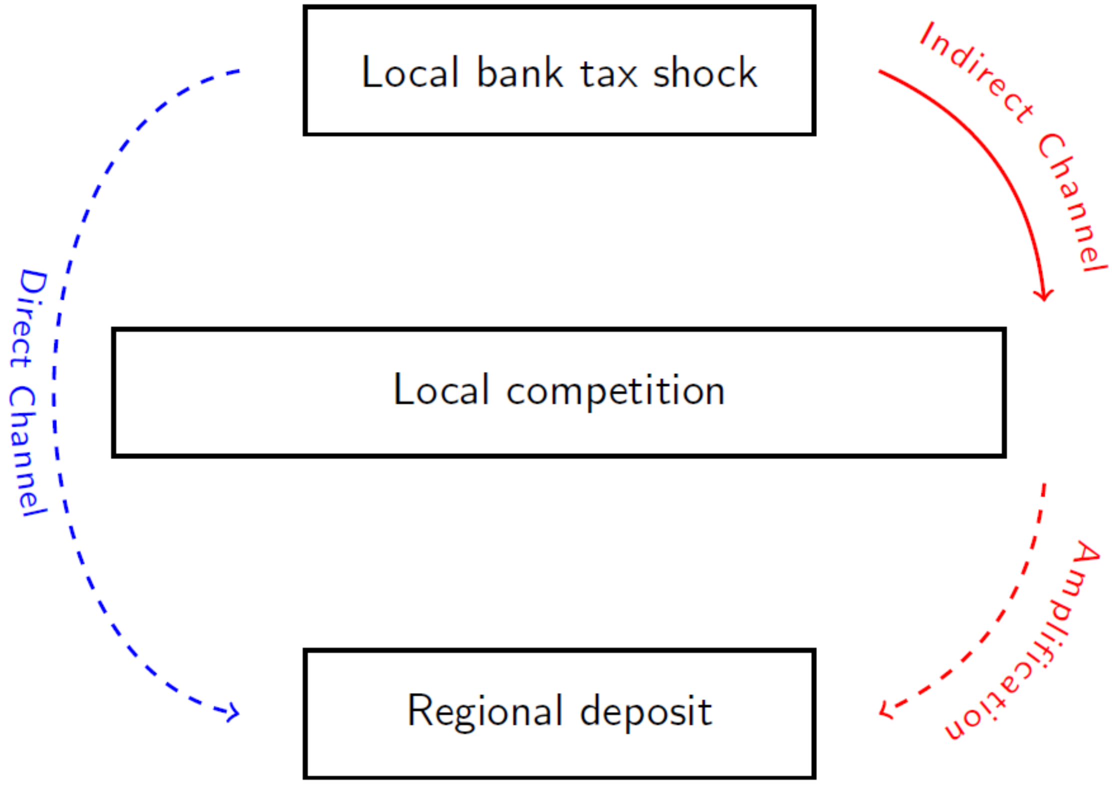


Figure 2: Average bank and non-bank income tax rate by years

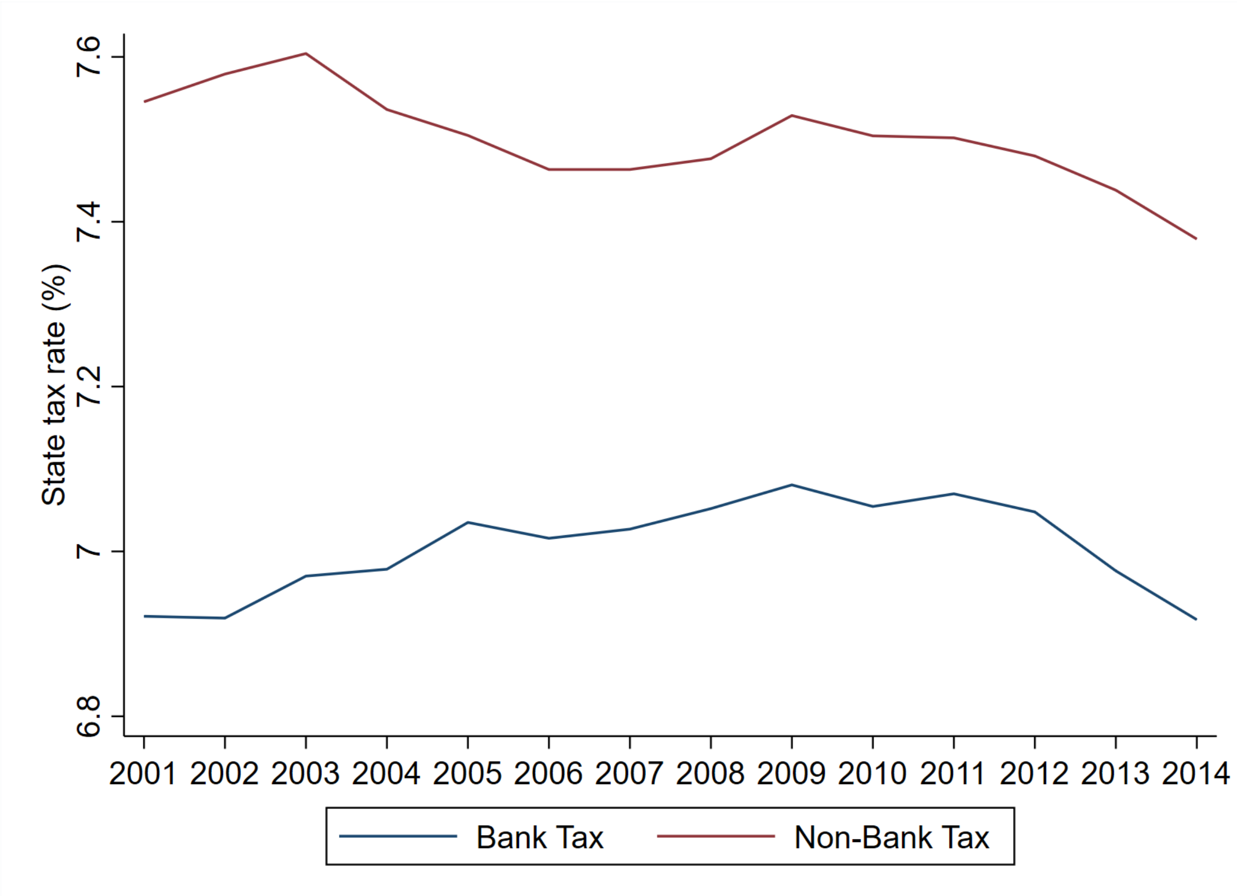


Figure 3: Bank income tax rate by states (2011)

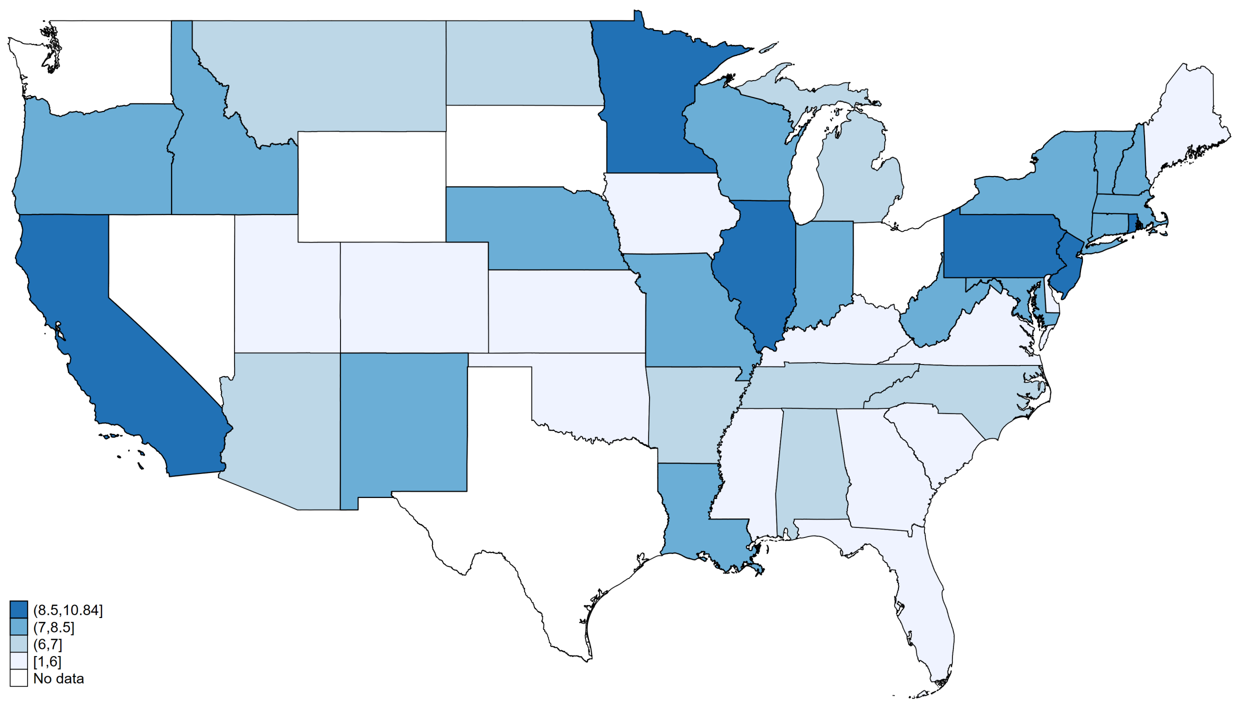


Figure 4: Branches affected by bank income tax changes by years (2001–2014)

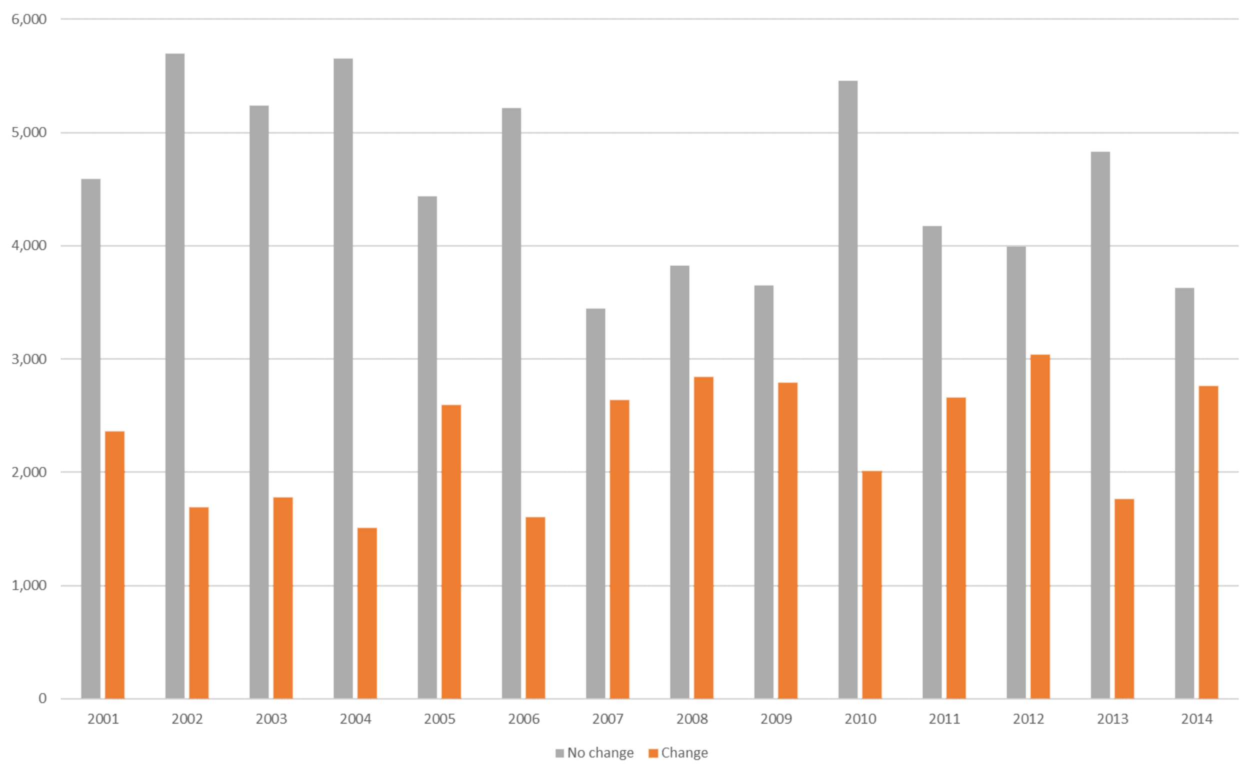
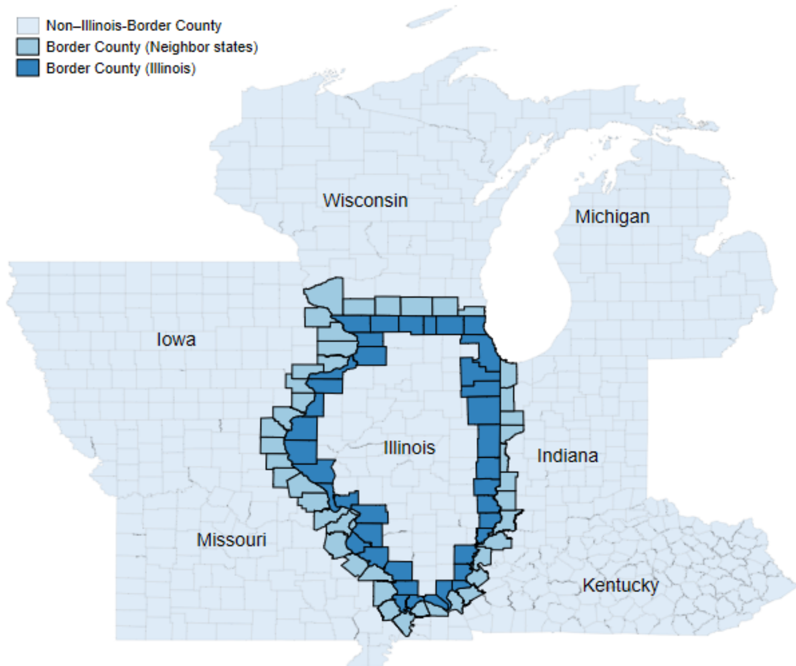


Figure 5: Adjacent counties example

(a) Treatment state adjacent counties (Illinois 2011)



(b) Bank branches in adjacent counties

(Cook County, Illinois vs. Lake County, Indiana)

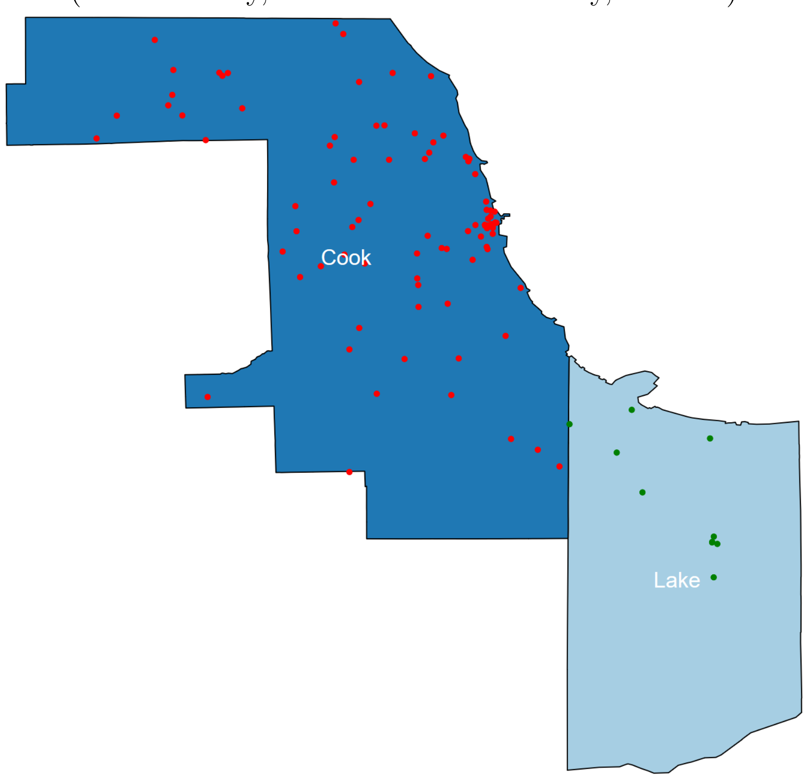
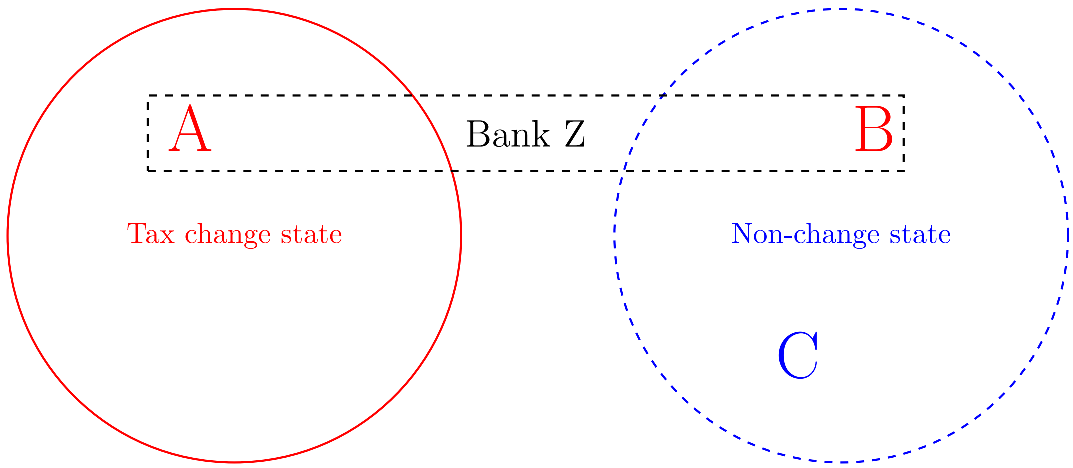


Figure 6: Spillover example



- Branch A: tax-affected branch
- Branch B: tax spillover branch
- Branch C: unaffected branch
- Bank Z: parent bank of branch A and branch B

Table 1: Bank current income domestic tax expenses examples (FY 2021 in millions $)

(a) National banks

Bank	Main operation	Federal	State and Local	State tax/total
JP Morgan Chase	Global	2,865	1,897	40%
Citi Group	Global	522	228	30%
Bank of America	Global	1,076	775	42%
Wells Fargo	US	5,850	849	13%
Fifth Third	Midwestern	657	102	13%

(b) State banks

Bank	Main operation	State tax type	State tax rate	State tax/total
Texas Capital	Texas	Franchise tax	0.75%	7%
Umpqua	Oregon	Income tax	7.60%	26%
Commerce	Missouri	Income tax	4.48%	13%

Table 2: Summary statistics

(a) Branch-level summary

Variable Name	Treatment Group			Control Group		
	Obs.	Mean	S.D.	Obs.	Mean	S.D.
Deposit rate level (bps)	3,253	159.96	124.19	40,059	182.25	135.52
Deposit rate change (bps)	3,253	−43.30	78.33	40,059	−14.81	79.78
Bank tax change (%)	3,253	0.21	1.25	40,059	0.00	0.00
Non-bank tax change (%)	3,253	0.16	1.08	40,059	−0.01	0.13
log(Real GDP)	3,253	15.51	1.79	40,059	15.36	1.83
GDP growth (%)	3,253	0.61	4.74	40,059	1.68	4.98
House Price ($ 1,000)	3,253	126.20	22.10	40,059	130.66	21.47
log(Median income)	3,253	10.77	0.25	40,059	10.73	0.23
log(Establishments)	3,253	8.06	1.61	40,059	7.95	1.67
Unemployment (%)	3,253	7.52	2.54	40,059	6.44	2.35
log(Population)	3,253	4.86	1.51	40,059	4.71	1.59
Bank age	3,253	84.55	55.47	40,059	80.15	49.48
Credit risk	3,253	0.003	0.005	40,059	0.002	0.004
Bank profitablity	3,253	0.000	0.005	40,059	0.001	0.004
Bank size	3,253	13.49	2.41	40,059	13.24	2.45

(b) County-level summary

Variable Name	Obs.	Mean	S.D.
Deposit growth	16,157	0.05	0.07
Bank tax change (%)	16,157	−0.02	0.20
Non-bank tax change (%)	16,157	−0.02	0.18
log(Real GDP)	16,157	14.50	1.41
GDP growth (%)	16,157	1.49	5.90
House Price ($ 1,000)	16,157	130.34	20.52
log(Median income)	16,157	10.69	0.23
log(Establishments)	16,157	7.17	1.29
Unemployment (%)	16,157	6.77	2.61
log(Population)	16,157	3.99	1.24

Table 3: Effects of bank tax on deposits

This table presents estimates of the effects of a state bank tax change on branch-level deposit rates and county-level deposit flows between 2001 and 2014. The dependent variable bank branch deposit rate change in columns (1) to (6) is the change in the average deposit rate offered by branch i from year $t-1$ to t. The dependent variable county deposit flow in columns (7) to (9) is the proportional change in deposit amounts held in county c from year $t-1$ to t. Bank tax change indicates the size of the bank tax change in the state where a bank branch (or county) is located from year $t-1$ to t. Large change Dummy is the dummy variable that indicates whether the state where a bank branch (or county) is located experienced a tax change greater than two percentage points: 1 is the bank branch (or county) treated with a large tax change, and 0 is not. Large tax change indicates the size of the tax change in the state bank branch (or county) located from year $t-1$ to t when the tax change is greater than two percentage points. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state bank branch (or county) located from year $t-1$ to t. All standard errors are clustered at the county level.

	Bank branch deposit rate change (bps)						County deposit flow		
	Full sample			One tax change only			Full sample		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bank tax change (%)	-3.73***			-5.04***			-0.01***		
	(0.92)			(1.13)			(0.00)		
Large change Dummy		-12.20***			-20.71***			-0.01**	
		(2.76)			(5.32)			(0.01)	
Large tax change (%)			-4.93***			-5.18***			-0.01***
			(0.93)			(1.33)			(0.00)
Non-bank tax change (%)	2.68***	2.45***	2.41***	0.01	-1.19	-1.19	0.01***	0.00	0.00
	(1.02)	(0.95)	(0.90)	(1.12)	(1.23)	(1.23)	(0.00)	(0.00)	(0.00)
Constant	72.59	65.08	65.68	82.79	69.17	69.17	-0.13	-0.15	-0.15
	(66.01)	(66.34)	(66.31)	(69.39)	(69.52)	(69.52)	(0.18)	(0.18)	(0.18)
County controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Observations	43,312	43,312	43,312	40,558	40,558	40,558	16,338	16,338	16,338
Adjusted R^2	0.86	0.86	0.86	0.86	0.86	0.86	0.24	0.24	0.24

Table 4: Effects of bank tax on deposits: stacked DID estimates

This table presents estimates of the effects of a state bank tax change on branch-level deposit rates and county-level deposit flows in a stacked difference-in-difference setting between 2001 and 2014. We create a $[-3, 3]$ event window cohort for every large tax change event. The dependent variable, bank branch deposit rate in columns (1) to (5) is the average deposit rate offered by branch i in year t. The dependent variable county deposit flow in columns (6) to (7) is the proportional change in deposit amounts held in county c from year $t-1$ to t. Treat is the dummy variable that indicates whether the state where a bank branch (or county) is located experienced a tax change greater than two percentage points in the past three years: 1 is the branch (or county) treated with a large tax change in the cohort, and 0 is not. Post is the dummy variable that indicates whether there was already a large tax change: 1 is after a large tax change, and 0 is before a large tax change. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a bank branch (or county) is located from year $t-1$ to t. Personal income tax change indicates the size of a personal income tax change in the state in which a bank branch (or county) is located from year $t-1$ to t. All standard errors are clustered at the county level.

	Bank branch deposit rate (bps)					County deposit flow	
	(1) Full sample	(2) Adjacent	(3) One tax	(4) Personal tax	(5) Dynamics	(6) Full sample	(7) Dynamics
Post×Treat	-8.23***	-5.96*	-10.96**	-8.28***		-0.01*	
	(2.18)	(3.48)	(5.51)	(2.19)		(0.00)	
Year 0×Treat					-13.42***		-0.03***
					(2.31)		(0.01)
Year 1×Treat					-5.82***		-0.01**
					(2.08)		(0.00)
Year 2×Treat					-8.46***		-0.00
					(2.77)		(0.00)
Year 3×Treat					-8.59***		0.00
					(2.54)		(0.00)
Non-bank tax change(%)	1.82***	1.36	1.38	1.61**	3.29***	0.00	0.01***
	(0.70)	(1.00)	(1.19)	(0.73)	(0.78)	(0.00)	(0.00)
Personal income tax change(%)				0.82			
				(0.68)			
Constant	-70.77	-110.46	271.45	-70.37	-73.46	0.42**	0.40**
	(98.30)	(337.97)	(209.59)	(98.38)	(98.56)	(0.18)	(0.18)
County controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	No	No
Cohort county FE	Yes	No	Yes	Yes	Yes	Yes	Yes
Cohort year FE	Yes	No	Yes	Yes	Yes	Yes	Yes
Pair county FE	No	Yes	No	No	No	No	No
Pair year FE	No	Yes	No	No	No	No	No
Observations	61,107	5,610	18,836	61,107	61,107	20,562	20,562
Adjusted R^2	0.92	0.94	0.86	0.92	0.92	0.18	0.18

Table 5: Spillover effects of a bank tax change

This table presents the spillover effects of a state bank tax change on the deposit rates in a stacked difference-in-difference setting between 2001 and 2014. We create a $[-3, 3]$ event window cohort for every large tax change event. The dependent variable bank branch deposit rate is the average deposit rate offered by branch i in year t. Treat is the dummy variable that indicates whether the state where a bank branch is located experienced a tax change greater than two percentage points in the event window. Spillover Treat is a dummy variable that indicates whether the state that a bank branch's parent bank has exposure to has experienced a tax change greater than two percentage points in the event window. Post is a dummy variable that indicates whether there was already a large tax change (excluding branches in the tax-changing states). Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a bank branch is located from year $t-1$ to t. All standard errors are clustered at the county level.

	Bank branch deposit rate (bps)		
	(1) No spillover sample	(2) No spillover sample	(3) Spillover
Post×Treat	-7.05***		
	(2.36)		
Year 0×Treat		-13.06***	
		(2.40)	
Year 1×Treat		-4.66**	
		(2.19)	
Year 2×Treat		-7.26**	
		(2.98)	
Year 3×Treat		-7.17***	
		(2.75)	
Post×Spillover Treat			-0.97
			(1.81)
Non-bank tax change (%)	1.64**	3.38***	2.13**
	(0.76)	(0.82)	(1.06)
Constant	-56.61	-60.47	-65.40
	(100.53)	(100.82)	(197.74)
County controls	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes
Cohort county fixed effects	Yes	Yes	Yes
Cohort year fixed effects	Yes	Yes	Yes
Observations	56,385	56,385	26,503
Adjusted R^2	0.92	0.92	0.91

Table 6: Placebo tests: effects of bank tax on credit unions

This table presents estimates of the credit union branch-level effects of a state bank tax change on deposit rates in a stacked difference-in-difference setting between 2001 and 2014. We create a $[-3, 3]$ event window cohort for every large tax change event. The dependent variable credit union branch deposit rate is the average deposit rate offered by credit union branch i in year t. Treat is the dummy variable that indicates whether the state where a credit union branch is located experienced a bank tax change greater than two percentage points in the event window: 1 is the branch treated with a large tax change in the cohort, and 0 is not. Post is a dummy variable that indicates whether there was already a large bank tax change: 1 is after the cohort experienced a large tax change, and 0 is before the cohort experienced a large tax change. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a bank branch is located from year $t-1$ to t. All standard errors are clustered at the county level.

	Credit union branch deposit rate (bps)	
	(1) Full sample	(2) Dynamics
Post×Treat	-2.30	
	(3.54)	
Year 0×Treat		1.12
		(5.40)
Year 1×Treat		-3.83
		(3.34)
Year 2×Treat		1.21
		(4.21)
Year 3×Treat		-4.99
		(4.00)
Non-bank tax change (%)	1.72	0.82
	(1.32)	(1.68)
Constant	908.67***	911.33***
	(196.43)	(194.98)
County controls	Yes	Yes
Credit union controls	Yes	Yes
Cohort county FE	Yes	Yes
Cohort year FE	Yes	Yes
Observations	22,912	22,912
Adjusted R^2	0.95	0.95

Table 7: The role of competition in tax incidence: stacked DDD estimates

This table presents stacked DDD estimates of the branch-level effects of a state bank tax change on the deposit rates in regions with different local competition between 2001 and 2014. We create a $[-3, 3]$ event window cohort for every large tax change event. The dependent variable branch deposit rate is the average deposit rate offered by branch i in year t. Treat is a dummy variable that indicates whether the state where a bank branch is located experienced a tax change greater than two percentage points in the event window: 1 is the branch treated with a large tax change, and 0 is not. Post is a dummy variable that indicates whether there was already a large tax change: 1 is after the large tax change, and 0 is before the large tax change. High competition is a dummy variable that indicates whether the county in which a bank branch is located has a branch HHI (competition) level lower (higher) than the national average: 1 indicates the county's HHI (competition) is below (above) the national average, and 0 indicates the county's HHI (competition) is above (below) the national average. Branch HHI is calculated as $\sum depositshare^2_{branch} \times 10,000$. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a bank branch is located from year $t-1$ to t. All standard errors are clustered at the county level.

	Bank branch deposit rate (bps)	
	(1) Full sample	(2) Adjacent counties
Post × Treat × High competition	8.46***	14.77**
	(3.19)	(6.24)
Post × Treat	-12.71***	-12.71***
	(2.15)	(4.51)
Non-bank tax change (%)	1.67**	1.16
	(0.71)	(1.00)
Constant	-80.22	-158.49
	(99.09)	(327.73)
County controls	Yes	Yes
Bank controls	Yes	Yes
Cohort county FE	Yes	No
Cohort year FE	Yes	No
Pair county FE	No	Yes
Pair year FE	No	Yes
Observations	60,316	5,610
Adjusted R^2	0.92	0.94

Table 8: Effects of bank tax on local competition

This table presents estimates of the county-level effects of a state bank tax change on local bank competition in a stacked difference-in-difference setting between 2001 and 2014. We create a $[-3, 3]$ event window cohort for every large tax change event. The dependent variable local competition is the level of different competition measures in county c in year t. Treat is a dummy variable that indicates whether the state in which a county is located experienced a tax change greater than two percentage points in the event window: 1 is the county treated with a large tax change, and 0 is not. Post is a dummy variable that indicates whether there was already a large tax change: 1 is after the large tax change, and 0 is before the large tax change. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a county is located from year $t-1$ to t. Branch HHI is calculated as $\sum depositshare^2_{branch} \times 10,000$. Bank HHI is calculated as $\sum depositshare^2_{bank} \times 10,000$. All standard errors are clustered at the county level.

	Local competition				
	Branches			Banks	
	(1) HHI	(2) HHI Dynamic	(3) Number	(4) HHI	(5) Number
Post×Treat	99.76**		-2.88***	108.23**	-0.58***
	(41.68)		(0.52)	(39.51)	(0.10)
Year 0×Treat		131.03***			
		(42.30)			
Year 1×Treat		94.37**			
		(39.92)			
Year 2×Treat		99.66**			
		(44.87)			
Year 3×Treat		92.36**			
		(44.63)			
Non-bank tax change (%)	-15.17**	-23.27***	0.26**	-11.97*	0.05**
	(6.63)	(7.12)	(0.11)	(6.93)	(0.03)
Constant	3,238.84***	3,270.42***	-226.73***	5,980.40***	-35.31***
	(1,173.09)	(1,176.92)	(40.19)	(1,279.50)	(5.03)
County controls	Yes	Yes	Yes	Yes	Yes
Cohort county FE	Yes	Yes	Yes	Yes	Yes
Cohort year FE	Yes	Yes	Yes	Yes	Yes
Observations	21,721	21,721	21,721	21,721	21,721
Adjusted R^2	0.94	0.94	0.94	0.94	0.99

Table 9: Effects of bank tax on local bank branch exits and entries

This table presents estimates of the county-level effects of a state bank tax change on local bank branch exit and entry in a stacked difference-in-difference setting between 2001 and 2014. We create a $[-3, 3]$ event window cohort for every large tax change event. The dependent variable local competition is the level of different branch entry/exit measures in county c in year t. Treat is a dummy variable that indicates whether the state in which a county is located experienced a tax change greater than two percentage points in the event window: 1 is the county treated with a large tax change, and 0 is not. Post is a dummy variable that indicates whether there was already a large tax change: 1 is after the large tax change, and 0 is before the large tax change. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a county is located from year $t-1$ to t. All standard errors are clustered at the county level.

	County branch exit/entry			
	(1) Entry/total	(2) Exit/total	(3) Entry No.	(4) Exit No.
Post×Treat	-0.03***	0.00	-0.60*	-0.03
	(0.01)	(0.00)	(0.31)	(0.11)
Non-bank tax change (%)	-0.01*	-0.00*	-0.09	-0.03
	(0.01)	(0.00)	(0.10)	(0.04)
Constant	0.17	-0.06	-54.98***	-16.48***
	(0.40)	(0.10)	(8.77)	(4.81)
County controls	Yes	Yes	Yes	Yes
Cohort county FE	Yes	Yes	Yes	Yes
Cohort year FE	Yes	Yes	Yes	Yes
Observations	21,715	21,715	21,721	21,721
Adjusted R^2	0.31	0.04	0.78	0.69

Appendices

A Control variables

Table A1: Control variables

(a) County information

Variable	Data source	Details
Real GDP	BEA	ln(Annual county real GDP)
GDP growth	BEA	Real GDP growth
House price	U.S. Census	Average housing pricing
Median income	U.S. Census	ln(Median Household Income)
Establishments	BLS	ln(Number of establishments)
Unemployment	BLS	County unemployment rate
Population	U.S. Census	ln(Total population)

(b) Local competition (county)

Variable	Data source	Details
Branch HHI	SOD	HHI of branch deposit holdings
County branch count	SOD	Number of branches in the county
Bank HHI	SOD	HHI of bank deposit holdings
County bank count	SOD	Number of banks in the county

(c) Commercial bank and credit union controls

Variable	Data source	Details
Age	Call reports and SNL	Number of years since establishment
Credit risk	Call reports and SNL	Risk = Loan provisions/Total loans
Profitability	Call reports and SNL	ROA = Net incomes / Total assets
Size	Call reports and SNL	ln(Total assets)

B Omitted Proofs

B.1 Proof of Proposition 1

To derive the result of Proposition 1, apply the implicit function theorem to the bank manager's first-order condition (6). That is

$$\frac{\partial r^d}{\partial \tau} = -\frac{\partial FOC/\partial \tau}{\partial FOC/\partial r^d}. \tag{B.1}$$

The bank passes through taxation to its depositors if $\partial r^d/\partial \tau < 0$. Then

$$\frac{\partial FOC}{\partial \tau} = r^d \left(1 + \frac{1}{\epsilon^d}\right) > 0 \tag{B.2}$$

$$\frac{\partial FOC}{\partial r^d} = -(1-\tau)\left(1 + \frac{1}{\epsilon^d} - \frac{r^d}{(\epsilon^d)^2}\frac{\partial \epsilon^d}{\partial r^d}\right) + \frac{\partial r^e}{\partial r^d}\left(1 + \frac{1}{\epsilon^e}\right) - \frac{r^e}{(\epsilon^e)^2}\frac{\partial \epsilon^e}{\partial r^d}. \tag{B.3}$$

Therefore, the sign of the derivative depends on the sign of (B.3). Given that the numerator (B.2) is positive under the model assumptions, banks pass through their tax burden if and only if (B.3) is positive as well.

B.2 Proof of Proposition 2

The final expression for the pass-through is

$$\frac{\partial r^d}{\partial \tau} = \frac{r^d \left(1 + \frac{1}{\epsilon^d}\right)}{(1-\tau)\left(1 + \frac{1}{\epsilon^d} - \frac{r^d}{(\epsilon^d)^2}\frac{\partial \epsilon^d}{\partial r^d}\right) - \frac{\partial r^e}{\partial r^d}\left(1 + \frac{1}{\epsilon^e}\right) + \frac{r^e}{(\epsilon^e)^2}\frac{\partial \epsilon^e}{\partial r^d}}. \tag{B.4}$$

The denominator is increasing in the number of banks N, since

$$\epsilon^e = \frac{\partial e}{\partial r^e} r^e \frac{N}{1-D} \tag{B.5}$$

Therefore, the pass-through must be decreasing in N.

B.3 Proof of Proposition 3

Recall that the objective function of a bank is

$$\pi = \frac{1}{N}\left[(1-\tau)\left(r^{\ell} - r^{d}D\right) - r^{e}\left(\frac{1-D}{N}\right)(1-D)\right] - V_c. \tag{B.6}$$

Then, by the envelope theorem,

$$\frac{\partial \pi^*}{\partial N} = -\frac{1}{N^2}\left[(1-\tau)\left(r^{\ell} - r^{d}D\right) - r^{e}\left(\frac{1-D}{N}\right)(1-D)\right] + \frac{1}{N^3}(1-D)^2\frac{\partial r^e}{\partial e} < 0 \tag{B.7}$$

Thus equilibrium profits decrease in the number of banks N. But the participation constraint requires equilibrium profits to be positive, or

$$\frac{1}{N}\left[(1-\tau)\left(r^{\ell} - r^{d*}D^*\right) - r^{e}\left(\frac{1-D^*}{N}\right)(1-D^*)\right] \geq V_c \tag{B.8}$$

By (B.7), the left-hand side of the participation constraint (B.8) is decreasing in the number of banks. This implies that there exists a maximum number $\bar{N}$ banks that can exist in equilibrium, where $\bar{N}$ is the largest integer that satisfies (B.8). Clearly, $\bar{N}$ is the equilibrium number of banks, given free entry, and is a function of the current tax rate.

Furthermore, an increase in taxation also reduces the optimal profits. By the envelope theorem on (B.6),

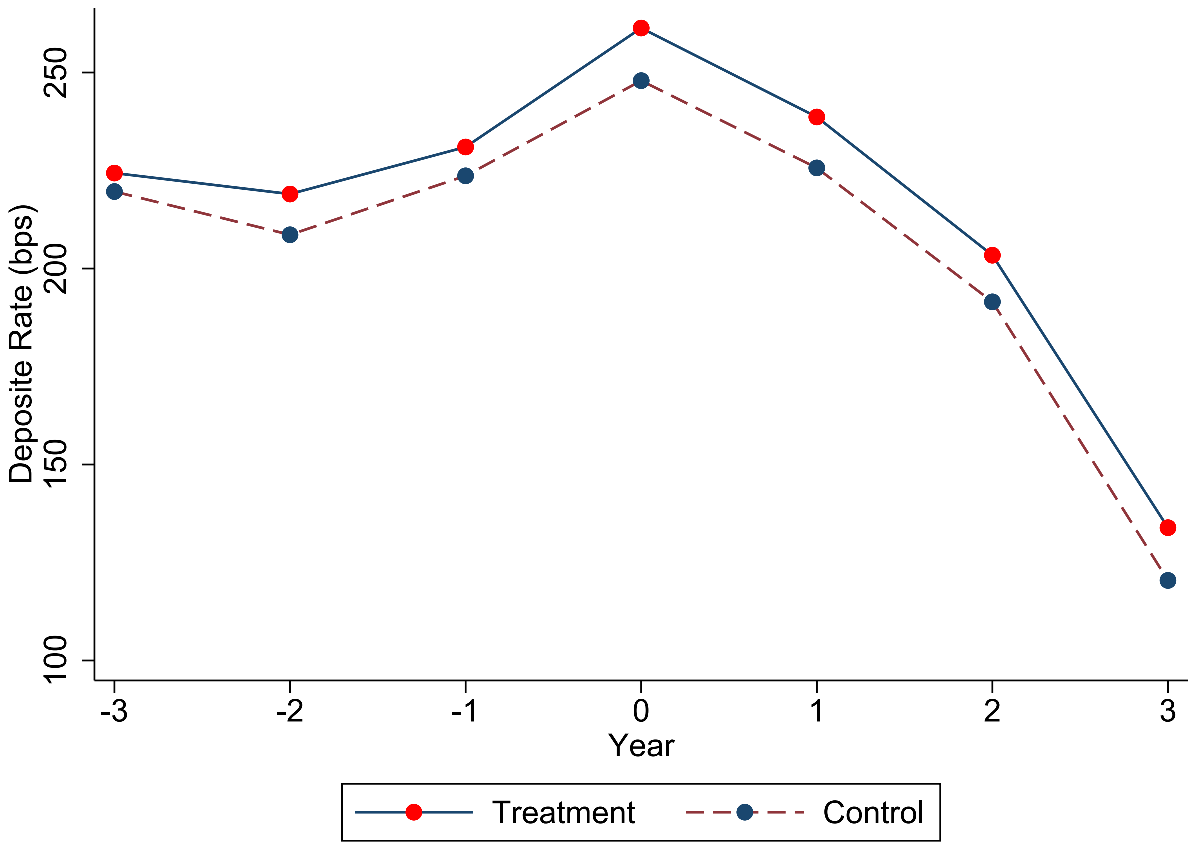
$$\frac{\partial \pi^*}{\partial \tau} = -\frac{1}{N}\left(\left(r^{\ell} - r^{d}\left(D^*\right)D^*\right)\right) < 0. \tag{B.9}$$

Thus an increase in the tax rate also tightens the participation constraint (B.8) by lowering the left-hand side. An increase in the tax rate thus has the same directional effect as adding an additional bank to the market. Thus, if the tax increase is large enough, it will make it impossible to sustain the same $\bar{N}$ banks, and the number of banks in equilibrium will decrease.

Also note that (B.7) and (B.9) are larger the less competition there is in the market. Therefore, the effect of taxation is small in competitive markets and large in oligopolistic ones. This is particularly important when the barriers to entry are relatively high, which generates natural oligopolies. A small tax change can then generate a large change in profits, which makes it more likely for (B.8) to fail and therefore generate an even less competitive market.

C Parallel trends analysis

Figure A1: Parallel trends with adjacent counties



D Cross-sectional analysis

Table A2: Effects of bank tax on deposit rates (cross-sectional analysis)

This table presents cross-sectional estimates of the branch-level effects of a state bank tax change on deposit rates in a stacked difference-in-difference setting between 2001 and 2014. We create a $[-3, 3]$ event window cohort for every large tax change event. The dependent variable bank branch deposit rate is the average deposit rate offered by branch i in year t. Treat is the dummy variable that indicates whether the state where a bank branch is located experienced a tax change greater than two percentage points in the event window: 1 is the branch treated with a large tax change in the cohort, and 0 is not. Post is the dummy variable that indicates whether there was already a large tax change: 1 is after the large tax change, and 0 is before the large tax change. High branch NIM is the dummy variable that indicates whether the branch's net interest margin is above the sample median: 1 is above the median, and 0 is otherwise. National bank is a dummy variable that indicates whether the branch's parent bank operates in other states: 1 is the parent bank operates in other states, and 0 is otherwise. High bank ROA is a dummy variable that indicates whether the branch's parent bank's return on assets is above the sample median: 1 is above the median, and 0 is otherwise. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a bank branch is located from year $t-1$ to t. All standard errors are clustered at the county level.

	Bank branch deposit rate (bps)		
	(1) High branch NIM	(2) National bank	(3) High bank ROA
Post×Treat	-13.17***	-9.62***	-10.95***
	(4.52)	(2.02)	(2.38)
High branch NIM×Post×Treat	5.72		
	(5.19)		
National bank×Post×Treat		7.88	
		(7.79)	
High bank ROA×Post×Treat			5.56***
			(2.15)
Non-bank tax change (%)	2.34	1.96***	2.08***
	(1.60)	(0.72)	(0.72)
Constant	-735.05**	-118.70	-80.18
	(307.72)	(97.64)	(97.75)
County controls	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes
Cohort county FE	Yes	Yes	Yes
Cohort year FE	Yes	Yes	Yes
Observations	7,918	58,424	61,107
Adjusted R^2	0.92	0.92	0.92

E Loan products

Table A3: Effects of bank tax on loan products

This table presents estimates of the bank branch–level effects of state bank tax change on the loan rates in a difference-in-difference setting between 2001 and 2014. The dependent variable branch loan rate is the average loan rate offered by bank branch i in year t. Treat is a dummy variable that indicates whether the state where a bank branch is located experienced a bank tax change greater than two percentage points in the past three years: 1 is the branch treated with a large tax change in the cohort, and 0 is not. Post is a dummy variable that indicates whether there was already a large bank tax change in the cohort: 1 is after the cohort experienced a large tax change, and 0 is before the cohort experienced a large tax change. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a bank branch is located from year $t-1$ to t. Column (1) reports the results in the full sample. Column (2) reports the dynamics of post-treatment effects in the full sample. All standard errors are clustered at the county level.

	Bank branch loan rate			
	Unsecured personal loans		Mortgages	
	(1) Full sample	(2) Dynamics	(3) Full sample	(4) Dynamics
Post×Treat	-1.05		-2.17	
	(20.45)		(2.66)	
Year 0×Treat		-38.56		13.74
		(25.81)		(11.12)
Year 1×Treat		-0.61		-5.42
		(22.54)		(3.93)
Year 2×Treat		10.28		-0.55
		(24.08)		(3.97)
Year 3×Treat		2.30		-2.25
		(26.23)		(2.93)
Non-bank tax change (%)	-0.66	8.94	2.16	-3.56
	(6.92)	(9.64)	(1.54)	(4.60)
Constant	2,079.28**	2,047.24*	838.46***	842.12***
	(1,051.39)	(1,053.11)	(184.34)	(184.73)
County controls	Yes	Yes	Yes	Yes
Credit union controls	Yes	Yes	Yes	Yes
Cohort county FE	Yes	Yes	Yes	Yes
Cohort year FE	Yes	Yes	Yes	Yes
Observations	22,744	22,744	11,441	11,441
Adjusted R^2	0.42	0.42	0.88	0.88

F Alternative analysis on competition

Here, we examine the effects of local competition on the bank's tax pass-through by adding the interaction term between the large change dummy and high competition dummy to the panel data analysis in section 4.2.1. We use two measures to estimate local competition within the branch-located county: branch deposit holding HHI and commercial bank deposit holding HHI. High competition is a dummy variable that indicates whether the county where a bank branch is located has a HHI (competition) level lower (higher) than the national average. The results are shown in Table A4. Bank branches located in counties with competition levels lower than the national median will experience a 16 basis point reduction in deposit rates after they experience a tax increase greater than two percentage points. This is significantly higher than our baseline results in Table 3, suggesting the tax incidence effects are heterogeneous across different competition environments, as Proposition 2 predicts. Meanwhile, competition would reduce the tax pass-through by 40% to 52% and effectively mitigate the tax incidence.

Table A4: The role of competition in tax incidence

This table presents estimates of the branch-level effects of a state bank tax change on the deposit rates in regions with different local competition between 2001 and 2014. The dependent variable rate change is the change in the average deposit rate offered by branch i from year $t-1$ to year t. Treat is the dummy variable that indicates whether the state a bank branch is located experienced a tax increase greater than two percentage points: 1 is the branch treated with a large tax increase, and 0 is not. High competition is a dummy variable that indicates whether the county in which a bank branch is located has a branch HHI (competition) level lower (higher) than the national average: 1 indicates the county's HHI (competition) is below (above) the national average, and 0 indicates the county's HHI (competition) is above (below) national average. Branch HHI is calculated as $\sum depositshare^2_{branch} \times 10,000$. Bank HHI is calculated as $\sum depositshare^2_{bank} \times 10,000$. Non-bank tax change indicates the size of a non-bank corporate income tax change in the state in which a bank branch is located from year $t-1$ to t. All standard errors are clustered at the county level.

	Bank branch deposit rate change	
	(1) Branch HHI	(2)Bank HHI
Treat	-15.94***	-15.99***
	(2.62)	(2.66)
Treat × High competition	8.23**	6.27*
	(3.76)	(3.73)
High competition	0.34	-0.26
	(1.06)	(0.87)
Non-bank tax change (%)	2.14**	2.36**
	(0.93)	(0.95)
Constant	63.03	64.07
	(66.27)	(66.18)
County controls	Yes	Yes
Bank controls	Yes	Yes
County FE	Yes	Yes
Year FE	Yes	Yes
Bank FE	Yes	Yes
Observations	43,312	43,312
Adjusted R^2	0.86	0.86