Financing Public Goods

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Abstract

I study whether and how local government access to bond financing affects the quantity and quality of local public goods provision. I use a difference-in-differences approach based on regulations that affected bank demand for municipal bonds. Credit-constrained municipalities cut spending, especially infrastructure investment. Public service quality deteriorates, manifested in increased water contamination and prolonged power outages. While amendments to the regulation mitigated municipal credit constraints, evidence is mixed on whether the quality of public service recovered. My results highlight the impact of financial market disruptions on local governments and people, and the unintended consequences of post-crisis banking regulation.

In this paper, I test whether and how local government access to bond financing affects both the quantity and quality of local public goods provision. The municipal bond market has grown from $360 billion in 1980 to $4 trillion today. It is an increasingly important source of capital for local governments. Despite its size and growth, we know little about its impact on the quality of public goods and local residential life.

A priori, it is not clear that bond market access would affect local public goods provision. Ricardian Equivalence suggests that tax and bonds are equivalent sources of finance for governments, as bonds are ultimately paid off by future taxes (Barro 1974). At the local level, this equivalence further stems from the capitalization of bond values into local land prices (Akai 1994; Hatfield 2010). This equivalence implies that governments can substitute bond financing with taxation without friction, and thus access to bond markets should not affect local outcomes. However, because this equivalence relies on strict assumptions, to what extent it holds in reality remains an open question (Banzhaf and Oates 2013).

Empiricists face two barriers in testing the relationship between bond market access and the quantity and quality of local public goods. The first is measurement: the quality of public goods typically involve non-monetary dimensions that are difficult to quantify, such as convenience, cleanliness, and safety. To overcome this challenge, I gather nationwide, district-level data on municipal wastewater inspections and power outages to measure quality. The second barrier is endogeneity: researchers observe only the equilibrium amount of bond issuance, which is a function of both local governments' demand for, and investors' supply of, credit. I use a difference-in-differences approach based on the implementation of a banking regulation and its subsequent amendments, which caused fluctuations in bank credit supply to the municipal bond market.

Specifically, in 2014, US banking regulators implemented the the Liquidity Coverage Ratio (LCR) rule, which excluded municipal bonds as a type of qualifying asset for banks. Although the implementation of LCR was largely expected by US banks, the disqualification of municipal bonds was not, as the disqualification was in direct contrast to the terms set forth in the Basel III Accord.[1] This unanticipated standard change reduced the appeal of municipal bonds to banks, because it put municipal bonds at a disadvantage compared to other qualifying asset classes.

Both statistical and anecdotal evidence suggests that this unanticipated standard change reduced the appeal of municipal bonds to commercial banks. In a bank-level difference-in-differences test, I find that treated banks reduce municipal bond holdings by about 25%. This effect holds when restricting the sample to comparable banks slightly above and below the treatment threshold. Moreover, anecdotes suggest that after the rule's proposal, local governments around the nation,

[1] Before the U.S. LCR was implemented, there was uncertainty over the institutional details of the rule, because the Federal Reserve Governor Daniel Tarullo had raised the possibility that the U.S. LCR might differ from international standards, but did not indicate how it would differ. See his speech "Evaluating Progress in Regulatory Reforms to Promote Financial Stability".

ranging from state and county treasuries to local water and sewer districts, collectively wrote to the regulators, warning that banks would likely reduce the purchase of municipal bonds or demand higher yields as a consequence of the rule.[2]

The LCR rule is part of a global banking sector reform and is unrelated to changes in municipal issuer fundamentals. This rule allows me to isolate changes in local government behaviors that are caused by an exogenous reduction in credit supply. An important aspect of the rule is that it only applies to banks with above $50 billion in assets. Motivated by this aspect of the rule, I exploit regional variation in treatment exposure based on the fraction of local banks subject to the rule. My difference-in-differences approach compares outcomes, such as bond issuance and public spending, before and after the policy across counties with different levels of exposure.

This approach relies on two main assumptions. First, I assume that changes in the outcomes would have been the same across counties with different policy exposures in the absence of the policy. Second, I argue that exposure to the policy affects outcomes through a specific channel. The channel I propose is that bank credit supply to municipalities declines more in counties where more banks are subject to the Liquidity Coverage Ratio rule.

I take several steps to substantiate both assumptions. One concern is that because bank locations are not random, counties with different policy exposures may have different trends in public spending and investment. To alleviate this concern, I show that these variables did not diverge across counties until after the policy implementation. To support the channel I propose, I show that counties with a higher fraction of affected banks reduce bond issuance more: a one standard deviation (i.e., 25 percentage point) increase in the fraction of regulated banks is associated with a 10% drop in the amount of bond issuance following the policy implementation. Importantly, local governments only reduce the issuance of bonds normally purchased by banks, but increase the issuance normally purchased by non-bank investors. This dichotomy supports the channel of credit *supply* reductions from banks rather than credit *demand* reductions from municipalities. Furthermore, the changes in bond issuance are not accompanied by concurrent changes in local government credit ratings in the year of policy implementation, suggesting that the reduction in bank credit supply is independent of confounding changes in local fiscal conditions.

After assessing the validity of my empirical design, I estimate the effects of the credit supply shock on local government spending. Holding other factors constant, a county with all regulated banks reduces public spending by 4.1% compared to a county with no regulated bank, after the introduction of the policy. Local governments cut long-term, investment spending rather than

[2]For example, the letter written by the Chief Financial Officers from eighteen of the largest US cities says that "using the City of Chicago as just one example, it has approximately $20 billion of bonds outstanding and over $6 billion of credit exposure to commercial banks. Imposition of the proposed rule will increase borrowing costs and dramatically reduce the pool of banks willing to grant credit to Chicago on an ongoing basis." See the complete letter here: https://www.gfoa.org/sites/default/files/LCRComment.pdf.

short-term, operational spending. I find a 31% reduction in investment spending, which is capital expenditure to build and improve infrastructure assets such as roads, buildings, water plants, and power lines. Back-of-the-envelope calculations suggest that a dollar reduction in bank credit supply to the municipal bond market reduces public investment by about 62 cents. By contrast, I find no effect of the credit shock on current operation spending, such as spending on employee payrolls and office supplies.

Credit-constrained local governments may resort to alternative sources of funding. I observe substitution to property tax revenues, intergovernmental transfers, and cash holdings. Property tax revenues increase by 1-4% in high exposure counties, especially in states without tax laws limiting tax rates or property assessment values. State governments reallocate capital from less credit-constrained counties to more credit-constrained counties through intergovernmental transfers. Interestingly, the reallocation is larger in more corrupt states, consistent with Scharfstein and Stein (2000)'s view on division rent seeking in internal capital markets. I also find a sharp reduction in local government cash holdings, suggesting that local governments rely on cash to smooth spending much like corporations (e.g. Campello et al. 2011).

Does the large decline in public investment affect the quality of public goods and services? The answer to this question is not clear ex ante. While quality could decline as a result of reduced capital to sustain public goods, the potential for overspending by the "Leviathan" governments suggests that local governments might have the ability to cut waste without affecting service (e.g. Brennan and Buchanan 1977, 1978, 1980). Quality might even improve, as debtholders such as banks can exert pressure on borrowers to produce short-term cash flows at the expense of product quality (e.g. Maksimovic and Titman 1991). To answer this question, I measure public service quality through the lens of public utility districts. These districts provide essential services to local communities, such as water, sewage, and electricity. They are also economically important, as they account for over 15% of total local public investment.

To construct my first measure, I use the inspection records of municipal wastewater treatment plants from the Environmental Protection Agency (EPA) to identify whether a plant violates any pollutant standard in a given year. The Clean Water Act of 1972 requires that all municipal water treatment plants undergo periodic inspections. I find that the probability of violation increases by ten percentage points following the credit shock, which corresponds to a 16% increase in the annual unconditional probability of violation. Importantly, this effect is only at plants that need infrastructure improvements ex ante, such as expansion, rehabilitation, and technology upgrades. Perhaps, a mechanism behind the increased water contamination is a lack of financing to achieve expected infrastructure upgrades.

To construct my second measure of public service quality, I identify local power outages using electric utilities' annual reports filed with the Energy Information Administration (EIA). These reports are mandatory under the Federal Energy Administration Act of 1974 and contain information such as service areas, meter readings, and power outages. I find that the annual duration of power outages increases by 40 minutes for municipal utility customers, which is a 14% increase in the annual average duration of power outages. By contrast, there is no statistically significant change for customers served by investor-owned utilities in the same counties.

Importantly, there are two amendments to the LCR regulation relevant to the municipal bond market. In May 2015, the Federal Reserve Board issued a proposed rule to qualify a fraction of the General Obligation, investment-grade municipal bond market as liquid assets for the purpose of LCR. This amendment contains many further restrictions as to how and which municipal bonds can qualify. In November 2017, these restrictions were partially lifted in another rule proposal that requires all investment-grade municipal bonds to be qualified. I study not only the effects of the initial policy, but also whether the subsequent amendments relieved municipal credit constraints and caused a reversal in the quantity and quality effects. Overall, I find that while the first amendment was too restrictive to be effective, the second amendment led to an increase in municipal bond issuance, especially in the bank segment of the market, and alleviated municipal spending cuts. However, I find mixed evidence on whether the quantity effects reversal led to improvements in the quality of public service.

Additional tests suggest that alternative explanations such as confounding policy changes, omitted variable bias, and covariate imbalance do not drive my results. These tests include using a placebo policy implementation year, using a placebo bank asset threshold, conducting subsample analysis, and controlling for non-linear forms of county and bank characteristics. I also estimate local government-level triple difference regressions, where the third difference is a local government's ex ante reliance on bank financing. This specification allows me to include highly restrictive county-by-year fixed effects to control for unobserved time-varying county characteristics.

The primary contribution of this paper is to assess the real effects of access to finance for local governments. Most theories and evidence in the access to finance literature focus on firms.[3] Their insights are not necessarily applicable to local governments, which differ from firms in fundamental ways. Local governments have inherent financial flexibility stemming from their constitution-granted ability to tax. Indeed, Lemmon and Roberts (2010) find that the sensitivity of investment to credit supply is close to one for firms, whereas I find a lower sensitivity of 0.62 for local governments, who raise property taxes to cover spending shortfalls. Local governments and firms can also affect the real economy through different channels. Credit supply to firms can foster employment growth, output growth, and productivity, whereas credit supply to local governments can support

[3] See e.g., Chava and Roberts (2008), Duchin, Ozbas, and Sensoy (2010), Butler and Cornaggia (2011), Paravisini et al. (2014),Cohn and Wardlaw (2016), Bentolila, Jansen, and Jiménez (2017), Bai, Carvalho, and Phillips (2018), Carlin and Mann (2018), and Benmelech, Frydman, and Papanikolaou (2019).

the tangible goods and services residents receive, and consequently improve local quality of life.

Yet, I also show aspects in which local governments and firms are similar. For example, Aghion et al. (2010) argue that credit constraints reduce a firm's willingness to engage in long-term investments more than short-term ones. Likewise, I find that local governments cut long-term, capital investments more than short-term, operational spending. Additionally, I find that states use intergovernmental transfers to reallocate capital across local governments much like how conglomerates use internal capital markets. Interestingly, the reallocation is larger in more corrupted states, consistent with Scharfstein and Stein (2000)'s model in which internal capital markets facilitate rent-seeking from division managers.

My paper is most closely related to Adelino, Cunha, and Ferreira (2017) and Dagostino (2019), who study the effect of credit supply on public spending and local employment and estimate local fiscal multipliers. Two key features distinguish my study from prior work. First, I show changes in the *quality* of public goods in addition to the quantity, and therefore show spillover effects on households. Second, I utilize a source of variation that leads to a credit contraction rather than an expansion, and occurs during normal economic times instead of recessions (Butler and Yi 2019; Amornsiripanitch 2021; Agrawal and Kim 2021). Using this unique source of variation, I identify new channels through which the post-crisis banking sector reforms have unintended consequences on the real economy (e.g., Sundaresan and Xiao 2018; Smolyansky 2019).

1 Institutional Background

The municipal bond market is large and central to local government finance. The market has over one million bonds issued by more than 50,000 state and local governments around the country (MSRB 2019). Commercial banks have become the third largest player in this market since the Great Recession. Bonds issued by small municipalities are particularly attractive to banks, because banks receive tax benefits from holding bonds issued by local governments that raise no more than \$10M in a given year ("bank-qualified bonds"). Banks have over 80% market share in this segment of the market and are the single most important type of credit supplier to small municipalities (Dagostino 2019).

The LCR rule is a part of the Basel Committee's reforms to develop a more resilient banking sector after the Great Recession. Aimed to improve bank short-term liquidity, the rule requires that banks maintain an amount of high-quality liquid assets (HQLA) greater than cash outflows over a 30-day hypothetical stress period. A mathematical expression of the rule is:

$$\text{Liquidity Coverage Ratio} = \frac{\text{High Quality Liquid Assets}}{\text{Total Net Cash Outflow in 30 Days}} \geq 100\% \tag{1}$$

HQLA are assets that can be converted immediately into cash with little price depreciation during periods of financial distress. HQLA include three levels. Level 1 HQLA are the most liquid and include assets such as Federal Reserve Bank balances and Treasury securities. Level 2A HQLA, as defined in the original Basel III Accord, include securities issued by public sector entities such as state and local governments, government-sponsored enterprises such as Fannie Mae and Freddie Mac, and foreign sovereign securities. Level 2A assets are subject to a 15% haircut because of their increased liquidity risks compared to level 1 assets. Level 2B HQLA include investment-grade corporate bond and Russell 1000 Index equity securities, and are subject to 40% haircuts.

The Basel framework sets regulatory standards and allows its member countries to tailor the rules to banks in their jurisdictions. In October 2014, the Federal Reserve Board of Governors, the Office of the Comptroller of the Currency (OCC), and the Federal Deposit Insurance Corporation (FDIC) collectively implemented an adjusted and more restrictive version of the rule in the US. This rule excluded municipal securities from the definition of HQLA. This standard change raised tremendous concerns among municipal issuers about the unintended consequences on the municipal bond market.

In the 60-day comment period following the rule's proposal, the regulators received 392 public comment letters. In these letters, local governments, practitioners, and banks expressed concern that the exclusion of municipal securities from HQLA would discourage banks from purchasing the securities, and consequently raise funding costs for local governments. The increased funding costs would then pass on to local residents and businesses in the form of increased taxes and reduced public investments. For example, the State of Florida Division of Bond Finance writes that they "expect that regulated companies would need to either reduce their participation in the municipal securities market . . . or be forced to raise their pricing schematics accordingly." Likewise, the North Carolina Office of the Treasurer states that the rule would "increase borrowing costs, leading to increased taxes and rates for citizens and delayed or forgone capital projects."

Issuers also comment that bank credit supply is especially important for small local governments, who typically place bonds with banks through private placements. According to the Government Finance Officers Association, placing a bond privately with a bank can decrease issuance costs by approximately 25-40 basis points compared to public issuance.[4] Two factors drive this cost reduction. First, smaller, less-frequent issuers often pay higher yields to retail investors due to investor unfamiliarity with the issuer's jurisdiction. Second, private placement with banks reduces costs associated with the book-building process, such as advisor and bond counsel fees, underwriter discount, and rating agency fees. For these issuers, substituting for other types of investors can be difficult and costly. Consistent with this argument, the South Granville Water and Sewer Authority in North Carolina states in a comment letter that the rule would "disproportionately

[4] See https://www.gfoa.org/bank-qualified-debt.

affect small issuers who do not ordinarily attract bond fund and other non-bank purchasers."

Municipal issuers also note that the rule's exclusion of municipal securities was inconsistent with bank capital requirements implemented under Basel III, which assign municipal bonds to the 20% risk weight category in conjunction with level 2A HQLA such as the securities issued by government-sponsored enterprises and foreign sovereign entities. They further point out that the differential treatment of municipal securities in the US compared to other countries could disadvantage US municipalities. The European Bank Authority, for example, includes bonds issued by European local governments as HQLA.

An important characteristic of the LCR rule is that it does not apply to all banks. For bank holding companies, depository institutions, and savings and loan holding companies with $250 billion or more in assets or $10 billion or more in on-balance sheet foreign exposure (for example, loans to or investments with foreign firms), the rule requires an LCR of at least 100% and a daily calculation. For banks with between $50 billion and $250 billion assets, the rule requires a monthly calculation, and the ratio can be based on 21-day cash outflow projections rather than 30-day projections, effectively reducing the required ratio to 70%. For banks with below $50 billion assets, the rule does not apply at all. The regulatory impact on only a subset of banks gives rise to regional variation in exposure to the rule. I exploit this variation to conduct a difference-in-differences analysis, which I describe in detail in Section 3.

Two amendments of the LCR regulation are relevant to the municipal bond market, hence to this paper's empirical design. First, in May 2015, the Federal Reserve Board issued a proposed rule to include a fraction of the municipal bond market as Level 2B HQLA. This amendment became effective on July 1, 2016. However, it came with many restrictions as to how and which municipal bonds can qualify. In short, a municipal bond has to be a) a General Obligations bond, which is backed by the general revenue of an issuer rather than a specific revenue stream (such as fees collected from a tollway, a hydroelectric dam, or an airport); b) an investment grade bond; c) issued by an entity whose obligations have a proven record as a reliable source of liquidity in repurchase markets during a period of significant stress, such as the 2007-2009 financial crisis;[5] and d) in total, municipal bonds cannot count towards more than 5% of a bank's HQLA. Furthermore, this amendment is only issued by the Federal Reserve Board. The two other bank regulators, the OCC and the FDIC, did not adopt this amendment.

Second, in November 2017, the Economic Growth, Regulatory Relief, and Consumer Protect Act (EGRRCPA) contained a provision that require all investment-grade municipal bonds to qualify as HQLA for banks. All three banking regulators implemented this provision together in a new

[5] The amendment states that "to be liquid and readily marketable, a security must be traded in an active secondary market with more than two committed market makers, a large number of non-market maker participants on both the buying and selling sides of transactions, timely and observable market prices, and a high trading volume."

amendment to LCR that became effective in August 2018. The second amendment significantly expanded the scope of municipal bonds that could qualify as HQLA, was adopted by all three bank regulators, and was viewed more positively than the first one by industry experts and local government officials.[6] The dynamic interactions between the LCR rule and the two amendments are critical for my empirical design. In Section 4 and 5, I show that while the first amendment was not so effective at alleviating municipal credit constraints created by the LCR regulation, the second amendment was effective and led to a partial reversal in the quantity effects I document.

2 Data and Summary Statistics

2.1 Data Sources

I obtain bank quarterly financial data from the Federal Financial Institutions Examination Council (FFIEC) from 2005Q1 to 2018Q4. Banks are required to file Consolidated Reports of Condition and Income ("Call Report") with the FFIEC no later than 30 days after the end of each quarter. These reports contain data on bank holdings of municipal securities, loans, and deposits. Because the LCR rule's applicability criteria rely on the assets and foreign exposures of bank holding companies, I further obtain bank holding companies' annual FR Y-9C forms from the Federal Reserve Bank of Chicago's website. To calculate geographical exposure to the LCR regulation, I use bank branch location and deposit information from the FDIC.

I obtain local government municipal bond issuance data from the Securities Data Company's (SDC) Global Public Finance US New Issues database. I collect data on various bond characteristics, such as issuer, issue date, issue size, yield to maturity, coupon rate, maturity date, embedded options, credit enhancement information, credit rating by Moody's, S&P, and Fitch, and whether the bond is designated as "bank-qualified".

Local government spending data come from the US Census Bureau's Annual Survey of State and Local Government Finances (Pierson, Hand, and Thompson 2015). Because the sample of counties and variables surveyed by the Census became stable after 2005, I restrict my sample period to 2005 through 2018. Following Adelino, Cunha, and Ferreira (2017), I include local governments (counties, cities, special districts, and school districts) that are present in all years of the sample period. To investigate substitution to alternative sources of finance, I obtain local tax revenues data from Internal Revenue Service (IRS)'s SOI Tax Stats database, and state tax laws regarding property tax limitations from the Lincoln Institute of Land Policy.

To examine changes in the quality of public service, I obtain environmental inspection records of municipal water districts from the EPA. Established by the Clean Water Act of 1972, all municipal wastewater treatment plants are subject to periodic inspections. The EPA or EPA-designated

[6] See, e.g., https://www.sifma.org/resources/submissions/treatment-of-municipal-securities-under-the-liquidity-coverage-ratio-rules/.

state authorities inspect whether the pollutants discharged from wastewater treatment plants comply with the requirement set force in their permits. The EPA stores the inspection records in the National Pollutant Discharge Elimination System (NPDES). The dataset covers my entire sample period of 2005-2018. I use this dataset to calculate the total number of violations in a facility in a given year. However, this measure contains significant outliers, as it is often the case that a facility has a large number of violations related to the same incident. Thus, to ensure that outliers do not drive my results, I construct a dummy variable at the facility level that takes a value of one if a facility has any reported violations in a given year.

To connect pollutant violations to infrastructure needs, I further merge the NPDES database with the EPA's Clean Watersheds Needs Survey. The survey assesses the capital needs of publicly owned water treatment facilities to meet the water quality goals set by the Clean Water Act. Reported every four years to Congress, the survey evaluates whether a facility needs rehabilitation, expansion, technology upgrade, and climate change adaptations, and estimates the cost to achieve these improvements. This dataset also contains detailed facility-level characteristics that I use as control variables in my regressions, such as the amount of water flow, treatment technology, and population served.

I gather electric utility companies' annual reports filed with the Energy Information Administration (EIA) to construct a national database of power outages. These reports are filed through EIA Form 861 and 861S, and are mandatory under the Federal Energy Administration Act of 1974 (Public Law 93-275). The reports contain information such as utility ownership (public sector vs. private sector), service areas, North American Electric Reliability Corporation (NERC) regions, electricity sales, and customer counts. From 2013 to 2017, EIA also requires the reporting of reliability metrics defined by the Institute of Electrical and Electronics Engineers. A commonly used reliability metric is the System Average Interruption Duration Index, which indicates the total duration of electricity interruption an average utility customer experiences in a year.

I use an array of data sources to construct additional outcomes and control variables. Test scores for students enrolled in public school district grades 3-8 are obtained from the Stanford Education Data Archive (SEDA), which reports English Language Arts and Math test scores for students in grades 3 through 8 for years 2009-2016 (Fahle et al. 2019). The scores are standardized across states to facilitate comparison between states. County unemployment rates and personal income come from the Bureau of Labor Statistics and the Bureau of Economic Analysis, respectively. County population comes from the US Census Bureau's annual estimates. County income inequality measures come from the American Community Survey.

2.2 Summary Statistics

Table 1 presents summary statistics for my sample of counties. The average dollar amount of municipal bond issuance in a county in a given year is around \$432 per capita, among which \$158

(37%) are issuances of bank-qualified bonds. These statistics vary tremendously across counties, as the standard deviations for these variables are 2-3 times the means. The average issue yield on bank-qualified bonds is 50 basis points lower than the average issue yield on other bonds, even though bank-qualified bonds have marginally lower average ratings.

On average, local governments in a county have a total of about $3,168 in annual revenues per capita. Taxes account for about 30%, intergovernmental transfers account for around 40%, and the rest comes from user fees for utilities, hospitals, etc. Among taxes, property taxes are responsible for around 85%, and the majority of the rest comes from sales taxes. Local governments, on average, rely very little on income or business taxes directly. On the spending side, local governments in a county spend about $2,972 per capita. About 87% of the spending is to support government daily operations and employee wages (current operation spending). Investment spending, which is capital expenditures made to build, acquire, and improve fixed assets, only constitutes around 12% of total spending.

3 Empirical Strategy

3.1 Main Specification

I exploit regional variation in exposure to the LCR rule to identify the effect of credit supply on economic outcomes. I calculate a continuous policy treatment variable, *Exposure*, using the deposit share of local banks in a county that are subject to the LCR requirement. I calculate this variable based on bank assets and foreign exposure at the end of 2013, the year prior to policy implementation. A continuous policy treatment variable has been used in other studies (e.g., Card and Krueger 1992; Acemoglu, Autor, and Lyle 2004).

My exposure measure has a mean of 21% and a standard deviation of 25% (Table 1 Panel B). About 39% of counties in my sample have zero treatment exposure, and about 2% have 100% treatment exposure (Figure 1). Figure 2 shows the geographical distribution of county treatment exposure. The five states with the highest average exposure are Arizona, Nevada, Delaware, Alaska, and Utah.

I use c to index counties and t to index years. In county-level regressions (Section 4.2 and onwards), I estimate difference-in-differences models of the following form:

$$Y_{ct} = \alpha + \beta \text{Exposure}_c \times \text{Post } 1_t + \gamma \text{Exposure}_c \times \text{Post } 2_t + \delta' \mathbf{X}_{ct} + \eta_c + \eta_t + \varepsilon_{ct} \qquad (2)$$

Post 1 is an indicator variable that takes a value of one on and after 2014, the year in which LCR was finalized. *Post 2* is an indicator variable that takes a value of one after 2017, the year in which the second amendment to LCR was proposed. When testing the "first stage" effects of the regulation on bank municipal bond holdings, I also add other interaction terms of *Exposure* with indicators of whether the time period is after the proposal and adoption of both LCR amendments (see Section 4.1 for details).

The model controls for state income tax rate, because it can affect both state-wide demand for municipal bonds (through affecting tax benefits associated with holding municipal bonds) and local government spending (through affecting state government transfers). I also control for local unemployment rate and the number of bank branches to adjust for differences in local economic conditions and the overall presence of the banking industry. I lag the unemployment rate variable for one period, as Adelino, Cunha, and Ferreira (2017) find that local government spending can influence subsequent county employment through the fiscal multiplier channel. The specification further includes year and county fixed effects to account for persistent county characteristics and macroeconomic trends. In robustness tests, I estimate more restrictive specifications with county population decile by year fixed effects to account for the possibility that the Great Recession and the subsequent recovery may have affected large and small counties differently. I also validate my results using a traditional difference-in-differences approach, defining treated counties as counties with above zero exposure. One advantage of the continuous difference-in-differences model is that it allows for marginal effect estimations at different treatment intensities. I cluster standard errors by county.

I aggregate local government fiscal variables such as bond issuance and public spending across all local governmental units (counties, cities, and special districts) at the county-year level. I treat a county as an economic unit that performs a regular set of functions for local communities, by themselves or through delegation to local districts. This strategy avoids biases created by the dynamic growth and consolidation of district governments within a county.[7]

3.2 Identification Assumptions and Challenges

The continuous difference-in-differences approach compares outcomes before and after the policy across counties with different exposures to the LCR rule. This approach relies on two main assumptions. First, I assume that changes in the outcome of interest would have been the same across locations with different policy exposure, in the absence of the policy. Second, I claim that exposure to affected banks influences local government spending through a specific channel. The channel I propose is that municipal credit supply falls more in locations where more banks are subject to the LCR requirement.

I take a number of steps to substantiate these assumptions. One concern is that the branch locations of regulated banks are not randomly assigned. Therefore, locations with different policy

[7] The United States has 89,004 local governments as of 2012. Of those, 3,031 are counties, 19,522 are cities, 13,000 are school districts, and 37,203 are special districts. Special districts are delegated to perform a single primary function, such as water treatment, electricity distribution, firefighting, and public transit. School districts have consolidated from 24,000 in 1962 to 13,000 in 2012. By contrast, the number of special districts increased from 18,323 to 37,203 during the same period.

exposures might be observably different, and outcomes such as public spending and investment may have evolved differently in the absence of the policy. To alleviate this concern, I plot annual coefficient estimates illustrating that outcomes did not diverge across these counties before the policy was introduced (Figure 3). Rather, the divergence occurs only after the implementation year. I also compare the economic characteristics of counties with and without affected banks to investigate whether and exactly how the counties differ (Table 2). The two groups of counties are similar along a number of dimensions, including income per capita, income inequality, bank deposit per capita, and both migration inflow and outflow rates. However, the two groups differ along the dimension of population, unemployment rate, and the number of bank branches. To adjust for the differences in population, I use the per capita level of bond issuance and public spending variables rather than the total level, and include county fixed effects.[8] To adjust for the differences in unemployment rate and bank branches, I always control for these characteristics in my regressions.

Another concern is that exposure to the policy could lead to changes in other aspects of bank behaviors, such as an increase in investments in liquid asset categories, and affect local economic conditions more generally (e.g., Gete and Reher 2018). These changes in local economic conditions could then drive changes in both local government bond issuance and spending. Two results are inconsistent with this alternative explanation. First, I show that local governments reduce only the issuance of bonds normally purchased by banks, but increase the issuance of bonds normally purchased by non-bank investors (Table 4). An overall change in county economic conditions cannot explain this dichotomy. Rather, this dichotomy supports the channel of credit supply reductions from banks, and consequent local government substitution to other types of investors. Second, I also use a local government-level triple difference-in-differences design to study the heterogeneous effects across governments with high and low ex ante reliance on bank financing. These regressions are conditional on county-by-year fixed effects and compare local governments within a county within a year. This specification should control for time-varying county economic conditions. Using this specification, I find that public spending drops more for local governments with higher ex ante reliance on bank-purchased municipal bonds (Appendix Table A2).

My empirical approach will be most effective when bank holdings of municipal bonds are local. Using California's detailed bond placement data, I verify that around 70% of bank-financed bonds are placed with banks that have a physical branch in the county. The highly local nature of the relationship between banks and local governments might result from high information frictions and tax policies in this market (Green, Hollifield, and Schürhoff 2007; Butler 2008; Babina,

[8] I scale the variables by county population in 2013, the year prior to the policy implementation, to avoid any biases created by dynamic public finance-driven population changes. See the stream of literature started by Tiebout (1956) for details.

Jotikasthira, Lundblad, and Ramadorai 2021). Local banks can have an informational advantage over distant banks due to daily exposure to local news, firsthand knowledge of local infrastructure projects, and ongoing interactions with the local government through deposit accounts and revolving lines of credit. Local governments engage in infrequent and outdated financial reporting practices, preventing distant investors from easily acquiring the same set of information (Baber and Gore 2008).

Last but not least, concerns can arise if there are confounding regulatory changes. In addition to LCR, the Basel III Accord introduced another liquidity regulation: the Net Stable Funding Ratio. This regulation aims to increase bank reliance on long-term stable funding sources, such as customer deposits and long-term wholesale funding. However, this rule was not proposed in the U.S. until May 2016 and will not be implemented until July 2021. Hence it is unlikely to explain the effects I document, which occur in 2014. The Dodd-Frank Act also brought regulatory changes to banks, such as increased capital requirements and stress testing.[9] Many of these changes were implemented in 2012 and apply differentially to banks above and below the $10B asset threshold. My results are robust to controlling for bank capital ratios (Table 3 and Table A5). I also use $10B as a placebo treatment threshold, and use 2012 as a placebo treatment year (Table A4). I find no significant coefficient loading on the placebo variables in both cases. Rather, the coefficients load on the actual treatment and post variables.

4 Effects on the Municipal Bond Market

4.1 Bank-Level Results

I first present bank-level results that directly link the LCR rule to a reduction in bank investment in municipal bonds. I also examine whether the two relevant amendments to the LCR caused a reversal to this effect. Specifically, I exploit the size threshold of the LCR rule and estimate a difference-in-differences model, and present the results in Table 3. *Treat* is an indicator for whether a bank is subject to the LCR requirement by the third quarter of 2014, the quarter prior to the rule implementation. *Post LCR* is an indicator that takes a value of one after the effective date of the LCR rule, which is in 2014Q3. *Post LCR First Amendment (Proposal)* is an indicator that takes a value of one after the proposal of the first relevant amendment in 2015Q2. *Post LCR First Amendment (Adoption)* is an indicator that takes a value of one after the effective date of the first relevant amendment in 2016Q3. Similarly, *Post LCR Second Amendment (Proposal)* is an indicator that takes a value of one after the proposal of the second relevant amendment in 2017Q4. *Post LCR Second Amendment (Adoption)* is an indicator that takes a value of one after the effective date of the second relevant amendment in 2018Q3. I control for bank assets, deposits, bank risk-based

[9] See, e.g., Buchak, Matvos, Piskorski, and Seru (2018), Irani, Iyer, Meisenzahl, and Peydro (2020), and Reher (2020).

capital ratio, and state corporate tax rate, which affects the tax benefit banks receive for holding municipal bonds.[10]

Column (1) uses the entire sample of banks, whereas in Columns (2) and (3), I restrict the analysis to banks closer to the asset threshold to improve the comparability of treated and control banks. The table shows that treated banks reduce the fraction of municipal bond holdings by 1-1.5% percentage points following the adoption of the main LCR rule, which is a 20-30% reduction in the unconditional mean of 5.1%. Following both the proposal and adoption of the first amendment, there seems to be no increase in bank holdings of municipal bonds. However, following the proposal of the second amendment, banks increase municipal bond holdings by about 0.3-0.5 percentage points. This increase continues by about 0.2-0.4 percentage points after the second amendment was adopted.

Given these results, it is natural to ask why the first amendment, intended to increase bank participation in the municipal bond market and alleviate municipal credit constraints, was not effective. Emily Brock from the Government Finance Officers Association, Shaun Snyder from the National Association of State Treasurers, and Michael Decker from the municipal securities division at SIFMA together stated in a letter to the regulators that "The 2016 rulemaking regarding municipal securities has not been successful for several reasons. First, the fact that the OCC and FDIC have not made corresponding changes to their LCR rules makes the Fed's amendments much less useful, since most LCR banks are subject to the rules of all three agencies... Second, the Fed's 2016 rule changes are too restrictive and don't reflect the realities of the municipal securities market. Only general obligation municipal securities are eligible...The 2016 rule amendments limit the amount of securities issued by a single issuer that a bank may include as eligible HQLA... specify that municipal securities in the aggregate can comprise nomore than five percent of a bank's overall HQLA".

Given the bank-level findings, in the remainder of the paper, I will focus on the coefficients on *Post LCR*, which I call *Post 1* from now on, an indicator for time periods after the initial LCR rule, and *Post LCR Second Amendment (Proposal)*, which I call *Post 2* from now on, an indicator for time periods after the second amendment's proposal, rather than including all five interaction terms in the regressions.

4.2 County-Level Results

In this section, I provide evidence that the LCR rule disproportionately reduces municipal credit supply in counties with a higher fraction of affected banks after the LCR rule, and that this effect

[10] One might imagine that a regression discontinuity design would be another appropriate empirical strategy to use for bank-level tests. However, there are not enough banks around the threshold of \$50B, which is above the 95th percentile of bank size distribution. For example, a \$10B bandwidth would result in 11 banks, and a \$5B bandwidth would result in 3 banks.

is partially reversed after the second amendment.

In Table 4 Panel A Column (1), I find that a 10 percentage point (about 0.4 standard deviation) increase in the county share of regulated banks decreases per capita bond issuance by 4.2%, and this effect reverses by 3.9% following the proposal of the second amendment. In Column (2), I further investigate the effect on the extensive margin and reach a similar conclusion.

In Columns (3) and (4), I separately investigate the issuance of bonds that are financed by banks versus other types of investors. I find that the reduction in issuance following LCR is concentrated only among bank-qualified bonds. Column (3) and (4) coefficients show that a 10 percentage point increase in county regulated banks leads to a 7.8% decrease in bank-qualified bond issuance, but a 1.8% increase in non-bank bond issuance. The opposite effects for bond issuance financed by banks versus other types of investors lend support to the channel of the policy, rather than an overall change in local government demand for credit. The results also suggest that local governments partially substitute to other types of investors when banks are not willing to purchase their securities. Following the second amendment's proposal, municipalities adjust their behaviors by issuing more bank-qualified bonds, and less non bank-qualified bonds.

In Column (5), I investigate the effect of the policy on issue yield. I find that issue yield increases by 17.5 basis points in fully exposed counties, which is a 6.3% increase in the average municipal bond yield of 2.8%, or an 18% increase in the standard deviation. Importantly, this effect is independent of any changes in the credit quality of local governments. In Column (6), I replace the outcome variable with the average credit rating of newly-issued municipal bonds in a county, and find that the coefficient estimate on *Post* $1 \times$ *Exposure* is statistically indistinguishable from zero. Following the proposal of the second amendment, however, the increase in yield is fully reversed, and there seems to be a reduction in municipal credit ratings. The latter could be consistent with a deterioration in local government fiscal conditions and the ability to provide local public goods that I show in the next sections.

In Panel B, I use traditional difference-in-differences models, where *Exposure* is a dummy variable that takes a value of one if the county has any regulated banks. I reach the same overall conclusion: counties with higher exposure to the regulation experience a larger decrease in municipal bond issuance and increase in issue yield following the initial LCR rule, which are partially reversed following the second amendment. The interpretations of the coefficient magnitudes are different. Instead of comparing counties with different levels of exposure, traditional difference-in-differences models compare the average outcomes in exposed counties (counties with *any* exposure) to nonexposed counties. For example, Column (1) coefficient on *Post 1* $\times$ *Exposure* suggests that on average, exposed counties experience a 21% reduction in municipal bond issuance compared to non-exposed counties.

5 Quantity Effects

5.1 Public Spending

The evidence so far suggests that the LCR rule disproportionately reduces municipal bond issuance in counties with higher exposure to the LCR rule following the initial policy implementation. This increase in credit constraint is effectively alleviated by the second amendment to the LCR rule that qualified a large segment of the market towards HQLA. These results are important "first stage" results to the spending effects I document in this section.

I measure county total public spending using the sum of spending across all types of local governments, which include the county government (also called "borough" or "parish" in some states), cities, townships, school districts, and special districts. Sectors of spending cover education, health, transportation, utilities, fire protection, police, and recreation. I exclude intergovernmental transfers from my public spending measure to avoid double-counting when aggregating at the county level.

In Table 5 Panel A Column (1), the outcome variable is the natural logarithm of total public spending per capita. The coefficient estimate on *Post LCR* $\times$ *Exposure* suggests that a 10% increase in the fraction of regulated banks leads to a 0.41% reduction in public spending per capita. After the proposal of the second amendment, those counties increase public spending by 0.23%, which suggests a long-term reduction in public spending of about 0.18%.

Local governments have the autonomy to choose the mixture of spending cuts. I estimate the sensitivities of two major categories of spending to the credit shock: current operation spending and investment spending. Current operation spending is spending to support government daily operations and employee wages. Investment spending is the money spent to build, improve, and acquire physical assets, such as roads, school buildings, and power plants.

I present the results in Columns (2) and (3). A 10% increase in the fraction of regulated banks leads to a 3.2% reduction in investment spending per capita, but no change in current operation spending per capita. Among investment spending, new construction spending drops more than spending on the purchase and maintenance of existing structure (Table A1). Overall, the results are consistent with theories and evidence from corporate finance studies, which find that long term spending is more sensitive to credit supply shocks (e.g. Aghion et al. 2010). The granularity of the government spending data allows me to further decompose investment spending by 13 different public sectors (Figure A1). The three sectors that experience the largest investment cuts are elementary education, parks and recreation, and utility. Interestingly, although bond issuance increase in the post-second amendment years, this increase in bond issuance is not used to fully support infrastructure. I find a statistically significant increase in both investment and operational spending in the post-second amendment years.

Figure 3 presents the annual coefficient estimates on *Exposure* and the 95% confidence intervals for the spending variables. The spending variables did not diverge across counties with different levels of exposure before the policy was introduced. Rather, the divergence occurs only after the policy implementation year, and converges back again after the second amendment proposal year. For current operation spending, the effect seems statistically insignificant in most post-years.

Investment and current operational spending constitute about 99% of local government spending. For the remaining 1%, the Census Bureau further divides it into two categories: spending on subsidies and assistance, and spending on social insurance trust systems such as the employee retirement system and unemployment insurance system. I find economically small and statistically insignificant effects of the credit shock on these two types of public spending.

I conduct robustness tests to show that the results are not sensitive to the empirical specifications or subsamples I choose. In Appendix Table A3 Panel A, I show how the coefficient on *Post 1* $\times$ *Exposure* barely changes when I control for non-linear forms of state and county characteristics (second and third degree polynomial forms). The results are also robust to dropping any single state (Figure A2), dropping states that are in the top decile of exposure distribution (Table A3 Panel B), and dropping years of the Great Recession (Table A3 Panel C).

I also conduct within-county, across local governments triple difference-in-differences tests. The idea is that holding fixed county presence of regulated banks, local governments with high ex ante reliance on bank credit will respond more strongly to a reduction in bank credit supply. These local government-level regressions allow me to control for county-by-year fixed effects, which adjust for unobserved time-varying county characteristics. This specification is highly restrictive because any alternative explanations would have to also explain within county-year, across local government variations in public spending. A downside of this empirical approach is that it may introduce measurement errors. This approach requires a fuzzy matching from the SDC Public Finance database to the Census Local Government Finance database based on local government names. However, there are around 89,000 local governments in the U.S., over 50,000 of which are municipal bond issuers, and each issuer's name can be spelled in several different ways in the data.[11] Such matching errors are likely not random — they are likely larger for local governments that issue a large number of bonds. In choosing the threshold score for the fuzzy matching algorithm, there is a trade-off between matching accuracy and sample size. In Appendix Table A2, I show the regression results for two different threshold scores: 0.95 (Column (1)) and 0.99 (Column (2)). In both cases I obtain consistent results: Local governments with higher reliance on bank credit supply (measured using the fraction of bank-qualified municipal bond issuance in the

[11] For example, Fort Bend County Water Control and Improvement District 2 can be spelled as "Fort Bend County Water Control and Improvement District 2", "Fort Bend County WCID 2", "Fort Bend Co Wtr Ctl & Imp Dt #2", "Fort Bend Cnty. Wtr. Cont. & Imp. Dist 2", and "Fort Bend Co Wtr Ctl & Imp Dt No.2"

5 years prior to the policy) cut public spending more than other local governments in the same county and year.

5.2 Substitution to Alternative Sources of Capital

5.2.1 Property Tax Receipts and State Tax Laws

The ability of local governments to respond to credit supply reductions should depend on their ability to raise alternative sources of capital. Property taxes constitute about 85% of local government tax revenues and could be an important alternative source of finance for credit-constrained municipalities. In Table 6 Column (1), I document a 0.8% increase in property tax receipts in fully exposed counties following the credit shock.

The magnitude of this effect varies with state tax laws. A majority of states impose restrictions on property tax increases. There are three broad categories of property tax limitations: levy limits, rate limits, and assessment limits. Levy limits constrain the overall property tax revenue growth. Rate limits cap the property tax rate that can be set by local governments. Assessment limits cap the property assessment value or its growth rate. I identify a state as having property tax limitations if it employs at least one of the three measures. Five states did not adopt any property tax limitations in my sample: New Hampshire, New Jersey, Tennessee, Vermont, and Hawaii.

Column (2) shows that the increase in property tax receipts is mostly driven by states without any property tax limits. In these states, counties that are fully exposed to the credit shock experience a 4% increase in property taxes. In states with property tax limits, however, the magnitude of the effect is 3.2% smaller. This result is robust to using traditional difference-in-differences specification (Column (4)).

Interestingly, when I investigate the coefficients on the interaction term of *Post 2* and *Exposure*, there seems to be a reduction in property taxes following the introduction of the LCR second amendment that is statistically insignificant in most specifications, regardless of whether the states have property tax limitations or not. Furthermore, the economic magnitudes of these coefficients tend to be smaller.

5.2.2 State Internal Capital Markets

Local governments bear resemblance to corporations in the organizational structure of finance. Just as corporate subdivisions depend crucially on the capital allocated from headquarters, local governments in the U.S. depend crucially on the money transferred from state governments. In fact, these transfers typically exceed local governments' self-collected tax revenues. In my sample of counties, the average self-collected tax revenue per capita is around $1010 whereas state transfer per capita is around $1,236.

I study how state governments reallocate capital across counties with higher or lower credit constraints, holding fixed states' fiscal conditions (such as state government total revenues) using state-by-year fixed effects. In Table 7 Column (1), I find that counties with higher exposure to the credit shock experience a 12% relative increase in revenue transferred *from* the state governments. These counties also experience an 8% relative decrease in revenue transferred *to* state governments (Column (3)). These results imply the existence of state internal capital markets, where state governments actively shift funds across local governments much like corporate headquarters.

The documented results could be consistent with two different views of internal capital markets. On the one hand, states could be reallocating capital to mitigate negative effects on the overall economy, which adds value even when it cannot relax state-wide credit constraints (Stein 1997). On the other hand, local governments could be extracting rents from state governments, which destroys value by reducing investment efficiencies (Scharfstein and Stein 2000).

To distinguish between these two views, I test whether the state transfer effects are larger in more or less corrupted states. The assumption is if states reallocate capital because of rent extraction from local governments, we should see a higher effect in more corrupted states. Following Glaeser and Saks (2006) and Butler, Fauver, and Mortal (2009), I define high conviction states as states with above median corruption convictions per capita reported by the Department of Justice. Column (2) suggests that the increase in state transfers is more than twice as large in states with high corruption convictions. In Column (4), the coefficient magnitudes suggest a similar story, albeit statistically insignificant. Overall, these results appear to be relatively more consistent with the rent-extraction hypothesis in explaining state internal capital markets.

Similar to the property tax findings, these changes to internal capital market transfers seem to be permanent rather than temporary. These results do not reverse as a result of increased credit access brought by the second amendment to the LCR, as suggested by the coefficients on the interaction terms with *Post 2*.

5.2.3 Cash Holdings

Local governments face external financing frictions. These frictions can arise from state tax laws (such as those documented in section 5.2.1), adverse selection caused by information frictions (Butler 2008), and moral hazard (Butler, Fauver, and Mortal 2009; Gao, Ru, and Tang 2021). The existence of financing frictions suggests that local governments have incentives to hold precautionary cash much like corporations (Opler et al. 1999; Lins, Servaes, and Tufano 2010), and use the cash to smooth spending in periods of credit constraints (Campello, Graham, and Harvey 2010; Campello et al. 2011).

I investigate this hypothesis using local government cash and security holdings data. The data include cash on hand, balances in deposit and saving accounts, and holdings of Treasury securities and private securities, such as bonds, notes, mortgages, and stocks. I aggregate all cash and security holdings at the county level, and subtract the holdings prepared for specific purposes, such as for unemployment insurance systems, workers compensation systems, employee retirement systems, and bond funds. The resulting variable is my measure of total local government precautionary cash holdings in a county.

Table 8 presents the difference-in-differences estimates of the effect of the credit shock on government precautionary cash holdings. Column (1) shows that moving from a county with no regulated bank to a county with all regulated banks is associated with a 17% reduction in precautionary cash, ceteris paribus. Column (2) shows that on average, exposed counties experience a 5% decrease in local government precautionary cash compared to nonexposed counties. The reduction to local government cash holdings seems to be permanent rather than temporary.

6 Quality Effects

In this section, I test whether reduced access to credit also leads to changes in the quality of public goods provision. The direction of this effect is not clear ex ante. On the one hand, quality could decline as a result of reduced capital to sustain public goods. On the other hand, the potential for overspending by the "Leviathan" governments suggests that local governments might have the ability to cut waste without affecting service (e.g. Brennan and Buchanan 1977, 1978, 1980). Quality might even improve, as debtholders such as banks can exert pressure on borrowers to produce short-term cash flows at the expense of product quality (e.g. Maksimovic and Titman 1991). There has been little empirical evidence on the impact of public spending cuts on relevant public service outcomes (Glaeser 2013).

I measure public service quality through the lens of utility and school districts, for two reasons. First, both sectors are economically relevant, accounting for 15% and 44% of total public investment, respectively. Second, both sectors are subject to strong regulatory oversight that enables me to collect detailed data to construct quality measures.

6.1 Water Treatment Quality

The Clean Water Act of 1972 establishes that all municipal wastewater treatment plants are subject to periodic inspections by the EPA. These inspections identify whether the water discharged from treatment plants contains higher pollutant levels than permitted. Regulated pollutants include, for example, iron, chlorine, zinc, and dissolved oxygen. I obtain nationwide inspection records from the EPA to examine changes in wastewater treatment quality.

In Table 9, I estimate linear probability models where the outcome variable is an indicator that takes a value of one if a water facility violates any pollutant standard in a given year. I include county fixed effects to adjust for differences in county size, location (e.g. upstream vs. downstream), and main water discharge sources (e.g. residential vs. industrial). I include population decile-by-year fixed effects to account for differences in the inspection frequency across counties that serve different population sizes. I also control for time-varying facility-level characteristics such as the amount of water flow, type of treatment technology, and the natural logarithm of population served. The variable *Upgrade* in Column (1) is an indicator variable that takes a value of one if the EPA identifies a facility as needing any of the following upgrades: rehabilitation, expansion, technology improvement, and climate change adaptations. *Upgrade* in Column (2) is an indicator variable that takes a value of one if the EPA-estimated upgrade cost is above the national median.

Column (1) shows that the probability of violation increases by 10 percentage points following the initial credit shock, but only at plants in need of significant capital upgrades, such as rehabilitation, treatment technology improvement, and capacity expansion. The differential effects on plants with and without upgrade needs point to the channel of failing infrastructure, rather than reduced operational spending, such as cutting personnel. Hence, this result is consistent with the initial drop in capital spending documented in Section 5.1. In Column (2), I find that the probability of violation is 10 percentage points higher at facilities that have an above-median EPA-estimated cost of achieving such capital upgrades.

These effects reverse after the second amendment introduction, suggested by the negative loading on *Post 2* × *Exposure* × *Upgrade*. Interestingly, there also seems to be an overall reduction in pollutant violations, rather than just reduction in violations at plants that need upgrades. This overall improvement in water quality could be driven by increased operational spending following the second LCR amendment, documented in Table 5. These results suggest that recovered access to the municipal bond market can improve water treatment quality.

6.2 Electric Power Outages

In Table 10, I test whether the credit-induced utility spending cuts lead to changes in the duration of power outages. The outcome variable is the average duration of power outages a utility customer experiences in a year. Electricity is delivered to households first through high-voltage transmission grids, and then through low-voltage local distribution lines. The transmission grids are interconnected within some regions. Utility companies report two versions of power outages: one that includes outages caused by only distribution failures, and one that includes outages caused by either generation, transmission, or distribution failures. I use the first version of the outage measure to avoid spillover effects caused by interconnected transmission grids. This measure also ensures comparability across utilities because around 99.8% of public utilities engage in distribution, whereas only 12% engage in power generation and 18% engage in transmission.

The North American Electric Reliability Corporation (NERC) regularly monitors and enforces the reliability of electricity services in the United States. There are six regional entities that NERC delegates its authority to: the Midwest Reliability Organization, Northeast Power Coordinating Council, Reliability First Corporation, SERC Reliability Corporation, Texas Reliability Entity, and Western Electricity Coordinating Council. I include NERC region fixed effects in my regressions to adjust for possible differences in the reliability standards and monitoring frequency across regions.

In Table 10 Columns (1), I limit the sample to municipal utilities. I find that the credit shock leads to a 40 minute increase in annual power outages experienced by an average municipal utility customer. These effects are economically meaningful, as they represent a 14% increase in the annual minutes of outage. As a placebo test, in Columns (2), I limit the sample to private utilities, i.e., utilities owned by investors instead of municipalities. These utilities do not raise funding from the municipal bond market, and hence should not be affected by credit shock. Indeed, I find no statistically significant changes in the length of power outages experienced by private utility customers. In contrast to the findings in Section 6.1, the increase in power outage does not reverse after municipal credit constraints are alleviated.

To summarize, evidence suggests that the quality of public service deteriorates when municipalities are credit constrained, but mixed evidence exists on whether the subsequent credit access improvement effectively reversed the initial deterioration.

6.3 Education Outcome

Although utility district service quality deteriorates as a result of reduced credit supply, I find little such evidence for school districts. In Table A6, the outcome variables are standardized test scores for public school students in grades 3 through 8. I examine both English Language Arts scores (Panel A) and math scores (Panel B) because the effects could differ for different subjects of study (Neilson and Zimmerman 2014). Because the test score data only cover years 2009-2016, I cannot estimate coefficients on the interaction term *Post 2* $\times$ *Exposure*.

I find little impact of the credit shock on student test scores, despite a very large drop in public investment in education. Several possible explanations exist for the null result. First, school facilities may yield non-academic benefits such as improved student health and safety that are not captured by test scores (Cellini, Ferreira, and Rothstein 2010). Second, the academic benefits associated with school capital spending might need a longer horizon to manifest themselves (Conlin and Thompson 2017).

7 Conclusion

In recent decades, local government expenditures have exceeded those of the federal government in building public infrastructure. Understanding the factors that drive or constrain local public investment is therefore critical. In this paper, I test whether and how credit supply to the municipal bond market affects both the quantity and quality of local public goods provision.

To study this question, I amass a large database that includes comprehensive municipal bond issuance data, revenue and spending data of local governments in the U.S., and granular measures of public service quality through the lens of municipal utility districts. To identify causal effects, I use a difference-in-differences approach based on a post-crisis bank liquidity regulation that unintendedly decreased bank investment in municipal bonds, and two amendments to this regulation that partially reversed its effect.

I find that disruptions to the municipal bond markets profoundly influence local government finance and people. Local governments cut spending, especially infrastructure investment. Public service quality deteriorates, manifested in increased water contamination and prolonged power outages. While a subsequent amendment to the regulation alleviated municipal credit constraints and therefore mitigated public spending cuts, evidence is mixed on whether the quality of public service recovered. My paper highlights not only the impact of financial market disruptions on local governments and people, but also an unintended consequence of post-crisis banking regulation.

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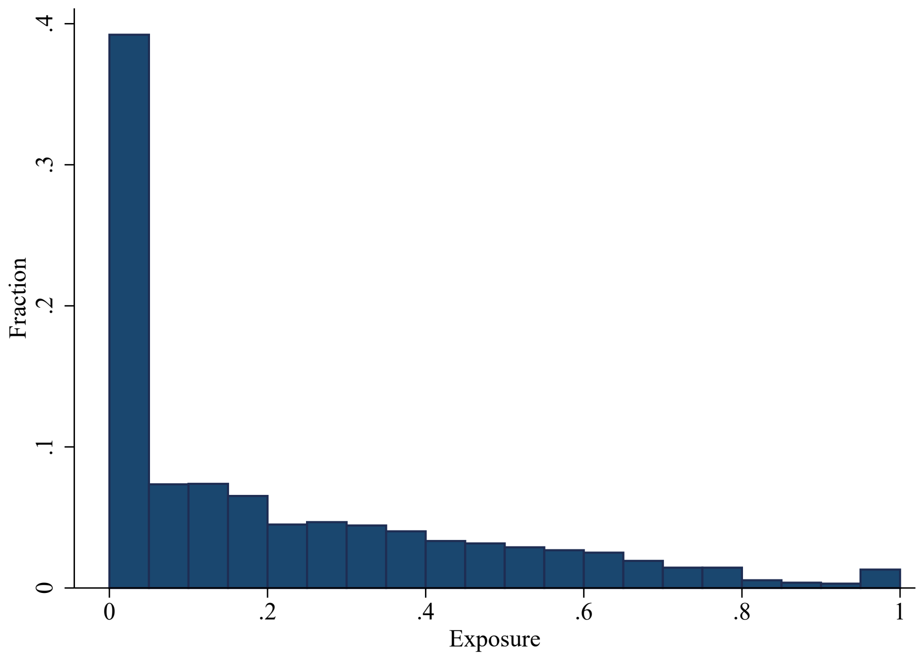

Figure 1: Policy Exposure Density Distribution

This figure shows the density distribution of county regulatory exposure. *Exposure* is the deposit share of local banks that are subject to the LCR requirement.

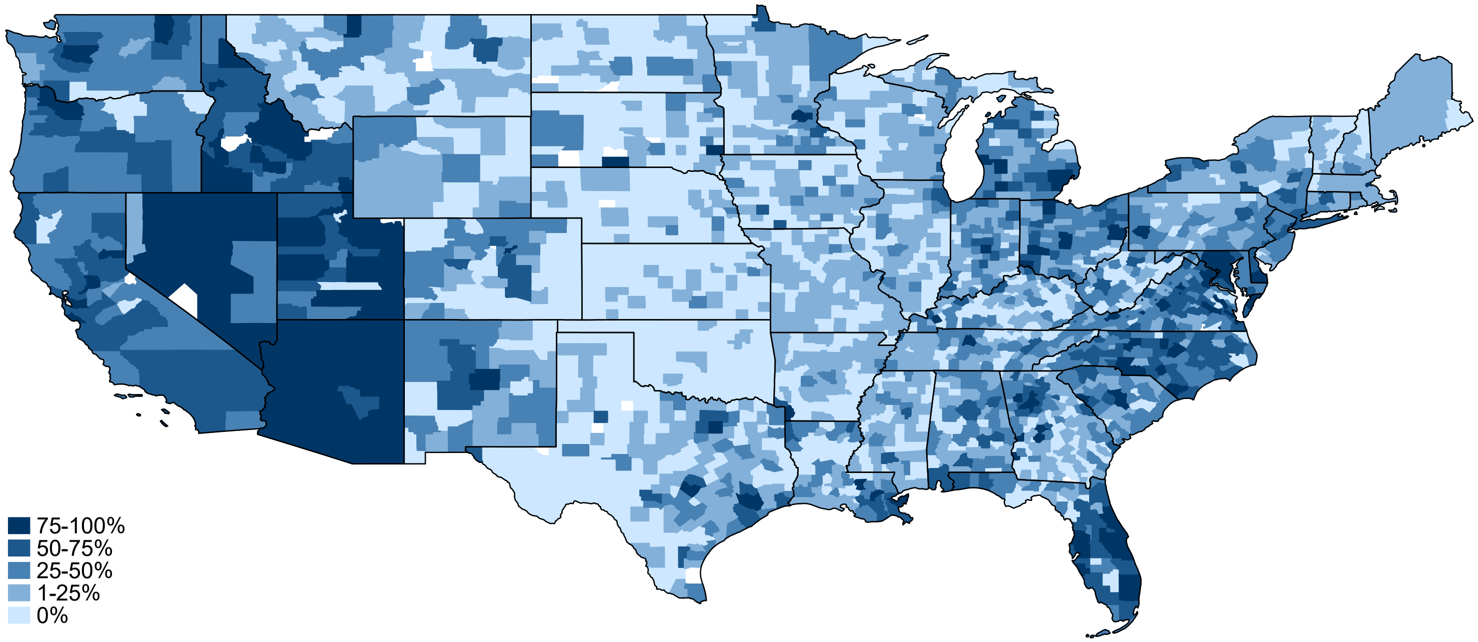

Figure 2: Spatial Heterogeneity in Policy Exposure

This figure displays the geographic distribution of county regulatory exposure. *Exposure* is the deposit share of local banks that are subject to the LCR requirement.

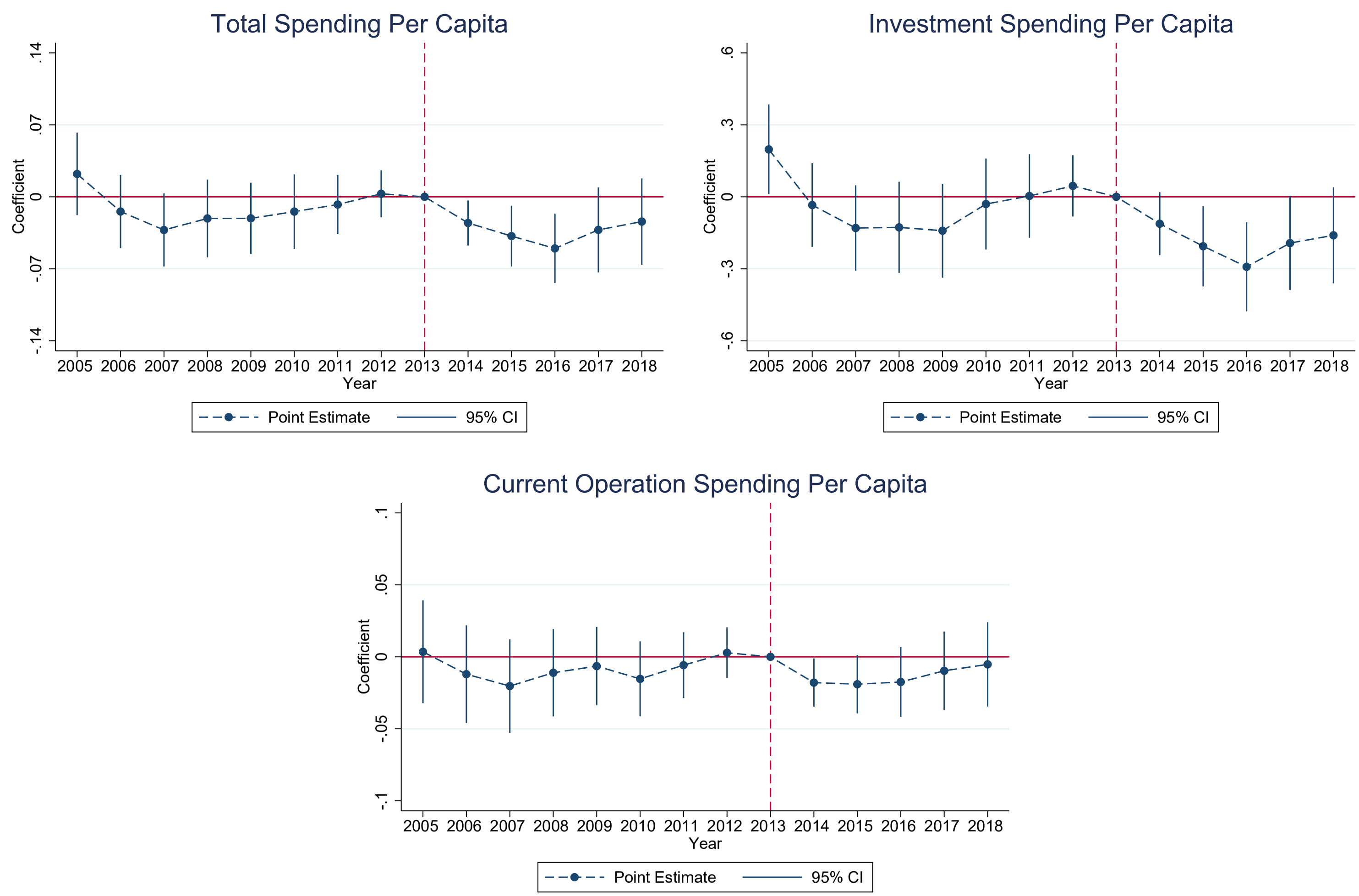

Figure 3: Annual Coefficient Estimates on Local Government Spending Categories

This figure displays the annual coefficient estimates on *Exposure* and two-tailed 95% confidence intervals based on standard errors clustered at the county level. The red vertical dashed line indicates the base year of 2013, the year before the implementation of the Liquidity Coverage Ratio rule. *Exposure* is the deposit share of local banks that are subject to the LCR requirement. The outcome variable is listed at the top of each graph. *Total Spending Per Capita* is the natural logarithm of the sum of all local government spending in a county divided by county population. *Investment Spending Per Capita* is the natural logarithm of the sum of all local government capital expenditures in a county divided by county population. *Current Operation Spending Per Capita* is the natural logarithm of the sum of all local government expenditures for employee wages and supplies, materials, and non-capital outlay contractual services divided by county population. For per capita variables, I scale the variable by county population in 2013, the year prior to the policy implementation. I control for the number of bank branches, unemployment rate (lag), state top personal income tax rate, and house price index (lag).

Table 1: Summary Statistics

The sample of local governments includes all counties, cities, special districts, and school districts that are present in U.S. Census Annual Survey of Local Governments in all years from 2005-2018. All local government finance variables are aggregated at the county-year level and reported on a per capita basis. I scale these variables by county population in 2013, the year prior to the policy implementation. In Panel A, *Bond Issuance Per Capita* is the per capita amount of municipal bond issuance. *Bond Issue Indicator* takes a value of one if a county has above zero bond issuance in a year. *Bond Issue Yield* is the average primary-market issue yield of municipal bonds. *Bond Rating* is the average credit rating of newly-issued municipal bonds. I map rating notches into numerical values, where 1 is the highest rating (Aaa or AAA), 2 the second highest (Aa1 orAA+),and so on. I use the rating by S&P, and if that's not available, the rating by Moody's. *Bond Issuance Per Capita - Bank-Qualified* is the per capita amount of municipal bond issuance that satisfies the bank qualification requirement. Bank qualification requires an issuer to raise no more than $10M in a given year, and banks receive tax benefits when they purchase bank-qualified bond. *Bond Issuance Per Capita - Other* is the per capita amount of municipal bond issuance that does not meet the bank qualification requirement. *Bond Issue Yield - Bank-Qualified (Other)* is the average primary-market issue yield of municipal bonds that satisfy (do not satisfy) the bank qualification requirement. *Bond Rating - Bank Qualified (Other)* is the average credit rating of newly-issued municipal bonds that satisfy (do not satisfy) the bank qualification requirement. *Total Revenue (Spending) Per Capita* is the per capita amount of local government revenues (spending). *Tax Revenue Per Capita* is the per capita amount of local government self-collected tax revenue. *Intergovernmental Transfer from (to) State Per Capita* is the per capita amount of all local government intergovernmental transfers from (to) the state government. *Current Operation Spending Per Capita* is the per capita amount of local government expenditures for employee compensations and supplies, materials, and non-capital outlay contractual services. *Investment Spending Per Capita* is the per capita amount of local government capital expenditures. *Precautionary Cash Per Capita* is the per capita amount of local government cash and security holdings that are not for designated purposes (e.g. public employee retirement system, unemployment and workers compensation, sinking fund, etc). In Panel B, *Exposure* is the deposit share of local banks that are subject to the LCR requirement. *Exposure Dummy* is an indicator variable that takes a value of one if the county has above zero number of affected banks. *Income Per Capita* measures county average income per capita. *Income Inequality (Gini)* is a measure of county income inequality using the Gini index. *Population* is county population. *Number of Bank Branches* is the number of bank branches in a county. *Bank Deposit Per Capita* is county total bank deposit divided by population. *Unemployment Rate* is county unemployment rate. *Net Migration Outflow Rate* is county migration outflow rate (per 100) minus migration inflow rate. In Panel C, *Total Utility Spending Per Capita* is the per capita amount of utility-related public spending in a county. *Electric (Water and Sewer) Utility Spending Per Capita* is the per capita amount of electric (water and sewer) utility-related spending in a county. *Public (Private) Utility Power Outage* measures the average minutes of power outage a municipal (investor-owned) utility customer experiences in a year. *Pollutant Violation Indicator* is an indicator for whether a municipal wastewater treatment plant has any pollutant violations in a given year. *Upgrade Indicator* is an indicator for whether the plant is identified by the EPA as needing any of the following upgrade: rehabilitation, expansion, technology improvement, and climate change adaptations. *Upgrade Cost Per Capita* is the EPA-estimated per capita cost to achieve the expected upgrades.

	Mean	SD	P10	Median	P90	N
Panel A: Local Government Finance Variables						
Bond Issuance Per Capita	432.5	1,184.8	0.0	139.7	1,009.2	40,740
Bond Issue Indicator	0.6	0.5	0.0	1.0	1.0	40,740
Bond Issue Yield (%)	2.8	1.0	1.6	2.6	4.0	24,997
Bond Rating	4.6	1.6	2.7	4.7	6.4	19,378
Bond Issuance Per Capita - Bank Qualified	158.5	417.7	0.0	14.5	443.0	34,920
Bond Issuance Per Capita - Other	272.1	1,092.2	0.0	0.0	703.8	34,920
Bond Issue Yield - Bank Qualified	2.6	1.0	1.4	2.4	3.9	18,125
Bond Issue Yield - Other	3.1	1.1	1.7	3.1	4.5	12,518
Bond Rating - Bank Qualified	4.7	1.5	3.0	5.0	6.8	12,855
Bond Rating - Other	4.5	1.7	2.4	4.2	6.6	10,439
Total Revenue Per Capita	3,168.8	2,609.2	1,418.3	2,616.7	5,319.4	40,740
Tax Revenue Per Capita	1,010.8	1,312.8	253.7	771.9	1,873.3	40,740
Intergovernmental Transfer from State Per Capita	1,236.6	667.3	657.1	1,149.4	1,850.9	40,740
Total Spending Per Capita	2,972.5	2,301.1	1,356.9	2,489.1	4,950.1	40,740
Current Operation Spending Per Capita	2,590.4	1,799.1	1,254.5	2,199.0	4,287.1	40,740
Investment Spending Per Capita	365.9	629.4	44.2	220.6	751.3	40,740
Intergovernmental Transfer to State Per Capita	42.5	544.7	0.0	0.0	23.1	40,740
Precautionary Cash Per Capita	1,228.8	2,681.5	232.6	828.0	2,277.6	40,740

Table 1 Continued

	Mean	SD	P10	Median	P90	N
Panel B: County Economic Characteristics						
Exposure (%)	21.3	24.7	0.0	12.3	59.8	40,740
Exposure Dummy (%)	64.5	47.9	0.0	100.0	100.0	40,740
Income Per Capita (K)	36.4	10.9	25.8	34.4	48.5	40,740
Income Inequality (Gini Index)	0.4	0.0	0.4	0.4	0.5	40,740
Population (K)	103.5	323.5	5.5	27.1	213.6	40,740
Bank Deposits Per Capita (K)	19.2	36.6	8.4	15.4	30.6	40,740
Unemployment Rate (%)	6.4	2.8	3.4	5.7	10.3	40,740
Net Migration Outflow Rate (%)	-0.0	0.9	-1.1	0.0	0.9	40,740
Number of Bank Branches	31.6	77.7	3.0	11.0	66.0	40,740
Panel C: Utility District Characteristics						
Total Utility Total Spending Per Capita	285.4	1,119.1	0.0	0.0	736.4	40,740
Electric Utility Total Spending Per Capita	147.6	974.0	0.0	0.0	348.7	40,740
Water and Sewer Total Spending Per Capita	98.3	225.4	0.0	0.0	288.4	40,740
Pollutant Violation Indicator	0.6	0.5	0.0	1.0	1.0	140,616
Upgrade Indicator	0.6	0.5	0.0	1.0	1.0	140,616
Upgrade Cost Per Capita	94.3	305.1	0.0	5.5	239.4	140,616
Public Utility Power Outage (Minutes)	269.6	416.9	36.0	148.4	541.9	13,974
Private Utility Power Outage (Minutes)	275.8	342.4	86.5	181.7	491.2	13,109

Table 2: Relationship between Exposure and County Economic Characteristics

This table reports the means and standard deviations of county economic variables for treated and control counties in 2013, the year before treatment. The last two columns report the P-values of the differences in means and the standardized differences in these variables between the two groups of counties. *Exposure* is the deposit share of local banks that are subject to the LCR requirement. *Income Per Capita* measures county average income per capita. *Income Inequality (Gini)* is measured using the county Gini Index. *Population* is county population reported in thousands. *Migration Inflow (Outflow) Rate* is the percentage of people moving out of (into) a county in a given year. *Unemployment Rate* is county unemployment rate reported in percentage points. *Bank Deposit Per Capita* is total county bank deposit divided by population. *Number of Bank Branches* is the number of bank branches in a county. ***, **, and * denote p-values that are below 1%, 5%, and 10% levels, respectively.

	Exposure = 0		Exposure >0			
	Mean	SD	Mean	SD	P-value	Std. Diff.
Income Per Capita (K)	39.31	(12.03)	38.58	(10.59)	(0.10)	-0.05
Income Inequality (Gini Index)	0.44	(0.04)	0.44	(0.03)	(0.18)	0.04
Population (K)	15.53	(34.21)	153.94	(399.01)	(0.00)***	0.35
Migration Inflow Rate (%)	5.07	(1.36)	5.15	(1.44)	(0.16)	0.04
Migration Outflow Rate (%)	5.09	(1.18)	5.08	(1.20)	(0.94)	-0.00
Unemployment Rate (%)	6.82	(2.99)	7.58	(2.38)	(0.00)***	0.20
Bank Deposit Per Capita (K)	21.68	(13.83)	19.62	(51.86)	(0.11)	-0.04
Number of Bank Branches	7.26	(8.53)	45.66	(95.92)	(0.00)***	0.40
Observations	1,033		1,877			

Table 3: Bank-Level Test of the Effect of LCR

This table studies the dynamic effects of the LCR rule and subsequent amendments on bank holdings of municipal bonds. The unit of observation is bank-quarter. *Treat* is an indicator that takes a value of one if a bank is subject to the LCR requirement. I measure it in the third quarter of 2014, the quarter prior to the implementation of the regulation. *Post LCR* is an indicator that takes a value of one after the effective date of the LCR rule, which is in 2014Q3. *Post LCR First Amendment (Proposal)* is an indicator that takes a value of one after the proposal of the first relevant amendment in 2015Q2. *Post LCR First Amendment (Adoption)* is an indicator that takes a value of one after the effective date of the first relevant amendment in 2016Q3. Similarly, *Post LCR Second Amendment (Proposal)* is an indicator that takes a value of one after the proposal of the second relevant amendment in 2017Q4. *Post LCR Second Amendment (Adoption)* is an indicator that takes a value of one after the effective date of the second relevant amendment in 2018Q3. Controls include *Log Asset, Log Deposit, State Corporate Tax Rate*, and *Average Risk-Based Capital Ratio (lag)*. In Column (1), the sample is all banks that file Call Reports with the FDIC from 2005 to 2018. In Column (2), the sample includes banks with assets greater than $1B and less than $100B. In Column (3), the sample includes banks with assets greater than $10B and less than $90B. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the bank level, are reported in parentheses.

	Municipal Bond Holdings/Asset		
	(1)	(2)	(3)
	Full Sample	Bank Size 1B-100B	Bank Size 10B-90B
Post LCR × Treat	-1.528***	-1.099***	-1.324***
	(0.194)	(0.254)	(0.431)
Post LCR First Amendment (Proposal) × Treat	-0.017	-0.210	-0.178
	(0.067)	(0.154)	(0.173)
Post LCR First Amendment (Adoption) × Treat	-0.045	0.175	0.102
	(0.128)	(0.135)	(0.191)
Post LCR Second Amendment (Proposal) × Treat	0.285***	0.467***	0.284***
	(0.106)	(0.074)	(0.105)
Post LCR Second Amendment (Adoption) × Treat	0.372***	0.321***	0.150**
	(0.077)	(0.057)	(0.075)
Controls	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes
Number of Obs.	434,751	33,046	5,577
Number of Banks	9,767	589	98
Adjusted R^2	0.79	0.79	0.69

Table 4: Effect on Municipal Bond Market Outcomes

This table presents difference-in-difference estimates of the following equation: $Y_{ct} = \alpha + \beta \text{Post } 1_t \times \text{Exposure}_c + \gamma \text{Post } 2_t \times \text{Exposure}_c + \delta' \mathbf{X}_{ct} + \eta_c + \eta_t + \varepsilon_{ct}$. *Exposure* in Panel A is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Exposure* in Panel B an indicator variable that takes a value of one if the county has above zero number of banks subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *Log Issue Per Capita* is the natural logarithm of county total municipal bond issue amount per capita. *Issue Indicator* is an indicator variable that takes a value of one if a county-year has above zero bond issuance. *Log Bank-Qualified Issue Per Capita* is the natural logarithm of per capita bond issuance that satisfies the bank qualification requirement. *Log Other Issue Per Capita* is the natural logarithm of per capita bond issuance that does not satisfy the bank qualification requirement. For per capita variables, I scale the variable by county population in 2013, the year prior to the policy implementation. *Issue Yield* is the average primary market issue yield of municipal bonds in a county-year. *Credit Rating* is the average credit rating for all municipal bonds issued in a county-year. I use the rating provided by Standard and Poor's, and when it's not available, I use Moody's. *Log Number of Bank Branches* is the natural logarithm of the number of bank branches in a county. *Unemployment Rate* is the county unemployment reported by the Bureau of Labor Statistics, lagged for one period. *State Personal Income Tax Rate* is the maximum personal income tax rate in a state. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

Panel A: Exposure = Affected Bank Share						
	(1)	(2)	(3)	(4)	(5)	(6)
	Log Issue Per Capita	Issue Indicator	Log Bank -Qualified Issue Per Capita	Log Other Issue Per Capita	Issue Yield	Credit Rating
Post 1 × Exposure	-0.428***	-0.067***	-0.780***	0.180**	0.175***	-0.049
	(0.098)	(0.016)	(0.094)	(0.090)	(0.032)	(0.089)
Post 2 × Exposure	0.399***	0.070***	0.513***	-0.287**	-0.186***	-0.500***
	(0.143)	(0.023)	(0.122)	(0.131)	(0.039)	(0.105)
Log Number of Bank Branches	-0.026	-0.009	0.002	0.002	-0.022	-0.378**
	(0.121)	(0.020)	(0.111)	(0.102)	(0.047)	(0.167)
Unemployment Rate (Lag)	-0.083***	-0.010***	-0.059***	-0.029***	0.045***	-0.036***
	(0.011)	(0.002)	(0.010)	(0.009)	(0.004)	(0.011)
State Personal Income Tax Rate	-0.046**	-0.007**	-0.091***	0.029	-0.027***	-0.040**
	(0.022)	(0.004)	(0.022)	(0.023)	(0.006)	(0.019)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	40,740	40,740	40,740	40,740	24,851	19,135
Number of Counties	2,910	2,910	2,910	2,910	2,567	2,273
Adjusted R^2	0.48	0.47	0.43	0.51	0.71	0.40

Panel B: Exposure Dummy

	(1) Log Issue Per Capita	(2) Issue Indicator	(3) Log Bank -Qualified Issue Per Capita	(4) Log Other Issue Per Capita	(5) Issue Yield	(6) Credit Rating
Post 1 × Exposure	-0.216***	-0.037***	-0.338***	0.185***	0.097***	0.001
	(0.061)	(0.010)	(0.060)	(0.053)	(0.018)	(0.075)
Post 2 × Exposure	0.174**	0.030**	0.134*	-0.143*	-0.066***	0.053
	(0.088)	(0.014)	(0.080)	(0.073)	(0.022)	(0.092)
Log Number of Bank Branches	-0.033	-0.011	-0.013	0.018	-0.015	-0.348**
	(0.121)	(0.020)	(0.111)	(0.102)	(0.047)	(0.168)
Unemployment Rate (Lag)	-0.084***	-0.011***	-0.061***	-0.028***	0.046***	-0.025**
	(0.011)	(0.002)	(0.010)	(0.009)	(0.004)	(0.011)
State Personal Income Tax Rate	-0.043*	-0.007*	-0.085***	0.025	-0.028***	-0.043**
	(0.022)	(0.004)	(0.022)	(0.023)	(0.006)	(0.019)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	40,740	40,740	40,740	40,740	24,851	19,135
Number of Counties	2,910	2,910	2,910	2,910	2,567	2,273
Adjusted R^2	0.48	0.47	0.43	0.51	0.71	0.41

Table 5: Effect of Credit Supply Reduction on Types of Public Spending

This table presents difference-in-difference estimates of the following equation: $Y_{ct} = \alpha + \beta \text{Post } 1_t \times \text{Exposure}_c + \gamma \text{Post } 2_t \times \text{Exposure}_c + \delta' \mathbf{X}_{ct} + \eta_c + \eta_t + \varepsilon_{ct}$. *Exposure* in Panel A is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Exposure* in Panel B an indicator variable that takes a value of one if the county has above zero number of banks subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *Log Total Spending Per Capita* is the natural logarithm of the sum of all local government spending in a county divided by county population. *Log Investment Spending Per Capita* is the natural logarithm of the sum of all local government capital expenditures in a county divided by county population. *Log Current Operation Spending Per Capita* is the natural logarithm of the sum of all local government expenditures for employee wages and supplies, materials, and non-capital outlay contractual services divided by county population. For per capita variables, I scale the variable by county population in 2013, the year prior to the policy implementation. *Log Number of Bank Branches* is the natural logarithm of the number of bank branches in a county. *Unemployment Rate* is the county unemployment reported by the Bureau of Labor Statistics, lagged for one period. *State Personal Income Tax Rate* is the maximum personal income tax rate in a state. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	(1) Log Total Spending Per Capita	(2) Log Investment Spending Per Capita	(3) Log Current Operation Spending Per Capita
Post 1 × Exposure	-0.041***	-0.315***	-0.001
	(0.010)	(0.043)	(0.009)
Post 2 × Exposure	0.023**	0.086*	0.030***
	(0.010)	(0.046)	(0.007)
Log Number of Bank Branches	0.110***	0.163***	0.106***
	(0.014)	(0.058)	(0.013)
Unemployment Rate (Lag)	-0.009***	-0.044***	-0.005***
	(0.001)	(0.004)	(0.001)
State Personal Income Tax Rate	-0.006*	0.013	-0.007**
	(0.003)	(0.010)	(0.003)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of Obs.	40,740	40,740	40,740
Number of Counties	2,910	2,910	2,910
Adjusted R^2	0.93	0.59	0.96

Table 6: State Tax Laws and Substitution to Property Taxes

In this table, Columns (1) and (3) present estimates of the following equation: $Y_{ct} = \alpha + \beta \text{Post } 1_t \times \text{Exposure}_c + \gamma \text{Post } 2_t \times \text{Exposure}_c + \delta' \mathbf{X}_{ct} + \eta_c + \eta_t + \varepsilon_{ct}$. Columns (2) and (4) present estimates of the following equation: $Y_{ct} = \alpha + \beta_1 \text{Post } 1_t \times \text{Exposure}_c + \beta_2 \text{Post } 1_t \times \text{Exposure}_c \times \text{State Property Tax Limit}_c + \gamma_1 \text{Post } 2_t \times \text{Exposure}_c + \gamma_2 \text{Post } 2_t \times \text{Exposure}_c \times \text{State Property Tax Limit}_c + \delta' \mathbf{X}_{ct} + \eta_c + \eta_t + \varepsilon_{ct}$. *Exposure* in Columns (1) and (2) is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Exposure* in Columns (3) and (4) is an indicator variable that takes a value of one if the county has above zero number of banks subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *State Property Tax Limit* is an indicator for whether a state employs any of the following property tax limitations: levy limit, rate limit, and assessment value limit. The dependent variable, *Log Property Tax Receipts Per Capita*, is the natural logarithm of the county total real estate tax receipts divided by the number of real estate tax payers. Property tax data are obtained from IRS and cover the period of 2011-2018. *Log Number of Bank Branches* is the natural logarithm of the number of bank branches in a county. *Unemployment Rate* is the county unemployment reported by the Bureau of Labor Statistics, lagged for one period. *State Personal Income Tax Rate* is the maximum personal income tax rate in a state. *Log House Price Index)* is the natural log of county house price index reported by FHFA, lagged for one period.***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	Log Property Tax Receipts Per Capita			
	Exposure = Affected Bank Share		Exposure Dummy	
	(1)	(2)	(3)	(4)
Post 1 × Exposure	0.008*	0.040**	0.003	0.018***
	(0.004)	(0.015)	(0.003)	(0.005)
Post 1 × Exposure × State Property Tax Limit		-0.032**		-0.015***
		(0.015)		(0.004)
Post 2 × Exposure	-0.010**	-0.006	-0.002	-0.006
	(0.004)	(0.020)	(0.003)	(0.006)
Post 2 × Exposure × State Property Tax Limit		-0.004		0.004
		(0.020)		(0.006)
Log Number of Bank Branches	0.017**	0.017**	0.018**	0.017**
	(0.009)	(0.009)	(0.009)	(0.009)
Unemployment Rate (Lag)	0.005***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
State Personal Income Tax Rate	-0.009***	-0.009***	-0.009***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
Log House Price Index (lag)	0.162***	0.162***	0.162***	0.163***
	(0.014)	(0.014)	(0.014)	(0.014)
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Number of Obs.	17,769	17,769	17,769	17,769
Number of Counties	2,549	2,549	2,549	2,549
Adjusted R^2	0.99	0.99	0.99	0.99
Within R^2	0.76	0.76	0.76	0.76

Table 7: Effect of Credit Supply Reduction on State Government Reallocation

In this table, Columns (1) and (3) present estimates of the following equation: $Y_{ct} = \alpha + \beta \text{Post } 1_t \times \text{Exposure}_c + \gamma \text{Post } 2_t \times \text{Exposure}_c + \delta' \mathbf{X}_{ct} + \eta_c + \eta_t + \varepsilon_{ct}$. Columns (2) and (4) present estimates of the following equation: $Y_{ct} = \alpha + \beta_1 \text{Post } 1_t \times \text{Exposure}_c + \beta_2 \text{Post } 1_t \times \text{Exposure}_c \times \text{High Corruption Conviction}_c + \gamma_1 \text{Post } 2_t \times \text{Exposure}_c + \gamma_2 \text{Post } 2_t \times \text{Exposure}_c \times \text{High Corruption Conviction}_c + \delta' \mathbf{X}_{ct} + \eta_c + \eta_t + \varepsilon_{ct}$. In Columns (1) and (2), the dependent variable is *Log Intergovernmental Transfer from State*, the natural logarithm of per capita intergovernmental transfers from the state government to local governments in a county. In Columns (3) and (4), the dependent variable is *Log Intergovernmental Transfer from State*, the natural logarithm of per capita intergovernmental transfers from local governments to the state government in a county. For per capita variables, I scale the variable by county population in 2013, the year prior to the policy implementation. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *High Corruption Conviction* is an indicator variable that takes a value of one if a state has above median corruption convictions per capita reported by the Department of Justice in 2013. *Log Number of Bank Branches* is the natural logarithm of the number of bank branches in a county. *Unemployment Rate* is the county unemployment reported by the Bureau of Labor Statistics, lagged for one period. The additional control variable, *State Personal Income Tax Rate* dropped out of the regression because of the inclusion of state-by-year fixed effect. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	Log Intergovernmental Transfer *from* State		Log Intergovernmental Transfer *to* State	
	(1)	(2)	(3)	(4)
Post 1 × Exposure	0.124***	0.097***	-0.080***	-0.068***
	(0.015)	(0.013)	(0.022)	(0.022)
Post 1 × Exposure × High Corruption Conviction		0.131***		-0.059
		(0.046)		(0.064)
Post 2 × Exposure	0.009	0.019	-0.008	-0.039
	(0.024)	(0.023)	(0.038)	(0.039)
Post 2 × Exposure × High Corruption Conviction		-0.046		0.148
		(0.071)		(0.098)
Log Number of Bank Branches	0.068***	0.069***	0.045***	0.045***
	(0.012)	(0.012)	(0.017)	(0.017)
Unemployment Rate (Lag)	-0.002	-0.002	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)
County FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes
Number of Obs.	40,726	40,726	40,726	40,726
Number of Counties	2,911	2,911	2,911	2,911
Adjusted R^2	0.94	0.94	0.82	0.82

Table 8: Effect of Credit Supply Reduction on Local Government Cash Holdings

This table presents difference-in-difference estimates of the following equation: $Y_{ct} = \alpha + \beta \text{Post } 1_t \times \text{Exposure}_c + \gamma \text{Post } 2_t \times \text{Exposure}_c + \delta' \mathbf{X}_{ct} + \eta_c + \eta_t + \varepsilon_{ct}$. *Exposure* in Columns (1) is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Exposure* in Columns (2) is an indicator variable that takes a value of one if the county has above zero number of banks subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. The dependent variable, *Log Precautionary Cash Holdings Per Capita*, is the natural logarithm of the sum of all local government cash and security holdings that are not of designated purposes (e.g. public employee retirement system, unemployment and workers compensation, sinking fund, etc) divided by county population. I scale the variable by county population in 2013, the year prior to the policy implementation. *Log Number of Bank Branches* is the natural logarithm of the number of bank branches in a county. *Unemployment Rate* is the county unemployment reported by the Bureau of Labor Statistics, lagged for one period. *State Personal Income Tax Rate* is the maximum personal income tax rate in a state. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	Log (Precautionary Cash Holdings Per Capita)	
	Exposure = Affected Bank Share	Exposure Dummy
	(1)	(2)
Post 1 × Exposure	-0.173***	-0.051***
	(0.040)	(0.019)
Post 2 × Exposure	0.026	-0.003
	(0.031)	(0.015)
Log Number of Bank Branches	0.134**	0.136**
	(0.055)	(0.055)
Unemployment Rate (Lag)	-0.005	-0.005
	(0.004)	(0.004)
State Personal Income Tax Rate	0.052***	0.053***
	(0.011)	(0.012)
County FE	Yes	Yes
Year FE	Yes	Yes
Number of Obs.	40,740	40,740
Number of Counties	2,910	2,910
Adjusted R^2	0.81	0.81

Table 9: Effect of Credit Supply Reduction on Municipal Water Quality

This table presents coefficient estimates of the following equation: $Y_{it} = \alpha + \beta_1 \text{Post } 1_t \times \text{Exposure}_c + \beta_2 \text{Post } 1_t \times \text{Exposure}_c \times \text{Upgrade}_i + \gamma_1 \text{Post } 2_t \times \text{Exposure}_c + \gamma_2 \text{Post } 2_t \times \text{Exposure}_c \times \text{Upgrade}_i + \delta_1' \mathbf{X}_{it} + \delta_2' \mathbf{X}_{ct} + \eta_c + \eta_{Pop\ Decile \times Year} + \varepsilon_{it}$, where i denotes water treatment facility, c denotes county, and t denotes year. *Exposure* is a continuous variable that measures county deposit share of banks affected by LCR. The dependent variable, *Pollutant Violation Indicator*, is an indicator variable that takes a value of one if a municipal wastewater facility violates any pollutant standard in a given year. *Upgrade* in Column (1) is an indicator variable that takes a value of one if the EPA identifies a facility as needing any of the following upgrades: rehabilitation, expansion, technology improvement, and climate change adaptations. *Upgrade* in Column (2) is an indicator variable that takes a value of one if the EPA-estimated upgrade cost is above the national median. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *Log Flow (Million Gallons Per Day)* is the natural logarithm of the quantity of water moving through the facility measured in units of million gallons per day. *Overflow* is an indicator variable that takes a value of one if the flow exceeds the planned design capacity of the facility. *Log Population Served* is the natural logarithm of the number of population connected to the water treatment facility. *Advanced Treatment* is an indicator variable that takes a value of one if the treatment technology of the facility is more advanced than secondary treatment. *Log Number of Bank Branches* is the natural logarithm of the number of bank branches in a county. *Unemployment Rate* is the county unemployment reported by the Bureau of Labor Statistics, lagged for one period. *State Personal Income Tax Rate* is the maximum personal income tax rate in a state. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	Pollutant Violation Indicator	
	(1)	(2)
Post 1 × Exposure × Upgrade	0.108***	0.104***
	(0.024)	(0.024)
Post 1 × Exposure	-0.033	-0.026
	(0.030)	(0.028)
Post 2 × Exposure × Upgrade	-0.065**	-0.052**
	(0.026)	(0.026)
Post 2 × Exposure	-0.090***	-0.100***
	(0.033)	(0.033)
Log Flow (Million Gallons Per Day)	0.054***	0.054***
	(0.005)	(0.005)
Overflow	-0.003	-0.003
	(0.008)	(0.008)
Advanced Treatment	0.015**	0.015**
	(0.007)	(0.007)
Log Number of Bank Branches	-0.073**	-0.072**
	(0.029)	(0.029)
Unemployment Rate (Lag)	0.008***	0.008***
	(0.002)	(0.002)
State Personal Income Tax Rate	-0.044***	-0.044***
	(0.005)	(0.005)
Log Income Per Capita (Lag)	0.129***	0.129***
	(0.043)	(0.043)
Facility Controls	Yes	Yes
State and County Controls	Yes	Yes
County FE	140,812	140,812
Population Decile × Year FE	0.25	0.25

Table 10: Effect of Credit Supply Reduction on Power Outage

This table presents difference-in-difference estimates of the following equation: $Y_{it} = \alpha + \beta \text{Post } 1_t \times \text{Exposure}_c + \gamma \text{Post } 2_t \times \text{Exposure}_c + \delta_1' \mathbf{X}_{it} + \delta_2' \mathbf{X}_{ct} + \eta_i + \eta_{NERC} + \eta_t + \varepsilon_{it}$. NERC Region is the primary North American Electric Reliability Corporation region that regulates the utility. The outcome variable, *Power Outage (Minutes)*, is measured using the System Average Interruption Duration Index, calculated as the average minutes of power outage a utility customer experiences in a year. Column (1) and (2) include the sample of publicly-owned utilities. Column (3) and (4) include the sample of investor-owned utilities. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *Log Highest Distance Voltage* is the natural logarithm of the highest voltage in the electricity distribution system. *Log Number of Customers* is the natural logarithm of the number of customers served by the utility. *Log Number of Bank Branches* is the natural logarithm of the number of bank branches in a county. *Unemployment Rate* is the county unemployment reported by the Bureau of Labor Statistics, lagged for one period. *State Personal Income Tax Rate* is the maximum personal income tax rate in a state. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	Power Outage (Minutes)	
	Public Utilities	Private Utilities (Placebo)
	(1)	(2)
Post 1 × Exposure	40.967***	8.302
	(15.593)	(10.269)
Post 2 × Exposure	35.183	52.397
	(65.290)	(52.352)
Log Highest Distance Voltage	-109.594***	-130.841***
	(21.599)	(11.551)
Log Sales Per Capita (Megawatthours)	271.146**	260.905***
	(114.941)	(57.264)
Log Number of Bank Branches	-4.474***	-1.549**
	(1.357)	(0.788)
Unemployment Rate (Lag)	-3.264	-0.026
	(2.256)	(0.657)
State Personal Income Tax Rate	-6.242	-94.060***
	(10.441)	(13.478)
Log Income Per Capita (Lag)	-23.074***	-0.251
	(8.172)	(4.162)
State and County Controls	Yes	Yes
Utility FE	Yes	Yes
Year FE	Yes	Yes
NERC Regioin FE	Yes	Yes
Number of Obs.	10,603	8,147
Adjusted R^2	0.36	0.36

Appendix

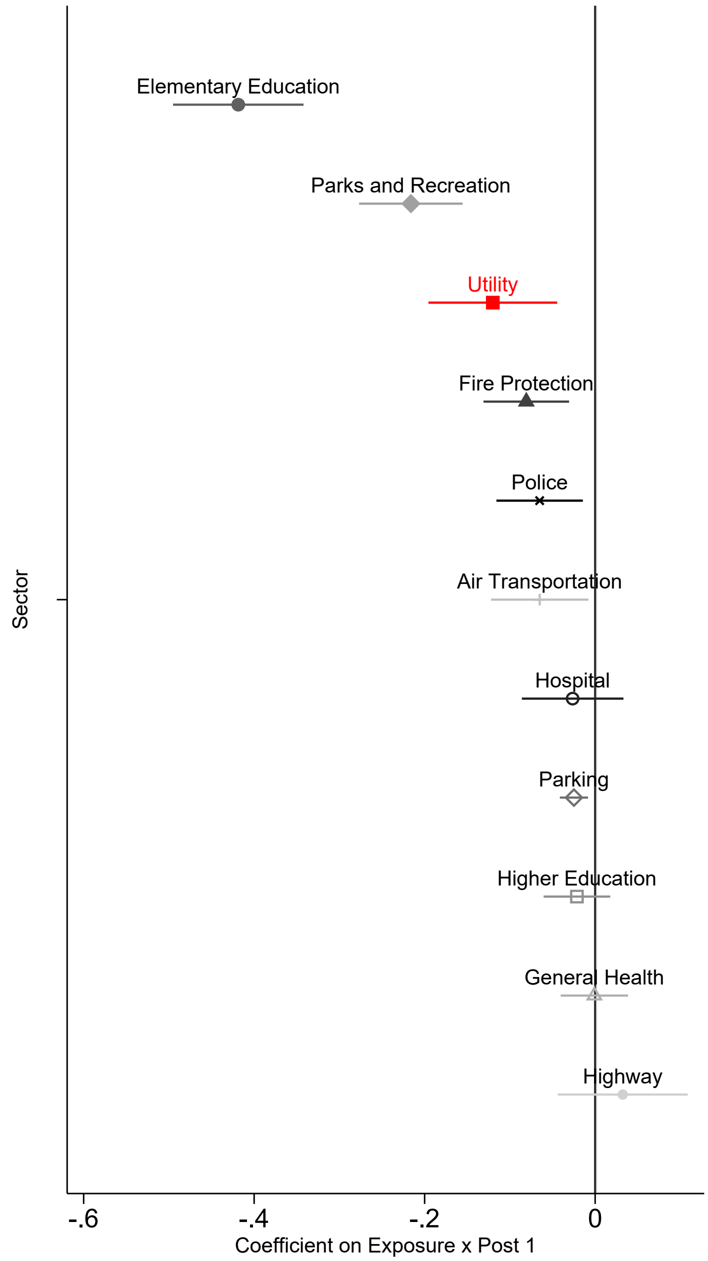

Figure A1: Which public sectors take larger hits?

This figure displays the difference-in-differences estimates for different public investment sectors and two-tailed 95% confidence intervals based on standard errors clustered at the county level. I plot the coefficient on *Post 1* $\times$ *Exposure* for each sector of spending. Sector names are displayed above each coefficient marker. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. For each sector, the investment spending is measured on a per capita basis.

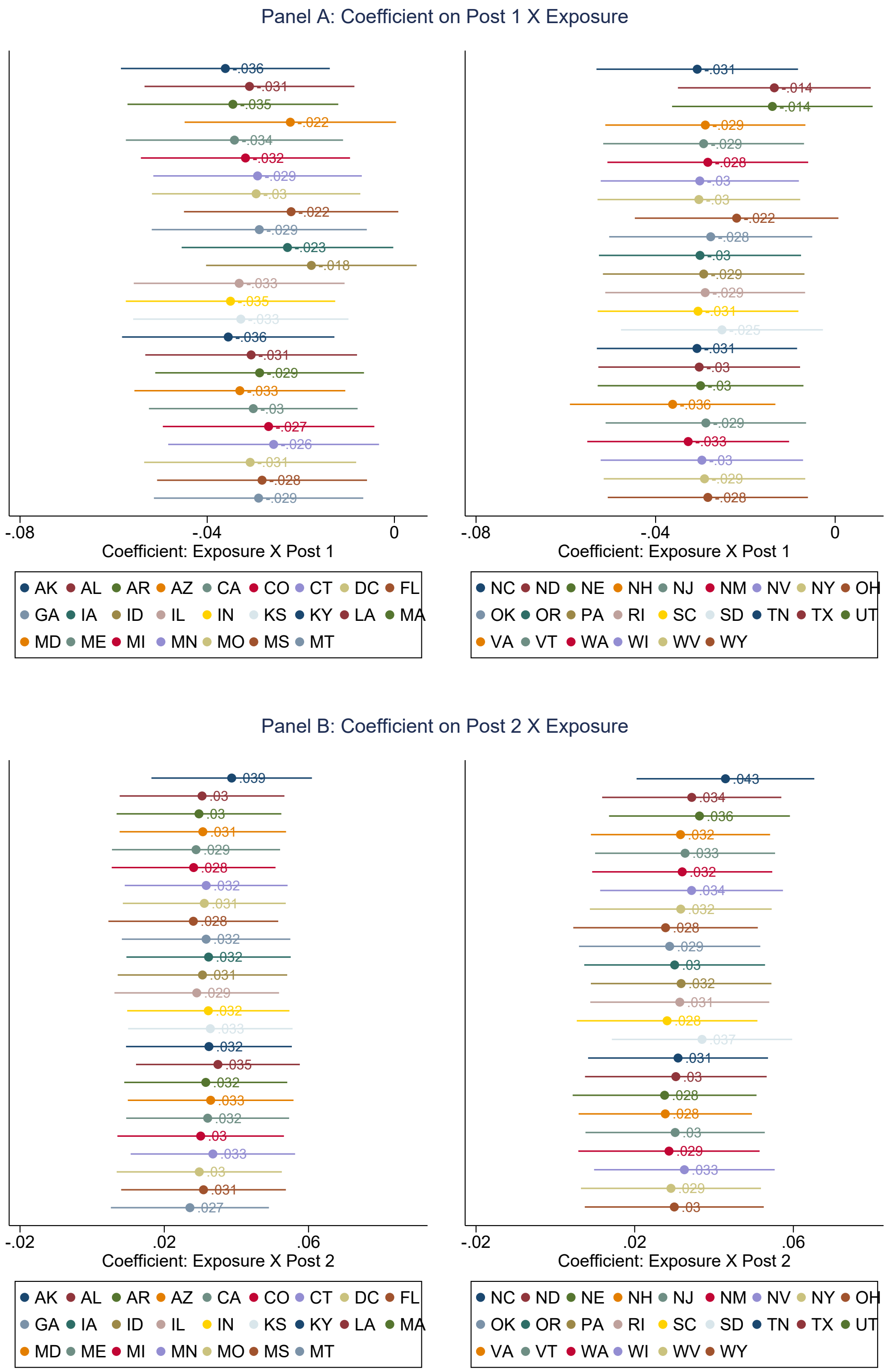

Figure A2: Excluding One State at A Time

This figure examines the sensitivity of my estimate by plotting the coefficient on *Exposure* X *Post 1* (Panel A), *Exposure* X *Post 2* (Panel B), and their 95% confidence intervals after removing one state from the sample at a time and re-estimating the specification. The legend displays the state that is removed from the sample for each coefficient estimate. The outcome variable is the natural log of total public spending. The regression specification is the same as the one used in Table 5 Column (1). Standard errors are clustered by county.

Table A1: Effect on New Construction vs Maintenance and Purchase of Existing Structure

This table presents effects of the credit shock on two types of investment spending. *Log New Construction Per Capita* is the natural log of per capita spending on the construction of buildings, grounds, and other improvements. *Log Existing Structure Maintenance and Purchase* is the natural log of per capita spending on the purchase of equipment, land, and existing structures, and the additions, replacements, and major alterations to fixed works and structures.*Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. Additional control variables include *Log Number of Bank Branches, Unemployment Rate (Lag),* and *State Personal Income Tax Rate*. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	(1) Log New Construction Per Capita	(2) Log Existing Structure Maintenance and Purchase
Post 1 × Exposure	-0.470***	-0.148***
	(0.079)	(0.045)
Post 2 × Exposure	0.084	0.093**
	(0.091)	(0.045)
State and County Controls	Yes	Yes
County FE	Yes	Yes
Year FE	Yes	Yes
Number of Obs.	40,740	40,740
Number of Counties	2,910	2,910
Adjusted R^2	0.52	0.64

Table A2: Local Government-Level Regressions: Heterogeneity by Bank Reliance

This table studies the effect of the credit supply shock at the local government level, and estimates heterogeneous effects based on local government ex ante reliance on bank credit. In Column (1), the sample includes all local governments that are matched from the SDC database to the Census government finance database with a matching score of above 0.95. In Column (2), the matching score is restricted to be above 0.99. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *Ex Ante Reliance on Bank Financing* is the fraction of total municipal bond issuance by a local government that is bank-qualified in the 5 years prior to the implementation of the policy (2009-2013). *Log Total Spending* is the natural logarithm of total local government spending. *Log Investment Spending* is the natural logarithm of the local government capital expenditures. *Log Current Operation Spending* is the natural logarithm of local government expenditures for employee wages and supplies, materials, and non-capital outlay contractual services. Additional control variables include *Log Number of Bank Branches, Unemployment Rate (Lag),* and *State Personal Income Tax Rate*. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	Log Total Spending Per Capita	
	Matching Score > 0.95	**Matching Score > 0.99**
	(1)	(2)
Post 1 × Exposure × Ex Ante Reliance on Bank Financing	-0.125***	-0.189***
	(0.019)	(0.038)
Post 2 × Exposure × Ex Ante Reliance on Bank Financing	0.008**	0.021**
	(0.003)	(0.008)
County X Year FE	Yes	Yes
Controls and Lower Order Interactions	Absorbed	Absorbed
Number of Obs.	90,874	31,990
Number of Counties	1,446	679
Adjusted R^2	0.52	0.44

Table A3: Robustness: Alternative Specification and Samples

In this table I re-estimate the main effects in Table 5 using different specifications and subsamples. In Panel A, I add the second and third degree polynomial terms of all control variables. Panel B excludes counties in states that are at the top decile of exposure distribution. The states include AZ, DC, NV, DE, AK, UT, ID, MD, VA, NC, and CA. In Panel C, I exclude the Great Recession years from 2007 to 2009. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Post 1* is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. Additional control variables include *Log Number of Bank Branches, Unemployment Rate (Lag),* and *State Personal Income Tax Rate*.***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	(1)	(2)	(3)
Panel A: Add Nonlinear Control Variables			
	(1)	(2)	(3)
	Log Total Spending Per Capita	Log Investment Spending Per Capita	Log Current Operation Spending Per Capita
Post 1 × Exposure	-0.023**	-0.251***	0.010
	(0.010)	(0.044)	(0.009)
Post 2 × Exposure	0.025**	0.082*	0.033***
	(0.010)	(0.047)	(0.007)
State and County Controls	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of Obs.	40,740	40,740	40,740
Number of Counties	2,910	2,910	2,910
Adjusted R^2	0.93	0.59	0.96
Panel B: Exclude Highest Exposure States			
	(1)	(2)	(3)
	Log Total Spending Per Capita	Log Investment Spending Per Capita	Log Current Operation Spending Per Capita
Post 1 × Exposure	-0.040***	-0.348***	0.007
	(0.011)	(0.051)	(0.010)
Post 2 × Exposure	0.040***	0.106*	0.047***
	(0.011)	(0.058)	(0.007)
State and County Controls	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of Obs.	37,198	37,198	37,198
Number of Counties	2,657	2,657	2,657
Adjusted R^2	0.93	0.58	0.96
Panel C: Exclude Financial Crisis Years			
	(1)	(2)	(3)
	Log Total Spending Per Capita	Log Investment Spending Per Capita	Log Current Operation Spending Per Capita
Post 1 × Exposure	-0.029***	-0.302***	0.009
	(0.009)	(0.043)	(0.008)
Post 2 × Exposure	0.026***	0.090*	0.033***
	(0.010)	(0.046)	(0.007)
State and County Controls	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of Obs.	32,010	32,010	32,010
Number of Counties	2,910	2,910	2,910
Adjusted R^2	0.93	0.60	0.96

Table A4: Main Effects Using a Placebo Treatment Year and Placebo Treatment Exposure

In this table I conduct placebo tests in which I use an alternative treatment year and an alternative bank asset threshold. In Panel A, I define *Placebo Post* as an indicator for years on and after 2012. I drop years on and after 2014, the year of LCR implementation. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement (assets above $50B). In Panel B, *Placebo Exposure* measures the deposit share of local banks that have assets above $10B. textitPost 1 is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *Log Total Spending* is the natural logarithm of total local government spending. *Log Investment Spending* is the natural logarithm of the local government capital expenditures. *Log Current Operation Spending* is the natural logarithm of local government expenditures for employee wages and supplies, materials, and non-capital outlay contractual services. Additional control variables include *Log Number of Bank Branches, Unemployment Rate (Lag),* and *State Personal Income Tax Rate*. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

Panel A: Placebo Treatment Year			
	(1) Log Total Spending Per Capita	(2) Log Investment Spending Per Capita	(3) Log Current Operation Spending Per Capita
Placebo Post × Exposure	-0.015	-0.072	0.003
	(0.009)	(0.048)	(0.007)
State and County Controls	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of Obs.	26,190	26,190	26,190
Number of Counties	2,910	2,910	2,910
Adjusted R^2	0.94	0.62	0.97
Panel B: Placebo Treatment Threshold			
	(1) Log Total Spending Per Capita	(2) Log Investment Spending Per Capita	(3) Log Current Operation Spending Per Capita
Post 1 × Exposure	-0.052***	-0.221**	0.012
	(0.020)	(0.107)	(0.023)
Post 1 × Placebo Exposure	0.016	-0.095	-0.005
	(0.017)	(0.091)	(0.021)
Post 2 × Exposure	0.034*	0.075	0.043**
	(0.019)	(0.105)	(0.018)
Post 2 × Placebo Exposure	-0.005	0.007	-0.004
	(0.017)	(0.091)	(0.017)
State and County Controls	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of Obs.	40,740	40,740	40,740
Number of Counties	2,910	2,910	2,910
Adjusted R^2	0.93	0.59	0.96

Table A5: Main Effects Controlling for Bank Capital Ratios

This table presents difference-in-difference estimates of the main effects controlling for average bank risk-based capital ratio in a county. *Average Risk-Based Capital Ratio* is the total risk based capital as a percent of risk-weighted assets averaged across all banks in a county in a given year. It is weighted by bank deposit and lagged for one period. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. textitPost 1 is an indicator for years after 2014, the year of LCR implementation in US. *Post 2* is an indicator that takes a value of one after the proposal of the second amendment to the LCR rule in 2017. *Log Total Spending* is the natural logarithm of total local government spending. *Log Investment Spending* is the natural logarithm of the local government capital expenditures. *Log Current Operation Spending* is the natural logarithm of local government expenditures for employee wages and supplies, materials, and non-capital outlay contractual services. Additional control variables include *Log Number of Bank Branches, Unemployment Rate (Lag),* and *State Personal Income Tax Rate*. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

	(1) Log Total Spending Per Capita	(2) Log Investment Spending Per Capita	(3) Log Current Operation Spending Per Capita
Post 1 × Exposure	-0.041***	-0.315***	-0.001
	(0.010)	(0.043)	(0.009)
Post 2 × Exposure	0.023**	0.087*	0.030***
	(0.010)	(0.046)	(0.007)
Average Risk-Based Capital Ratio (Lag)	-0.002***	-0.007***	-0.001**
	(0.001)	(0.003)	(0.000)
State and County Controls	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of Obs.	40,740	40,740	40,740
Number of Counties	2,910	2,910	2,910
Adjusted R^2	0.93	0.59	0.96

Table A6: Effect of Credit Supply Reduction on Education Outcomes

In Panel A, the outcome variable is the standardized test score of English Language Arts for students in grades 3 through 8. In Panel B, the outcome variable is standardized test score for Math. *Exposure* is a continuous variable that measures the deposit share of local banks that are subject to the LCR requirement. *Post 1* is an indicator for years after 2014. Because the test score data only cover years 2009-2016, I cannot estimate coefficients on the interaction term *Post 2* × *Exposure*. . Additional county control variables include *Log Number of Bank Branches* , the natural logarithm of the number of bank branches in a county; *Unemployment Rate*, lagged for one period; and *State Personal Income Tax Rate*, the maximum personal income tax rate in a state. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors, adjusted for clustering at the county level, are reported in parentheses.

Panel A: English Language Arts Grade

	(1) Grade 3	(2) Grade 4	(3) Grade 5	(4) Grade 6	(5) Grade 7	(6) Grade 8
Post 1× Exposure	0.002	0.003	0.004	-0.000	-0.005	0.010
	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
State and County Controls	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	20,761	20,806	20,763	20,594	20,484	20,324
Number of Counties	2,868	2,866	2,861	2,865	2,866	2,870
Adjusted R^2	0.77	0.79	0.80	0.80	0.80	0.80

Panel B: Math Grade

	(1) Grade 3	(2) Grade 4	(3) Grade 5	(4) Grade 6	(5) Grade 7	(6) Grade 8
Post 1× Exposure	-0.005	-0.008	-0.003	0.013	-0.010	-0.025*
	(0.013)	(0.013)	(0.013)	(0.012)	(0.013)	(0.015)
State and County Controls	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	20,541	20,570	20,137	20,036	18,409	17,211
Number of Counties	2,868	2,865	2,813	2,816	2,777	2,769
Adjusted R^2	0.75	0.77	0.78	0.80	0.83	0.82