Debt and Water: Effects of Bondholder Protections on Public Goods

Kelly Posenau*

November 12, 2021

Link to Current Version

Abstract

How do creditors influence the quality of local public goods through municipal debt contracts? I examine this question in the context of municipal water utility debt covenants. As utilities approach their covenant violation thresholds, they increase prices. But, utilities also reduce hiring growth and reduce manager pay. I also find that officials sequence their budget decisions according to a pecking order hierarchy: they raise revenues as much as possible, then cut spending. The incidence of cuts is first on water system expenses and then on administrative expenses. System problems and pipe breaks are most sensitive to distance to covenant thresholds for the most constrained utilities. These utilities respond on a per capita basis to a \$1 move toward covenant thresholds by raising revenues \$.26, cutting water system expenses \$.19, and reducing administrative expenses \$.13. I confirm the pecking order using a drought shock to water demand: covenant-constrained utilities raise prices 9% relative to unconstrained utilities following the shock. Local hostility to taxes imposes an additional friction on the revenue-raising process. After accounting for tax hostility following the drought shock, the overall effect of the rate covenant for an average covenant-constrained utility is a 9.5% reduction in water system expenses.

I am grateful to my dissertation committee Anil Kashyap (chair), Jessica Jeffers, Amir Sufi, and Eric Zwick for their guidance and support. I would also like to thank Vera Chau, John Heilbron, Alexander Herman, Agustin Hurtado, Yueran Ma, Scott Nelson, Ana-Maria Tenekedjieva, Constantine Yannelis, Anthony Zhang, and the participants in the financial workshops at Chicago Booth. I gratefully acknowledge Atlas Investment Research and the Fama-Miller Center for Research in Finance at the University of Chicago Booth School of Business for the use of the Atlas Muni Data.

*University of Chicago, Booth: kposenau@chicagobooth.edu

1 Introduction

State and local governments in the United States are responsible for the provision of essential services like water and wastewater treatment to millions of people. These services have important public health benefits: the development of municipal public water systems and the advancement of filtration and chlorination technologies have contributed to the decline of mortality rates, particularly for children (Alsan and Goldin, 2019; Cutler and Miller, 2005; Anderson et al., forthcoming). But the interaction of stressed municipal budgets and deteriorating infrastructure can have disastrous consequences, as seen in the drinking water crisis in Flint, Michigan. While economists understand Flint to be a "shocking aberration" in the context of healthy municipal water systems (Glaeser and Poterba, 2020), there are multiple accounts of fiscal stress, disinvestment, deferred maintenance, and neglected infrastructure.[1]

In the aftermath of the Great Recession, local governments contended with both sharp contractions in revenue and large outstanding on- and off-balance-sheet liabilities. These trends have inspired a growing literature exploring how state and local government financial structure might affect the provision of public goods. For example, debt market frictions can affect public sector infrastructure investment and lead to a deterioration in services (Adelino et al., 2017; Dagostino, 2019; Li, 2020; Agrawal and Kim, 2021). Another strand of the literature predicts that growing off-balance sheet pension liabilities will cause future budget crises (Novy-Marx and Rauh, 2011, 2014; Myers, 2021). Yet, no work to date considers how creditors specifically shape the quality of local public goods.

This paper examines whether creditors exert influence over the provision of a public good, clean drinking water, through debt contract covenants. Municipal water utilities grant a lien on streams of revenues from the water operation as collateral in order to finance improvements to infrastructure. To protect the value of this lien, water debt contracts feature a "rate covenant". The rate covenant is a contractual promise to set rates and fees in order to meet a minimum debt service coverage ratio (the covenant threshold) on an annual basis. Not only is the rate covenant ubiquitous in municipal water utility bonds, but this covenant is also a key creditor protection in municipal debt contracts that finance infrastructure improvements in sewer, electricity, hospitals, nursing homes, and parking garages, among other sectors.

I document that rate covenants serve as an important fiscal constraint on local government water

[1] An incomplete list of urban water systems that struggle to provide safe drinking water include: Chicago, IL, which has more lead service pipe lines than any other city; Jackson, MS, which has had continued problems with lead pipes and harmful contaminants; Newark, NJ, whose water system is contaminated with illegal levels of lead. Rural water systems with failing groundwater wells are also at risk: Turlock and Ceres, CA, which have struggled for 30 years to build a water treatment facility to replace degrading wells; Bethany, OK, which is facing a water supply crisis due to contaminated groundwater wells.

utilities, similar to other limits on governments like balanced budget amendments and spending limits. As utilities approach covenant thresholds, I find evidence of fiscal discipline: revenue growth rates are higher and administrative budgets are trimmed. These budget effects flow through to operational outcomes: utilities increase prices, reduce hiring growth, and reduce premiums paid to managers as they approach thresholds. The reduction of manager wage premiums in particular point to improved business practices and reduced rent-seeking. However, I also find that utilities trade off price increases against spending cuts on the water system and administrative expenses in a "pecking order" hierarchy. Following fiscal shocks, utilities increase prices and raise revenues as much as possible, subject to political and legal limits on rate increases. More constrained utilities reduce spending on the water system, including items like treatment and maintenance expenses. I find that cuts in the administrative budget are most dramatic for the most constrained utilities. It is also in this region of the distribution where manager wages are reduced. Furthermore, I find consequences of sacrificing water system spending: the most constrained utilities have accelerating system problems as they approach covenant thresholds. This results in larger year-over-year changes in water system problems, including pipe breaks and water outages.

To analyze how creditor protections like the rate covenant affect government operational decisions, I collect extensive data for a sample of more than 600 California municipal water utilities. This dataset includes information on water utility bond issues, covenant thresholds, debt service, revenues, expenditures, employment, wages, gallons of water sold, and system problems, which include pipe breaks, system outages, and boil water orders. Using the financial data, I construct a period-by-period proxy for the tightness of the utility's rate covenant, which is a normalized measure of the distance of a utility's debt service coverage ratio to its rate covenant's specified threshold.

I first document that the rate covenant thresholds are binding for utilities by demonstrating discrete changes in budget decisions following first-time violations. Violations are usually preceded by declining revenues growth rates, which recover and are on average 6.4% higher post-violation.[2] I confirm this result by separately collecting data on the dates of water rate increases for a subsample of city violations. Of these violations, I find that 71% are followed by the passage of rate increases within 3 years, with half of these occurring within the first year. Moreover, I find that operations and maintenance (O&M) expense growth rates sharply decline by 9.9% following a rate covenant violation, staying persistently below pre-period growth rates. I use this fact to motivate the main analysis, which uses the violation

[2] A first-time rate covenant violation is usually not considered an event of default. In general, bond indentures specify that water utilities must hire a consultant to evaluate rates and fees and propose changes. An event of default only takes place if a water utility fails to do this and fails to meet a lower threshold (usually 100%) the following year. Thus, the period following a covenant violation is one in which utilities should be more responsive to the tightness of their covenants.

threshold as a salient reference point for utilities' operational decision-making.

The main analysis exploits variation in covenant tightness resulting from shocks to the financials of utilities. I use the full sample of utility-year observations in a panel regression to measure how utilities adjust their budgets and operations as they approach their covenant thresholds, using within-utility and within-year variation and controlling for the county unemployment rate. The conceptual experiment that this approach approximates is one that randomly assigns a binding rate covenant. My design compares utilities that are more likely to violate their rate covenants in a given year to utilities that are less likely to violate, using random shocks that push utilities closer to or farther away from their thresholds.

The major challenge of the research design is that covenant tightness is not randomly assigned. There are two ways this could threaten identification. First, covenant tightness may be related to institutional skill or management deficiencies of the utility, which are correlated with the overall fiscal health of the utility. Assuming that these features are time-invariant, I account for this source of bias using utility-level fixed effects. Second, the water demand that drives variation in distance to the threshold may be correlated with time-varying local economic conditions that feed through to the general health of the local public sector. The benefit of my setting is that the revenue source of water utilities is limited geographically, so it is possible to control for these confounding forces more explicitly. I demonstrate in the main analysis that results are robust to including county-year fixed effects. Using the δ test statistic of Oster (2019), I show that the influence of unobservables would need to be between 1.75 and 9 times the influence of observable factors in order for the treatment effects I estimate to be zero.[3] I also use California water conservation standards during the 2012-2016 droughts as an exogenous shock to large, urban water utility budgets through a decline in water sales revenues. The drought experiment suggests that the main estimates of the effect of rate covenants on prices is understated. Although I find no effect on expenses overall, I find evidence of spending cuts following the drought shock that vary with the tax hostility of a utility's service population, but only for the most rate-covenant constrained utilities. The evidence suggests that rate covenants affect the budget and operational decisions of water utilities.

My main result is that utilities are sensitive to the covenant tightness measure even when not in violation of covenants. I show that previous year covenant tightness is significantly associated with year-over-year changes in revenues, prices, and O&M expenses. A standard deviation increase in covenant tightness is associated with a 3.2% increase in prices and a 2.9% increase in gross revenues.

[3] This is the range of positive δs that I calculate across all specifications. In one specification, I find a large and negative δ, meaning that unobservables would need to be negatively correlated with the treatment variable in order to explain away the results.

The increase in O&M expenses is driven by all categories, although administrative expenses display the highest sensitivity to previous period of covenant tightness, at 5.2%. I also find that utilities reduce employment growth by 1.5% and reduce the premium paid to administrators by about 2.9 percentage points per a standard deviation increase in covenant tightness.

Next, I test how public officials sequence these decisions. I examine how the elasticity of the operational outcomes to covenant tightness changes when utilities are at different terciles in the covenant tightness distribution. The intuition for these tests is that a changing elasticity demonstrates changing public official preferences for different budget levers. Low priority items, those that are less personally costly for officials to adjust, are likely to be those budget items that are *more* sensitive to covenant tightness *further* away from the covenant violation threshold. High priority items are likely to be more inelastic to covenant tightness.

I find evidence of a distinct pecking order to how water utilities implement fiscal adjustment. Utilities in the bottom, middle, and top terciles all respond to approaching covenant thresholds by increasing prices and revenues. The middle and top terciles, which are the more constrained utilities, are more sensitive to shocks to covenant tightness than the bottom, but coefficients are similar across all groups. However, I find notable differences between the terciles on the expense side. The middle and top terciles are more sensitive to approaching covenant thresholds than the bottom tercile for expenses on the water system, primarily treatment, transmission, and distribution expenses. The top tercile's administrative expenses are significantly more sensitive to covenant tightness than the bottom two terciles. This suggests the following order of adjustment: revenues, water system treatment and maintenance expenses, then administrative overhead. I calculate that the most constrained utilities respond to a $1 move towards covenant thresholds by raising revenues $.26, cutting water system expenses $.19, and reducing administrative expenses $.13, on a per capita basis.

I also compare the elasticity of real outcomes to covenant tightness for the three terciles, to rule out that a mechanical mean reversion effect is driving budget results. Confirming the sensitivity of administrative expenses to tightness for the top tercile, I find that the most constrained group's manager wages and employment growth are all significantly related to covenant tightness and drive the overall results. I also find that in the top tercile of covenant tightness, the most constrained utilities' yearly growth in system problems are significantly positively related to covenant tightness. System problems, which include pipe breaks and water outages, accelerate in this region of the tightness distribution. A standard deviation increase in covenant tightness is associated with a yearly increase of 4 system problems per 10 thousand people. This is a sizeable yearly increase, given that system problems are on average decreasing at a rate of .36 problems per 10 thousand people. Outside of the constrained region of the distribution, system problems are weakly decreasing as utilities approach thresholds. These findings suggest that cuts to the water system at less constrained points of the distribution have important real effects on the overall health of the water system.

I confirm the pecking order of fiscal adjustment using the enactment of California water conservation mandates during a drought emergency as an exogenous shock to water utility budgets. California experienced a severe drought between 2012 and 2016, with a statewide emergency declared in January 2014. Large urban water suppliers were first called to voluntarily reduce water consumption in June 2014. A mandated state-wide cut in residential water usage of 25% followed the next year. This led to a large shock to municipal water utility sales revenues during the years that the drought restrictions were in place, which was not driven by unobservable local economic conditions. The conceptual research design compares two utilities that are subject to the same drought shock, but one utility is pushed closer to the violation threshold. I sort water utilities into treated and control units based on how tight their covenant constraint is in the period leading up to the drought restriction. Treated utilities are those with a covenant tightness measure in the top 50% of the the distribution of urban water suppliers. In order to control for additional demand effects or exposure to the drought supply shock, I also include time-varying county fixed effects.

I find that more constrained utilities raised prices by 9% relative to unconstrained utilities following the drought shock. Moreover, I find that a standard deviation increase in pre-period covenant tightness is associated with a 5.5% increase in prices, which is greater than the OLS estimates in the main analysis. I find little evidence that constrained utilities cut expenses per million gallons of water delivered compared to unconstrained utilities; however, this effect masks important heterogeneity in the ability of the water utility to sufficiently raise revenues. When I include an interaction term that accounts for the water utility service area populations' general antipathy toward tax increases (which I refer to as the "tax hostility index"), I find that more constrained utilities in areas that are more hostile to tax increases reduce prices less and cut expenses more than utilities in less tax-averse areas. Moreover, the incidence of spending cuts for constrained utilities in tax-hostile areas is on water system expenses, rather than administrative expenses. After accounting for political frictions in utilities' revenue-raising abilities, I find that the overall spending response of an average rate covenant-constrained utility is a reduction in O&M expenses of 2.9% and water system expenses of 9.5%. This effect is consistent with the first two levers in the pecking order theory: constrained utilities raise prices, and then cut expenses on the water system in response to large shocks.

The composition of budget cuts when utilities are close to covenant thresholds points to the role of creditor influence on the quality of public goods. On the one hand, a binding constraint on a social-welfare optimizing government will distort spending choices away from optimal public good provisions. However, tighter covenants could improve fiscal discipline when public officials have incentives to shirk and elections are an ineffective disciplinary mechanism (Besley, 2006). In this setting, tight budget constraints reduce the amount of rents that can be extracted. I find evidence for both channels: officials reduce administrative overhead, but are most sensitive to approaching covenant thresholds only when very constrained. Budget cuts that directly affect water system quality occur in the unconstrained part of the distribution, resulting in increasing system problems when utilities are very constrained.

Related Literature

This paper's primary contribution is to bridge the gap between the literature on creditor control rights in corporate debt and public finance. This is the first paper to my knowledge to study covenants in municipal bond debt contracts. I illustrate how bondholder protections and debt covenants can constrain municipalities following fiscal shocks. This reflects similar findings in the corporate literature on debt covenants (Chava and Roberts, 2008; Nini et al., 2009; Falato and Liang, 2016). Despite having a financial ratio threshold, rate covenants do not trigger a renegotiation of debt contracts. Instead, they protect the value of the lien on revenues by reducing public official discretion over budgets on an ongoing basis. The role of covenants is similar to the role of restrictive covenants in the corporate bond setting (Smith and Warner, 1979). As in Green (2019), I demonstrate how the ex ante transfer of control rights affects borrower outcomes outside of covenant violations. In the water utility case, the rate covenant plays a primary role in both the choice of water rates and forecasts of expenses.

I also study the interaction of restrictive covenants with political agency problems. This leads to interesting new findings on how debt contracts affect government decisions outside of violations and how restrictive covenants may discipline governments. Utilities raise prices and improve their financial health as covenants tighten, suggesting that these contractual constraints serve as an implicit spending limit (Poterba, 1994). As in the theoretical literature that argues for additional restraints on governments when elections fail to discipline self-interested politicians (Besley and Smart, 2007), I find evidence of a disciplinary role for debt covenants. Constrained utilities reduce administrative expenditures as they approach covenant thresholds. However, I also find evidence that these spending limits may be distortionary as well: governments cut expenditures on the water system while preserving their administrative budgets, resulting in more system problems when utilities are very constrained. Finally, the addition of taxpayers in the municipal setting suggests that restrictive covenants may have welfare implications that extend beyond those suggested by traditional agency models in corporate finance.

There has also been an active literature studying the effect of municipal bond issuance on public goods investment (Adelino et al., 2017; Dagostino, 2019; Li, 2020; Agrawal and Kim, 2021). This literature finds that positive credit supply shocks in the municipal bond market expand debt issuance and leads to positive effects on employment and expenditures. Negative credit shocks have the opposite effect and can lead to a deterioration in the quality of public goods. Implicitly, credit supply shocks lower the cost of external finance relative to internally generated cash flows. I also study issues related to the cost of external finance in municipal debt markets, but my contribution is to analyze the effect of outstanding debt contracts on municipal budget decisions, rather than the debt issuance decision. In my paper, budget decisions are driven by shocks that push utilities closer to their covenant thresholds and fiscal frictions, rather than shocks to providers of credit.

2 Institutional Setting

Municipal debt contracts feature creditor protections that allocate control rights in order to preempt conflicts between government borrowers and their lenders. I use the setting of California water utilities to study how these protections affect the quality of publicly provided goods for three reasons. First, municipal water utilities provide an essential local public good, which is the prevention of water-borne disease. Second, California has unique legal restrictions on the ability to raise taxes that makes budget trade-offs following fiscal shocks more distinctive. Third, water utility debt contracts feature a ubiquitous bondholder protection called a "rate covenant" that shapes public official budget decisions. While my analysis focuses on water utility debt contracts, the rate covenant is a common feature in debt contracts that finance many municipal enterprises, including sewer, electricity, hospitals, nursing homes, and parking garages, among others. In this section, I discuss relevant details of the institutional setting, specifically the financial structure and legal environment that characterize water operations.

2.1 California Water Utilities

Water Utilities and their Financial Structure. The provision of safe drinking water is considered to be an essential public good. But water providers are also important participants in commercial, irrigation, and agricultural functions. In California, most of the population receives their drinking water from a municipal water provider.[4] These municipal water utilities are financially operated as an enterprise separate from general government functions, where general government functions are backed by a pool of tax revenues. This financial independence is directly related to the water utility's ability

[4] Kristin Dobbin and Amanda Fencl, "Who governs California's drinking water systems?" UC Davis' Center for Watershed Sciences California WaterBlog, September 9 2019, Available online. Types of governments that have water utilities include cities, counties, and special districts.

to cover the cost of services through user fees and charges, rather than the general government's pool of tax revenues. It also prevents the holders of obligations backed by liens on water utility revenues from seeking repayment from general government funds. The purpose of this financial structure across all providers is to transparently delineate the revenues and costs of operations backed by water user fees from operations that are backed by other taxes and fees.

Water Systems and the Structure of Costs. Water utility operations include two main functions: procuring an adequate supply of water and distributing it to water users. Procurement can involve purchasing surface water (i.e., water from rivers or lakes and reservoirs) from state, federal, or other municipal and private entities. Another common source of water is groundwater, which utilities access using pumping technology. Utilities are also responsible for the delivery of potable water to end-users. Transmission and distribution expenses capture the costs associated with delivery, including everything from routine maintenance of pipes to the cost of electricity to pump water through the system. Some utilities also treat their own potable water supply, making it safe for consumption. Functional water expenses are costs that are directly attributable to the water system. Remaining costs related to the overall operation of the utility are categorized as general administrative and other expenses.

Water Infrastructure Improvements and their Financing. The provision of water is capital-intensive. Robust water infrastructure thus requires both investment in new physical infrastructure (e.g. new pipes) as well as the continued maintenance of existing facilities and infrastructure. Investment can be financed using debt or pay-as-you-go financing, where utilities raise rates slowly over time and tackle a project in pieces. For very large projects, municipal water utilities access tax-exempt financing in the municipal bond market. Because utilities can pay for the costs of service directly from rates and fees collected, their financing arrangements are similarly backed by the revenues of the enterprise itself. Water utility bond indentures provide bondholders both a lien on the revenues of the enterprise, as well as covenants to protect the value of the collateral and going concern of the enterprise. Improvements to the water system can also be financed using alternative municipal debt structures, but these are much less common than the water revenue debt structure due to preferential treatment in bankruptcy and legal limits on other types of debt. I provide more details on the specifics of these bondholder protections in the next section.

Legal Limits on Rates and Fees. Although utilities are monopolistic over their service areas and have independent rate-setting authority, there are important legal and political limits on the ability to raise rates and fees in California. Water utilities' rate-setting ability is limited by Proposition 218, which imposes a non-profit constraint that affects the operational flexibility of utilities by raising the marginal cost of public funds. Passed in 1996, Proposition 218 provides taxpayers the ability to veto proposed increases in ad valorem taxes. Proposition 218 considers water and sewer rates to be an ad valorem tax, so any proposed rate increases must go through the same process of voter approval as any other tax increase in California. Water users also have the opportunity to veto any proposed increase. If a majority of property owners vote to veto the increase, the rate increase initiative will fail. Proposition 218 also requires that rates be proportional to the cost of service. The law requires utilities to demonstrate that any proposed increases meet this standard, often through the preparation of a water rates study conducted by an independent consultant. Although budgets are reviewed annually, most utilities propose changes to water rate structures in multi-year increments due to the administrative burden associated with passing water rate hikes.

2.2 Rate Covenants: Characteristics and Legal Requirements

Description. The most common bondholder protection in revenue debt structures is the rate covenant. Municipal water utilities promise in these covenants to maintain rates and fees in order to meet a minimum debt service coverage ratio. I provide a sample from a water revenue bond official statement in Figure 1, panel 1a. There is usually a "sum sufficient" ratio as well as a covenant regarding net revenues. The "sum sufficient" covenant requires gross revenues to be sufficient to cover operations and maintenance expenses along with debt service (i.e., a coverage ratio greater than or equal to 100%). The net revenue covenants require that net revenues are set so that a debt service coverage ratio exceeds a higher threshold, which is usually 120% but varies across enterprises. Utilities are required to report their coverage ratios annually in their audited financial statements and in new debt issuance disclosure documents. Enforcement of disclosure rules by the Securities and Exchange Commission has increased since 2010.

Comparison to Corporate Debt. Rate covenants are unique from those found in corporate bond or loan contracts, reflecting the unique agency problems in the municipal setting. Debt covenants are designed to alleviate agency conflict between borrowers and lenders by reducing the discretion of managers. Corporate debt contracts generally have affirmative, restrictive, and financial covenants. Financial covenants specify acceptable ranges of accounting ratios, while restrictive covenants restrict pre-specified activities, and affirmative covenants require bondholders to perform certain actions, such as insuring property. The financial covenant thresholds often represent a trigger point for the renegotiation of debt contracts, where lenders can demand immediate repayment and force concessions from borrowers (Chava and Roberts, 2008; Nini et al., 2009). Because of the difficulty of renegotiating public bond contracts, financial covenants are more common in private debt contracts than in public debt contracts. Although borrowers cede control to lenders in contracts using all types of covenants, violations of financial covenants represent a discrete shift in the allocation of control rights to lenders through threats of payment acceleration.

The rate covenant is expressed in the language of an affirmative covenant, compelling utilities to raise rates and fees, but uses a financial ratio threshold in its implementation. While financial covenants are rare in public bond contracts, the rate covenant is ubiquitous in water utility revenue bonds. Unlike a financial covenant in a private debt contract, the rate covenant specifies the specific actions the utility must undertake to maintain the specific financial ratio. A minimum debt service coverage ratio of 120% would be considered relatively loose in the corporate setting, but this ratio is more binding when combined with the nonprofit constraints imposed on municipal utilities by law. Because of the inherent coordination problems from having a diffuse investor base, violations of the rate covenant do not trigger renegotiation of bond contracts.

Consequences of Violations. Covenant violations are considered technical violations, but they do not necessarily imply an event of default. Figure 1, panel 1b shows an example of the responsibilities of a water utility following a rate covenant violation. In this case, the utility can comply with the bond agreement by transferring cash from other funds, if available, or by hiring a consultant to analyze water rates and fees and implement recommended changes. Another common feature in bond indentures is the requirement of meeting a 100% debt service coverage ratio in the fiscal year following the first violation. Entities that do not comply are considered to be in default. After an event of default, bondholders can seek a court action to force the utility to raise rates. Outside of default, utilities respect their rate covenants in order to prevent rating agency downgrades and keep borrowing costs low.[5]

Bond Indenture Coverage Ratios. The coverage ratio used in the rate covenant is defined as:

$$\text{Coverage Ratio} = \frac{\overbrace{\text{Gross Revenues - Operation \& Maintenance Costs}}^{\text{Net Revenues}}}{\text{Revenue Bond Principal and Interest Payments}} \tag{1}$$

Although the calculation of the numerator (Net Revenues) varies across entities, there are common features. Net revenues is defined broadly as Gross Revenues minus Operation and Maintenance Costs. Gross Revenues include all gross income received or receivable from the ownership and operation of

[5] After a rate covenant violation in 2016, S&P downgraded Oxnard's water obligations. The city council explicitly stated the consequences of not raising rates in its agenda report for a April 18, 2017 meeting to discuss proposed water rate increases, available here: "If water rates are not raised, the water enterprise fund soon will not have sufficient revenue to cover expenses beginning this coming fiscal year 2017-2018. The fund will not be able to meet bond coverage requirements which could result in another credit downgrade and increased cost for funding required maintenance projects."

the water utility. This generally includes investment income and excludes grants and other federal or state aid. Operation and Maintenance Costs are defined as the reasonable and necessary costs and expenses paid for maintaining and operating the water utility, excluding depreciation expense and debt service costs. In practice, the calculation of gross revenues can vary across governments. The most common additions/exclusions of gross revenues include: property and ad valorem taxes, connection and developer fees, and transfers from a rate stabilization fund. The debts used in calculating debt service are those obligations that are also backed by a lien on the water utility's net revenues.

3 Data and Summary Statistics

Existing data on water utilities is insufficient to assess the effects of debt contracts and bondholder protections on the quality of local public goods. For example, most public finance datasets that include water utility finances are limited both in coverage and in scope. Moreover, there are no comprehensive datasets on the operations of water utilities. I overcome this challenge by creating a new database of California water utility finances and hand-collected debt contract characteristics. I link this data to water utility wage, employment, and operational data. To my knowledge, this is the first dataset of its kind. In this section, I discuss the data sources, main variables used in the analysis, and how I construct a measure of covenant tightness. More details on the dataset construction are included in Appendix A.

3.1 Sources and Variable Construction

Water Utility Financials. I construct a panel of water utility financial data using California's required reporting of local government finances. Local governments in California are required to file annual Financial Transactions Reports (FTR) by law. FTRs are based on audited GAAP financial statement data (when available) and are available from 2003 to 2019. The data include income statement, balance sheet, cash flow, and fund balance data.[6] I use the water proprietary fund balance schedules to construct a panel of water utility revenues and expenses, including expense categories that align with the water system structure of costs outlined in the previous section.[7] I limit analysis to utilities that report positive operating revenues for all 17 years of data. The final panel includes

[6]Government funds generally rely on modified accrual accounting, where revenues and expenses are booked when cash is received or expended. Modified accrual accounting can lead to important discrepancies from audited financial statements (Ahern, 2021). However, accrual accounting is the standard for proprietary funds and is recommended in the FTR instructions.

[7]Government accounting generally consists of accounting for general government activities (e.g., public safety and recreation) and business-type activities (e.g. utilities and airports), with general government funds and proprietary funds accounting for the revenues and expenses of these respective activities.

622 water utilities.

This dataset has several advantages relative to existing government finance databases, like the Census of State and Local Governments. First, my sample includes more small government entities than what is included in the annual Census of State and Local Governments, which is biased towards larger governments. For example, between 2003 and 2019, the Census data fully covers water utility operations for only 143 entities in California. Second, the fund-level data allows entities to classify operating expenses according to an operating function: water supply and purchases, treatment, transmission and distribution, pumping, customer accounting and collecting, and sales and promotions. Census data only reports aggregate categories and audited financial statements vary depending on the reporter.

I construct outcome variables to replicate bond indenture-specified items or important costs in the operation of water utilities. To proxy for operating and maintenace costs, I define the variable gross operating and maintenance (O&M) expenses as total operating expenses minus depreciation expense. I use total operating revenues plus investment earnings as my measure of gross revenues for cities, and total operating revenues plus investment earnings and property taxes for special districts. My proxy for water prices is water sales revenues per million gallons of water delivered. I construct water source expenses as the sum of pumping and water purchase expenses. I group transmission, distribution, and treatment expenses together as a measure of water retail expenses, because these costs are associated with the delivery of water to customers. I refer to the sum of water source and retail expenses as all functional water expenses.

Outstanding Debt and Debt Service. I construct a panel of outstanding water revenue bonds and debt service using the FTR's bonded debt, other long-term debt, and lease schedules. These schedules include issue-level data on type of debt (Revenue, General Obligation, Lease, Certificates of Participation, etc.), the outstanding amounts at the beginning and end of each fiscal year, principal payments, interest payments, and defeased or adjusted amounts. I use this data to identify outstanding water revenue bonds and then construct revenue debt service in each fiscal year.

With the sample of identified water revenue issues and associated debt service, I hand-match bonds to the California Debt and Investment Advisory Commission (CDIAC) database of debt issues. California requires all municipalities to report debt issuance to the CDIAC, including private placements since 2012. Features of the dataset include the issuer name, type, project, source of revenues pledged, as well as pricing information and the purchaser/lender. The CDIAC also posts the issuance documents for bond issues, although coverage is spotty for bonds issued prior to 2000. Using this database, I collect data on bondholder protections, including details on rate covenants. I link this data to the outstanding debt series in order to create a time series for each utility of outstanding bond requirements.

Wage, Employee, and Operations Data. I collect other data related to the operation of water utilities. Employee wage and benefits data are from the California State Controller's Government Compensation in California for cities and water districts covering the time period 2009 to 2019. This data provides both the department name and position name for all public sector employees in California. I use this to construct the total number of water employees, identify the top administrative officials in each special district and city, and construct median wages. City water employees are rarely located in a separate department that is identifiable and consistent in the data, so I identify department labels that correspond to the water department's "parent" for each city and use these departments names (e.g., public works, public utilities) to calculate the relevant variables. This ensures a consistent time series for the number of department employees and the median base wages, but introduces measurement error because the wages of very few employees in the parent departments can be charged 100% to the water utility. I construct an administrator wage premium from this employment data, calculated as the percentage increase of the general manager or director's base wage over the median employee's base wage.

I also collect data on the number of reported system problems, which includes service connection breaks, main breaks and leaks, water outages, and boil water orders, as well as total water delivered in million gallons. This data is from electronic annual reports (EAR) that all California public water systems are required to file. In addition to system problems, these reports include sources of water supply among other items. The California State Water Resources Control Boards provides this data for the years 2013 through 2019.[8]

Other demographic and county employment data are from the Census, the American Community Survey, and the Bureau of Labor Statistics. Water service area boundaries are from the California State Water Resources Control Board. I use block-group level demographic data to capture the demographic features of water utility users.

3.2 An Empirical Proxy for Rate Covenant Tightness

The main variable in the analysis is a measure of how binding covenants are on an annual basis. I calculate a proxy of covenant tightness, which is motivated by similar work in the literature on corporate loan financial covenants and their "slack" (Dichev and Skinner, 2002; Murfin, 2012; Demerjian and Owens, 2016):

$$\text{Covenant tightness}_{it} = -1 \times \frac{\text{Distance to Threshold}_{it}}{SD(\text{Coverage Ratio})_i} \tag{2}$$

[8] I am in the process of procuring and cleaning data for 2009 to 2012.

The numerator, Distance to Threshold, is derived as Coverage Ratio- Rate Covenant Minimum Coverage Ratio. First, I calculate the bond indenture-specified debt service coverage ratio, using the procedure outlined in the previous subsection. Then, I subtract the rate covenant threshold from the calculated debt service coverage ratio.[9] Finally, I standardize this distance by the standard deviation of the utility-level debt service coverage ratio. Large positive numbers of the tightness measure are associated with a high likelihood of violating a covenant. I winsorize this at the 1 % level.

3.3 Summary Statistics

Summary statistics for the analysis are contained in Table 1. Variation in water source expenses is higher than it is in other expense categories, including water retail and general and administrative expenses. In the analysis, I winsorize all outcome variables at the 1% level, in order to limit the influence of extreme observations. There is also a great deal of variation in the median household income of the population living within a water system's service boundaries.

Only a subset of water utilities have revenue debt outstanding at any one point in time. About 47% of water utilities in the sample do not access municipal bond market financing during the time period. However, the 53% of water utilities that have revenue debt outstanding represent 89% of the total 2010 population of people living within sample service boundaries. The size of the sample in the analysis of covenant tightness varies based on data availability: the largest sample includes 316 utilities; the smallest includes 195.

Summary statistics for covenant tightness are reported at the bottom of Table 1. On average, the utilities with revenue debt are relatively unconstrained: covenant tightness is on average about -.77 standard deviations. About 25% of this sample is relatively constrained, with covenant tightness measures close to 0. Within this sample of debt issuers, the ratio of revenues to expenses is also higher; utilities without debt are constrained by law to charge rates and fees to cover costs of service.

4 Do Water Utilities Comply with their Covenants?

In order to test the effect of creditor protections on the operations of utilities, it is necessary to demonstrate that these covenants truly bind at the violation threshold. But it is not obvious that municipal bond covenants are respected. Municipal debt suffers from the same coordination problem among creditors as corporate bonds. Additionally, rating agencies assess financial data only when new

[9] I find no water revenue bonds without a rate covenant. Therefore, for cases where there is no rate covenant information, due to missing or incomplete issuance documents, I use the sum sufficient threshold of 100%.

issues come to market, so intensive monitoring is largely absent on a recurring basis. On top of these issues, municipal governments are sub-sovereign entities and may be more likely to repudiate their contractual obligations. I attempt to rule out the hypothesis that rate covenants are not binding using two pieces of evidence: bunching in the distribution of covenant tightness at the violation threshold and changes in operating decisions following first-time violations.

Bunching. First, I examine whether there is bunching at the violation threshold. If utilities are indifferent about violating their covenants, I would expect to see a smooth distribution of covenant tightness and no discontinuity at the threshold that triggers a violation. Bunching on one side of the threshold strongly suggests avoidance of violating the rate covenant.

Figure 2 depicts the histogram of covenant tightness, winsorized at the 1% level. I plot utility-year observations where there is a rate covenant outstanding. The x-axis reports the covenant tightness measure, expressed in terms of utility-level standard deviations of the debt service coverage ratio. The y-axis reports the percent of the sample in each bin, with 99% of observations falling within the 6 standard deviations depicted. I have grouped the observations into 30 bins. Most of the mass of the distribution is to the left of zero, representing that most entities are relatively unconstrained. However, entities are in violation of their rate covenant about 23% of the time. Moreover, there is significant bunching in the bin to the left of 0, with a large spike in mass at the (-.2,0] bin. I therefore reject the hypothesis that the covenant tightness distribution is smooth: Figure 2 suggests that utilities are not indifferent about violating their covenant.

Outcomes following violations. Second, I test whether utilities change their behavior following a covenant violation. As reported previously, a covenant violation is only considered an event of default when it is not remedied in the year following the first violation: utilities have a grace period to enact changes and comply with their bond indentures. If utilities are indifferent about violating their rate covenant, post-violation trends in revenues and expenses would reflect pre-violation trends. On the other hand, if the violation is a salient event for utility officials implying consequences, there should be substantial adjustment: utilities would raise fees and rates to increase revenues and potentially curb costs to comply with the minimum debt service coverage ratio.

Using my dataset of water utility finances, I identify a sample of likely first-time covenant violations.[10] Violation years are those in which a utility's coverage ratio tightness measure is above 0. In

[10] Because utilities are technically required to disclose rate covenant violations in their annual financial statements, I could also collect these disclosures as a more direct measure. However, there are disadvantages to this approach. First, the sample of utilities that provide annual financial statements through time is small relative to what is available using accounting data. Second, continuing disclosure rules were improved post-crisis and so pre-2010 audited financial statement availability is limited, particularly for small utilities. Finally, the coverage ratio disclosure section is often unaudited, and may not reflect the audited report of compliance sent to bond trustees.

order to cleanly identify the effects of a first-time violation, I limit analysis to violation years where there no covenant violations in the three years prior. I also only consider violation years that have a full 7 years of data surrounding each violation, which restricts the sample to covenant violations that occur between 2006 and 2016. This leaves 152 violation events, 72 of which are city violations. Approximately 28% of violations occur in fiscal years 2009 to 2011.

A natural question is: why do utilities violate their covenants if they bunch at the violation threshold? There are several reasons why violations happen. Violations may occur if there are management deficiencies and institutional stress. For example, following periods of large turnover in staff, new officials may not be aware of bond indenture requirements or may not be paying attention to financial deficiencies. Dramatic changes in water usage patterns also precipitate violations. Following the financial crisis, utilities that had anticipated large amounts of housing development and pledged developer fees were no longer able to depend on that income. In California, drought shocks to water supply also dramatically change water usage: utilities institute mandatory reductions in consumption, leading to large drops in revenues. Finally, utilities may be unable or unwilling to raise prices sufficiently. This occurs when voters veto rate increases. However, it can also occur when public officials are pressured by political interest groups.

Following a covenant violation, water utilities can comply with their contractual obligations through the use of reserves or by hiring an independent consultant to design water rate increases. I collect data on historical water rate increases for the sample of city violators using bond disclosure documents, local news sources, EAR public water system reports, and city websites. To rule out automatic yearly increases, I collect the dates of rate increases that are associated with a water rate study, Proposition 218 hearing, and/or city resolution. When available, I collect the date of the city council protest hearing; otherwise, I collect the effective date of the rate increase. I am able to find historical data for 62 out of 72 cities, although there is limited coverage before 2010. Of these 62 violations, I find that 71% of cities increase water rates in the three years following a rate violation.[11] 52% of these 44 increases are passed within the first year of a violation. Thus, most of the identified city covenant violations are followed by actions to increase rates and fees. Other utilities meet their requirements by relying on fund reserves, and put off rate increases for future dates.

Given that the majority of cities raise fees within 3 years following a covenant violation. I present graphs of both the year-over-year change in log gross revenues and O&M expenses in the three years and changes in the log of each outcome before and three years after a covenant violation in Figure 3.

[11] I include the second half of the same fiscal year, because a proposition passing in May or June of the year of a rate covenant violation is most likely addressing the current year's budget stress.

These graphs plot the coefficients β_k from the following regression specification, which is at the utility i, county j, fiscal year t, time since covenant violation k level:

$$\Delta(Y_{ijtk}) = \gamma_i + \delta_t + \beta_k + \psi X_{jt-1} + \varepsilon_{ijtk} \tag{3}$$

Y_{ijtk} denotes the log of the outcome of interest. I include both utility-level fixed effects γ_i to account for unobservable time-invariant features of utility and fiscal-year fixed effects δ_t to account for the macroeconomic environment. I also include the lagged county-level j unemployment rate to account for any time-varying changes in the local economic environment. β_k thus has the interpretation of the average growth rate at each period k since the covenant violation. $k = 0$ represents the fiscal year of the violation, while $k \in [-3, -1]$ represents the fiscal years prior to covenant violation, and $k \in [1, 3]$ represents fiscal years following the covenant violation. All coefficients in the graph are presented with respect to a base period of the year of first violation. Standard errors are clustered at the utility level and I present 95% confidence intervals around the point estimates.

For ease of exposition and to rule out small effects, I also include the average post-violation changes in revenue and expenses growth rates in Table 2. This table presents estimates β_{post} from the following regression:

$$\Delta(Y_{ijtk}) = \gamma_i + \delta_t + \beta_{post} 1_{k>0} + \psi X_{jt-1} + \varepsilon_{ijtk} \tag{4}$$

Note that the only difference between this specification and the previous one is that the variable of interest is $1_{k>0}$, which is an indicator variable that switches on if the observation occurs in a period k following the covenant violation. Standard errors are still clustered at the utility level.

Following a covenant violation, gross revenues growth rates are on average 6.4% higher (reported in the first column of Table 2). The top panel of Figure 3 depicts the dynamics of revenues in the pre- and post-violation periods. The growth rate between periods -3 and -2 are constant, reflecting increasing revenues in the two to three years before a violation. In the year preceding the covenant violation, the growth rate of revenues slows before significantly dropping in the year of the violation. Following the covenant violation, revenues recover and increase at pre-violation levels. In levels, revenues collapse between periods -2 and 0, and steadily increase in periods 1 through 3. The top panel suggests that covenant violations are driven in part by a decline in revenue growth. Extrapolating the trend into the post period would put utilities on a path of declining revenues. Instead, the sharp return to previous period growth upwards in the year following a violation is consistent with raising revenues and complying with contractual requirements.

Although the rate covenant is specified as a requirement to set rates and fees, the presence of a minimum debt service coverage ratio incentivizes utilities to curb costs in order to avoid implementing unpopular high rate increases. I test whether utilities' expenses continue their pre-violation trajectory following a rate violation in the bottom panel of Figure 3. As with revenues, I interpret a sharp adjustment downward as evidence against the null hypothesis that rate covenants are inconsequential. Following a violation, there is a large negative adjustment and growth rates are persistently 9.9% lower. In periods -3 to -1, expenses accelerate: expense growth rates in the period of violation is significantly higher than expense growth rates in periods -3 and -2. In the years following a violation, I find that growth rates are significantly below their period 0 value. Furthermore, they remain significantly below their pre-period values for periods 2 and 3 as well. In levels, these dynamics correspond to increasing expenses up to the point of the violation; after a violation, expenses flatten.

The overall picture of the pre-violation period is one of deteriorating financial health: revenues fall and expenses increase. In contrast to what one would expect if utilities are indifferent about violating their covenants, I find that utilities improve their financial health by increasing revenues and curbing expenses following a violation. The presence of these sharp adjustments away from pre-violation trends suggests that the penalty associated with continued violation of rate covenants following a first-time violation is severe enough that public officials not only raise rates, but also curb costs to ensure future compliance.

5 Characterizing the Budget Trade-offs of Rate Covenants

Public officials raise prices and cut spending as they approach covenant thresholds. Moreover, constrained utilities trade off cuts to maintenance and treatment budgets with administrative expenses and employee wages. To demonstrate these facts, first I draw on insights from the empirical and theoretical literature on budget institutions to motivate two counterfactuals for how a binding rate covenant affects the quality of public goods provision. These two benchmarks depend on preexisting agency conflicts between taxpayers and public officials. I then test how distance to covenant thresholds drives budget decisions and operating outcomes in a panel regression setting by relying on within-utility, within-year variation.

5.1 Setting a Benchmark for Fiscal Adjustment and Spending Cuts

How would public officials respond to a binding rate covenant? There are no existing models that shed light on this question or consider the unique interactions between creditors, public officials, and taxpayers. Moreover, the literature on corporate loan covenant violations views changes in operating decisions and management as the result of a shift in bargaining power to creditors, which is absent from the municipal bond covenant setting (Falato and Liang, 2016). Instead, I argue that rate covenants are similar to fiscal institutions (e.g., balanced budget amendments), which are designed to impose fiscal discipline on local governments when elections are an imperfect mechanism to prevent political rent-seeking. However, budget rules limit operational flexibility following fiscal shocks, particularly when governments have limited ability to raise sufficient revenues (Glaeser, 2013). I rely on empirical work on fiscal adjustment to budget shocks and theoretical work on the role of fiscal institutions to discuss how a binding rate covenant affects the fiscal trade-offs facing water utilities and the conditions under which this has implications for public goods.

The first step of this argument is to note the ways in which rate covenants are similar to fiscal institutions. Fiscal institutions take a variety of forms, but the most prominent rules at the local level are restrictions on deficit financing (balanced budget amendments) and limitations on taxes and expenditures. Balanced budget amendments are most similar to rate covenants for two reasons. First, these rules force governments to exceed a numerical target for their budgets; that is, revenues raised during the current period must be sufficient to cover current period spending. Rate covenants also have a minimum numerical target that utilities must exceed, a debt service coverage ratio. In this case, utility revenues raised during the current period must exceed spending and debt service times a constant, the covenant threshold. Second, balanced budget rules incentivize governments to raise sufficient revenues to cover current period costs. Rate covenants similarly force utilities to increase rates and fees in order to meet projected current period costs.

The second step is to describe the sequence of fiscal adjustment that governments take following fiscal shocks and how fiscal institutions affect this sequence. The empirical literature suggests that governments respond to unexpected shocks by raising revenues and cutting expenses. Poterba (1994) finds that state governments respond to a \$100 unexpected deficit fiscal with a \$54 increase in taxes and a \$22 spending reduction over the current and following year. In a vector error correction model of city governments, Buettner and Wildasin (2006) find that fiscal imbalances, both deficits and surpluses, associated with revenue shocks are followed by substantial changes to spending: municipal governments increase public spending \$.51 per a \$1 innovation in revenues. Moreover, fiscal adjustment occurs faster when governments face binding budget constraints. For example, states with strong balanced budget requirements raise taxes and cut spending more than states with weak balanced budget requirements: strong states reduce deficits by \$102 per \$100 in unexpected deficits, and weak states only adjust their budgets by \$79 per \$100 in unexpected deficits (Poterba, 1994). Based on the conclusions of the empirical literature, utilities that are closer to covenant thresholds should raise revenues and cut expenses more than utilities that are further away from their thresholds following a fiscal shock.

The incidence of spending cuts has implications for taxpayer welfare and the quality of public goods, but the empirical literature has little to say about what parts of the spending budget are affected by fiscal shocks and budget rules. The theoretical literature on political agency costs motivates two alternative "benchmarks" for spending cuts in response to binding fiscal institutions, based on extreme assumptions regarding the objective function of government and public officials (Besley and Smart, 2007; Denzau et al., 1981). On the one hand, extra budget constraints on a social-welfare maximizing government distort spending choices away from the optimal level of public service provision and taxation. The logic is intuitive, but can also be motivated by dynamic optimal taxation theories like tax smoothing (Alesina and Perotti, 1995, 1996). However, in a model of public sector moral hazard where politicians are rent-seeking, budget constraints can force fiscal discipline ex ante when elections are an insufficient disciplining mechanism. In a situation where budget decisions leave faithful public official behavior unchanged, a strict cap on government size improves voter welfare by reducing the rents that can be extracted by self-serving public officials (Besley, 2006).

The governments in my analysis all face tax limits and restrictions on deficit financing. In this setting, the rate covenant is then a private addendum to these budget rules that tightens overall budget constraints. When binding, a rate covenant forces utilities to increase rates and fees. However, there are limits on how much revenue a government is willing to raise. At this point, public officials will reduce expenditures. In my empirical strategy, I use the order in which officials reduce expenditures to characterize the role that debt covenants play in the public sector. If rate covenants distort the spending of a social-welfare maximizing utility, water utilities would reduce preferred public spending to a level below the optimal provision of services. In my setting, I interpret this outcome as a reduction in expenditures on the water system and an increase in system problems. If rate covenants are disciplinary, officials should reduce administrative overhead first. Under this model, there are important benefits associated with appeasing lenders in capital markets: utilities discipline their budgets and cut wasteful spending as they become more constrained.

5.2 Research Design and Identification

An ideal experiment that tests how rate covenants affect fiscal adjustment and the quality of public goods would randomly assign a binding constraint to utilities. I approximate this experiment by using within-utility, within-year variation in the tightness of rate covenants, which is the operating budget's current period distance to the rate covenant-specified threshold. The logic of this design originates from the empirical literature on fiscal adjustments to shocks. I assume that every year the water utility is hit by random shocks to its stream of revenues that push the utility closer or further away to its covenant threshold. This is the source of variation in covenant tightness I exploit. The regression model is:

$$Y_{ijt} = \gamma_i + \delta_t + \beta \text{Covenant Tightness}_{ij,t-1} + \psi X_{jt} + \varepsilon_{ijt} \tag{5}$$

for utility i in county j in year t. The outcome Y_{ijt} represents the budget and operational outcomes of interest.[12] X_{jt} are county-year varying covariates that I discuss more in the next paragraphs. I cluster standard errors at the utility-level. The coefficient of interest is β, which reflects the sensitivity of the outcomes to a unit change in covenant tightness or a standard deviation change in coverage ratios.

The primary challenge of my research design is that covenant tightness is not randomly assigned. There are two ways this could bias estimates: first, covenant tightness may be correlated with the skill level of public officials running the water utility. Evidence of cuts in response to approaching thresholds may be evidence of fiscal adjustment, or it could be related to mismanagement of the water utility. Assuming that the relative skill level of the utility is time invariant, I control for this potential source of endogeneity by including utility-level fixed effects. This strategy also accounts for other variation that is correlated with the overall fiscal health of the utility but is relatively stable over the time period, like the size of the population served and whether the utility's service area is primarily rural or urban.

Second, water demand drives variation in covenant tightness, but water sales may be related to time-varying economic conditions of the local service area that feeds through to the fiscal health of the local government.[13] Consider the following empirical model of an outcome, such as utility employment growth. The outcome is modeled as the result of both previous period's covenant tightness and some county-level demand shock η_{jt}, along with some idiosyncratic demand component u_{ijt} and an unobserved residual ν_{ijt}. This demand shock could be related to the county's local business cycle or housing demand.

$$Y_{ijt} = \gamma_i + \eta_{jt} + \beta \text{Covenant Tightness}_{ij,t-1} + u_{ijt} + \nu_{ijt} \tag{6}$$

β estimates will be biased if the demand shock and covenant tightness are correlated such that cov(Covenant Tightness,η_{jt}) $\neq 0$. There are reasons to believe this covariance may not be zero. For example, counties with negative demand shocks are likely areas with negative shocks to local eco-

[12] I analyze operational outcomes such as employment growth, manager wages, and a measure of water prices in order to confirm that the budget results, which are expressed as delta logs, are not driven by mechanical mean reversion.

[13] See the Appendix C for this analysis.

nomic conditions, which would correlate with lower overall tax revenue collections by the public sector generally. This fiscal health effect would drive the results, rather than the rate covenant. In the case of employment growth, this may result in a downward-biased coefficients that are already negative.

However, the benefit of my setting relative to the corporate setting is that the revenue source of water utilities is limited geographically, so it is possible to more explicitly control for economic conditions that could contaminate the estimates. I account for potential bias that could arise from county-level demand shocks in several ways. First, I control for the lagged unemployment rate at the county-level in X_{jt}, to account for local economic conditions in baseline specifications. Second, I include county-year fixed effects in additional specifications. I identify the effect of covenant tightness by comparing utilities in the same county in the same year, accounting for unobservable time-varying county differences that could bias estimates. In these specifications, I estimate the following regression:

$$Y_{ijt} = \gamma_i + \alpha_{jt} + \beta \text{Covenant Tightness}_{ij,t-1} + \varepsilon_{ijt} \tag{7}$$

Note that this specification identifies β in equation 6, because I partial out county-year level demand shocks. Additionally, I use insights from Altonji et al. (2005) and Oster (2019) to characterize the degree of selection on unobservables that would be needed to explain a zero treatment effect. For all of the county-year fixed effects specifications, I provide the δ measure from Oster (2019) and compare it to a bound of 1, which would imply that observables are at least equally important as unobservables in explaining the result. This analysis provides a bound on how important unobserved heterogeneity would need to be to explain my results.[14]

Although the bounds I calculate suggest that selection on unobservables would need to be quite high in order to explain my results, there could be potential sources of bias that are not captured by the county-year fixed effects strategy. For example, if skill level and institutional stress are time-varying over the full sample of 17 years, the utility fixed effects will fail to account for this omitted variable. Time variation in local economic conditions *within* counties may also bias estimates, such that cov(Covenant Tightness,u_{ijt}) $\neq 0$ in equation 6. In Appendix C, I find that variation in commercial, institutional, and industrial water delivered is still highly correlated with covenant tightness after accounting for county-year fixed effects.

I address these concerns in Section 6, using droughts as a natural experiment that exogenously tightens rate covenants through conservation mandates that reduced residential consumption for ur-

[14] I follow the procedure in Oster (2019). For the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls, I use the approach suggested by Oster (2019), which is the R-squared of the fully specified regression times a factor of 1.3. I also assume that utility-level fixed effects are controls, rather than nuisance parameters.

ban water suppliers. Because mandates were enacted on residential consumption, variation in covenant tightness following the drought was driven primarily by a reduction in residential urban water consumption, after accounting for county-level unobservable differences. In this case, quasi-exogenous variation in local demand shocks is driven by conservation mandates, rather than underlying economic conditions. I discuss the main identifying assumptions for this experiment in Section 6.

It is worth describing an alternative approach to how I have approximated the ideal experiment. There are two elements of the ideal experiment: first, the presence of the rate covenant; and second, whether it is binding. My strategy exploits the second element, but other work exploring the implications of covenants on firm outcomes exploits variation in the first. For example, Lian and Ma (2021) demonstrate that debt issuance sensitivity to fluctuations in cash flows is not present in firms that do not tend to have covenants regarding earnings (e.g., those that borrow by pledging tangible assets). I do not pursue this approach because it faces numerous challenges in this setting. First, most utilities borrow by pledging revenue streams, all of which are backed by the rate covenant. There are utilities that borrow unsecured, but these borrowers tend to have a mixed debt structure with pledged revenue debt contracts outstanding at the same time as their unsecured borrowings are outstanding. Second, the utilities that do not have a rate covenant are those that do not borrow in municipal markets. Comparing the rate covenant group to a group without a rate covenant would amount to a comparison of utilities that borrow and those that do not borrow. Utilities that do not issue debt tend to be smaller, serve lower-income populations, and have more frequent health violations than those that do not. β estimates that use this counterfactual group of utilities would therefore be contaminated by factors that determine the endogenous issuance decision.

5.3 Findings

Raising Prices and Revenues. I first test whether utilities respond to approaching covenant thresholds by raising prices and revenues, using specification 5. Results are reported in Table 3. Across all specifications, I can reject the null that β is 0. The first two columns report results for the change in log "prices", which is water sales revenues divided by million gallons of water delivered. When controlling for the lagged county unemployment rate, I find that prices increase 3.2% over the next year for every unit in covenant tightening. Similarly in column 3, I find that gross revenues increase 2.9%. Controlling for all unobservable time-varying differences across counties does not meaningfully change results in columns 2 and 4: prices increase 2% and revenues increase 2.8% per unit in tightening. These coefficients are large compared to the overall levels of outcome variables. The unconditional average of changes in prices and revenues are 4.4% and 2.7%, respectively. Moreover, the R-squared in columns 2 and 4 are twice the size of those in columns 1 and 3, respectively, doubling from .17 to .36 for change in prices and .16 to .33 for changes in revenues. This doubling demonstrates that the county fixed effects account for meaningful variation in both outcomes. I find that the degree of selection on unobservable factors, δ, would need to be 1.75 and 7 times greater than observable factors to explain away the results for prices and revenues, respectively.

I graphically depict how gross revenues change across the distribution of lagged covenant tightness in Figure 4 in the left panel. Unconstrained utilities, those beyond -2 standard deviations in the covenant tightness distribution, have decreasing revenue growth. For utilities that are above the threshold, revenue growth increases linearly as utilities approach covenant thresholds. Revenue growth of the most constrained utilities flattens at 5% year-over-year.

To lead into the next set of results, I graph O&M expense growth against covenant tightness in the right panel. The relationship between expense growth and tightness is more nonlinear, with steep declines across the violation threshold, where revenue growth tends to flatten. This is consistent with the first lever of budget adjustments: utilities first raise revenues as much as possible and then reduce expenditures. When utilities are constrained by their debt covenants, they improve their fiscal health. Unconstrained utilities, on the other hand, forgo increases to revenues and spend more. The response of operation and maintenance expenses to the tightness measure suggests that utilities do not meet their covenants solely through rate hikes. To make statements about effects on public goods, I next analyze what is cut as utilities become more constrained.

Spending Distortions. First, I test whether the budget constraint imposed by rate covenants leads to distorted spending choices on the water system, including treatment and maintenance. In order to test whether these spending cuts are actually distortionary, I also analyze changes in the number system problems as a proxy for deterioration of water system quality. I rerun regression 5 for each of these outcomes. Results are reported in Table 4. The first two columns report results for all expenses attributable to the water system. The outcome variable specifically is the change in the log of all functional water expenses, which is the sum of retail and water source expenses. In line with the hypothesis that approaching thresholds distorts spending, I find that functional water expenses decrease 3.6% per unit in covenant tightness. As in the prices and revenue specification, including county-year fixed effects now quadruples the R-squared but does not change the coefficients: the influence of unobservable factors would need to be 8 times observable factors to conclude zero treatment effect. Expenses increase on average 1.8% per year, so this is a large effect relative to the unconditional average.

To isolate expenses that are most likely associated with treatment and maintenance, I analyze water retail expenses in columns 3 and 4. These expenses are a subcategory of all water expenses and represents costs associated with the treatment, transmission, and distribution functions of the water utility. I find a lower absolute sensitivity of water retail expenses to covenant tightness, at 3.3%, but it is still significant and negative. As with all water expenses, including county-year fixed effects slightly decreases the coefficient to 3% and quadruples the R-squared value; I find that δ would have to be 8 to find a zero treatment effect. Both total water expenses and retail water expenses exhibit the same elasticity with respect to approaching covenant thresholds.

The estimates are consistent with a reduction in spending on the water system, but does this have real repercussions in the form of increased system problems? Next, I analyze the change in the number of system problems, which include breaks, leaks, water outages, and boil water orders, weighted by the population (measured in units of 10 thousand). Columns 5 and 6 in Table 4 suggest that the answer for most of the utilities in the sample is "no". In column 5, I find that a unit in tightening is associated with a decrease of .5 system problems per 10 thousand people, relative to an unconditional average of -.36. However, I cannot reject that the coefficient is zero. Similarly, the last column reports results including county fixed effects. County-level variation explains a substantial proportion of variation in system problems, and I find a slightly more positive coefficient of -.2 system problems per 10 thousand people. This estimate is not statistically distinguishable from zero. Although utilities reduce spending, I find little evidence of increasing problems for most of the distribution of covenant tightness. It appears that distance to the covenant threshold does not have a distortionary effect on water system spending for most of the distribution.

Disciplining Governments. Given that I find little evidence of negative impacts to water system quality in response to approaching covenant thresholds, I next examine whether rate covenants have a disciplining effect on budgets through a reduction in administrative expenses and top employee wages. This test aligns with the second benchmark suggested by political agency models, where public officials are self-interested and elections have limited ability to improve political agent's incentives. I also examine changes in employment growth, although it is less apparent that changes in overall employment are the result of fiscal prudence.

Results are reported in Table 4. I first analyze the change in log administrative and other expenses in columns 1 and 2. Because these expenses are not attributable to any direct water function, this is one of the most malleable parts of a utility's spending budget. I find that as utilities approach covenant thresholds, they cut these administrative expenses. A one unit increase in covenant tightness is associated with a 5.2% decrease in administrative and other expenses. This is larger than the estimate on water system expenses, but administrative expenses on average grow 3% over the time period. Accounting for county-fixed effects in column 2 quadruples the R-squared from .06 to .27, but does not change the coefficient. As in the previous specifications, the influence of unobservables would have to be at least 5 times the influence of observables to explain away the result. I can reject a β equal to zero in both specifications.

Next, I examine employment outcomes like employment growth and general manager wage premiums over the median department employee's base wage. The results for employment growth are reported in columns 3 and 4. I find that a standard deviation increase in tightening is associated with a reduction in hiring growth of 1.5%, relative to an unconditional average of -1.2% over the sample period. Column 4 reports results with county-year fixed effects. I find that accounting for unobserved time-varying county effects leads to a larger absolute coefficient of 2.1% per unit in tightening. As in columns 1 and 2, I find that the R-squared is quadrupled from .07 to .31 by the addition of county-year fixed effects. Additionally, I calculate a very high δ for employment growth: unobservables would need to be 9.5 times as important as observables to see zero treatment effect. I can reject that each β I estimate is zero at the 5% level. Because full-time employees at utilities are unionized, this negative coefficient likely does not represent firing of employees. Instead, this result most likely reflects a slowdown in hiring: constrained utilities might leave positions open after employees leave, leading to an overall year-over-year decline in employment growth.

Finally, I examine how manager pay changes as utilities approach covenant thresholds. Why analyze manager pay premia? General managers are generally the highest paid employees in water utilities. High manager pay may reflect a skills premium, particularly for managing large urban water suppliers, but it may also reflect rent-seeking at the expense of the water system. Historically, some of the highest paid general managers have been those that are implicated in corruption scandals at water departments. For example, the former general manager of San Francisco's Public Utilities' Commission was charged in 2020 with fraud for engaging in a bribery scheme.[15] The former general manager of the Metropolitan Water District of Southern California was fired in 2019 for misuse of district resources, including the purchase of an $8 thousand 3-D printer for home use and joyriding and crashing a District-owned street sweeper multiple times.[16] I use the markup of manager pay over the median employee pay as a measure of the extent of general manager rent-seeking. I normalize by

[15] See Jaxon Van Derbeken, "San Francisco Public Utilities Commission GM Harlan Kelly Charged With Fraud", NBC Bay Area, November 30, 2020, available https://www.nbcbayarea.com/news/local/sfpuc-gm-harlan-kelly-charged-with-wire-fraud-by-federal-prosecutors/2410959/.

[16] See Adam Elmahrek, "He was the king of water in the desert. His abusive reign revealed a troubling culture," Los Angeles Times, March 18, 2021, Available https://www.latimes.com/california/story/2021-03-18/mwd-manager-left-legacy-abuse-desert-water-world.

the median wage to account for both the higher cost of living in urban areas and any skill premia. The logic behind the skill premia is that more skilled managers should hire a more skilled workforce, as reflected in higher base pay for the median worker. Manager wage premia should be more compressed when there are complementary skills between the manager and the utility's workforce.

Results are reported in columns 5 and 6. I find that manager pay premia decrease 3 percentage points per standard deviation increase in tightening. This is a small effect relative to overall level of manager pay, which tends to be 119% of the median employee's base wage during the time period. Including county-year effects attenuates this estimate in column 6 to 2.9 percentage points. I cannot reject that the estimate in column 6 is zero at the 5% level. I calculate a large absolute δ in column 6 of -25.7. The negative number indicates that if observables are positively correlated with the treatment, unobservables would have to be *negatively* correlated with the treatment for a zero treatment effect. This seems unlikely, if unobservables are related to local economic conditions. The results are weakly suggestive that constrained utilities reduce manager pay premia. As with employment growth, the mechanism for reduced pay is not straightforward for public employees: it is unlikely that utilities reduce overall manager base wages due to outstanding contracts with union members. However, utilities can influence the overall pay rate of general managers by encouraging early retirement or resignations for highly paid managers.

Discussion. Covenant constrained utilities increase prices and cut spending. I find evidence consistent with the disciplining role of covenants: utilities reduce administrative expenses. Moreover, they reduce employment growth and manager wages. I also find some evidence to support the distortionary role of covenants, but I find little evidence that this has meaningful real effects for most of the distribution of covenant tightness. Next I test how public officials trade-off revenue increases with maintenance and administrative cuts by examining outcomes at different points in the covenant tightness distribution.

5.4 A Pecking Order of Fiscal Adjustment

Utilities should be most responsive to covenant thresholds ex ante when they are more likely to violate their covenants. I exploit this observation to demonstrate evidence of a pecking order in how public officials adjust budgets as they approach covenant thresholds. I test which budget items are more sensitive to distance to covenant thresholds for different terciles of covenant tightness. Second, I calculate how utilities in each tercile allocate a $1 move toward covenant thresholds to revenue increases and spending cuts.

Slope discontinuities. I split the covenant tightness distribution into thirds. Next, I run the following regression at the utility i, county j, year t level:

$$Y_{ijt} = \gamma_i + \delta_t + \beta \text{Covenant Tightness}_{ij,t-1} \times \text{Tercile}_{ij,t-1} + \psi X_{jt-1} + \varepsilon_{ijt} \tag{8}$$

$\text{Tercile}_{ij,t-1}$ is an indicator variable that measures whether previous period tightness is in the top, middle, or bottom third of the distribution. Referring back to the histogram, Figure 2, the bottom third includes many of the utilities that are bunching in the (-.2,0] bucket in addition to more clear violators. This specification still exploits within-utility and within-year variation, so β compares the elasticity of budget outcomes to covenant tightness within utilities for each part of the tightness distribution. The outcome Y_{it} represents the budget and operational outcomes of interest. I include county-level unemployment rates in $X_{j,t-1}$ to control for any local time-varying economic conditions. All outcome variables are winsorized at the 1% level to limit the influence of extreme values. Finally, I cluster standard errors at the water utility level.

The intuition for this analysis is that budget items that are more sensitive to the distance to threshold are expenses that are less "costly" for officials to adjust when utilities are far away from the constraint . I start by analyzing changes in the budget outcomes: gross revenues, administrative expenses, water retail expenses, and water source expenses. I break out the functional water expenses into separate categories for this analysis in order to demonstrate trade-offs between supply and treatment, transmission, and distribution expenses. Results are displayed in Figure 5, with coefficients reported in Table 6. I group the outcomes in threes along the x-axis. The first three coefficients depicted are the βs for the top, middle, and bottom terciles of the distribution respectively for regression 8 with outcome variable change in log revenues. The next group of three coefficients is for the change in log source expenses. The third group of coefficients is for the change in log water retail expenses, and the final group of three coefficients is for the change in log administrative expenses. β is reported along the y-axis.

I arrange the outcomes in the order that they become more sensitive to covenant tightness. In the first group of three coefficients, the elasticity of revenue growth to covenant tightness is positive and significant for all parts of the distribution; however, elasticity is increasing for the bottom and middle thirds (2.8% and 5.1% per standard deviation in tightening, respectively), but falls for the top third to 3.3% per standard deviation in tightening. This is consistent with the first lever in a local government pecking order: governments raise revenues first. The lower coefficient, while not statistically indistinguishable from the top and middle third, is suggestive that more constrained utilities face restrictions on raising revenues.

The next lever of adjustment is water retail expenses. Utilities with covenant tightness in the middle and top of the distribution adjust retail expenses more (about 6 percentage points more) per standard deviation of tightening than utilities in the bottom of the distribution. The difference between the middle third in water retail expenses to the middle third in administrative expenses is stark: I cannot reject that the elasticity of administrative expense growth rates is zero per standard deviation in tightening for the middle third. However, there is also a very large elasticity of administrative expenses for the bottom third: utilities in this region reduce administrative expense growth 19% per standard deviation in tightening.

When very constrained, public officials reduce budgets related to both water system quality and administrative overhead. However, there is an order where these budgets become more sensitive to tightening. My findings suggest that, when relatively unconstrained by covenants, water utility officials reduce expenses on treatment, transmission, and distribution to a larger extent than administrative overhead.

Next, I examine the real outcomes and demonstrate that this pecking order has consequences for the water system. I also use these results to confirm that that the budget results are not driven by mechanical mean reversion. Prices, employment, manager wage premiums, and growth in system problems follow a similar pattern as the budget items. All of the coefficients are reported in Table 7. The first outcome is the change in log prices. Similar to the specification for gross revenues, I find that the elasticity of prices to covenant tightness is increasing across all parts of the distribution. Price increases are largest for the top tercile, at 6% per unit in tightening. The next two groups of coefficients are for the change in employment and general manager wage premiums. I find that the dramatic elasticity of administrative expenses to tightness in the bottom third of the distribution can be replicated in these outcomes: manager wage premiums are significantly related to tightness only in the bottom third of the distribution. In this region, premiums are 7 percentage points lower per standard deviation in tightening. Similarly, I find that changes in employment are driven by the bottom third of the distribution, although the elasticity coefficient (2.9%) is only marginally significantly different from zero.

Finally, in the top tercile of the distribution, covenant tightening is significantly positive related to accelerating system problems like broken pipes. In this region, one standard deviation in tightening is associated with an increase of 4 problems per 10,000 people. Considering that system problems per 10,000 people decrease by .36 problems per year overall, this is a substantial acceleration. Additionally, the coefficients for the top and middle groups are negative, but I cannot reject that they are zero.

Although the estimates for the bottom two terciles are statistically noisy, there is a clear nonlinearity for the most constrained utilities that is masked by the rest of the distribution.

I find evidence consistent with a disciplinary role for covenants. As utilities approach covenant thresholds, utilities primarily reduce administrative expenses, cut employment growth, and reduce manager wages. However, this effect is concentrated in the most constrained utilities. Adjusting administrative expenses and manager wages is more costly to officials than reducing expenditures on the water system. Water retail expenses become more sensitive to covenant tightness for utilities in the middle of the distribution. This has implications for the operation of the water system: utilities in the most constrained region in the distribution experience accelerating system problems. The budget constraints imposed by the rate covenant therefore have distortionary implications for the provision of public goods.

$1 Allocation. How do utilities allocate a $1 move toward covenant thresholds? There are two challenges to answering this question using the estimates from the previous section: first, the budget elasticities I measure are not easily convertible to dollar amounts due to the variability across utilities. Second, the covenant tightness measure is expressed as standard deviations of coverage ratios, which also vary widely across utilities. To estimate a budget response in dollar terms, I convert the main budget items to dollar amounts, specified on a per capita basis. I first calculate the minimum required net revenues specified by the rate covenant. This is the covenant threshold multiplied by annual debt service. I subtract the realized net revenues from this rate covenant minimum requirement and normalize by the local service area population size (measured in 10 thousands) in order to form the yearly deficit on a per capita basis. When this number is positive (negative), utilities are below (above) the minimum requirement. Next, I calculate the yearly change in budget items, and normalize by population size. I run the following regression:

$$\Delta Y_{ijt} = \gamma_i + \delta_t + \beta \text{Covenant ``Deficit''}_{ij,t-1} \times \text{Tercile}_{ijt} + \varepsilon_{ijt} \tag{9}$$

Tercile_{ijt} is an indicator variable that measures whether covenant tightness is in the top, middle, or bottom third of the distribution. ΔY_{ijt} are the per capita changes in three budget items: gross revenues, administrative expenses, and water system expenses. Covenant "Deficit"$_{ij,t-1}$ is the lagged difference between realized net revenues and the minimum required net revenues specified by the rate covenant, expressed per capita. I include utility fixed effects and year fixed effects. Standard errors are clustered at the utility level.

Results are depicted in Figure 6. I group estimates of each of the reponse of the three budget items based on the covenant tightness distribution terciles, arranged from unconstrained to more constrained. Each bar denotes a different budget item response: purple bars correspond to gross revenues, orange to administrative expense, and blue to water system expenses. I include the estimated coefficient for each bar in the plot, which are expressed on a per capita basis. The overall budget response, which is how much utilities in each tercile recoup of a dollar move toward the threshold in the next year, is denoted at the top of the chart in bold. The bottom tercile has the most limited response, at \$.15. The middle and top terciles have much larger responses, at \$.41 and \$.51 respectively. In line with the previous section, the middle and top of the distribution are similar in terms of how much they raise in revenues. However, the constrained group of utilities have very large spending cuts. In this representation, I find that the burden of a dollar move towards thresholds falls primarily on the water system. For a \$1 move toward covenant thresholds, the most constrained utilities raise \$.26 in revenues, cut spending on the water system \$.19, and reduce administrative expenses \$.13.

6 Addressing Endogeneity: Drought Emergencies as a Natural Experiment

In an ideal experiment, a binding constraint would be randomly assigned to water utilities; however, covenant tightness is jointly determined with the budget outcomes of interest. There are two ways this could bias estimates: first, covenant tightness may be positively correlated with time-varying inattention or skill levels of public officials. Second, water sales drive variation in covenant tightness, but water sales may be related to time-varying economic conditions of the local service area that then feed through to the fiscal health of the local government. In this section, I approximate the ideal experiment by analyzing a presumably exogenous fiscal shock to water utility budgets, the 2014-2016 California drought. I also test whether heterogeneity in the ability to raise revenues following drought restrictions leads to spending cuts.

6.1 Droughts as Fiscal Shock

Identifying the effect of the rate covenant requires exogenous variation in covenant tightness that pushes utilities closer to their covenant thresholds. This instrument should be uncorrelated with management capabilities and the overall economic conditions of the utility's service area. Therefore, I use state-mandated conservation standards following a severe drought in California as a shock to covenant tightness, which materializes through a decline in revenues.

Overview. While droughts are typically a supply shock, I exploit the effect of California's conservation mandates on the residential water sector as a demand shock.[17] California experienced a historic drought between the years 2012 and 2016, which peaked in severity in the summer of 2014. Starting in 2014, the state of California issued multiple edicts restricting water use in the residential sector. The first was a state of emergency declaration in January 2014, which was followed by three executive orders calling for voluntary reductions in water use in 2014. In June 2015, mandatory restrictions were enacted to achieve a statewide reduction in residential water use per capita to 25% of 2013 levels. These restrictions applied to urban water suppliers with greater than 3,000 connections. Urban water suppliers were sorted into 9 tiers based on residential gallons per day, measured in 2014. Each tier was mandated to reduce residential gallons by some percentage of 2014 usage, varying from 4% in Tier 1 to 36% in Tier 9.[18] Additionally, California required urban water suppliers to submit monthly conservation reports on water production, sectoral breakouts, and average residential use per day. Non-compliers were first issued a warning and then fined. The emergency declaration was lifted on April 2017, but some water conservation requirements were made permanent in May 2016.

Drought Restrictions: Average Effects on Quantities and Revenues. The drought restrictions had a sizeable effect on both quantities of water delivered and the residential use of water. I plot these outcomes in Figure 7. Data for the top panel is from the California EAR reports, covering years 2013 to 2019. Data for the bottom panel is from the California State Water Resources Board's Water Conservation and Production Reports for urban water suppliers, which was collected from June 2014 until the present. The top panel in Figure 7 plots the average log amount of annual water delivered (in million gallons) by urban water suppliers, accounting for utility-specific fixed effects. The amounts of water delivered overall was significantly lower following 2014, although it had been falling in the year prior to the drought restrictions. The bottom panel plots the average monthly residential gallons per capita daily for the months June through December in each year, collected from urban water supplier monthly conservation reports collected by the State Water Control Boards and controlling for month fixed effects and water supplier fixed effects.[19] Residential water usage dropped significantly after the imposition of mandatory restrictions in the second half of 2015. It recovered by 2019, but still remained significantly below 2014 levels.

Because residential water use is on average 70% of urban water suppliers' total usage, the drought

[17] In the next section, I discuss how I control for potential variation in exposure to the concurrent drought supply shock.

[18] In Appendix D, I conduct robustness analysis to demonstrate that controlling for variation in exposure to the drought by including drought tier fixed effects does not affect my conclusions.

[19] The year 2014 only includes months June through December, which include the peak period of water consumption during the summer. In order to avoid overstating consumption in 2014, I only analyze months June through December in all other years.

restrictions represented a large shock to the revenue base of water utilities. However, in order to argue that these restrictions were a financial shock to water utilities, it is important to link the declines in water quantities to water revenues. I plot log water sales revenues of urban water suppliers in my main California sample that were also subject to drought restrictions. in Figure 8. Based on the timing of the announcements, fiscal year 2015 covers the voluntary mandate while fiscal year 2016 covers the mandatory mandate. The plot removes utility-level fixed effects in water sales revenues, and is plotted relative to base year 2014. Leading up to the drought restrictions, water sales revenues increased on average. Following the drought restrictions, water utilities' revenues experienced a steep decline in both fiscal years 2015 and 2016 before recovering to 2014 levels by 2017.

6.2 Experiment Design and Identification

Conceptual Design. Consider the earlier equation 6 of utility budget outcomes:

$$Y_{ijt} = \gamma_i + \eta_{jt} + \beta \text{Covenant Tightness}_{ij,t-1} + u_{ijt} + \nu_{ijt}$$

Where η_{jt} are county-level demand shocks, u_{ijt} are idiosyncratic demand shocks, and ν_{ijt} is some other unobservable residual. The treatment is Covenant Tightness, which exhibits significant nonlinearities close to the threshold. β is not identified if covenant tightness is correlated with within-county demand shocks (cov(Covenant Tightness,u_{ijt}) $\neq 0$) or correlated with the unobserved residual (cov(Covenant Tightness,ν_{ijt}) $\neq 0$); however, leveraging exogenous shocks to covenant tightness should recover β. An instrument $Z_{ijt} = f_{ijt}(g; w)$ for covenant tightness, where g are observable shocks and w is a vector of variables that govern exposure to the shock, should suffice to recover the treatment effect.[20] In the context of a drought emergency, g is a vector of 1s and 0s: g takes a value of 1 in periods following the enactment of the first state emergency, for all utilities in the sample. However, specifying the w vector and shock assignment process f is nontrivial in this setting. I instead impose assumptions on the unobservables, particularly parallel trends conditional on observables. My instrument Z_{ijt} is then a collection of time-dependent dummies that switch on post-2014. The main threat to identifying β is a violation of the parallel trends assumption, primarily that the treatment assignment process of covenant tightness is correlated with elements of w, which drive exposure to the drought shock. I discuss this threat more after discussing the treatment assignment process, the implementation of this design, and support for the parallel trends assumption.

Treatment Assignment. To account for nonlinearities in the treatment measure, I create a

[20]This discussion follows the exposition of Borusyak and Hull (2021). A difference is that w is observable in their set-up, which allows them to create and control for a counterfactual shock process.

treated and control group by sorting urban water suppliers into the top and bottom 50% percentiles based on the the distribution of average covenant tightness measures in the pre-period.[21] The intuition of the design is to compare two utilities exposed to the same demand shock, but one utility is closer to its rate covenant threshold. The drought shock should on average push utilities closer to their rate covenant thresholds, but the treated group is pushed into the nonlinear space of the distribution where rate covenants are most binding. I call this treatment designation $Constrained_i$. The constrained group are those with tight rate covenants in the top 50% of the covenant tightness distribution; the control group is the bottom 50%. There are 93 utilities in the treated group and 92 utilities in the control group.

Implementation. To test the effect of an exogenous shock to the constraints on utilities, I run the following regression specification for the sample of urban water suppliers at the utility i, county j level.

$$\Delta \log(Y_{ij}) = \gamma_j + \beta Constrained_i + \varepsilon_{ij} \tag{10}$$

This is a first-difference specification, where I collapse outcome variables $\log(Y_{ijt})$ into their pre-period and post-period averages and then take the difference. Based on the timing of the drought restrictions, I define my pre-period to be fiscal years prior to the enactment of drought restrictions (2010-2014) and post-period to be years following the drought restrictions (2015-2019). $Constrained_i$ is my measure of rate covenant tightness, corresponding to the treatment designation. I include county-level fixed effects γ_j. Because the γ_j are introduced after first-differcing, they capture time-varying county-level effects. As in the main analysis, I calculate the extent of selection on unobservables that would be necessary in order to explain away the treatment effect I find. Due to the regional nature of water provision, the specifications that include γ_j provide the strongest evidence against a violation of the parallel trends assumption by controlling for county-level unobservables in w that influence the shock assignment process (discussed more below).

This research design improves on the approach in Section 5 in the following ways. First, the demand shock largely originates from state conservation mandates. Importantly, assignment of the demand shock is not driven by unobservable local economic conditions that are correlated with the fiscal health of the water utility. Second, the shock was not transitory. Not only were some water conservation requirements made permanent in 2016, but many consumers permanently changed their water consumption behaviors in response to the droughts by adopting water-conserving technologies

[21] I recalculate the measure by using observations from 2003 to 2014 in the calculation of the standard deviation of the coverage ratio.

and practices (e.g., low-flow shower heads and toilets, xeriscaping in landscaping and garden design, etc.).

There are also limitations to this experiment. The set of utilities most affected by the drought restrictions are all large urban water suppliers. This greatly reduces statistical power, so I limit the analysis to budget outcomes. The sample composition also introduces external validity concerns. In particular, large urban water suppliers are those that have the most flexibility to raise rates and prices and are therefore less likely to cut spending. Therefore, I test whether heterogeneity in a population's hostility to tax increases affects constrained utilities' spending decisions in the last section.

Parallel Trends Assumption. The identifying assumption is parallel trends, conditional on observables. I examine how reasonable this assumption is in Figure 9 for a variety of outcomes. These figures plot coefficients β_t from the regression:

$$\log(Y_{ijt}) = \gamma_i + \delta_t + \beta_t Constrained_{ij} + \psi X_{jt-1} + \varepsilon_{ijt} \tag{11}$$

The main outcomes of interest are log "price", which is water sales revenue divided by water delivered in million gallons, and log gross O&M per million gallons water delivered. These outcomes are reported in Panels 9b and 9d. Because the water quantity data is only available starting in 2013, I also include log gross revenues and log gross O&M in Panels 9a and 9c and extend the pre-period to 2010. I include the log amount of water delivered as an outcome variable in Panel 9e, in order to test whether there is any variation in treatment intensity between treated and control groups on the amount of water delivered. $Constrained_{ij}$ is an indicator variable that takes a value of 1 if a utility is in the bottom 50% of the covenant tightness distribution between 2010 to 2014. To control for time-varying county-level differences, I include the lagged unemployment rate in X_{jt-1}. The coefficients of interest are β_t, which is the treatment effect of interest at each year t.

Panels 9a and 9b demonstrate how covenant constrained utilities adjust their revenues and prices. Pre-trends are insignificant in both plots, and I find a sizeable positive increase in gross revenues following the drought emergency declaration in 2014. I find more of a delay in price adjustment in the treated group: constrained utilities start to increase prices significantly relative to the unconstrained group in 2017. In panel 9e, I show that this adjustment is not mechanically related to a change in the water provided: there are no years in the post-drought period where the constrained group is significantly different from the unconstrained group.

I also examine changes in O&M expenses in panels 9c and 9d. The left panel demonstrates the treatment effect in gross O&M expenses and the right panel is the treatment effect for gross O&M

expenses per unit of water delivered. The per-unit specification is the most appropriate outcome to examine, as a reduction in water delivered may have led to a reduction in the overall cost of providing water. I find a significant difference between the constrained and unconstrained group in year 2010 for gross O&M expenses, but the remaining pre-periods are insignificantly different from zero. At both the gross level and on a per unit basis, I fail to find a significant difference between the treated and the control group in the post emergency declaration period.

Threats to Identification. The main threat to identification is violation of the parallel trends assumption. In particular, the main challenge in the analysis is that water utilities in the constrained group might be differentially exposed to the drought shock. The treatment effect estimate may be biased if variation that drives utilities close to their rate covenant thresholds in the pre-period is correlated with drought exposure. I first discuss characteristics of the constrained group that likely determined their treatment status, before turning to a discussion of how water utilities may be exposed to the drought shock through avenues other than the state mandates.

I report summary statistics in Table 8. The two groups are similar in important ways. First, I find that population size and median household income are similar between the constrained and unconstrained group. I fail to reject that the differences in means are significant on these dimensions.[22] I also fail to reject a difference in exposure to the commercial sector. Because commercial water tends to drive local variation in covenant tightness, this is an important piece of evidence in favor of the parallel trends assumption: both groups are similarly exposed to the commercial sector prior to the drought shock. However, the significant differences between the groups appear to be related to exposure to the housing crisis. The constrained group experienced higher population growth between 2000 and 2010 and more building in the run-up to the financial crisis (reflected in a larger percent increase in county building permits). To address this potential source of bias, I include county fixed effects, capturing any time-varying differences across counties that may bias the results.

Additional drought exposure may be driven by either supply chain or demand effects. Because droughts are fundamentally supply shocks, water utilities may vary in their supply chain fragility. For example, utilities with a concentrated water source portfolio will have to cut back quantity supplied to consumers. Utilities with exposure to regional wholesalers may pass on reduced water allocations or increased prices to consumers. However, supply chain variation has a strong regional component. For example, utilities in the southern part of California often rely on a few large regional wholesalers. Utilities in the northern part of California tend to have different water supply portfolios than those in the south, for example relying on more local water. I therefore use county fixed effects to control for

[22] I control for these factors in Appendix D, in case there is a time-varying effect.

this exposure.

Demand might differentially affect the treated group in two ways. First, the constrained group was sorted into a higher drought tier than the unconstrained group and therefore had a higher conservation mandate. Second, economic conditions may deteriorate in areas with more agriculture activity. To rule out this channel, I include robustness checks in Appendix Table D.3 that control linearly for the conservation standard and the share of farmers in a water utility's service area. In more stringent tests, I also include drought tier fixed effects for the 9 Tiers (leaving out one dummy). These tests compare utilities within the same conservation standard group, holding fixed the relative intensity of the conservation mandate.

6.3 Findings

Results for regression specification 10 are reported in Table 9. These specifications include outcomes on a per-unit of water delivered basis. Because water quantity data is only available for two years in the pre-period, I also report results for the change in gross revenues and gross O&M expenses in Table 10. However, my preferred measurement of the outcomes are per unit of water because the droughts greatly affected the total sum of variable costs of water. The first three columns report results for the change in the log price, which is water sales revenues divided by water delivered in millions of gallons. The last three columns report results for the change in O&M expenses per million gallons of water. Columns 2, 3, 5, and 6 include county-fixed effects to control for unobservable time-varying differences at the county-level. In columns 3 and 6, I substitute in the direct measure of covenant tightness in the pre-period for the constrained dummy variable. I find that the average treatment effect on prices is consistent across the columns: constrained utilities raise prices by 9.2 to 9.3% following drought restrictions. I can reject that there is no effect in all specifications. Notably, the R-squared increases from .05 to .25 when I add county fixed effects, but the treatment effect does not change substantially. In column 3, I directly estimate the effect of pre-period covenant tightness on changes in prices. I find that utilities raise prices 5.5% per a unit increase in covenant tightness. This estimates exceeds the OLS estimates from the main analysis in Table 3, which range from 2% to 3.2%. The drought experiment results suggests that the OLS estimates are downward-biased. In both columns 3 and 6, I find that the degree of selection on unobservables that would be necessary to find a zero treatment effect ranges from 4 to 6 times relative to observables. I also fail to find an effect on O&M expense per million gallons in all specifications: I find a negative coefficient in columns 4 and 5, but cannot reject no effect. These results are consistent with the predictions of the first lever: utilities that are constrained by their rate covenants increase prices.

Because of the short pre-period, I also report results for the change in gross revenues and gross O&M in Table 10. Columns 1 to 3 report results for the change in log gross revenues, and columns 4 to 6 report results for the change in log gross expenses. I find similar results to Table 9: revenues are higher for the most constrained group of utilities following the drought restrictions. The coefficients suggest that constrained utility gross revenues are 4% to 4.5% higher in the post-period. The direct effect of covenant tightness in column 3 is 2.5% per unit increase in covenant tightness. This is comparable to the OLS estimates I find of 2.9% and 2.8% in Table 3. I also find a negative effect on gross O&M expenses in all specifications: expenses are on average 3% lower for the most constrained group of utilities. However, caution is warranted regarding these results, as the coefficients are only marginally significant across specifications. Overall, the results are consistent with the previous findings: constrained utilities raise their prices and increase revenues following drought restrictions, consistent with meeting covenant requirements. However, I fail to find an effect consistent with a reduction in expenses.

Finally, I examine whether the aggregate expense effects obscure differences in allocations across different expenses categories, particularly administrative and water expenses. Results are reported in Table 11. The first three columns report results for the change in log administrative and other expenses per million gallons of water delivered, which are expenses that cannot be charged to a particular water function. The next three columns report results for the change in log water expenses per million gallons of watered delivered, which are all functional water expenses. The coefficients associated with administrative expenses are positive in column 1, but I cannot reject that the coefficients are zero. In column 2, when I compare utilities within counties, I find a statistically insignificant negative effect. Similarly, I find a negative but insignificant direct effect of covenant tightness. In columns 4 and 5, I find that constrained water utilities reduced expenses on the water system on a per-gallon basis by 14.5% compared to unconstrained utilities. However, this result is only marginally significant. The effect is reduced by a third when accounting for county fixed effects.

I find strong support that rate covenant-constrained utilities raised prices following an exogenous shock to budgets. These utilities increase prices, although there is weak support that they subsequently reduce expenses on the water system. However, there is substantial variation in the ability to raise revenues, due to differences in political frictions that limit rate increases. I explore the implications of these frictions in the next section.

6.4 Interactions with Tax Hostility

Following the drought shock, rate covenant-constrained utilities exhibit a large response in prices and a limited adjustment in spending. Is this a rejection of the pecking order hypothesis, or is there heterogeneity in the ability of utilities to raise revenues? Recall that the pecking order hypothesis of fiscal adjustment suggests that governments facing constraints will increase revenues and cut expenses in response to shocks when they can no longer raise sufficient revenues. If utilities are able to absorb the fiscal shock of droughts primarily through rate increases, then the pecking order would predict that there should be little adjustment on the expense side of the budget. I test this mechanism by assessing how heterogeneity in the ability to raise revenues affect large urban water suppliers' response to the drought shock. I examine variation in a political friction that might limit free adjustment in prices and revenues: local hostility to tax increases.

A key challenge in measuring hostility to taxes is that time variation in attitudes towards taxes may be correlated with time-varying local economic conditions. To overcome this, I construct a measure of tax hostility based on demographic features of water utilities' service areas, measured prior to the sample period start date in 2010. Recent work on the formation of policy views suggests that individual attitudes towards taxes reflect social preferences and views on the normative role of government (Stantcheva, 2021). Assuming that attitudes are fairly stable across time for individuals, I measure variation in policy views by measuring population characteristics that can predict policy views. I construct an index of tax hostility, which is the predicted share of "no" votes on a tax referendum based on variation in water utilities' population characteristics (more details on the construction of this index are included in Appendix E). The tax hostility index is designed to capture the difficulty of passing a tax referendum, given the demographic characteristics of a utilities' service area: for example, areas with a larger share of registered Republicans tend to have a higher "no"-vote share on tax referenda. I create a standardized variable that has a mean of 0 and a standard deviation of 1 based on the predicted share of "no" votes for the full sample of over 600 water utilities, where a higher number indicates a more "hostile" area. A one unit increase in the tax hostility index (standard deviation in the predicted "no"-vote share) is roughly equivalent to a move from San Diego to Fresno.

Utilities that serve populations that are less amenable to tax increases are predicted to struggle to raise sufficient revenues when constrained, under the guiding framework. Because of the constraint imposed by the rate covenant, I test whether constrained utilities with tax-hostile populations cut expenses more than constrained utilities in less hostile areas. To do so, I run the following regression, including the tax hostility index and interacting it with the indicator variable Constrained_i:

$$\Delta \log(Y_{ij}) = \beta \text{Constrained}_i \times \text{Tax Hostility}_i + \psi_1 \text{Constrained}_i + \psi_2 \text{Tax Hostility}_i + \gamma_j + \varepsilon_{ij} \tag{12}$$

Equation 12 is similar to Equation 10: I include county j fixed effects to account for time-varying differences across counties and cluster standard errors at the county level. As in the main drought analysis, differential exposure to droughts through both supply and demand channels is the most likely confounder that would bias estimates of the effect of the rate covenant. The analysis therefore exploits within-county variation, in order to account for regional differences in these factors that might differentially affect exposure. I report results for the change in the log amount for four outcomes, all of which are a proportion of million gallons of water delivered: "prices" (water sales revenues divided by million gallons delivered), O&M expenses, water expenses (including water source and retail expenses), and administrative expenses. The estimate of interest is β, which measures the effect of tax hostility on prices and expenses for rate covenant-constrained utilities following the drought.

Within-county variation is vital for identifying the effects of the interaction of tax hostility with rate covenant constraints. First, the summary statistics in Table 8 demonstrate that the tax hostility index is on average significantly higher in the sample of rate-covenant constrained than unconstrained utilities, at .23 and -.04 standard deviations, respectively. Other points of the distribution of tax hostility also reflect this disparity. At the median, unconstrained utilities have a tax hostility index measure of .15 standard deviations and constrained utilities have a measure of .38 standard deviations. On the one hand, this is strong support for the underlying fiscal adjustment mechanism: in areas where it is more difficult to raise rates, utilities are more likely to be constrained. However, this could also challenge the identification strategy if tax hostility is correlated with drought exposure. One potential concern is geography. For example, water utilities in more rural parts of the state exhibit more hostility to tax increases (see Figure E.1 in Appendix E). If rural urban water suppliers are more exposed to agriculture, then tax hostility could be an instrument for drought exposure rather than political frictions. Because much of these demand effects are likely to be determined at the county level, the inclusion of county fixed effects is a necessary addition to the empirical strategy.

In the first column in Table 12, I find a significant and negative relationship between hostility and prices following drought restrictions, but only for the set of constrained utilities. A standard deviation increase in the tax hostility measure is associated with a decrease in prices of 11.2% for constrained utilities. The overall effect of the rate covenant on the constrained group is calculated as $\beta \times \overline{\text{Tax Hostility}} + \psi_1 = .075$, where $\overline{\text{Tax Hostility}}$ is the average tax hostility in the constrained group.

Using the full range of the constrained group's tax hostility distribution, which varies from -2.218 to 2.637, the predicted price response is -19% to 35%. This result is consistent with the predicted effect of tax hostility: constrained utilities that serve populations that are more hostile to tax increases are unable to raise rates to the same extent as similar utilities in less hostile areas following a large fiscal shock.

Because constrained utilities with higher tax hostility measures raise prices less, the pecking order would predict a reduction in expenses for constrained utilities in more tax-hostile areas. This is what I find. The remaining columns in Table 12 demonstrate the repercussions of tax hostility on budget cuts following the drought restrictions. I find significant variation in the constrained group's expense response: a standard deviation increase in the tax hostility measure is associated with a decrease in O&M expenses and water expenses of 12.3% and 21.0%, respectively. The overall spending response of an average rate covenant-constrained utility is a reduction in O&M expenses of 2.9% and water system expenses of 9.5%. I also find a negative but insignificant relationship between tax hostility and administrative expenses in the constrained group.

As further evidence in favor of the rate covenant binding for constrained utilities, I fail to find a significant relationship between tax hostility and spending changes in the unconstrained group. I examine this relationship in Table 12, by examining the coefficients associated with Tax Hostility. Rate covenant-unconstrained utilities could exhibit their own unique constraints, captured by my measure of political frictions. For example, I find that tax hostility is significantly related to price increases in the unconstrained group. A standard deviation increase in tax hostility in the unconstrained group of utilities is associated with an 9.7% increase in prices following the drought shock. For the average utility in the unconstrained group, the predicted change in prices is $\psi_2 \times \overline{\text{Tax Hostility}} = -.004$, where $\overline{\text{Tax Hostility}}$ is the average tax hostility in the unconstrained group. The full range of predicted price responses for the unconstrained group, which has tax hostility measures that vary from -2.371 to 1.903 standard deviations, is -22% to 18%. In Appendix table D.4, I find that this result can primarily be explained by controlling for income and population, which does not affect the interaction term β. However, across all expense specifications, I cannot reject zero relationship between tax hostility and changes in log expenses. Because these utilities are unconstrained with respect to their rate covenants, I do not find evidence in favor of adjustment in expenses.

The average budget response to the drought restrictions in the rate covenant-constrained group masks important heterogeneity. I find evidence consistent with a pecking order: governments that fail to raise sufficient revenues following fiscal shocks cut expenses. Constrained utilities on average raise prices and revenues; however, constrained utilities that have frictions in the ability to raise revenues reduce expenses on the water system. I propose a new measure of heterogeneity, tax hostility, that affects a water utility's ability to raise revenues following shocks. I find that constrained utilities with populations that are predicted to have a higher "no"-vote share on tax increase referenda raise rates less than utilities with populations that are more amenable to tax increases. As a result of this, I find that constrained utilities in more tax-hostile areas cut expenses more than other constrained utilities. Notably, this expense effect is absent for unconstrained utilities. Because expenses are measured as expenses per million gallons of water delivered, the effect I measure is not due to a decrease in the overall quantity of water delivered and resulting drop in the total amount of variable costs of water delivery.

7 Conclusion

In this paper, I study how debt contracts affect the operation of municipal water utilities. Using a sample of California water utilities, I demonstrate that granting a lien on municipal revenues and enforcing bondholder protections affects the budgetary decisions of local officials. I find that when approaching covenant thresholds, utilities raise prices and cut their operations and maintenance expenses. Utilities that are more constrained by their covenants raise prices more following drought restrictions.

The cuts to operating expenses are severe when rate covenants are most binding. I find evidence that administrative expenses are most sensitive to distance to the covenant threshold, which is partly explained by a reduction in the premium paid to the general manager of the utility. However, utilities persistently reduce expenses on treatment, transmission, and distribution costs in response to distance to the rate covenant threshold, even far away from the violation threshold. This has implications for the well-being of water systems: system breaks and leaks increase in response to tightening covenants in the region where contractual constraints are most binding.

My results speak to the role of revenue debt in municipal settings as a constraint on operational decisions. The rate covenant in particular has disciplinary features coming from a reduction in administrative overhead, but it also constrains utilities following severe fiscal shocks.

References

Adelino, Manuel, Igor Cunha, and Miguel A. Ferreira, 2017, The economic effects of public financing: Evidence from municipal bond ratings recalibration, *Review of Financial Studies* 30, 3223–3268.

Agrawal, Ashwini, and Daniel Kim, 2021, Municipal bond insurance and the U.S. drinking water crisis, *Working paper* .

Ahern, Kenneth A., 2021, The business of city hall, *NBER working paper* .

Alesina, Alberto, and Roberto Perotti, 1995, The political economy of budget deficits, *International Monetary Fund Staff Papers* 42, 1–31.

Alesina, Alberto, and Roberto Perotti, 1996, Fiscal discipline and the budget process, *The American Economic Review* 86, 401–407.

Alsan, Marcella, and Claudia Goldin, 2019, Watersheds in child mortality: The role of effective water and sewerage infrastructure, 1880-1920, *Journal of Political Economy* 127, 586–638.

Altonji, Joseph G., Todd E. Elder, and Christopher R. Taber, 2005, Selection on observed and unobserved variables: assessing the effectiveness of Catholic schools, *Journal of Political Economy* 113, 151–184.

Anderson, D. Mark, Kerwin Kofi Charles, and Daniel I. Rees, forthcoming, Public health efforts and the decline in urban mortality, *American Economic Journal: Applied Economics* .

Besley, Timonty, and Michael Smart, 2007, Fiscal restraints and voter welfare, *Journal of Public Economics* 91, 755–773.

Besley, Timothy, 2006, *Principled agents? The political economy of good government* (Oxford University Press, New York).

Borusyak, Kirill, and Peter Hull, 2021, Non-random exposure to exogenous shocks: theory and applications, *Working paper* .

Buettner, Thiess, and David E. Wildasin, 2006, The dynamics of municipal fiscal adjustment, *Journal of Public Economics* 90, 1115–1132.

Chava, Sudheer, and Michael R. Roberts, 2008, How does financing impact investment? The role of debt covenants, *Journal of Finance* 63, 2085–2121.

Cutler, David, and Grant Miller, 2005, The role of public health improvements in health advances: The twentieth-century United States, *Demography* 443, 1–22.

Dagostino, Ramona, 2019, The impact of bank financing on municipalities' bond issuance and the real economy, *Working paper* .

Demerjian, Peter R., and Edward L. Owens, 2016, Measuring the probability of financial covenant violation in private debt contracts, *Journal of Accounting and Economics* 61, 433–447.

Denzau, Arthur T., Robert J. Mackay, and Carolyn L. Weaver, 1981, *On the initiative-referendum option and the control of monopoly government* (The Urban Institute).

Dichev, Ilia D., and Douglas J. Skinner, 2002, Large–sample evidence on the debt covenant hypothesis, *Journal of Accounting Research* 40, 1091–1123.

Falato, Antonio, and Nellie Liang, 2016, Do creditor rights increase employment risk? Evidence from loan covenants, *Journal of Finance* 71, 2545–2590.

Glaeser, Edward L., 2013, *Urban public finance*, volume 5 (Elsevier B.V.).

Glaeser, Edward L., and James M. Poterba, 2020, Introduction to economic analysis and infrastructure investment, in *Economic Analysis and Infrastructure Investment* (University of Chicago Press).

Green, Daniel, 2019, Corporate refinancing, covenants, and the agency cost of debt, *Working paper* .

Li, Hanyi Livia, 2020, Finance, public goods, and migration, *Working paper* .

Lian, Chen, and Yueran Ma, 2021, Anatomy of corporate borrowing constraints , *Quarterly Journal of Economics* 136, 229—-291.

Manson, Steven, Jonathan Schroeder, David Van Riper, Tracy Kugler, and Steven Ruggles, 2021, IPUMS National Historical Geographic Information System: Version 16.0 , [dataset], Minneapolis, MN: IPUMS.

Murfin, Justin, 2012, The supply-side determinants of loan contract strictness, *Journal of Finance* 67, 1565–1601.

Myers, Sean, 2021, Public employee pensions and municipal insolvency, *Working paper* .

Nini, Greg, David C. Smith, and Amir Sufi, 2009, Creditor control rights and firm investment policy, *Journal of Financial Economics* 92, 400–420.

Novy-Marx, Robert, and Joshua D. Rauh, 2011, Public pension promises: How big are they and what are they worth?, *Journal of Finance* 66, 1211–1249.

Novy-Marx, Robert, and Joshua D. Rauh, 2014, The revenue demands of public employee pension promises, *American Economic Journal: Economic Policy* 6, 193–229.

Oster, Emily, 2019, Unobservable selection and coefficient stability: theory and evidence, *Journal of Business and Economic Statistics* 37, 187–204.

Poterba, James M., 1994, State responses to fiscal crises: the effects of budgetary institutions and politics, *Journal of Political Economy* 102, 799–821.

Roberts, Michael R, and Amir Sufi, 2009, Control rights and capital structure: an empirical investigation, *The Journal of Finance* 64, 1657–1695.

Smith, Clifford W. Jr., and Jerold B. Warner, 1979, On financial contracting: an analysis of bond covenants, *Journal of Financial Economics* 7, 117–161.

Stantcheva, Stefanie, 2021, Understanding tax policy: how do people reason?, *The Quarterly Journal of Economics* 136, 2309–2369.

Figure 1: Rate Covenant Example

An example of a rate covenant from Stinson Beach County Water District's 2013 private placement Refunding Bond Agreement with Bank of Nevada. Issuance documents are from the CDIAC's database. The top panel discusses the rate covenant. The bottom panel discusses necessary actions the water district must take upon violation of a rate covenant.

(a) Bond Agreement Rate Covenant

Section 5.3. Rates, Fees, and Charges. (a) The District will, at all times while the Refunding Bonds remains outstanding, fix, prescribe and collect rates, fees and charges in connection with the Enterprise so as to yield Revenues at least sufficient, after making reasonable allowances for contingencies and errors in the estimates, to pay the following amounts in the order set forth below:

(1) All Maintenance and Operation Costs of the Enterprise;

(2) The Debt Service payments and all other payments (including payments under reimbursement agreements) with respect to all Parity Obligations as they become due and payable;

(3) All payments required to meet any other obligations of the District that are charges, liens, encumbrances upon, or which are otherwise payable from the Revenues during such Fiscal Year.

(b) Furthermore, the District shall fix, prescribe, revise and collect rates, fees and charges for the services and facilities furnished by the Enterprise during each Fiscal Year which are sufficient to yield estimated Net Revenues which are at least equal to one hundred twenty-five percent (125%) of the aggregate amount of Debt Service on all Parity Obligations payable from Net Revenues coming due and payable during such Fiscal Year. The District may make adjustments, from time to time, in its rates, fees and charges as it deems necessary, but shall not reduce its rates, fees and charges below those in effect unless the Net Revenues resulting from such reduced rates, fees and charges shall at all times be sufficient to meet the requirements set forth in this paragraph.

(b) Following Violation

(c) If the District violates the covenants set forth in subsections (a) or (b) hereof, such violation shall not, in and of itself, be a default under this Loan Agreement and shall not give rise to a declaration of an Event of Default so long as (i) Net Revenues (calculated without taking into account any amounts transferred into the Revenue Fund from the Rate Stabilization Fund pursuant to subsection (e) below), are at least equal to the Debt Service coming due and payable during such Fiscal Year, and (ii) within 120 days after the date such violation is discovered, the District either (y) transfers enough moneys from the Rate Stabilization Fund sufficient to yield estimated Net Revenues which are at least equal to one hundred twenty-five percent (125%) of the aggregate amount of Debt Service on all Parity Obligations payable from Net Revenues coming due and payable during such Fiscal Year in compliance with subsection (b) hereof, or (z) hires an Independent Financial Consultant to review the revenues and expenses of the Enterprise, and abides by such consultant's recommendations to revise the schedule of rates, fees, expenses and charges, and to revise any Maintenance and Operation Costs insofar as practicable, and to take such other actions as are necessary so as to produce Net Revenues to cure such violation for future compliance; provided, however, that, if the District does not, or can not, transfer from the Rate Stabilization Fund the amount necessary to comply with subsection (b) hereof, or otherwise cure such violation within twelve (12) months after the date such violation is discovered, an Event of Default shall be deemed to have occurred under Section 6.1(a)(2) hereof.

Figure 2: Rate Covenant Tightness

I plot the histogram of covenant tightness, proxied by distance to the rate covenant threshold normalized by the standard deviation of the debt service and winsorized at the 1% level:

$$\text{Covenant Slack}_{it} = -1 \times \frac{\text{Distance to Threshold}_{it}}{SD(\text{Coverage Ratio})_i}$$

The coverage ratio is defined as:

$$\text{Coverage Ratio} = \frac{\text{Gross Revenues - O\&M Expenses}}{\text{Revenue Bond Principal and Interest Payments}}$$

There is a significant spike in mass at the 0 threshold.

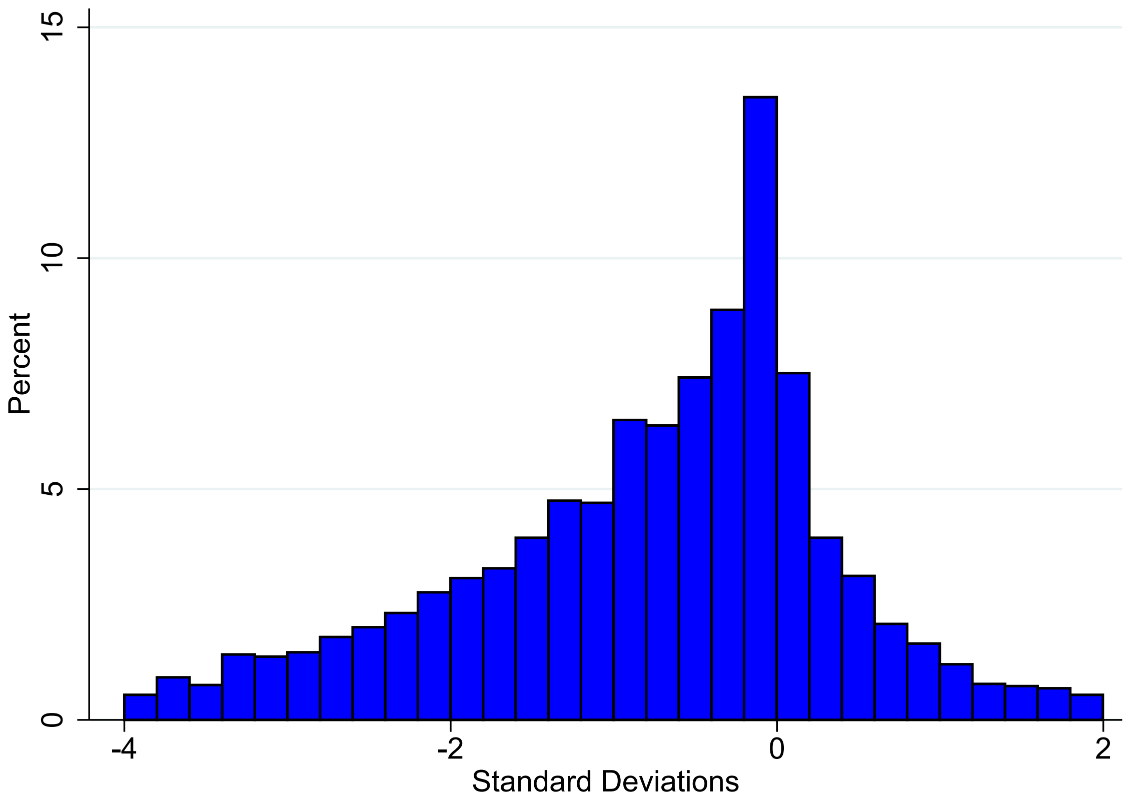


Figure 3: Revenues and Expenses Following Covenant Violations

I plot outcomes in the three years prior to and three years following a covenant violation. The plots contain the coefficients β_k from the regression:

$$\Delta(Y_{ijtk}) = \gamma_i + \delta_t + \beta_k + \psi X_{jt-1} + \varepsilon_{ijtk}$$

This specification is run at the utility i, county j, time t, time since violation k level. I include both utility and time fixed effects, and control for the lagged county unemployment rate in X_{jt-1}. Standard errors are clustered at the utility i level. The top figure represents the change in the log of gross revenues, which are operating revenues plus additional non-operating revenues that are pledged. The bottom figure is the change in total operations and maintenance expenses, which are total operating expenses minus depreciation expense. Negative values on the x-axis depict fiscal years leading up to the covenant violation and positive values represent fiscal years following the covenant violation. The sample consists of utility-year observations between 2003 and 2019 where: (1) a utility's coverage ratio tightness measure is greater than 0 in time 0, representing a violation; (2) there were no covenant violations in the three years prior to the violation; and (3) there are a full 7 years of data surrounding each covenant violation, which restricts the sample to covenant violations that occur between 2006 and 2016. All coefficients are depicted relative to the base year, period 0, with 95% confidence intervals. Regressions adjust for utility and year fixed effects, and standard errors are clustered at the utility level.

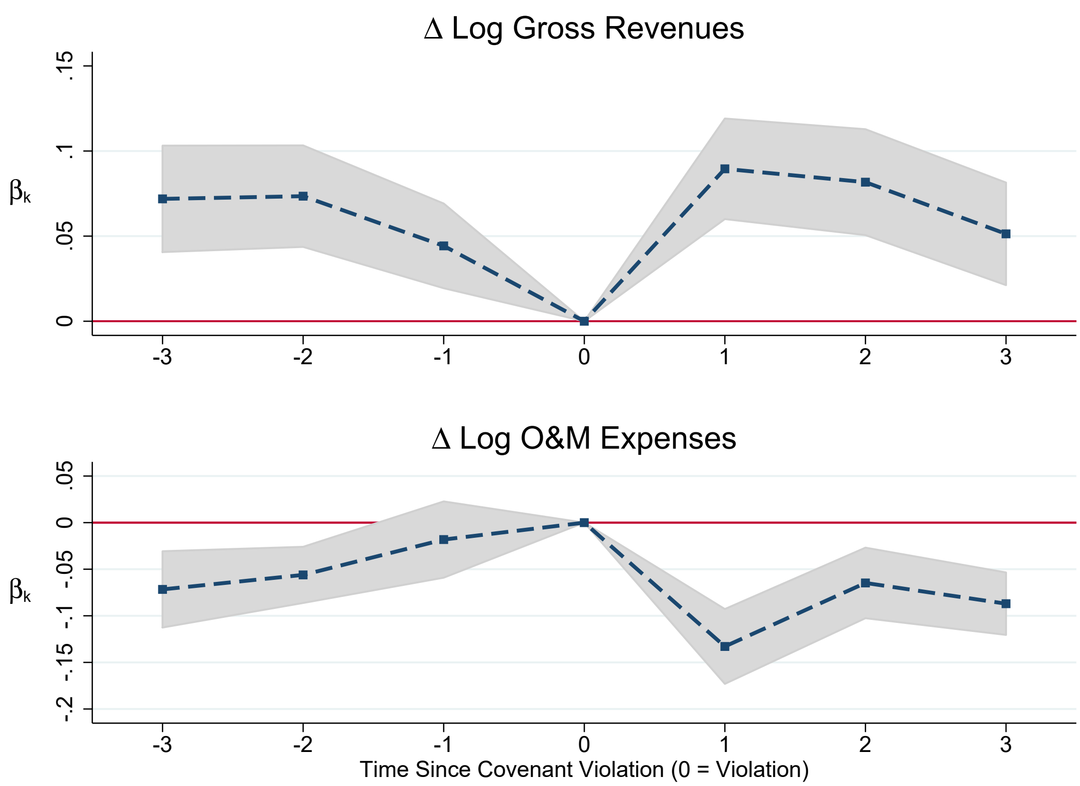


Figure 4: Covenant Tightness and Changes in Operating Revenues and Expenses

I present a kernel-weighted local polynomial regression of the yearly change in log gross revenues and O&M expenses between t and $t-1$ against lagged $t-1$ covenant tightness for California water utilities. I winsorize all variables at the 1% level. Covenant tightness is proxied by:

$$\text{Covenant tightness}_{it} = -1 \times \frac{\text{Distance to Threshold}_{it}}{SD(\text{Coverage Ratio})_i}$$

The coverage ratio is defined as:

$$\text{Coverage Ratio} = \frac{\text{Gross Revenues - O\&M Expenses}}{\text{Revenue Bond Principal and Interest Payments}}$$

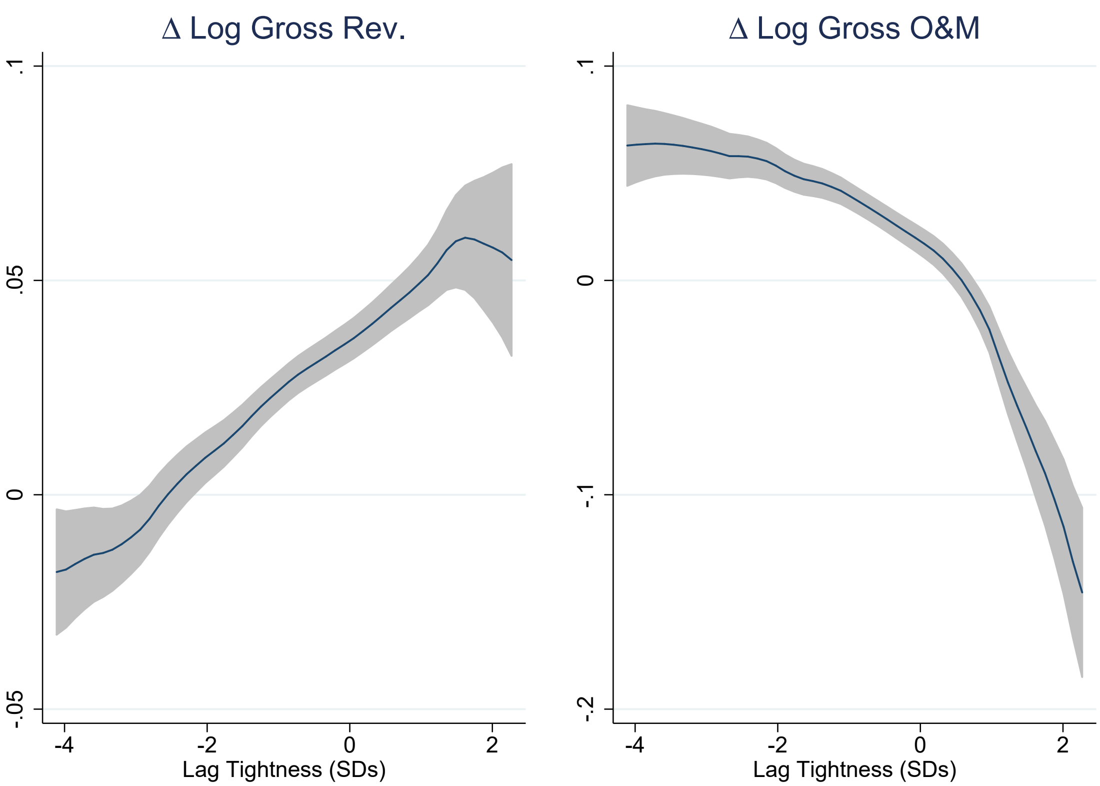


Figure 5: Pecking Order: Heterogeneity in Budget Outcomes

This figure plots the coefficients in Table 6. The y-axis represents the βs from the following regression:

$$Y_{ijt} = \gamma_i + \delta_t + \beta \text{Cov. Tightness}_{ij,t-1} \times \text{Tercile}_{ij,t-1} + \psi \text{Unemploy. Rate}_{j,t-1} + \varepsilon_{ijt}$$

Covenant Tight.$_{ij,t-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. I interact this with a variable, Tercile$_{ij,t-1}$, which is an indicator variable for the top, middle, and bottom terciles of the Covenant Tight.$_{ij,t-1}$ distribution. The coefficients are grouped in three by outcome variables, listed along the x-axis at the bottom of the figure. The first category represents β for the bottom tercile of the distribution of Covenant Tight.$_{ij,t-1}$, which are relatively unconstrained utilities. The middle category represents β for the middle tercile of the distribution of Covenant Tight.$_{ij,t-1}$. The third category is the β for the top tericle of the distribution of Covenant Tight.$_{ij,t-1}$, which are very constrained utilities. All specifications include utility-level γ_i and year δ_t fixed effects, as well as the lagged county-level unemployment rate. Standard errors are all clustered at the utility level. The first group of coefficients shows results for the change in log gross revenues. The second group shows results for the change in log water source expenses, which combines water supply and pumping expense into one category. The third group shows results for the change in log water retail expenses, which combine treatment, transmission, and distribution costs into one category. The last group shows results for the change in log administrative and other expenses, which includes all gross O&M expenses that cannot be chargeable to one of the water functions.

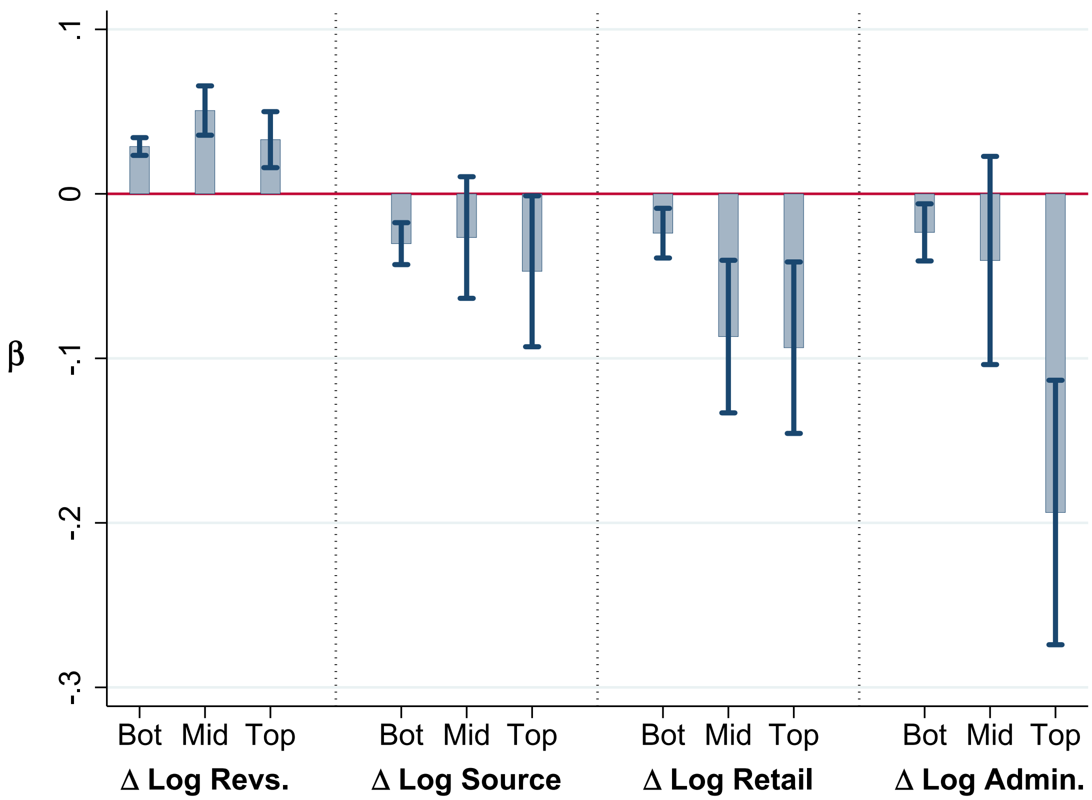


Figure 6: Pecking Order: $1 Allocation

This figure plots the coefficients βs from the following regression:

$$\Delta Y_{ijt} = \gamma_i + \delta_t + \beta \text{Covenant "Deficit"}_{ij,t-1} \times \text{Tercile}_{ijt} + \varepsilon_{ijt}$$

Covenant "Deficit"$_{ij,t-1}$ is the lagged difference between realized net revenues and the rate covenant specified minimum required net revenues, expressed per capita. I interact this with a variable, Tercile, which is an indicator variable for the top, middle, and bottom thirds of the covenant tightness distribution. The coefficients are grouped in three based on these terciles, listed along the x-axis at the bottom of the figure. The first group represents β for the bottom third of the distribution of covenant tightness, which are relatively unconstrained utilities. The middle group represents β for the middle third of the distribution of covenant tightness. The third group is the β for the top third of the distribution of covenant tightness, which are very constrained utilities. All specifications include utility-level γ_i and year δ_t fixed effects. Standard errors are all clustered at the utility level. Each bar corresponds to a different outcome variable, expressed as changes in per capita budget items. The first bars in purple denote gross revenues. The second bars in orange denote administrative expenses. The third bars in blue denote water system expenses. Each estimated coefficient is listed above (below) the bars. The overall budget reponse, how much utilities respond to a $1 move toward covenant thresholds, is listed above each tercile group.

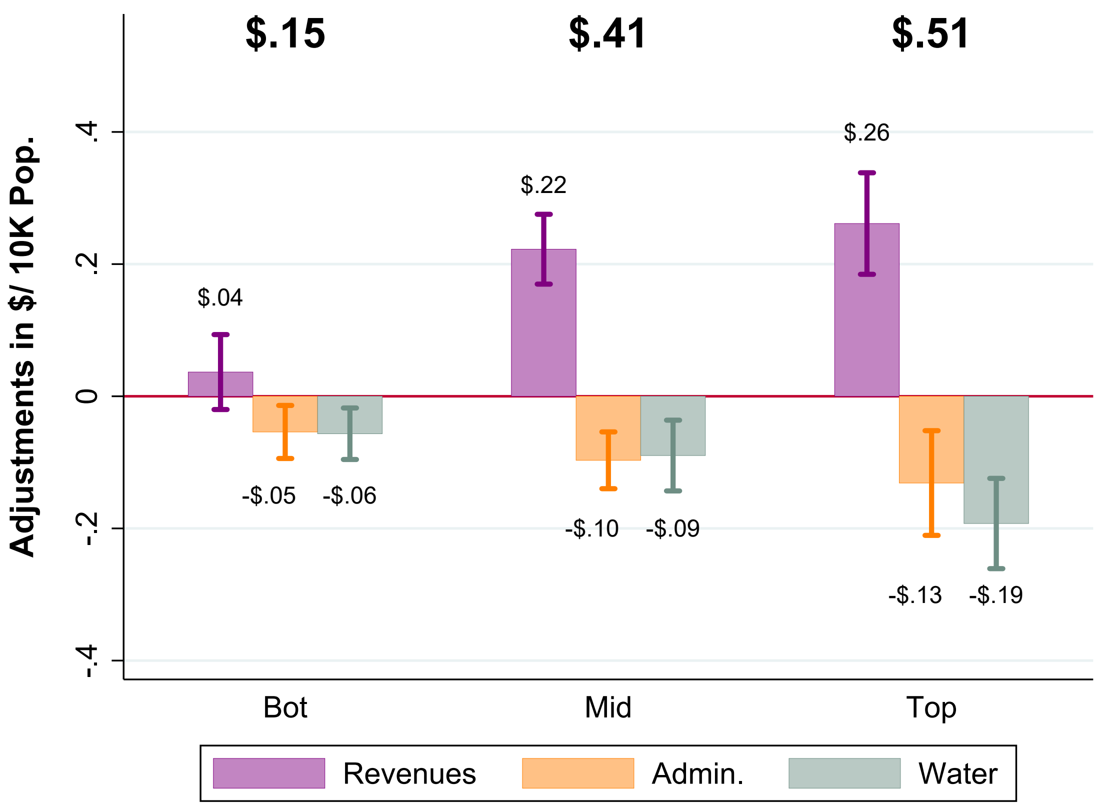
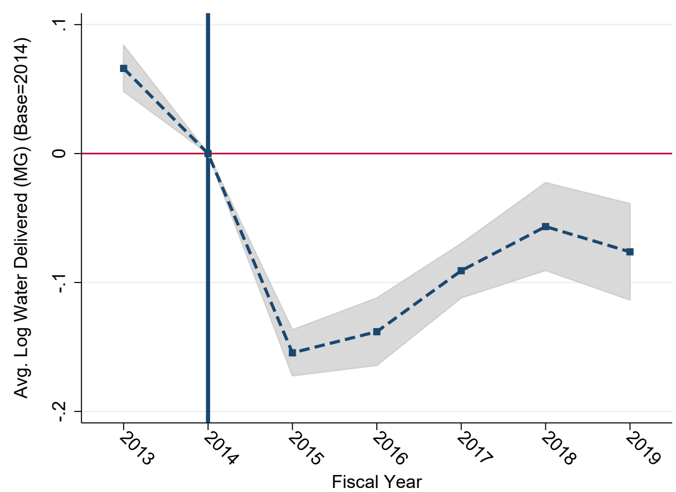


Figure 7: Drought Restrictions and Initial Outcomes: Quantities and Consumption

I plot average water quantity outcomes over the course of 2013 to 2019. The top figure plots the log of annual water delivered in million gallons for the sample of urban water suppliers that have water data available from the California State Water Board's EAR dataset. The emergency declaration date in 2014 is indicated with a solid blue line. The top panel plots the log of annual water delivered and the bottom panel plots average monthly residential gallons per capita daily (R-GPCD). Data in the bottom panel are from the California State Water Resources Control Board's Urban Water Supplier Monthly Reports, available from 2014 through 2020. In the bottom panel, I only analyze the second half of each year in the data because 2014 data only includes June through December. Because water consumption is seasonal, I account for month fixed effects. I also account for utility level fixed effects. 95% confidence intervals are plotted around the coefficient estimating the average outcome relative to 2014. The 2014 R-GPCD was 121.3 on average and the average log of water delivered was 10.24.

(a) Log annual water delivered



(b) Average monthly residential gallons per capita daily

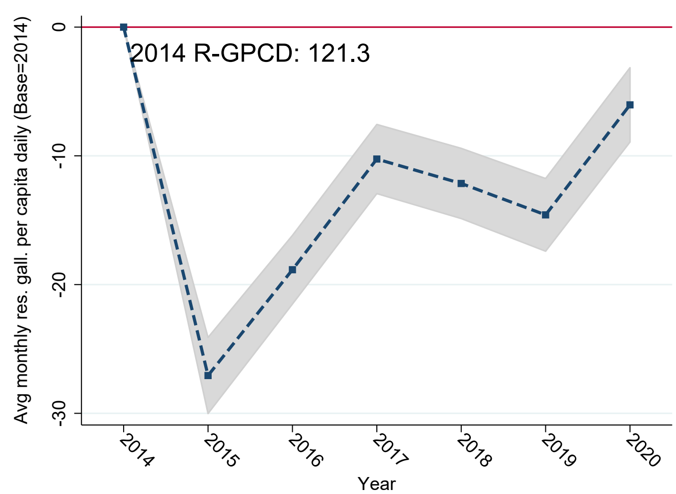


Figure 8: Revenues of Urban Water Suppliers Following Drought Restrictions

I plot the average change in outcomes for urban water suppliers in the sample of water districts by fiscal year. The figure plots the log of water sales revenues in levels. The time period includes 2010 to 2019. The points on the plot are the β_t from the following regression, with 2014 serving as the base year:

$$Y_{it} = \gamma_i + \beta_t + \varepsilon_{it}$$

The plot includes 95% confidence intervals and a vertical line indicates the date of the drought emergency declaration.

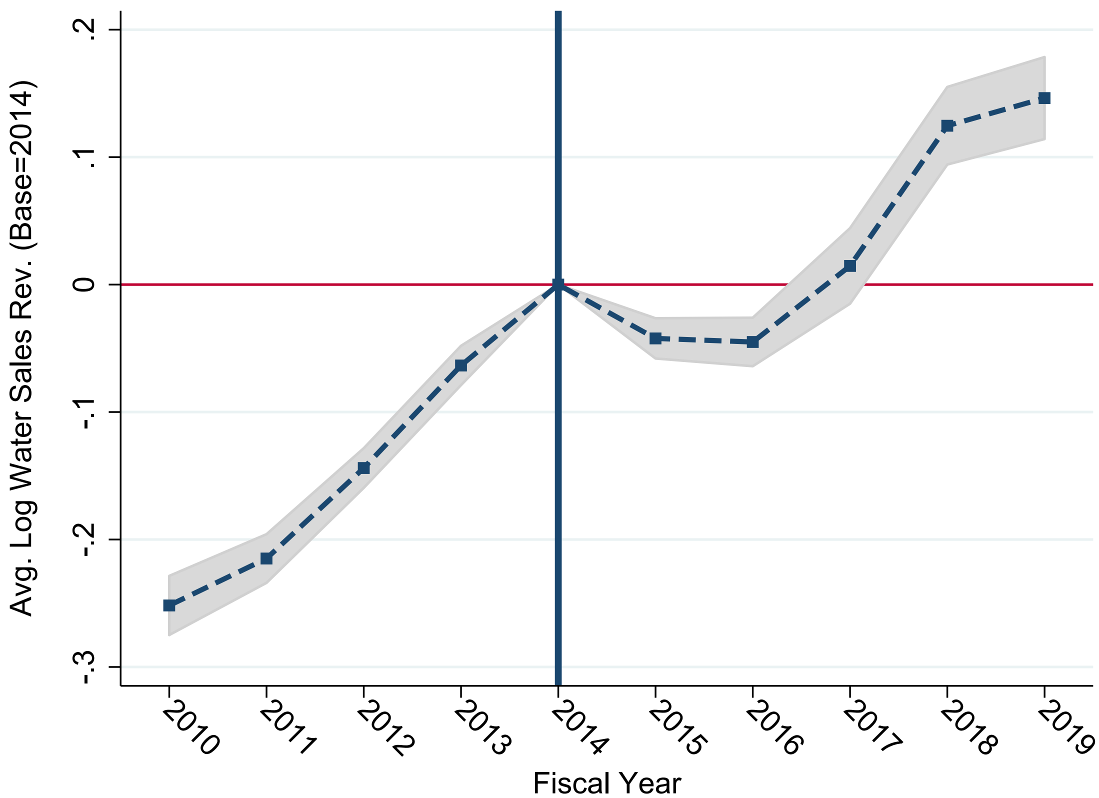


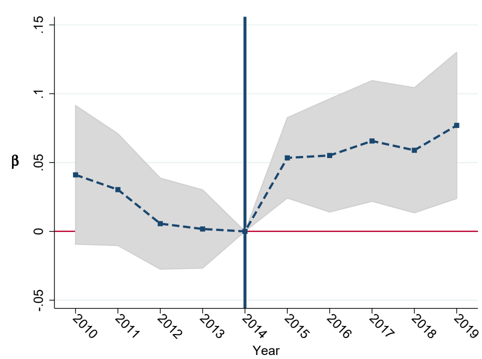
Figure 9: Effect of Droughts on Water Utilities: Rate Covenants

This figure presents the coefficients β_t from the regression:

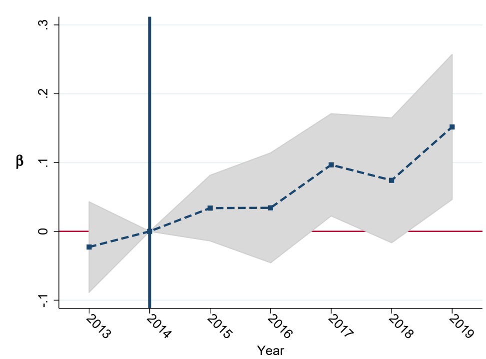
$$Y_{ijt} = \gamma_i + \delta_t + \beta_t Constrained_{ij} + \psi X_{j,t-1} + \varepsilon_{ijt}$$

This specification is run at the utility i, year t level. Y_{it} are the outcomes of interest, log gross revenues and log gross O&M expenses on both an aggregate basis and per million gallons of water delivered. O&M expenses are defined as total operating expenses minus depreciation. Constrained$_i$ is assigned based on average covenant slack between 2010 and 2014. Utilities in the bottom 50% percentile are coded with a value of 1. β_t represents the differences-in-differences coefficients over time, with a base year of 2014, the last year in the pre-period. Panel 9a depicts the coefficients β_t for log gross revenues. Panel 9b depicts coefficients for outcome log price, which is water sales revenues per million gallons of water delivered. Panel 9c depicts β_t for log gross O&M expenses, with gross O&M expenses on a per million gallon basis reported in Panel 9d. Finally, Panel 9e reports the log of water delivered in million gallons. Panels 9a and 9b are reported from years 2009 to 2019 and the remaining panels use data from 2013 to 2019. I control for utility i and time fixed effects, and cluster standard errors at the utility i level. I also control for previous period county-level unemployment rates.

(a) Log Gross Revenues

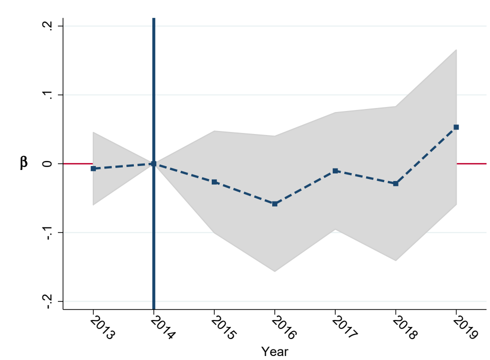


(b) Log "Price"



(c) Log Gross O&M

(d) Log Gross O&M/Million Gallons



(e) Log Water Delivered in MG

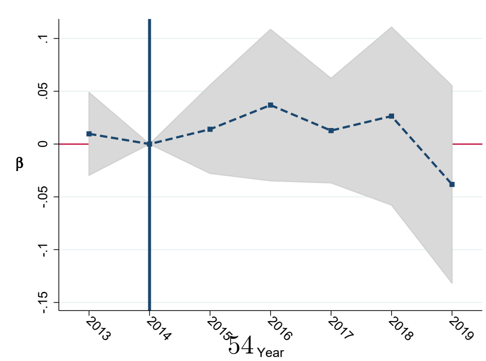


Table 1: Summary Statistics

Financial data is from the California Financial Transactions Report, covering fiscal years 2003 to 2019. *Log Gross Revenues* is the log of gross revenues as defined in the text. *Log Gross O&M Expenses* is the log of total reported operating expenses minus reported depreciation expense. *Op. Revenues/Gross O&M Ratio* is the ratio of total operating revenues to gross O&M expenses. *Log Water Source Expenses* is the log of the sum of water purchases, groundwater replenishment, and pumping expense. *Log Water Retail Expenses* is the log of the sum of water treatment and transmission and distribution expenses. *Log All Functional Water Expenses* is the log of the sum of water source expenses and water retail expenses. This encompasses all expenses that an entity reports chargeable to a particular function. *Log General and Admin. Expenses* is calculated as Gross O&M Expenses minus all functional water expenses. This includes expenses that cannot be charged to a particular function as well as customer billing and sales expenses. I adjust all financial variables for inflation using CPI-U, and winsorize at the 1% level. *Log Census Population* is the log of the population living within the reported service boundaries. I calculate this by merging data on public water system boundaries to Census data on block boundaries. I then sum up the populations for all blocks within a water system's boundaries. *Median Household Income* is from the Census American Community Survey. I calculate a weighted average of the block-group level median household income using the proportion of the total water system's population that lives in each block group. *Covenant tightness* is defined as:

$$\text{Covenant tightness}_{it} = -1 \times \frac{\text{Distance to Threshold}_{it}}{SD(\text{Coverage Ratio})_i}$$

The coverage ratio is defined as:

$$\text{Coverage Ratio} = \frac{\text{Gross Revenues - O\&M Expenses}}{\text{Revenue Bond Principal and Interest Payments}}$$

Log Revenue Debt Outstanding is the log of the total water revenue debt principal amount outstanding. Importantly, it does not capture general obligation debt, assessment bonds, or equipment leases. *Log # Employees* is the total number of employees employed by the water district or "parent" department. *Gen. Manager Wage Premium* is the base wage of the general manager or department director as a percent of the median employee's base wage. Both of these employment variables are from the California State Controller's Government Compensation in California database. *County Unemployment Rate* is from the BLS. *System Problems* is the sum of reported system problems from EAR data, and includes service connection breaks, main breaks and leaks, water outages, and boil water orders.

	N	Mean	SD	P25	P50	P75
Log Gross Revenues	10574	14.303	2.122	12.792	14.393	16.01
Log O&M Expenses	10573	14.051	2.095	12.579	14.072	15.728
Operating Revenues/Gross O&M Ratio	10574	1.263	0.419	1.015	1.196	1.44
Log General and Admin. Expenses	10558	12.529	3.144	11.354	13.029	14.496
Log All Functional Water Expenses	10572	12.585	4.047	11.421	13.322	15.233
Log Water Source Expenses	8340	12.92	2.566	10.986	13.033	15.062
Log Water Retail Expenses	8649	12.665	2.232	11.137	12.931	14.374
Log Census Population (Block-Level)	10557	8.937	2.193	7.217	9.09	10.633
Median Household Income	9295	64,173	27,101	45,430	58,318	77,388
Covenant Tightness	4351	-0.781	1.224	-1.473	-0.539	-0.026
Log Revenue Debt Outstanding	4472	15.311	3.063	14.159	15.782	17.112
Log # Employees	4594	48.486	88.204	7	17	48
Gen. Manager Wage Premium	2906	1.188	0.655	0.686	1.144	1.615
County Unemployment Rate	10574	8.422	4.002	5.2	7.6	10.6
System Problems	3798	3.095	1.776	1.609	3.178	4.382

Table 2: Revenues and Expenses Following Covenant Violations

This table reports coefficients of the following regression for utility i of county j in fiscal year t for the three years k surrounding a covenant violation:

$$Y_{ijtk} = \gamma_i + \delta_t + \beta Post_k + \psi X_{j,t-1} + \varepsilon_{ijtk}$$

$Post_k$ is an indicator variable that takes the value 1 in the years 0 to 3 following a covenant violation. Outcome variables Y_{itk} include gross revenues in column 2 and operating and maintenance expenses in column 3, defined as total operating expenses minus depreciation expense. The last column analyzes water revenue debt outstanding. I include utility-level fixed effects γ_i and fiscal year fixed effects δ_t in all specifications and cluster standard errors at the utility level. I also include the county-level lagged unemployment rate in $X_{j,t-1}$. The sample consists of utility-fiscal year observations between 2003 and 2019 where: (1) a utility's coverage ratio tightness measure is greater than 0 in time 0, representing a violation; (2) there were no covenant violations in the three years prior to the violation; and (3) there are 7 years of data surrounding each covenant violation, which restricts the sample to covenant violations that occur between 2006 and 2016.

	(1) Δ Log Gross Revenues	(2) Δ Log O&M Expenses
Post Violation	0.0638***	-0.0993***
	(0.0147)	(0.0182)
Unemploy. Rate$_{t-1}$	-0.0209***	-0.000889
	(0.00682)	(0.0103)
Observations	1,046	1,046
R-squared	0.175	0.135
FE	Entity/Year	Entity/Year
Cluster	Entity	Entity

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

Table 3: Covenant Tightness and Operating Decisions: Prices and Revenues

This table reports coefficients from the following regression at the utility i, county j, year t (ijt) level:

$$Y_{ijt} = \gamma_i + \delta_t + \beta \text{Covenant Tight.}_{ij,t-1} + \psi X_{jt} + \varepsilon_{ijt}$$

Covenant Tight.$_{ij,t-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. The left hand side variables are first differences in log outcomes. Columns 1 and 2 report results for the change in log "price", which is defined as water sales revenues per million gallons of water delivered. Columns 3 and 4 report the results for the change in log gross revenues. All specifications include utility-level γ_i. Columns 1 and 3 control for the lagged county-level unemployment rate and a year fixed effect δ_t. Columns 2 and 4 include county-year fixed effects. In these columns, I also include δ, which is the degree of selection on unobservables relative to observables that would be necessary for β to equal 0. I use Oster (2019)'s suggestion for R-max (the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls) of 1.3 times the R-squared from the fully controlled regression specifications in columns 2 and 4. Utility-level fixed effects are treated as controls. Standard errors are all clustered at the utility level.

	(1) Δ Log "Price"	(2) Δ Log "Price"	(3) Δ Log Gross. Revenues	(4) Δ Log Gross Revenues
Cov. Tight. (SDs)$_{t-1}$	0.0320***	0.0202***	0.0288***	0.0276***
	(0.00766)	(0.00750)	(0.00256)	(0.00294)
County Unemploy. Rate$_{t-1}$ (%)	0.0197**		-0.00783***	
	(0.00949)		(0.00262)	
Observations	1,140	1,099	4,096	3,936
R-squared	0.174	0.355	0.164	0.327
E[LHS]	.044	.044	.027	.027
δ		1.7528		7.0401
FE	Entity/Year	Entity/County-Year	Entity/Year	Entity/County-Year
Cluster	Entity	Entity	Entity	Entity

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

Table 4: Covenant Tightness and Operating Decisions: Water System Expenses and Quality

This table reports coefficients from the following regression at the utility i, county j, year t (ijt) level:

$$Y_{ijt} = \gamma_i + \delta_t + \beta \text{Covenant Tight.}_{ij,t-1} + \psi X_{jt} + \varepsilon_{ijt}$$

Covenant Tight.$_{ij,t-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. The first two columns report results for the change in the log of all water expenses, which combines retail and water source expenses into one category. Columns 3 and 4 report results for the change in log water retail expenses, which is a subcategory of all water expenses and combines transmission, distribution, and treatment expense into one category. The last two columns report the population-weighted change in the number of reported distribution problems, which includes breaks, leaks, water outages, and boil water orders. I weight the raw change in system problems by the Census Population divided by 10,000. All specifications include utility-level fixed effects γ_i. Columns 1, 3, and 5 control for the lagged county-level unemployment rate and a year fixed effect δ_t. Columns 2, 4, and 6 include county-year fixed effects. In these columns, I also include δ, which is the degree of selection on unobservables relative to observables that would be necessary for β to equal 0. I use Oster (2019)'s suggestion for R-max (the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls) of 1.3 times the R-squared from the fully controlled regression specifications in columns 2, 4, and 6. Utility-level fixed effects are treated as controls. Standard errors are all clustered at the utility level.

	(1) Δ Log All Water Exp.	(2) Δ Log All Water Exp.	(3) Δ Log Retail Exp.	(4) Δ Log Retail Exp.	(5) Δ Sys. Problems/ 10K	(6) Δ Sys. Problems/ 10K
Cov. Tight. (SDs)$_{t-1}$	-0.0383***	-0.0368***	-0.0326***	-0.0298***	-0.504	-0.205
	(0.00456)	(0.00516)	(0.00652)	(0.00732)	(1.014)	(1.437)
County Unemploy. Rate$_{t-1}$ (%)	-0.0102*		-0.00992		1.005	
	(0.00537)		(0.00657)		(1.512)	
Observations	3,857	3,702	3,348	3,213	1,338	1,275
R-squared	0.072	0.299	0.076	0.307	0.063	0.290
E[LHS]	.018	.018	.017	.017	-.356	-.356
δ		8.4205		8.0055		.4043
FE	Entity/Year	Entity/County-Year	Entity/Year	Entity/County-Year	Entity/Year	Entity/County-Year
Cluster	Entity	Entity	Entity	Entity	Entity	Entity

Standard standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Covenant Tightness and Operating Decisions: Administrative Expenses and Wages

This table reports coefficients from the following regression at the utility i, county j, year t (ijt) level:

$$Y_{ijt} = \gamma_i + \delta_t + \beta \text{Covenant Tight.}_{ij,t-1} + \psi X_{jt} + \varepsilon_{ijt}$$

Covenant Tight.$_{ij,t-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. The first two columns report results for the change in log administrative and other expenses, which includes all gross O&M expenses that cannot be chargeable to one of the water functions. Columns 3 and 4 report the results for the change in log number of department employees. The last two columns report results for the general manager's wage mark-up over the median employee, which is expressed as a ratio. All specifications include utility-level fixed effects. Columns 1, 3, and 5 control for the lagged county-level unemployment rate and a year fixed effect δ_t. Columns 2, 4, and 6 include county-year fixed effects. In these columns, I also include δ, which is the degree of selection on unobservables relative to observables that would be necessary for β to equal 0. I use Oster (2019)'s suggestion for R-max (the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls) of 1.3 times the R-squared from the fully controlled regression specifications in columns 2 and 4. Utility-level fixed effects are treated as controls. Standard errors are all clustered at the utility level. .

	(1) Δ Log Admin & Oth. Exp.	(2) Δ Log Admin & Oth. Exp.	(3) Δ Log # Employees	(4) Δ Log # Employees	(5) Gen. Manager Wage Premium	(6) Gen. Manager Wage Premium
Cov. Tight. (SDs)$_{t-1}$	-0.0517***	-0.0514***	-0.0152**	-0.0214***	-0.0293**	-0.0286*
	(0.00684)	(0.00736)	(0.00682)	(0.00758)	(0.0132)	(0.0158)
County Unemploy. Rate$_{t-1}$ (%)	0.00297		0.000846		-0.00579	
	(0.00594)		(0.00924)		(0.0205)	
Observations	3,900	3,750	2,125	2,052	1,526	1,471
R-squared	0.060	0.256	0.071	0.308	0.803	0.847
E[LHS]	.03	.03	-.012	-.012	1.188	1.188
δ		5.457		9.5339		-25.7657
FE	Entity/Year	Entity/County-Year	Entity/Year	Entity/County-Year	Entity/Year	Entity/County-Year
Cluster	Entity	Entity	Entity	Entity	Entity	Entity

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

Table 6: Pecking Order: Heterogeneity in Budget Outcomes

This table reports coefficients from the following regression at the utility i, county j, year t (ijt) level:

$$Y_{ijt} = \gamma_i + \delta_t + \beta \text{Cov. Tightness}_{ij,t-1} \times \text{Tercile}_{ij,t-1} + \psi \text{Unemploy. Rate}_{j,t-1} + \varepsilon_{ijt}$$

Covenant Tight.$_{ij,t-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. I interact this with an indicator variable, Tercile$_{ij,t-1}$, which is an indicator variable for the top, middle, and bottom terciles of the Covenant Tight.$_{ij,t-1}$ distribution. This regression is identical to running specification 5 for each part of the Covenant Tight.$_{ij,t-1}$ distribution separately. The variable Top Third$\times$ Cov. Tight$_{t-1}$ is the coefficient of the effect of covenant tightness on Y_{ijt} for values of Cov. Tight$_{t-1}$ in the top third of the distribution. The variable Middle Third$\times$ Cov. Tight$_{t-1}$ is the coefficient of the effect of covenant tightness on Y_{ijt} for values of Cov. Tight$_{t-1}$ in the middle third of the distribution. The variable Bottom Third$\times$ Cov. Tight$_{t-1}$ is the coefficient of the effect of covenant tightness on Y_{ijt} for values of Cov. Tight$_{t-1}$ in the bottom third of the distribution. The left hand side variables Y_{ijt} are changes in log outcomes for financial variables. All specifications include utility-level γ_i and fiscal year δ_t fixed effects, as well as the lagged county-level unemployment rate. Standard errors are all clustered at the utility level. The first column reports results for the change in log gross revenues. The second column reports results for the change in log administrative and other expenses, which includes all gross O&M expenses that cannot be chargeable to one of the water functions. The third column reports results for the change in log water retail expenses, which combine treatment, transmission, and distribution costs into one category. The last column reports the change in log water source expenses, which combines water supply and pumping expense into one category. These coefficients are also depicted in Figure 5.

	(1) Δ Log Gross Revs.	(2) Δ Log Admin Exp.	(3) Δ Log Water Retail Exp.	(4) Δ Log Water Source Exp.
Bottom Third$\times$Cov. Tight$_{t-1}$	0.0288***	-0.0234***	-0.0239***	-0.0303***
	(0.00274)	(0.00883)	(0.00768)	(0.00648)
Middle Third$\times$Cov. Tight$_{t-1}$	0.0506***	-0.0405	-0.0868***	-0.0265
	(0.00762)	(0.0322)	(0.0236)	(0.0188)
Top Third$\times$Cov. Tight$_{t-1}$	0.0329***	-0.194***	-0.0935***	-0.0471**
	(0.00865)	(0.0409)	(0.0265)	(0.0233)
County Unemploy. Rate$_{t-1}$ (%)	-0.00760***	0.00177	-0.0109	-0.0158*
	(0.00255)	(0.00730)	(0.00667)	(0.00939)
Observations	4,096	4,076	3,348	3,271
R-squared	0.166	0.061	0.082	0.082
E[LHS]	.027	.026	.017	.009
FE	Entity/Year	Entity/Year	Entity/Year	Entity/Year
Cluster	Entity	Entity	Entity	Entity

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

Table 7: Pecking Order: Heterogeneity in Real Outcomes

This table reports coefficients from the following regression at the utility i-county j-year t (ijt) level:

$$Y_{ijt} = \gamma_i + \delta_t + \beta \text{Cov. Tightness}_{ij,t-1} \times \text{Tercile}_{ij,t-1} + \psi \text{Unemploy. Rate}_{j,t-1} + \varepsilon_{ijt}$$

Covenant Tight.$_{ij,t-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. I interact this with an indicator variable, Tercile$_{ij,t-1}$, which is an indicator variable for the top, middle, and bottom thirds of the Covenant Tight.$_{ij,t-1}$ distribution. This regression is identical to running specification 5 for each part of the Covenant Tight.$_{ij,t-1}$ distribution separately. The variable Top Third$\times$ Cov. Tight$_{t-1}$ is the coefficient of the effect of covenant tightness on Y_{ijt} for values of Cov. Tight$_{t-1}$ in the top third of the distribution. The variable Middle Third$\times$ Cov. Tight$_{t-1}$ is the coefficient of the effect of covenant tightness on Y_{ijt} for values of Cov. Tight$_{t-1}$ in the middle third of the distribution. The variable Bottom Third$\times$ Cov. Tight$_{t-1}$ is the coefficient of the effect of covenant tightness on Y_{ijt} for values of Cov. Tight$_{t-1}$ in the bottom third of the distribution. The left hand side variables Y_{ijt} are the real outcomes. All specifications include utility-level γ_i and fiscal year δ_t fixed effects, as well as the lagged county-level unemployment rate. Standard errors are all clustered at the utility level. The first column reports results for the change in log "price", which is defined as water sales revenue divided by million gallons water delivered. The second column reports results for the change in log number of department employees. The third column reports results for general manager wage premiums, which is the ratio version of the percentage increase of the general manager base wage to the median department employee wage. The last column reports the change system problems, which includes pipe breaks, water outages, and boil water orders, weighted by the Census population (per 10 thousand people).

	(1) Δ Log "Price"	(2) Δ Log # Employees	(3) Gen. Manager Wage Premium	(4) Δ Sys. Problems/ 10K
Bottom Third×Cov. Tight$_{t-1}$	0.0272***	-0.0120	-0.0211	-1.349
	(0.00837)	(0.00808)	(0.0147)	(1.252)
Middle Third×Cov. Tight$_{t-1}$	0.0353	-0.00216	-0.0263	-2.926
	(0.0227)	(0.0230)	(0.0332)	(3.163)
Top Third×Cov. Tight$_{t-1}$	0.0642***	-0.0293*	-0.0715**	4.182**
	(0.0212)	(0.0164)	(0.0349)	(2.119)
County Unemploy. Rate$_{t-1}$ (%)	0.0192**	0.000767	-0.00587	0.944
	(0.00958)	(0.00925)	(0.0204)	(1.514)
Observations	1,140	2,125	1,526	1,338
R-squared	0.176	0.072	0.803	0.064
E[LHS]	.044	-.012	1.188	-.356
FE	Entity/Year	Entity/Year	Entity/Year	Entity/Year
Cluster	Entity	Entity	Entity	Entity

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

Table 8: Balancing: Covenant Constrained v. Covenant Unconstrained

This table reports summary statistics for treated (constrained) and control (unconstrained) groups in the rate covenant constraint experiment. The sample includes urban water suppliers with drought restrictions. The control group is defined as suppliers with an average covenant tightness measure (defined below) in the bottom 50th percentile of the group. The treated are suppliers in the top 50th percentile. The sample period is 2010 to 2019, and the statistics as averages in the pre-period, 2010-2014. I report the mean of each group as well as the p-value of the test of the difference in means. *Covenant Tightness* is the average covenant tightness for utilities that report revenue debt outstanding between 2010 and 2014. *Commercial, Institutional, Industrial Share Water* is the share of total water delivered that is delivered to the commercial sector. *Log Population* is the log of the population living within the reported service boundaries. Δ *Pop. (%) '00-'10* is calculated as the change in log population between 2010 and 2000. *Median Household Income* is the weighted average of the block-group level median household income measured using the 2010-2014 American Community Survey. Δ *County Building Permits* is the percent change in county-level unit building permits between 2000 and 2005, from the Census Residential Building Permits Survey. *County Unemploy. Rate* is the county unemployment rate, from the Bureau of Labor Statistics. *Tax Hostility Index* is a normalized index that predicts the share of "no" votes on a given tax referendum measure using demographic data measured prior to 2010. Details on construction are included in Appendix E. *Drought Restriction Tier* is the state-assigned tier corresponding to drought restrictions. Higher numbers required larger cuts in residential consumption. The corresponding conservation standard for tier 6 was a 24% reduction in water consumption relative to 2014 residential use.

	Unconstrained	Constrained	P(Difference)
N	92	93	-
Covenant Tightness	-1.586	-0.046	0.00
Log Operating Revenues	16.406	16.105	0.00***
Commercial, Institutional, Industrial Share Water (%)	17.8	18.4	0.67
Log Population	10.973	10.882	0.27
Log Med. House. Income	11.114	11.078	0.09
Δ Pop. (%),'00-'10	8.6	13.8	0.00***
Δ County Building Permits (%, units), '00-'05	17.586	33.251	0.02***
County Unemployment Rate (%)	10.561	11.027	0.05
Tax Hostility	-0.039	0.233	0.00***
Drought Restriction Tier	5.806	6.304	0.00***

Table 9: Effect of Rate Covenants and Droughts on Utilities: Outcomes per Million Gallons

This table reports coefficients of the following regression for utility i in county j for:

$$\Delta \log(Y_{ij}) = \gamma_j + \beta \text{Constrained}_i + \varepsilon_{ij}$$

Δ is the first difference operator: this specification collapses outcomes into pre- and post-period averages and takes the difference. $Constrained_i$ is an indicator variable equal to 1 if a water utility's average covenant tightness measure over the course of 2010 to 2014 is in the top 50th percentile. The indicator is set to 0 for utilities in the bottom 50th percentile. The treatment effect of interest is β. I do not include utilities without a rate covenant outstanding in the pre-period (2010-2014). In the first three columns, the outcome of interest is the change in log prices, which is water sales divided by million gallons of water delivered. In the last three columns, the outcome is the change in log gross O&M expenses per million gallons of water delivered. Standard errors are clustered at the county-level. Columns 2, 3, 5, and 6 include county fixed effects. In these columns, I also include δ, which is the degree of selection on unobservables relative to observables that would be necessary for β to equal 0. I use Oster (2019)'s suggestion for R-max (the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls) of 1.3 times the R-squared from the fully controlled regression specifications. Columns 3 and 6 estimate the direct effect of average covenant tightness in the pre-period on each of the outcomes. The time period of analysis is 2010 to 2019: however, water quantities are only available for 2013 through 2019. Thus, the time period for these outcomes is 2013 to 2019. The pre-period covers fiscal years prior to 2014 (inclusive), the post-period are years after 2014.

	Δ Log "Price"			Δ Log O&M/Million Gallons		
	(1)	(2)	(3)	(4)	(5)	(6)
Constrained	0.0937***	0.0924**		-0.00776	-0.0106	
	(0.0315)	(0.0366)		(0.0341)	(0.0359)	
Covenant Tightness (Pre)			0.0554***			-0.00422
			(0.0130)			(0.0109)
Constant	0.0991***	0.0984***	0.190***	0.261***	0.259***	0.250***
	(0.0241)	(0.0177)	(0.0111)	(0.0254)	(0.0173)	(0.00925)
Observations	154	143	143	154	143	143
R-squared	0.050	0.246	0.279	0.000	0.223	0.223
δ		6.0665	4.1323		2.0496	3.2385
FE	No	County	County	No	County	County
Cluster	County	County	County	County	County	County

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Effect of Rate Covenants and Droughts on Utilities: Gross Revenues and Expenses

This table reports coefficients of the following regression for utility i in county j for:

$$\Delta \log(Y_{ij}) = \gamma_j + \beta \text{Constrained}_i + \varepsilon_{ij}$$

Δ is the first difference operator: this specification collapses outcomes into pre- and post-period averages and takes the difference. $Constrained_i$ is an indicator variable equal to 1 if a water utility's average covenant tightness measure over the course of 2010 to 2014 is in the top 50th percentile. The indicator is set to 0 for utilities in the bottom 50th percentile. The treatment effect of interest is β. I do not include utilities without a rate covenant outstanding in the pre-period (2010-2014). In the first three columns, the outcome of interest is the change in log gross revenues. In the last three columns, the outcome is the change in log gross O&M expenses. Standard errors are clustered at the county-level. Columns 2, 3, 5, and 6 include county fixed effects. In these columns, I also include δ, which is the degree of selection on unobservables relative to observables that would be necessary for β to equal 0. I use Oster (2019)'s suggestion for R-max (the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls) of 1.3 times the R-squared from the fully controlled regression specifications. Columns 3 and 6 estimate the direct effect of average covenant tightness in the pre-period on each of the outcomes. The time period of analysis is 2010 to 2019. The pre-period covers fiscal years prior to 2014 (inclusive), the post-period are years after 2014.

	Δ Log Gross Revenues			Δ Log Gross O&M		
	(1)	(2)	(3)	(4)	(5)	(6)
Constrained	0.0448**	0.0402**		-0.0396**	-0.0334*	
	(0.0180)	(0.0190)		(0.0157)	(0.0165)	
Covenant Tightness (Pre)			0.0246***			-0.0242***
			(0.00773)			(0.00845)
Constant	0.0910***	0.0889***	0.130***	0.0954***	0.0902***	0.0529***
	(0.0159)	(0.00958)	(0.00656)	(0.0147)	(0.00831)	(0.00717)
Observations	185	173	173	185	173	173
R-squared	0.029	0.322	0.337	0.020	0.264	0.280
δ		7.4987	6.9235		4.6843	6.3256
FE	No	County	County	No	County	County
Cluster	County	County	County	County	County	County

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

Table 11: Effect of Rate Covenants and Droughts on Utilities: Admin and Water Expenses

This table reports coefficients of the following regression for utility i in county j for:

$$\Delta \log(Y_{ij}) = \gamma_j + \beta \text{Constrained}_i + \varepsilon_{ij}$$

Δ is the first difference operator: this specification collapses outcomes into pre- and post-period averages and takes the difference. $Constrained_i$ is an indicator variable equal to 1 if a water utility's average covenant tightness measure over the course of 2010 to 2014 is in the top 50th percentile. The indicator is set to 0 for utilities in the bottom 50th percentile. The treatment effect of interest is β. I do not include utilities without a rate covenant outstanding in the pre-period (2010-2014). In the first three columns, the outcome of interest is the change in log administrative expenses per million gallons of water delivered. These are all expenses not charged to a particular water function. In the last three columns, the outcome is the change in log water expenses per million gallons of water delivered. This is an aggregate category of both water source and retail expenses. Standard errors are clustered at the county-level. Columns 2, 3, 5, and 6 include county fixed effects. In these columns, I also include δ, which is the degree of selection on unobservables relative to observables that would be necessary for β to equal 0. I use Oster (2019)'s suggestion for R-max (the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls) of 1.3 times the R-squared from the fully controlled regression specifications. Columns 3 and 6 estimate the direct effect of average covenant tightness in the pre-period on each of the outcomes. The time period of analysis is 2010 to 2019. The pre-period covers fiscal years prior to 2014 (inclusive), the post-period are years after 2014.

	Δ Log Admin per MG			Δ Log Water Expense per MG		
	(1)	(2)	(3)	(4)	(5)	(6)
Constrained	0.0827	-0.00774		-0.145**	-0.0552	
	(0.0842)	(0.0818)		(0.0672)	(0.0527)	
Covenant Tightness (Pre)			-0.0122			-0.0154
			(0.0256)			(0.0171)
Constant	0.276***	0.311***	0.297***	0.182***	0.146***	0.107***
	(0.0425)	(0.0391)	(0.0216)	(0.0330)	(0.0243)	(0.0153)
Observations	147	136	136	144	132	132
R-squared	0.006	0.255	0.255	0.026	0.302	0.300
δ		-.2087	-1.0969		1.2617	1.3167
FE	No	County	County	No	County	County
Cluster	County	County	County	County	County	County

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12: Effect of Rate Covenants and Droughts on Utilities: Interactions with Tax Hostility

This table reports coefficients of the following regression for utility i in county j for:

$$\Delta \log(Y_{ij}) = \beta Constrained_i \times \text{Tax Hostility}_i + \psi_1 Constrained_i + \psi_2 \text{Tax Hostility}_i + \gamma_j + \varepsilon_{ij}$$

Δ is the first difference operator: this specification collapses outcomes into pre- and post-period averages and takes the difference. $Constrained_i$ is an indicator variable equal to 1 if a water utility's average covenant tightness measure over the course of 2010 to 2014 is in the top 50%. The indicator is set to 0 for utilities in the bottom 50%. The treatment effect of interest is β. I do not include utilities without a rate covenant outstanding in the pre-period (2010-2014). γ_j is a county-level fixed effect and I cluster errors at the county level. The outcomes of interest are all expressed as a ratio of million gallons. In order across the columns, they include water sales revenues, O&M expenses, water expenses (source and retail combined), and administrative expenses. The time period of analysis is 2013 to 2019, due to the availability of water quantity data. The pre-period covers fiscal years prior to 2014 (inclusive), the post-period are years after 2014.

	(1) Δ Log "Price"	(2) Δ Log O&M/Mill. Galls.	(3) Δ Log Water Exp./Mill. Galls.	(4) Δ Log Admin Exp./Mill. Galls.
Constrained × Tax Hostility	-0.112***	-0.123**	-0.210***	-0.163
	(0.0385)	(0.0541)	(0.0516)	(0.128)
Constrained	0.101***	-0.00198	-0.0458	-0.00147
	(0.0338)	(0.0369)	(0.0510)	(0.0847)
Tax Hostility	0.0966***	0.0512	0.0186	0.145
	(0.0331)	(0.0456)	(0.0441)	(0.117)
Observations	143	154	132	136
R-squared	0.282	0.296	0.335	0.267
FE	County	County	County	County
Cluster	County	County	County	County

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

A Data Appendix

A.1 FTR Utility Sample Construction

My sample consists of cities and special districts that have reported positive operating expenses and revenues in the water enterprise schedule of the Financial Transaction Report and are considered public water systems. City water providers are often enveloped into the city's public works department. However, city utilities are financially operated as an enterprise separate from the general government functions, where general government functions are backed by a pool of tax revenues. Special districts are created in order to meet a specific need of a local community, and so are responsible for a fewer number of services than cities. But special districts are still government entities that can raise taxes and are governed by publicly elected boards. The water enterprise of a special district is also financially independent from other enterprises (e.g., wastewater, electricity). I remove entities that have less than the full 17 years of data available and do not have cumulative annual financial reports (CAFR) available to gather additional data.[23] I also remove special districts that are unlikely to be water providers, by string-searching specific words in the entity's name.[24] Finally, I match entities to their public water system IDs and drop water districts that do not have service boundary data from the California State Water Resources Control Board. This step drops about 201 entities, including very large wholesalers (the Metropolitan Water District of Southern California) and many irrigation districts.

Subcategories of expenses and revenues are not standardized across entities. Practically, this is because cities, counties, and special districts file different report forms, although items like total operating expenses and total revenues are comparable across entities. But even within entities, different cities provide different water services and therefore have different reporting systems. In order to include analysis of subcategories, I adjust the data in the following manner. I combine treatment and transmission and distribution costs together, and combine source of water, groundwater, and pumping expenses together. Treatment and transmission and distribution are more directly related to the provision of water to retail customers, while pumping and source of water expenses are related to the acquisition of adequate water supplies. Importantly, this smooths out reporting irregularities in the individual categories, where water utilities may change how they report their expenses across years. For entities where I hand collect data, I collect total operating expenditures, depreciation, and other

[23] Infrequent reporters are also more likely to be inconsistent reporters of expense categories. This screen ensures that the sample consists of reliable reporters.

[24] Key terms that are dropped include: "STORAGE", "MAINTENANCE", "RESORT", "WATERSHED", "CONSERVATION", "FLOOD", "STORAGE", "BANK", "SITES PROJECT", "DESALTER", "CONTRACTORS", "RECLAMATION", "REPLENISHMENT", "RECREATION", "RIVER", "GROUNDWATER", "WATER MANAGEMENT", "WATER AND POWER", "WATER QUALITY", "AQUEDUCT", "CANAL", "WATER FACILITIES", and "CLEAN WATER". I also remove city financing authorities.

reported operating expenses that are not included in the FTR operating expenses (primarily taxes). I construct the functional expenses using the relevant subcategory's share of total operating expenses excluding depreciation in the previous year and multiply by the hand-collected CAFR operating expense minus depreciation.

Operating revenues similarly have a breakdown of customer type for special districts, and whether revenues are from within or outside city limits for cities. Because city and special district revenue subcategories are incomparable for most of the sample, I only examine total water operating revenues. I also collect certain nonoperating revenue items that are frequently classified as gross revenues in bond indentures. These include investment and interest income for all reports, and certain property taxes for special districts only. The property taxes include secured and unsecured property taxes apportioned by the county. This leaves out property assessments made on a non-ad valorem basis, special assessments, and voter-approved taxes. I use total operating revenues plus investment earnings as my measure of gross revenues for cities, and total operating revenues plus investment earnings and property taxes for special districts.

A.2 Identifying Revenue Bonds

I start with the FTR's debt schedules rather than issuance data because many entities issue bonds through joint powers authorities or financing authorities that are difficult to trace back to the underlying city. Starting with debt service schedules provides a detailed look at the overall financial position of a city that might be obscured by these conduit issuers. For cities, I identify water revenue bonds by filtering debt type to only consider certificates of participation and revenue bonds and then string-searching for key words related to water. I drop bonds that are wastewater bonds, and split joint water and wastewater obligations into their separate components using information from the bond official statements, where available. In cases where there is a joint revenue pledge, I drop the obligation in order to be conservative. I repeat the same string-search exercise for the capital lease obligation schedule because most revenue bonds issued by California cities are recorded on this schedule prior to 2017. I drop equipment leases from analysis, as these bonds are usually backed by the asset being financed rather than the revenues of the utility. I only use data from the Construction Financing and Other Long-Term Debt Schedules if an issue appeared on the lease or bonded debt schedule at some point, was inconsistently reported across years, or I could verify that the obligation is a revenue bond from bond documents.

Because special districts provide fewer services that cities, identifying water revenue bonds involves fewer steps. I start with the same long-term debt and capital lease schedules in the special district reports, and filter to revenue bonds and certificates of participation. Special districts report fewer bonds as capital leases than cities, but more bonds as other types of debts. Because most bonds are backed by water revenues, I start with the full sample of bonds and then filter out bonds backed by other revenues that I identify. Otherwise, the steps for identifying bonds are largely the same as for cities.

After identifying water revenue bonds, I verify that the bonds are correct and consistently reported across years. I verify using the CDIAC data that the use of funds for the identified bonds is for Water Supply, Storage, and Distribution or Public Works and Capital Improvements, and that the type of debt is a revenue or certificate of participation debt obligation. I also use the CDIAC's database to identify bond issues that are missing from the first pass of filtering, and find them in the other liability schedules. I drop bonds that are backed by tax assessments, lease payments with no lien on revenues, or are general obligation bonds.

A.3 Constructing Pledged Debt Service

I construct the pledged revenue bonded debt service by combining the principal payments and interest paid in each fiscal year for the set of bonds identified. In years when debt is defeased, but the defeased amount is mistakenly reported as a principal payment rather than an adjustment, I recode the principal payment as zero. I also verify that outstanding amounts are consistently reported across years, and adjust fiscal year end outstanding amounts to reflect defeased debt if the corresponding refunding debt is not reported on balance sheet until the next fiscal year. This ensures continuity in the outstanding debt measures.

I also take some basic steps to clean the data. I hand collect data on debt service in cases where data is missing for a couple of years using CAFRs and bond indentures (e.g. San Diego in 2006 and 2010); otherwise, I drop cities where there is a substantial amount of data missing and no CAFRs to verify outstanding amounts. I also clean common reporting mistakes, including duplicate debt obligations that are reported as both a bond and lease in the same fiscal year and mistakes in carrying forward the beginning outstanding amounts. I only include state and federal loan debt service when there is an outstanding revenue bond and the bond indenture specifically includes these loans as a prior obligation. Interest payments are not available at the issue-level for special districts from 2003-2016, so I rely on the overall water fund's reported interest on long-term debt. This overstates interest expense for large entities that have taxing authority and issue general obligation bonds (such as the Metropolitan Water

District of Southern California). However, I compare interest payments on revenue bonds identified in 2017-2019 to water utility interest expense and find that the difference between the two numbers for the 25th through 75th percentiles is 0.

A.4 Accounting for a large series break in reporting

There were two major changes to reporting in the California Transactions Report over the time period. These occurred in both the special district and cities report forms. I include the specific language from the report forms below.

1. In 2016, the instructions required reporting to be based on audited financial statements. This was a request in the previous reporting, and many entities complied. The effect of this on average was small.

2. In 2017, the report form changed and included several new categories so that the reports would be more aligned with GAAP reporting. Many entities did not change their reporting, but others did. The operating expense items added were:

    - Personnel services: "Report salaries, wages, and related employee benefits not chargeable to a particular operating function."
    - Contractual services: "Report all services rendered by outside agencies, individuals, or businesses under contractual agreement to perform such services not chargeable to a particular operating function."
    - Materials and supplies: "Report tangible goods that are acquired for use in a productive process not chargeable to a particular operating function. Also, report articles and commodities that are consumed or materially altered when used (e.g., office supplies, operating supplies, repair and maintenance supplies)."
    - Other operating expenses: "Report all other operating expenses for which a specific reporting category has not otherwise been provided." (This category was included in special district report forms historically.)

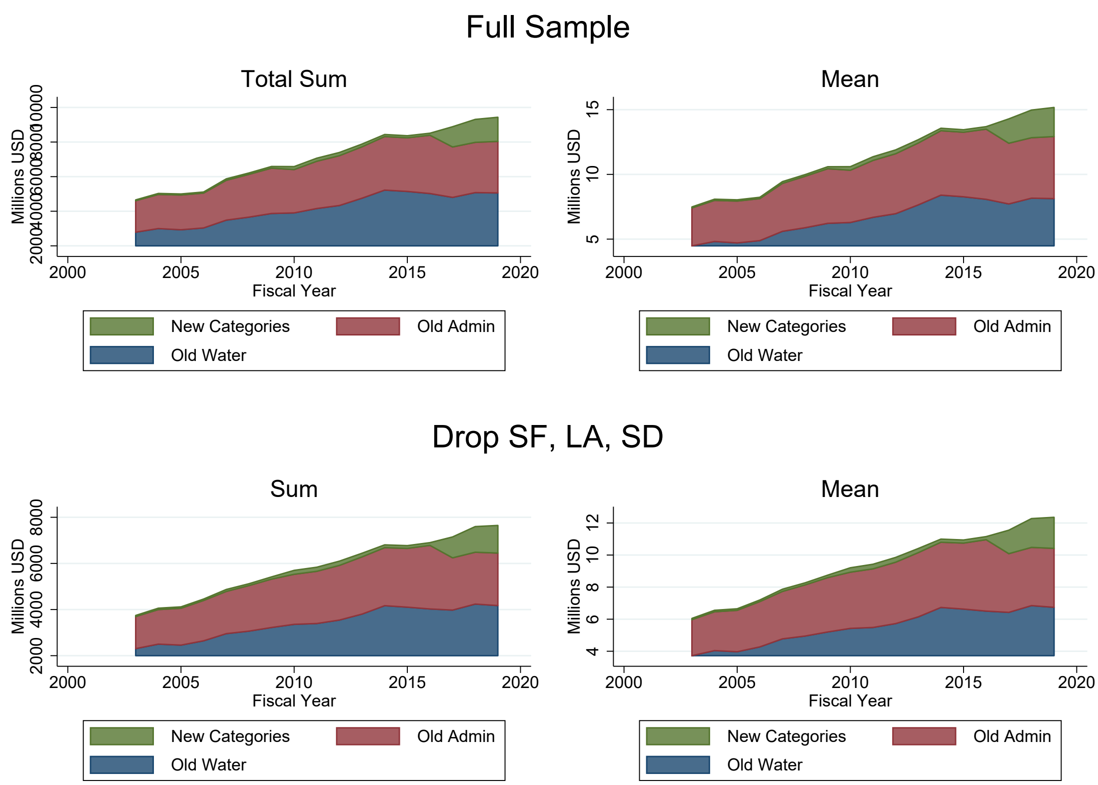
To demonstrate the series break effect, I classify expenses as follows:

- Old water: Water supply, pumping, treatment, transmission and distribution.
- Old admin: Administrative and general, customer accounting and collection, sales promotion (not included in special district report forms, but included in city report forms), depreciation expense.

- New categories: personnel services, contractual services, materials and supplies, other operating expenses

Effects are illustrated in Figure A.1. Both water supply and administrative expenses decline in 2017. I depict the sum and the mean of expenses. I also drop the largest cities in the bottom panels.

Figure A.1: Effect of Series Break: All Utilities

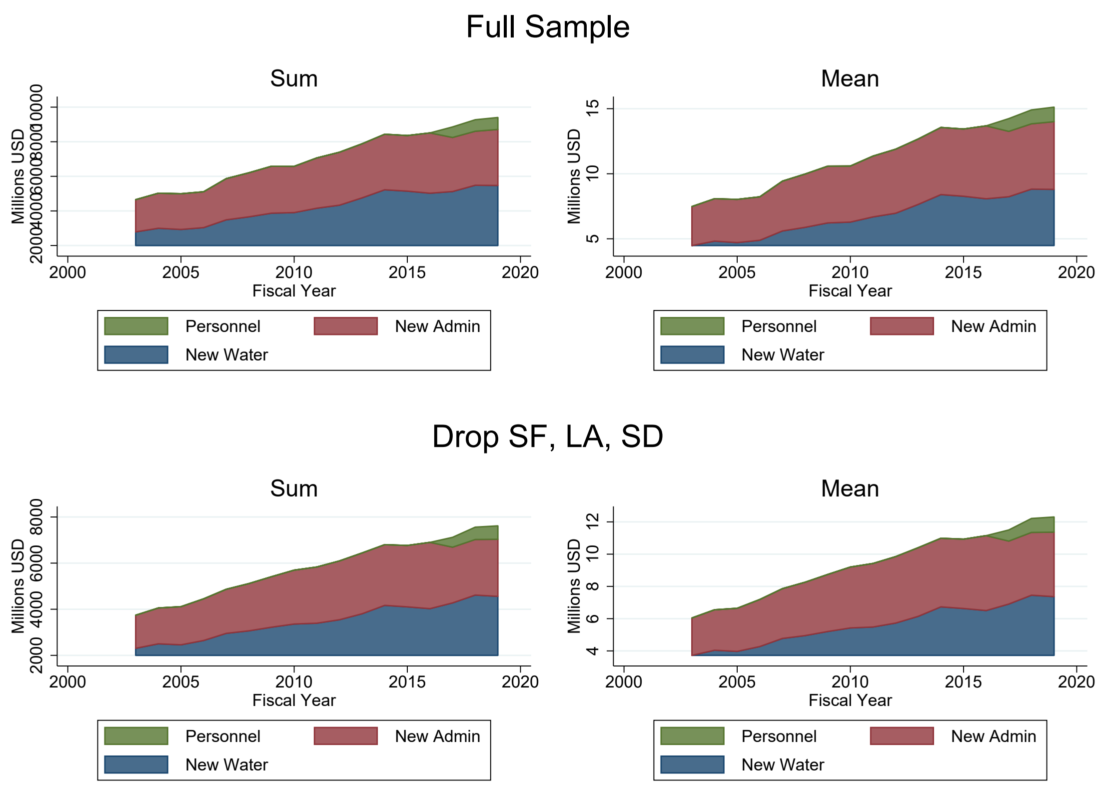


I make the following proposed adjustments, based on the definitions of the new reporting categories:

- New water: Water supply, pumping, treatment, transmission and distribution, contractual services, materials and supplies, .
- New admin: Administrative and general, customer accounting and collection, sales promotion, other operating expenses.
- Remainder: personnel services

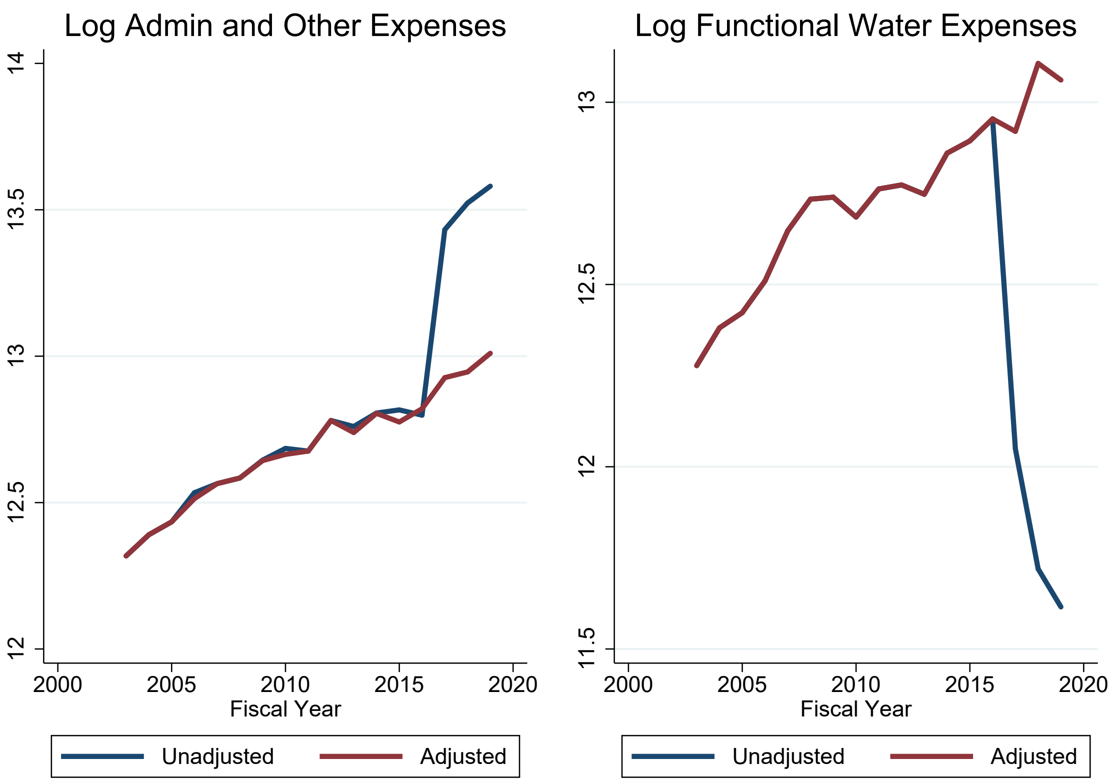
The new proposed categories are presented in Figure A.2. In terms of both averages and sums, the breakdown appears to capture the time series variation in these expense categories. There is a slight uptick in water expenses outside of the three largest cities, but this appears to capture the overall trend in operating expenses. Based on these figures, I classify personnel services as administrative expenses. This in line with the report form instructions, which dictates that personnel services are specifically nonchargeable to a particular operating function.

Figure A.2: Proposed New Categories: All Utilities



I plot the log of the adjusted and un-adjusted series for both the administrative/other expense category and function water expenses in Figure A.3. Importantly, I readjust the proposed series so that if a utility historical reports zero functional water expenses or zero admin expenses, they continue to do so.

Figure A.3: Proposed New Categories: Final Time Series (Log 1+ X)



B Budget Cuts Following Violations

Beyond establishing that the rate covenant threshold is a salient trigger point for utilities, the allocation of budget cuts has important implications for the operating efficiency of utilities and provision of public goods. For example, utilities that cut administrative and general expenses could be reducing discretionary spending and curbing labor costs. However, a utility that cuts treatment, transmission, and distribution expenses may be sacrificing water quality and deferring necessary maintenance expenses on pipes and infrastructure in order to comply with covenants. A utility that cuts its water source expenses may either be curbing the quantity of water delivered to users, or it could be saving money by finding cheaper sources of water.

I examine these margins of adjustment in Table B.1. This table reports results for regression equation 4. Now I consider outcome variables water retail, water source, and administrative and other expenses as well as revenue debt outstanding. Water retail expenses are treatment, transmission, and distribution expenses. Water source expenses are water purchases and groundwater pumping expenses. I classify administrative expenses as all other expenses that cannot be allocated to one of these two water functions. In order to prevent reporting inconsistencies from influencing the analysis of subcategories, I only examine violations where there are 7 years of the subcategory expense reported.

I find that the overall drop in growth rates is driven by a decline in both water retail expense growth in column 3 and administrative expenses in column 4. Water retail expense growth rates are 19.1% lower following a covenant violation. Administrative expenses are cut less, but are still 13.7% lower than the pre-period. Notably, the coefficients in columns 4 for water source expenses are insignificant. This suggests that margins of adjustment occur in both discretionary expense items and items related to the quality of the water system, but the overall quantity of water supplied is unaffected by budget cuts. Finally, I find that utilities reduce their outstanding water revenue debt following a covenant violation, although this primarily reflects the paying down of existing debt. Following a rate covenant violation, utilities do not expand their revenue debt stock, reflecting findings in the private debt covenant literature of declines in net debt issuance following covenant violations (Roberts and Sufi, 2009).

There are important dynamic effects to these findings, demonstrated in Figure B.1. The drop in administrative expense growth is largely a one period phenomenon following the covenant violation: although coefficients are persistently negative, I can reject that they are statistically different from 0 in periods 2 and 3. However, water retail growth rates are persistently lower in the entire post-violation period. In levels, utilities maintain both expense categories at period 0 levels in the years following a violation, despite increases in both in the periods before. However, pre-violation period acceleration in expenditures on the water system, particularly treatment, transmission, and distribution, is greatly reduced in the years following a violation.

Table B.1: Revenues and Expenses Following Covenant Violations

This table reports coefficients β of the following regression for utility i of county j in fiscal year t for the three years k surrounding a covenant violation:

$$\Delta Y_{ijtk} = \gamma_i + \delta_t + \beta Post_k + \psi X_{j,t-1} + \varepsilon_{ijtk}$$

$Post_k$ is an indicator variable that takes the value 1 in the years 0 to 3 following a covenant violation. Outcome variables Y_{itk} include the following operating expenses categories (in logs): water retail (treatment and transmission/distribution), water source (water supply and pumping), and administrative and other expenses (all non functional water expenses). The last column includes revenue debt outstanding. To minimize the effect of reporting changes on results, I only analyze violations where there are 7 years of each expense sub-category. The last column analyzes water revenue debt outstanding. I include utility-level fixed effects γ_i and fiscal year fixed effects δ_t in all specifications and cluster standard errors at the utility level. I also include the county-level lagged unemployment rate in $X_{j,t-1}$. The sample consists of utility-fiscal year observations between 2003 and 2019 where: (1) a utility's coverage ratio tightness measure is greater than 0 in time 0, representing a violation; (2) there were no covenant violations in the three years prior to the violation; and (3) there are 7 years of data surrounding each covenant violation, which restricts the sample to covenant violations that occur between 2006 and 2016. In order to prevent reporting inconsistencies from influencing the analysis of subcategories, I only examine violations where there are 7 years of the subcategory expense reported.

	(1) Δ Log Water Retail Expenses	(2) Δ Log Water Source Expenses	(3) Δ Log Admin/Other Expenses	(4) Δ Log Rev. Debt Outstanding
Post Violation	-0.191***	-0.0631	-0.137***	-0.777***
	(0.0473)	(0.0532)	(0.0499)	(0.252)
Unemploy. Rate$_{t-1}$	-0.0163	-0.00467	0.0319	0.229*
	(0.0267)	(0.0182)	(0.0291)	(0.124)
Observations	781	745	1,044	952
R-squared	0.135	0.097	0.074	0.194
FE	Entity/Year	Entity/Year	Entity/Year	Entity/Year
Cluster	Entity	Entity	Entity	Entity

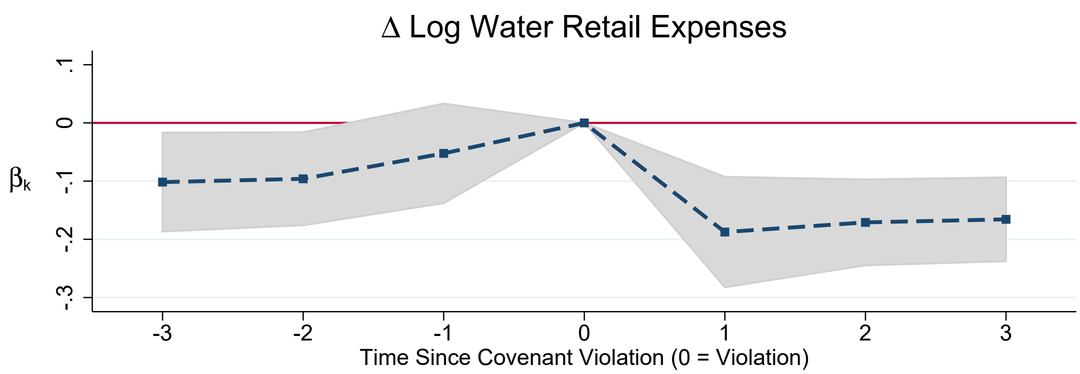
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

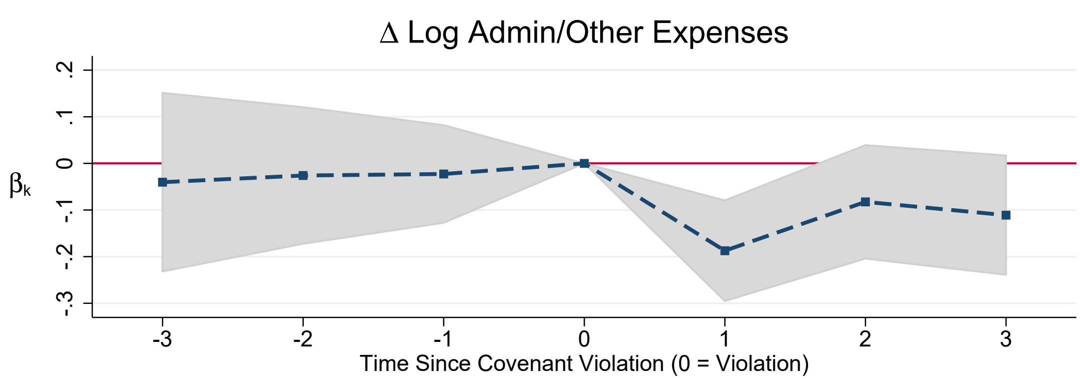
Figure B.1: Covenant Violations: Margins of Adjustment

I plot outcomes in the three years prior to and three years following a covenant violation. The plots contain the coefficients β_k from the regression:

$$\Delta(Y_{ijtk}) = \gamma_i + \delta_t + \beta_k + \psi X_{jt-1} + \varepsilon_{ijtk}$$

Which is run at the utility i, county j, time t, time since violation k level. I include both utility and time fixed effects, and control for the lagged county unemployment rate in X_{jt-1}. Standard errors are clustered at the utility i level. The top figure represents the change in the log of water retail expenses. The bottom figure is the change in the log of administrative and other expenses. Negative values on the x-axis depict fiscal years leading up to the covenant violation and positive values represent fiscal years following the covenant violation. The sample consists of utility-fiscal year observations between 2003 and 2019 where: (1) a utility's coverage ratio tightness measure is greater than 0 in time 0, representing a violation; (2) there were no covenant violations in the three years prior to the violation; and (3) there are 7 years of data for each subcategory reported surrounding each covenant violation, which restricts the sample to covenant violations that occur between 2006 and 2016. All coefficients are depicted relative to the base year, time 0, with 95% confidence intervals. Regressions adjust for utility and fiscal year fixed effects, and standard errors are clustered at the utility level.





C What Drives Variation in Covenant Tightness?

Covenant tightness is correlated both with the aggregate business cycle and local economic conditions. To demonstrate the relationship with the aggregate business cycle, I plot the time series of average covenant tightness in Figure C.1. The y-axis reports average covenant tightness across all utilities with a rate covenant outstanding. The x-axis reports the fiscal year. The Great Recession time period is indicated using the gray shaded region. Coverage ratios were relatively unconstrained prior to the financial crisis. The average covenant tightness is -.87 standard deviations on average prior to 2008. This period also coincided with a large increase in municipal borrowing. Covenants tightened considerably following the crisis: between fiscal years 2008 and 2011, covenant tightness was on average -.58 standard deviations. This tightening was due to the slowdown in new development and consequent lower revenue growth, new water quality regulations increasing operations costs, and debt service requirements for large outstanding debts. The years after the crisis have been marked by a slow recovery, as water utilities have improved their balance sheet position: covenant tightness after 2011 has been -.82 standard deviations on average.

In order to analyze how local economic conditions may be correlated with covenant tightness, I examine how variation in water deliveries is related to covenant tightness. Total water deliveries reflects water quantity demanded, which should be correlated with the development of local service areas. Similarly, deliveries to commercial, institutional, and industrial customers should be correlated with the overall economic development of the area. In Figure C.2, I plot coefficient β from the following regression:

$$\text{Cov. Tightness}_{ijt} = \beta \log \text{Water Deliveries}_{ijt} + \gamma_i + \varepsilon_{it}$$

I examine both total water deliveries and total water deliveries to commercial, institutional, and industrial customers. The first bar in each group of explanatory variables represents β from a specification with utility fixed effects and year fixed effects. I find in this specification that both total and commercial water deliveries are negatively related to covenant tightness. Positive shocks to water demand are correlated with decreases in covenant tightness. While I can reject zero effect for commercial water at the 5% level, the effect of all water deliveries on covenant tightness is weakly significant at the 10% level. When I control for county-level time varying unobservables by including county-year fixed effects, I find the effect of commercial water deliveries is slightly attenuated, and there is no longer a significant relationship between all water deliveries and covenant tightness.

Figure C.1: Rate Covenant Tightness Across the Business Cycle

I plot the business cycle variation in covenant tightness for California water utilities. The graph below plots average covenant tightness in each fiscal year (ending June 30). Covenant tightness is proxied by:

$$\text{Covenant tightness}_{it} = -1 \times \frac{\text{Distance to Threshold}_{it}}{SD(\text{Coverage Ratio})_i}$$

and is winsorized at the 1% level. The coverage ratio is defined as:

$$\text{Coverage Ratio} = \frac{\text{Gross Revenues - O\&M Expenses}}{\text{Revenue Bond Principal and Interest Payments}}$$

NBER Recession dates are indicated by the gray shaded region.

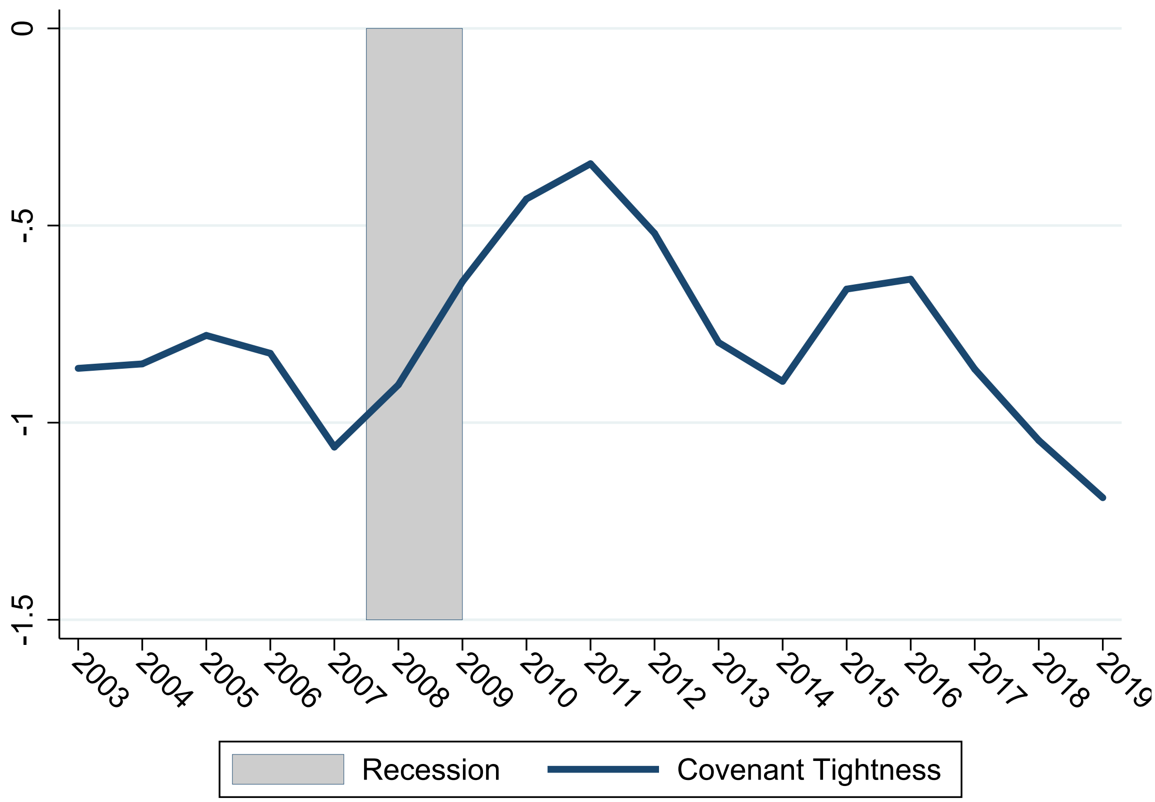
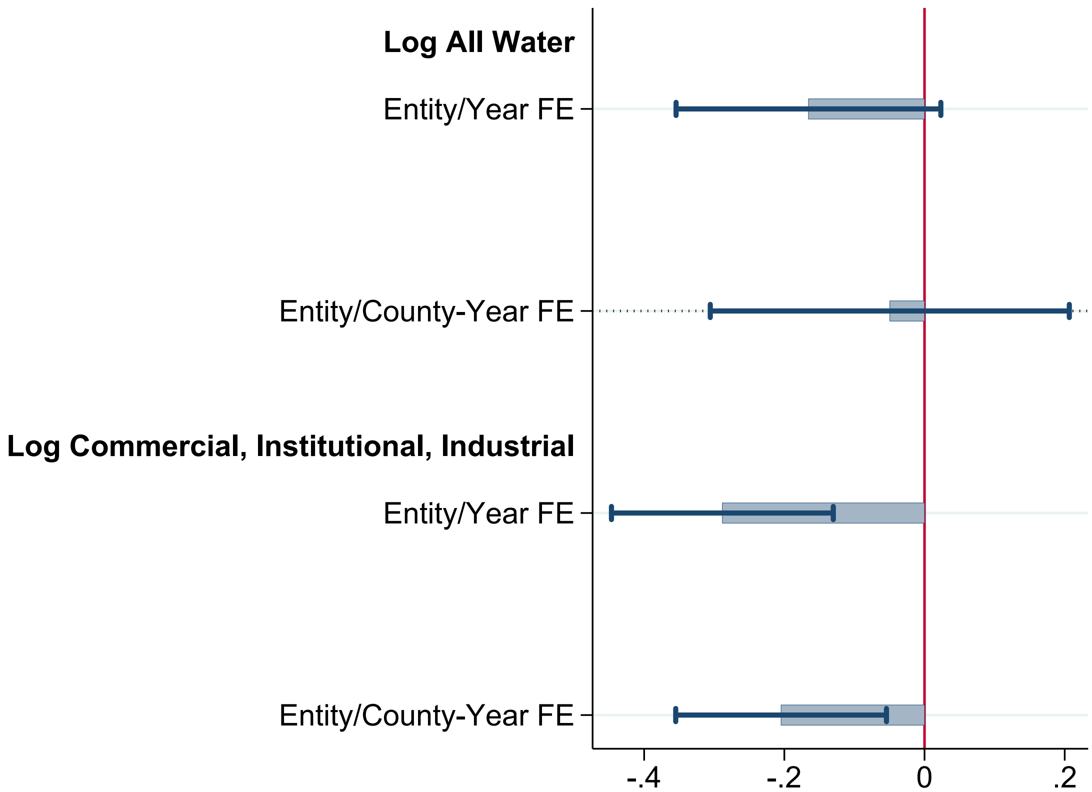


Figure C.2: Correlation of Covenant Tightness and Water Deliveries

I plot the coefficient β with 95% confidence intervals for the following regression:

$$\text{Cov. Tightness}_{ijt} = \beta \log \text{Water Deliveries}_{ijt} + \gamma_i + \varepsilon_{it}$$

The specifications reflect the addition of either a year fixed effect δ_t or county-year fixed effects δ_{jt} The top two bars use all water deliveries (in million gallons) as the explanatory variable. The bottom two bars uses water deliveries to commercial, institutional, and industrial customers as the explanatory variable. The coefficients associated with Entity/Year FE include utility- and year- level fixed effects. The coefficients associated with Entity/County-Year FE use utility and county-year fixed effects.



D Drought Robustness Checks

D.1 Main Analysis

Table D.1: Robustness: Controlling for Utility-Level Variables in Per Unit of Water Outcomes

This table reports coefficients of the following regression for utility i in county j for:

$$\Delta \log(Y_{ij}) = \gamma_j + \beta \text{Constrained}_i + \psi X_{ij} + \varepsilon_{ij}$$

Δ is the first difference operator: this specification collapses outcomes into pre- and post-period averages and takes the difference. $Constrained_i$ is an indicator variable equal to 1 if a water utility's average covenant tightness measure over the course of 2010 to 2014 is in the top 50th percentile. The indicator is set to 0 for utilities in the bottom 50th percentile. The treatment effect of interest is β. I do not include utilities without a rate covenant outstanding in the pre-period (2010-2014). In the first three columns, the outcome of interest is the change in log prices, which is water sales divided by million gallons of water delivered. In the last three columns, the outcome is the change in log gross O&M per million gallons of water delivered. Standard errors are clustered at the county-level. Columns 2, 3, 5, and 6 include county fixed effects. In these columns, I also include δ, which is the degree of selection on unobservables relative to observables that would be necessary for β to equal 0. I use Oster (2019)'s suggestion for R-max (the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls) of 1.3 times the R-squared from the fully controlled regression specifications. Columns 3 and 6 estimate the direct effect of average covenant tightness in the pre-period on each of the outcomes. In these robustness checks, I also include utility-level controls in X_{ij}: the log of pre-period median household income and the log of the 2010 Census population. The time period of analysis is 2010 to 2019: however, water quantities are only available for 2013 through 2019. Thus the time period for these outcomes is 2013 to 2019. The pre-period covers fiscal years prior to 2014 (inclusive), the post-period includes years after 2014.

	Δ Log "Price"			Δ Log O&M/Million Gallons		
	(1)	(2)	(3)	(4)	(5)	(6)
Constrained	0.0933***	0.0962**		-0.00780	-0.0126	
	(0.0330)	(0.0397)		(0.0348)	(0.0359)	
Log Med. House. Income (Pre)	-0.0231	-0.0822	-0.106	0.00919	-0.0687	-0.0673
	(0.0483)	(0.0682)	(0.0722)	(0.0464)	(0.0613)	(0.0627)
Log Pop. (Pre)	0.00334	0.00360	0.00934	-0.00233	-0.0136	-0.0136
	(0.0179)	(0.0210)	(0.0227)	(0.0122)	(0.0135)	(0.0134)
Covenant Tightness (Pre)			0.0609***			-0.00439
			(0.0156)			(0.0127)
Constant	0.319	0.971	1.270	0.185	1.174	1.149
	(0.572)	(0.819)	(0.872)	(0.531)	(0.739)	(0.753)
Observations	154	143	143	154	143	143
R-squared	0.052	0.255	0.295	0.001	0.230	0.230
δ		6.440	4.557		2.610	3.135
FE	No	County	County	No	County	County
Cluster	County	County	County	County	County	County

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

Table D.2: Robustness: Controlling for Utility-Level Variables in Gross Outcomes

This table reports coefficients of the following regression for utility i in county j for:

$$\Delta \log(Y_{ij}) = \gamma_j + \beta \text{Constrained}_i + \psi X_{ij} + \varepsilon_{ij}$$

Δ is the first difference operator: this specification collapses outcomes into pre- and post-period averages and takes the difference. $Constrained_i$ is an indicator variable equal to 1 if a water utility's average covenant tightness measure over the course of 2010 to 2014 is in the top 50th percentile. The indicator is set to 0 for utilities in the bottom 50th percentile. The treatment effect of interest is β. I do not include utilities without a rate covenant outstanding in the pre-period (2010-2014). In the first three columns, the outcome of interest is the change in log gross revenues. In the last three columns, the outcome is the change in log gross O&M expenses. Standard errors are clustered at the county-level. Columns 2, 3, 5, and 6 include county fixed effects. In these columns, I also include δ, which is the degree of selection on unobservables relative to observables that would be necessary for β to equal 0. I use Oster (2019)'s suggestion for R-max (the R-squared from a hypothetical regression of outcomes on the treatment, observed, and unobserved controls) of 1.3 times the R-squared from the fully controlled regression specifications. Columns 3 and 6 estimate the direct effect of average covenant tightness in the pre-period on each of the outcomes. In these robustness checks, I also include utility-level controls in X_{ij}: the log of pre-period median household income and the log of the 2010 Census population. The time period of analysis is 2010 to 2019. The pre-period covers fiscal years prior to 2014 (inclusive), the post-period includes years after 2014.

	Δ Log Gross Revenues			Δ Log Gross O&M		
	(1)	(2)	(3)	(4)	(5)	(6)
Constrained	0.0457**	0.0380*		-0.0389**	-0.0322*	
	(0.0176)	(0.0194)		(0.0155)	(0.0162)	
Log Med. House. Income (Pre)	0.0529*	0.0546	0.0471	0.0315	-0.0252	-0.0167
	(0.0298)	(0.0413)	(0.0409)	(0.0285)	(0.0336)	(0.0341)
Log Pop. (Pre)	-0.0116	-0.000865	3.64e-05	-0.00480	0.00139	0.000233
	(0.0103)	(0.0126)	(0.0127)	(0.00539)	(0.00621)	(0.00564)
Covenant Tightness (Pre)			0.0231***			-0.0236***
			(0.00832)			(0.00833)
Constant	-0.370	-0.507	-0.395	-0.202	0.355	0.237
	(0.343)	(0.526)	(0.515)	(0.331)	(0.401)	(0.394)
Observations	185	173	173	185	173	173
R-squared	0.054	0.331	0.344	0.026	0.266	0.281
δ		6.0744	5.2898		4.1874	5.4043
FE	No	County	County	No	County	County
Cluster	County	County	County	County	County	County

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

Table D.3: Robustness: Controlling Drought Demand Factors

This table reports coefficients of the following regression for utility i in county j for:

$$\Delta \log(Y_{ij}) = \beta \text{Constrained}_i + \psi_3 X_{ij} + \gamma_j + +\varepsilon_{ij}$$

Δ is the first difference operator: this specification collapses outcomes into pre- and post-period averages and takes the difference. $Constrained_i$ is an indicator variable equal to 1 if a water utility's average covenant tightness measure over the course of 2010 to 2014 is in the top 50th percentile. The indicator is set to 0 for utilities in the bottom 50th percentile. The treatment effect of interest is β. I do not include utilities without a rate covenant outstanding in the pre-period (2010-2014). γ_j is a county-level fixed effect and I cluster errors at the county level when I include county-level fixed effects. In these robustness checks, I include utility-level controls in X_{ij}. The first and fourth columns control linearly for the conservation standard, which ranges from 8% to 36% in sample. The second and fifth columns control for the share of civilian employed population 16 years and over that works in agriculture, forestry, fishing, and hunting (from the American Community Survey) in 2005-2009. The third and sixth columns are the most restrictive: I include drought restriction tier fixed effects, and cluster standard errors at the tier level. These specifications include a set of 8 dummies for each tier (leaving out the ninth tier). I exploit within-tier variation. The outcomes of interest are all expressed as a ratio of million gallons of water delivered. The first three columns analyze the change in log "price" (water sales revenue as a proportion of million gallons of water delivered). The last three columns analyze the change in log O&M expenses as a proportion of million gallons of water delivered. The time period of analysis is 2013 to 2019, due to the availability of water quantity data. The pre-period covers fiscal years prior to 2014 (inclusive), the post-period includes years after 2014.

	(1) Δ Log "Price"	(2) Δ Log "Price"	(3) Δ "Price"	(4) Δ Log O&M Exp.	(5) Δ Log O&M Exp.	(6) Δ Log O&M Exp.
Constrained	0.0866**	0.0824**	0.0921*	-0.0193	-0.0164	-0.0140
	(0.0360)	(0.0400)	(0.0421)	(0.0343)	(0.0365)	(0.0332)
Conservation Standard	0.299			0.446***		
	(0.225)			(0.140)		
Share Farmers		0.846			0.491	
		(0.872)			(0.742)	
Observations	143	143	154	143	143	154
R-squared	0.253	0.259	0.080	0.240	0.227	0.027
FE	County	County	Tier	County	County	Tier
Cluster	County	County	Tier	County	County	Tier

D.2 Tax Hostility

Table D.4: Robustness: Tax Hostility and Utility Controls

This table reports coefficients β of the following regression for utility i in county j for:

$$\Delta \log(Y_{ij}) = \beta Constrained_i \times \text{Tax Hostility}_i + \psi_1 Constrained_i + \psi_2 \text{Tax Hostility}_i + \psi_3 X_{ij} + \gamma_j + + \varepsilon_{ij}$$

Δ is the first difference operator: this specification collapses outcomes into pre- and post-period averages and takes the difference. $Constrained_i$ is an indicator variable equal to 1 if a water utility's average covenant tightness measure over the course of 2010 to 2014 is in the top 50th percentile. The indicator is set to 0 for utilities in the bottom 50th percentile. The treatment effect of interest is β. I do not include utilities without a rate covenant outstanding in the pre-period (2010-2014). γ_j is a county-level fixed effect and I cluster errors at the county level. In these robustness checks, I also include utility-level controls in X_{ij}: the log of pre-period median household income and the log of the 2010 Census population. The outcomes of interest are all expressed as a ratio of million gallons of water delivered. They are water sales revenues (column 1), O&M expenses (column 2), all water expenses (column 3), and administrative expenses (column 4). The time period of analysis is 2013 to 2019, due to the availability of water quantity data. The pre-period covers fiscal years prior to 2014 (inclusive), the post-period includes years after 2014.

	(1) Δ Log "Price"	(2) Δ Log O&M/Mill. Galls.	(3) Δ Log Water Exp./Mill. Galls.	(4) Δ Log Admin Exp./Mill. Galls.
Constrained × Tax Hostility	-0.110***	-0.119**	-0.192***	-0.183
	(0.0382)	(0.0545)	(0.0540)	(0.130)
Constrained	0.101**	-0.00279	-0.0410	-0.0249
	(0.0378)	(0.0377)	(0.0592)	(0.0858)
Tax Hostility	0.0851	0.0343	-0.0325	0.215
	(0.0511)	(0.0489)	(0.0546)	(0.147)
Log Med. House. Income (Pre)	-0.0415	-0.0817	-0.224*	0.0490
	(0.0960)	(0.0715)	(0.119)	(0.172)
Log Pop. (Pre)	-0.00145	-0.00999	-0.0251	-0.0600
	(0.0235)	(0.0161)	(0.0289)	(0.0467)
Observations	143	154	132	136
R-squared	0.284	0.303	0.346	0.277
FE	County	County	County	County
Cluster	County	County	County	County

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

E Tax Hostility Index Construction

E.1 Data

Tax Referenda. Data on tax votes are from the California Elections Data Archive (CEDA), which is provided by the Center for California Studies at California State University and the California Secretary of State. This dataset provides a summary of all local elections in each calendar year, from 1995 to 2019, for both political office candidates and ballot measures. Data on measures cover city, county, and school district ballots for 1995 to 2019. I use ballots from 1997 to 2019, after Proposition 218 was passed. I only include ballot measures on taxes, with the following measure types: utility tax, business tax, sales tax, property tax, transient occupancy tax, miscellaneous tax, development tax, and gasoline tax. I calculate the share of "no" votes as a proportion of total votes for these measures. I also string-search ballot questions for negative phrases (e.g. "repealing") and reverse the "no" vote share for measures that repeal taxes. The full dataset of tax ballots includes more than 3 thousand measures for 914 unique places.

Geographic shapefiles. I hand-match place names in CEDA to the boundaries of governments using Atlas Investment Research's Atlas Muni Data and the California State Water Board's public water system boundaries dataset (for water districts and community service districts). I am able to match 2,520 tax ballots for 725 government entities: 216 school districts, 458 cities, 20 counties, and 31 water districts. 75 % of measures are city measures, and 21.5 % are school district measures. I perform a spatial merge of geographic boundaries to Census block data. I use the block data to create an accurate measure of population living within government boundaries and to create population weights for block groups for the American Community Survey data. I also match block-level voter registration data.

Demographic and political data. I use voter registration data to measure the share of Republican voters living within government boundaries. Voter registration data is from the Statewide Database (SWDB), which is California's redistricting database hosted by the Institute of Governmental Studies at U.C. Berkeley. I use block-level voter registration data for the 2004 general election. I create share of Republicans by summing the number of Republicans and total registered voters across all blocks within a government's boundaries.

I collect other demographic data from the American Community Survey, for the 2005 to 2009 survey (Manson et al., 2021). I construct the following:

- Share of population older than 60.

- Share of population that is white.
- Share of population that is black.
- Share of population that is Asian.
- Share of population that is Hispanic or Latino.
- Share of families with children younger than 18.
- Share of population (for whom poverty status is determined) whose ratio of income to poverty level in 12 months is less than 1.
- Share of population (for whom poverty status is determined) whose ratio of income to poverty level in 12 months is greater than 2.
- Median household income.
- Share of households with public assistance income in last 12 months.
- Share of civilian employed population 16 years and older that works in agriculture, forestry, fishing, and hunting.
- Median gross rent as a percent of household income

E.2 Approach

I use demographics data to predict the share of "no" votes on a hypothetical tax referendum for each water utility. To do this, I run an OLS regression of share of note votes for all of the tax ballots with demographic data on the above demographic variables, log population size, and share of Republican voters:

$$\text{“No” Votes/Total Votes}_{ib} = \alpha + \beta' X_i + \varepsilon_{it}$$

where X_i is a vector containing all of the demographics and voter data for each government entity i. I run this regression at the measure level b.[25] I report results in Table E.1. I take the vector of estimated coefficients $[\hat{\alpha} \quad \hat{\beta}']$ and calculate the predicted "no" vote share at the i level for the sample of water utilities:

$$\text{Share “}\hat{\text{N}}\text{o” Vote}_i = \hat{\alpha} + \hat{\beta}' X_{i,water}$$

[25]The appearance of tax measures on the ballots may be endogenous. This regression does not adjust for potential selection.

I have data for 616 out of the 622 utilities in the main sample. I create an index by normalizing the predicted share within the sample of water utilities. The result is plotted in Figure E.1, with summary statistics in Table E.2.

Table E.1: Tax Hostility: Predictors

This table reports coefficients α and β from the following regression:

$$\text{“No” Votes/Total Votes}_{ib} = \alpha + \beta' X_i + \varepsilon_{it}$$

The regression is run at the government i, measure b level for the sample of governments with tax ballots in the CEDA database and with matched boundary data.

	"No" Votes/Total Votes
Share Republican	0.253***
	(0.0247)
Share Over 60	-0.265***
	(0.0704)
Share White	0.0505
	(0.0613)
Share Black	0.181*
	(0.0934)
Share Asian	0.0377
	(0.0690)
Share Hispanic	0.0803**
	(0.0320)
Share w/ Children	-0.189***
	(0.0608)
Share $<1\times$ Poverty Line	-0.223**
	(0.112)
Share $>2\times$ Poverty Line	0.156*
	(0.0889)
Share Public Assistance	0.595***
	(0.184)
Share Farmer	0.259***
	(0.0636)
Rent % Household Income	0.000635
	(0.000686)
Log Population Size	0.0112***
	(0.00248)
Log Income	-0.118***
	(0.0221)
Constant	1.425***
	(0.204)
Observations	2,520
R-squared	0.140

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

Table E.2: Tax Hostility Summary Statistics Sample

This table reports statistics for the sample of water utilities used to construct the tax hostility index. The table reports both the outcomes (Predicted "No" Vote Share and Tax Hostility Index), as well as the component pieces used to construct the index.

	count	mean	sd	p25	p50	p75
Water District Sample						
Predicted "No" Vote Share	616	0.401	0.052	0.367	0.404	0.433
Tax Hostility Index	616	0	1	-0.64	0.073	0.622
Share Republican	616	0.394	0.129	0.297	0.4	0.483
Share Over 60	616	0.188	0.086	0.13	0.168	0.225
Share White	616	0.748	0.162	0.654	0.786	0.872
Share Black	616	0.026	0.042	0.001	0.011	0.032
Share Asian	616	0.059	0.098	0.008	0.026	0.063
Share Hispanic	616	0.311	0.26	0.1	0.235	0.444
Share w/ Children	616	0.463	0.123	0.4	0.477	0.542
Share $<1\times$ Poverty Line	616	0.135	0.085	0.068	0.116	0.179
Share $>2\times$ Poverty Line	616	0.66	0.169	0.557	0.683	0.787
Share Public Assistance	616	0.033	0.032	0.011	0.024	0.048
Share Farmer	616	0.067	0.113	0.004	0.018	0.073
Rent % Household Income	616	30.773	8.384	27.028	31.612	35.264
Log Population Size	616	8.898	2.143	7.263	8.996	10.592
Log Income	616	10.932	0.37	10.694	10.927	11.172
Full Government Sample						
Share Republican	725	0.344	0.124	0.255	0.336	0.445
Share Over 60	725	0.184	0.073	0.137	0.172	0.217
Share White	725	0.704	0.169	0.584	0.739	0.843
Share Black	725	0.038	0.052	0.008	0.019	0.045
Share Asian	725	0.1	0.118	0.023	0.051	0.134
Share Hispanic	725	0.286	0.233	0.101	0.218	0.387
Share w/ Children	725	0.476	0.087	0.434	0.48	0.528
Share $<1\times$ Poverty Line	725	0.117	0.076	0.061	0.1	0.155
Share $>2\times$ Poverty Line	725	0.71	0.156	0.607	0.737	0.83
Share Public Assistance	725	0.03	0.024	0.012	0.022	0.042
Share Farmer	725	0.036	0.08	0.003	0.007	0.033
Rent % Household Income	725	30.912	5.469	27.842	30.928	33.869
Log Population Size	725	10.238	1.451	9.338	10.31	11.146
Log Income	725	11.099	0.386	10.844	11.104	11.347

Figure E.1: Tax Hostility Index

I plot the normalized predicted share of "no" votes on a hypothetical tax vote for the full sample of water utilities. Darker colors correspond to areas with a population more opposed to tax increases. Light colors denote areas where it is easier to pass a tax increase measure.