Debt and Water
Effects of Bondholder Protections on Public Goods

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September 2021

Preliminary draft.

Abstract

I analyze how creditors exert influence over local governments using municipal debt contracts. I examine this question in the context of municipal water utility debt contracts, which have a common bond and loan covenant called the rate covenant. Water utilities promise to raise rates and fees in order to meet a minimum debt service coverage ratio threshold on an annual basis. This paper argues that the rate covenant shapes water utility budgets and operational decisions. First, water utilities respond to covenant violations by raising revenues and cutting expenditures. Second, as utilities approach the covenant violation threshold, they increase prices, reduce hiring growth, and reduce manager pay. These results suggest an improvement in operational efficiency: by reducing resources available to public officials, bond contracts discipline spending and encourage governments to raise sufficient revenues to cover current period expenses. However, I also find evidence of a hierarchy in how officials sequence their budget decisions: they first raise revenues, then they cut expenses to the water system (like treatment and maintenance), and finally they cut administrative overhead. System problems, like pipe breaks and outages, are most sensitive to distance to covenant thresholds for the most constrained utilities. Finally, I use droughts as a shock to water utility budgets as a test of the mechanism, and find that covenant-constrained utilities raise prices by 10% relative to an unconstrained group of utilities.

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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. For example, 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). However, the provision of these essential services depend on continued municipal maintenance of critical infrastructure systems. The aftermath of the Great Recession, when local governments contended with both sharp contractions in revenue and large outstanding on- and off-balance-sheet liabilities, highlighted the importance of fiscal stress on the provision of public goods.

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. Because of the large up-front costs necessary for water infrastructure improvements, most projects are financed using debt contracts like municipal bonds and government loans. Therefore, the features of these debt contracts and how creditors ensure repayment have important implications for both access to capital markets and in the day-to-day operation of municipal utilities and provision of essential services.

This paper examines whether creditors exert influence over the local public sector through debt contracts and how this influence affects the provision of an essential public good, safe drinking water. I study this question in the context of municipal water utility debt contracts and their covenants. In order to finance improvements to infrastructure, municipal water utilities grant a lien on streams of revenues from the water operation as collateral. The vast majority of municipal utility bonds have rate covenants to protect the value of this pledged collateral. Rate covenants compel utilities to raise rates and fees in order to meet a minimum debt service coverage ratio (the covenant threshold) on an ongoing basis. This is a useful setting to study questions of creditor influence, because governments with rate

1Researchers disagree on the magnitudes of the effect of some interventions, but all have found a significant effect of water filtration on infant mortality.

2As part of Flint’s fiscal crisis, an emergency manager was appointed to oversee the management of the city’s budget. One of the cost-saving measures enacted was to locally treat water from the Flint River, rather than importing costly water from Detroit. Due to a lack of corrosion control in the treatment process, the water quickly degraded Flint’s lead pipe systems, leading to a city-wide drinking water crisis that was concentrated in poor areas.

3An incomplete list of urban water systems that struggle to provide safe drinking water include: Chicago, IL’s has more lead service pipe lines than any other city; Jackson, MS has had continued problems with lead pipes and harmful contaminants; Newark, NJ water system contaminated with illegal levels of lead. Rural water systems with failing groundwater wells are also at risk: Turlock and Ceres, CA struggle for 30 years to build a water treatment facility to replace degrading wells; Bethany, OK facing water supply crisis due to contaminated groundwater wells.
covenants face tighter budget constraints than governments without rate covenants and public officials have discretion over their budgets.

In this paper, I study how governments respond when approaching their covenant thresholds and what budget levers are pulled in order to fulfill promises to creditors. My findings point to both the disciplining features of debt and the limits of covenants in the municipal space. When rate covenants are more binding, I find evidence of improved business practices: revenue growth rates are higher and administrative budgets are trimmed. In particular, utilities increase prices, reduce premiums paid to managers, and reduce hiring growth. However, I also document important trade-offs that affect the provision of public goods. I find evidence that utilities adjust their budgets following a hierarchy (“pecking order”). All utilities increase prices and raise revenues. More constrained utilities next reduce expenses 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 where manager wages are reduced. Furthermore, I find consequences of sacrificing water system expenditures: the most constrained utilities have accelerating system problems as they approach covenant thresholds. This results in larger year-over-year growth rates in water system problems, like water outages and pipe breaks.

The composition of budget cuts following bad shocks as utilities approach covenant thresholds points to the role of creditor influence on the public sector. Governments could improve operational efficiency to comply with covenants and appease debtholders as in the buyout literature (Jensen, 1986; Kaplan, 1989): they could raise prices, trim unnecessary expenses, and reduce rents paid to public officials. On the other hand, because the covenant is only specified as an affirmative covenant rather than triggering a renegotiation of debt contracts, governments could sacrifice the quality and long-term health of the water system: they may raise prices but could also defer maintenance expense, resulting in the long-term deterioration of essential infrastructure. In the first outcome, debt covenants ease agency frictions, both between creditors and governments but also between public officials and taxpayers. In the second case, debt covenants tighten budget constraints of already constrained governments without resolving underlying agency frictions. I find evidence for both channels: officials reduce administrative overhead, but are most sensitive to approaching covenant thresholds only when very constrained. Budget cuts on the quality on the water system occur much earlier, in the unconstrained part of the distribution, resulting in more severe system problems when utilities are very constrained.

To analyze how bondholder protections like the rate covenant affect government operational decisions, I collect extensive data for a sample of over 600 California municipal water utilities. This dataset includes information on water utility bond issues, debt service, revenues, expenditures, employment,
wages, gallons of water sold, and system problems, which include pipe breaks, system outages, 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 analyze how variation in covenant tightness resulting from shocks to the financials of utilities is related to budget decisions and operational outcomes. First, I argue that rate covenants are binding, using an event study analysis to examine budget decisions following violations of rate covenants. Second, I use the full sample of utility 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. Finally, I use California drought restrictions as an exogenous shock to large, urban water utility budgets in order to address endogeneity concerns that emerge in the panel setting.

First, I demonstrate that water utilities change their budget decisions when covenants are most binding, following a first-time violation. Water utilities in the two years leading up to a covenant violation have declining revenues, which then recover to higher growth rates following a violation. 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 70% are followed by the passage of rate increases within 3 years, with half of these occurring within the first year. Moreover, I find that O&M expense growth rates sharply decline following a rate covenant violation, staying persistently below pre-period growth rates. Finally, the margin of adjustment largely appears to be driven by water treatment, transmission, and distribution expenses, as well as administrative and general expenses. I conclude that rate covenants are binding on water utilities, and use this fact to motivate the remaining analysis.

Second, I demonstrate 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 operation and maintenance expenses. A standard deviation increase in covenant tightness is associated with a 4.9% increase in prices, a 2.9% increase in gross revenues, and a 4.4% decrease in O&M expenses. The increase in O&M expenses is driven by all categories, although administrative expenses displays the highest sensitivity to previous period of covenant tightness, at 5.5%. 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.

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.
Next I examine whether there is a hierarchy to how public officials decide to allocate budgets as water utilities approach covenant thresholds. The idea behind this pecking order is based on an empirical observation: governments meet revenue shortfalls through future tax increases and current period expenditure reductions (Poterba, 1994). To test how officials make these decisions, I examine how the elasticity of the operational outcomes to covenant tightness changes when utilities are at different terciles in the 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 budget cuts. I find that 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 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 covenant tightness 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 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 top tercile (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 accelerate 18% per standard deviation in covenant tightness in this region. 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.

Finally, I test an exogenous shock to utility budgets. One of the main challenges to identification is that covenant tightness measure is not exogenous. Covenant tightness may be related to time-varying skill or inattention of public officials, which may be correlated with the budget decisions of the utility and the overall health of the water system. To address this concern, I use the California droughts
as a large shock to the revenues of large urban water suppliers. California experienced a severe drought between 2012 and 2016, with a statewide emergency declared in January 2014. Municipal water providers 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 budgets during the years that the drought restrictions were in place. Some of the drought restrictions were made mandatory in 2016, leading to a long-run reduction in residential water consumption for urban suppliers.

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. I find that more constrained utilities raised prices by 10-12% relative to unconstrained utilities following the drought shock. Moreover, I find that constrained utilities had insignificantly lower expenses per million gallons of water delivered compared to unconstrained utilities. This overall effect obscures changes in the incidence of cuts: I find weak evidence that expenses on the water system were lower for the more constrained utilities following the drought restrictions. 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.

Related Literature

This paper’s primary contribution is to bridge the gap between the literature on debt structure and public finance. A prominent research agenda in corporate finance has been to document the myriad ways that debt structure varies across firms (Rauh and Sufi, 2010). Heterogeneity in debt structure has important implications for firm outcomes, like borrowing constraints (Lian and Ma, 2021). This perspective on capital structure has not necessarily extended to the municipal setting, which largely considers municipal debt to be a form of sovereign debt. My contribution is to note that most municipal debt is backed by revenue streams of municipal enterprises. This debt structure is similar to that of small firms that borrow secured and pledge accounts receivable or inventory as collateral (Chodorow-Reich et al., forthcoming). Importantly, the contractual features of revenue-backed debt leads to different incentives than what might be implied by a model of sovereign debt.

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). However, the mechanism driving this effect is very different and shaped by the frictions that characterize the municipal setting. Despite having a financial ratio threshold, rate covenants do not trigger a renegotiation of debt contracts. Instead, they
serve to protect the value of the lien on revenues by reducing public official discretion over budgets on an ongoing basis. This leads to interesting new findings on how debt contracts discipline governments. Utilities raise revenues and improve their financial health as covenants tighten, suggesting that these contractual constraints serve as an implicit spending limit (Poterba, 1994). However, governments still have a sizeable amount of control over their budgets, and cut expenditures on the water system while preserving their administrative budgets.

I also contribute to the literature that studies the effect of large outstanding liabilities on the functioning of states and local governments. This literature primarily focuses on the size of under-reported pension liabilities (Novy-Marx and Rauh, 2011). Underfunded pension plans constitute a major off-balance sheet liability for governments, with implications for future taxing decisions, service provision, and insolvency risk (Novy-Marx and Rauh, 2014; Myers, 2021). Relatedly, empirical work has found that the extent of this off-balance sheet liability increases the borrowing costs of governments today (Novy-Marx and Rauh, 2012; Boyer, 2019). Most of this literature only considers unsecured liabilities, like general obligation debt and pension obligation bonds, that are statutorily similar in priority to pension obligations. However, a discussion of the extent of the revenue bond structure in local government liabilities is absent from research to date. I contribute to this literature by demonstrating how outstanding bonded debt liabilities affects government spending on these essential services decisions outside of states of financial distress. I use the trigger point of a rate covenant threshold as a measure of the extent that debt limits government operational flexibility.

Finally, there has 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 public goods quality. 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 Background and Data

I construct a comprehensive dataset on the operations of water utilities from publicly available sources. I link water enterprise finances and debt characteristics to service area boundaries, wage, employment, and operational data of the water utility. To my knowledge, this is the first dataset of its kind. I begin with an overview of the setting, discussing the financial structure and legal environment that characterize water operations. I then discuss the public data sources used to construct my panel, along with some of key outcomes of interest. Many more details on the construction of the dataset are included in Appendix A.

2.1 Institutional Background

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. Water providers include cities, counties, and special districts. 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. This financial independence is directly related to the utility’s ability 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 enterprise revenues from seeking repayment from general government funds. 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). 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 (Brennan and Buchanan, 1978).

Water Functions and the Structure of Costs. The provision of safe drinking water involves two main functions: procuring an adequate supply of water and distributing it to constituents. 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 extraction, which utilities access using pumping technology. I refer to the costs related to these two functions, pumping and water purchases, as “water source expenses”. Utilities are also responsible for the delivery of potable water to constituents. 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 to end-users. Some utilities also treat their own potable water supply, making it safe for consumption. Because transmission, distribution, and treatment expenses are costs associated with the delivery of water to customers as “water retail expenses.” Functional water expenses are thus anything that can be allocated to these categories. 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.\(^7\) For very large projects, municipal water utilities can 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.\(^8\) 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. I provide more details on the specifics of these bondholder protections in the next section.

**Legal Limits on Rates and Fees.** Utilities are monopolistic over their service areas and have independent price-setting authority. However, there are important limits on this rate-setting authority. In California, water utilities’ rate-setting ability is limited by Proposition 218. Passed in 1996, Proposition 218 provides taxpayers the ability to veto any proposed increase in ad valorem taxes. Prop 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. Utilities must send out a notice to all affected property owners in the service area and hold a public meeting where property owners may submit a petition to veto the proposed increase. If a majority of property owners vote to veto the increase, the rate increase initiative will fail. There have been several vetos of water and sewer rate increase over the last decade, although in most cases a later rate increase initiative does

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\(^7\)Lansing, Michigan replaced all of its lead pipes over the period of several years using pay-as-you-go financing, rather than debt financing.

\(^8\)Improvements to the water system can also be financed using general obligation debt or general fund revenues, but are less common. This is because of the limits on general obligation debt and the unique role of special revenues in the bankruptcy process.
Prop 218 imposes additional requirements on utilities: rate increases are limited to covering the proportional cost of service. Utilities are required to justify the proposed increases, 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 rates. This is a “non-profit” constraint that greatly affects the operational flexibility of utilities.

2.2 Water Utility Financial Data

I construct a panel of water utility financial data using California required reporting of local government finances. Local governments in California are required to file annual Financial Transactions Reports (FTR) by law. Reports are due either 110 days for cities or 7 months for special districts following the fiscal year end in June. FTRs are based on audited GAAP financial statement data (when available) and are available from 2003 to 2019, with a break in series reporting in 2017. The data include income statement, balance sheet, cash flow, and fund balance data. 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. I use the water proprietary fund balance schedules to construct a panel of water utility revenues and expenses.

My final panel includes 622 water utilities, incorporating 236 cities and 386 special districts. The special districts are comprised of 119 community service districts, 100 county water districts, 13 irrigation districts, 41 public utility districts, and 113 general water districts. My sample includes many more smaller 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 only has full data on water utility operations for 40 cities and 103 special districts in California.

The fund-level data is also unique from the Census of State and Local Governments and audited financial statement data in that it 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. General and administrative expenses

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9I provide more detail on how I ensure consistent data across the series break in Appendix A.

10Government 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 for proprietary funds.

11County water service providers largely appear as special districts, so I limit analysis to cities and special districts.
accounts for all expenses that cannot be allocated to a particular function. Operating expenses and 
depreciation expenses are consistent across reporters, and often match or are more conservative than 
what is reported in audited financial statement data. I also collect data on revenues from fees, charges, 
investment earnings, and taxes. 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 earn-
ings and property taxes for special districts. I also collect revenues from water sales from this dataset. 
My proxy for water prices is water sales revenues per million gallons of water delivered.

2.3 Debt Data

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 fiscal year, principal payments, interest payments, and defeased or adjusted 
amounts.\textsuperscript{12} 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. Cali-
ifornia 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 docu-
ments for bond issues, although coverage is spotty for bonds issued prior to 2000. Using this data, I 
pull in relevant issue-level information about the rating, the interest rate, credit enhancements, and 
whether the obligation is a private placement. I collect data on bondholder protections, including 
details on rate covenants, from the CDIAC’s database of disclosure and legal documents. I link this 
data to the outstanding debt series in order to create a time series for each utility of outstanding bond 
requirements.

2.4 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

\textsuperscript{12}I start with this data 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.
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 100% charged 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 annual electronic annual reports (EAR) that all California public water systems are required to file, although the report form changes substantially through time and some items are optional for small water systems. In addition to system problems, this report and sources of water supply among other items. The California State Water Resources Control Boards provides this data for the years 2013 through 2019.\(^{13}\)

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 feature of water utility users.

### 2.5 Summary Statistics

Summary statistics for the analysis are contained in Table 1. There are some missing observations in the financial data due to the appearance of negative operating revenues or expenses. Variation in water source expenses is higher than it is for 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

\(^{13}\)I am in the processing of procuring and cleaning data for 2009 to 2012.
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.

3 Bondholder Protections in Water Debt

3.1 Rate Covenants: Characteristics and Legal Requirements

The most common bondholder protection in water and other municipal utility revenue bonds is the rate covenant. The language most often states that the enterprise will maintain fees and rates 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, although compliance with this requirement is correlated with the size and sophistication of the utility. They are also required to report coverage ratios in new issuance disclosure documents. Enforcement of these disclosure rules by the Securities and Exchange Commission has increased since 2010.

Comparison to Corporate Debt. These 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 risk 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. Most importantly, 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.

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

\[
\text{Coverage Ratio} = \frac{\text{Net Revenues}}{\text{Debt Service}} \tag{1}
\]

The calculation of net revenues varies across entities, but there are some common features. Net revenues is defined broadly as Gross Enterprise Revenues minus Maintenance and Operating Costs. Gross Enterprise Revenues includes all gross income received or receivable from the ownership and operation of the water enterprise. This generally includes investment income and excludes grants and other federal or state aid. Maintenance and Operation Costs means the reasonable and necessary costs and expenses paid for maintaining and operating the water enterprise, excluding depreciation expense and debt service costs. In practice, the calculation of gross revenues can vary across enterprises. The most common additions/exclusions of gross revenues include: property and ad valorem taxes (generally disallowed in city bond indentures), 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 enterprise’s net revenues. This excludes general obligation and other tax
assessment bonds, but it may include loans from federal and state entities.  

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

(2)

### 3.2 An Empirical Proxy for Rate Covenant Tightness

Using my sample of identified water revenue bonds, I also collect data from the CDIA’s database of official statement and legal documents on the type of revenue pledged, whether there is a rate covenant, the level of the rate covenant’s required debt service coverage ratio, and any extraordinary items that are considered part of Net Revenues.

I then calculate a proxy of covenant tightness.  

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

(3)

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. 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 percent level.

Summary statistics for this variable 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.

Water utility covenant tightness is closely related to the business cycle. I plot the time series of average covenant tightness in Figure 2. 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

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14 State loans are often backed by a lien on net revenues, but without the loan documentation it is difficult to assess the extent of the lien and whether there is a rate covenant so I leave them out of the revenue debt calculation. I include debt service when there is a revenue bond outstanding and prior obligations includes state loans. Usually I leave them out to be conservative.

15 This measure is similar in spirit to Murfin (2012), although its calculation is simpler because there is only one financial ratio covenant in municipal bond indentures. I also do not calculate the probability of violations.

16 For cases where there is no rate covenant information, due to missing or incomplete issuance documents, I use the sum sufficient threshold of 100%.
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 slow-down 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 paid down debts, refinanced existing debt at lower interest rates, and improved their balance sheet position: covenant tightness after 2011 has been -.82 standard deviations on average.

3.3 Do Water Utilities Comply with their Covenants?

In order to test the effect of bondholder 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. After all, municipal debt suffers from the same coordination problem among creditors as corporate bonds. The role of monitor is also largely absent on a recurring basis, with rating agencies assessing financial data only when new issues come to market. 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, we 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 3 depicts the histogram of covenant tightness, winsorized at the 1% level. I have plotted 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. 99% of observations fall 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 3 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, we would expect to see no difference in revenues and expenses during this grace period. 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, we would expect to see substantial adjustment: raising fees and rates to increase revenues and potentially curbing 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. 17 Violation years are those in which a utility’s coverage ratio tightness measure is above 0. In 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.

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. 18 To rule out automatic yearly increases, I collect the dates of rate increases that are associated with a water rate study, Prop 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. 19 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

17Because 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 so may not reflect the audited report of compliance sent to bond trustees. Because violations are not always an event of default, they may also not appear in trustee event reports.

18I am in the process of collecting special district data, although there is very little reporting on special district water rate increases.

19I 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.
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 4. These graphs plot the coefficients $\beta_k$ from the following regression specification, which is at the utility $i$-county $j$-fiscal year $t$-time since covenant violation $k$ level:

$$\Delta(Y_{ijtk}) = \gamma_i + \delta_t + \beta_k + \psi X_{jt-1} + \epsilon_{ijtk}$$  (4)

$Y_{ijtk}$ denotes the log of the outcome of interest. I include both utility-level fixed effects $\gamma_i$ to account for unobservable time-invariant features of utility and fiscal-year fixed effects $\delta_t$ 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. $\beta_k$ 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, columns 1 and 2. This table presents estimates $\beta_{post}$ from the following regression:

$$\Delta(Y_{ijtk}) = \gamma_i + \delta_t + \beta_{post}1_{k>0} + \psi X_{jt-1} + \epsilon_{ijtk}$$  (5)

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. The top panel of Figure 4 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 4. As with revenues, I interpret a sharp adjustment downward as evidence against the null 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 are accelerating: 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 time 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 are falling and expenses are increasing. 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.

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 2, columns 3 through 6. This table reports results for regression equation 5. 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 is a full 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 are occurring 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 5. 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.

4 Effect of Bondholder Protections on Operations

What are the benefits and costs associated with a rate covenant? How should we expect a government to respond to a binding rate covenant? A simple model of the local government budget process can shed light on these questions. In this model, local officials enjoy spending but dislike voter hostility resulting from tax increases (Glaeser, 2013). Public officials would prefer to delay the costs of current spending and avoid current period citizen anger. In a Leviathan model of government, there is an additional problem, where an undisciplined government would prefer to pay itself in bonuses and rents
using its taxing power rather than serve the public interest (Brennan and Buchanan, 1978). Budget rules like restrictions on deficit financing force officials to link current period expenditures to current period revenues. Clearly linking the funds raised from taxpayers to the services provided also ties the hands of public officials.

Of course, these rules sacrifice operating flexibility following adverse budget shocks. Empirically, the literature has found that fiscal shocks tighten budget constraints (Poterba, 1994). Without deficit financing, governments are unable to smooth the provision of services over time. Thus, governments respond to shocks primarily by raising taxes, and then cutting expenditures. The extent to which governments can raise taxes is moderated by legal restrictions (e.g. Proposition 218 in California) and political factors like voter anger. I refer to this pattern, raising revenues before cutting expenditures, as the “pecking order” of local governments, because there is a hierarchy of government officials’ preferences regarding how to meet budget needs.

The more interesting question regarding the pecking order is how do government officials implement these cuts? This is an empirical question, and is related to the unique agency frictions in the municipal setting. Without budget rules, public officials have an incentive to greatly increase the size of government and expand personal compensation. Tight budget constraints discipline myopic officials by both reducing the incentive to run large deficits (Alesina and Perotti, 1996) and reducing resources available to officials. With fewer resources at their disposal, officials may operate more efficiently and slim administrative overhead. This is the classic disciplinary function of debt (Jensen, 1986).

However, officials may still defer some costs if they are relatively opaque in order to avoid raising current period taxes and cutting private benefits. For example, cities delay paying labor costs by underfunding pension plans (Novy-Marx and Rauh, 2011). Water utilities defer necessary maintenance on hundred year old pipes that are unobserved by the average voter (ASCE, 2021). California’s Proposition 218 imposes additional restrictions on the amount of revenues that can be raised, which further incentivizes delaying the recognition of current period costs. In this case, budget rules are limited in their ability to align current revenues with current costs: they tighten budget constraints without imposing discipline.

A rate covenant is a private addendum to these budget rules. 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 are disciplinary and solve the public sector version of the free cash flow problem, 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. If rate covenants tighten budget constraints without disciplining governments, water utilities sacrifice water system quality as they become more constrained, deferring necessary maintenance rather than reducing private benefits.

**Empirical approach.** I test how rate covenants affect the provision of public services by testing how increasing covenant tightness affects budget decisions. To do this, I examine in a panel regression how previous period covenant tightness is related to current period changes in operating outcomes. I discuss this specification more in the next section. If rate covenants are binding, I expect to see a positive association between previous period covenant tightness and current period price growth. Although prices and revenues are generally increasing after adjusting for inflation, utilities that are far away from the threshold have little incentive to greatly increase their revenues compared to utilities that are closer to the threshold.

**Prediction 1 (P1):** Rate covenants are binding if growth in prices and gross revenues are positively related to previous period covenant tightness.

Rate increases in general tell us little about the incentives of the government, beyond complying with contractual promises. For example, rate increases allow governments to raise revenues to appropriately cover current period expenses (good behavior), but they may also reflect an undisciplined government that increases rates, but shirks on duties and pays itself in rents (bad behavior). An additional budget discipline mechanism would imply that previous period tightening in covenants is associated with a decrease in operating expenses growth over the next period. This effect would appear if utilities experience constraints on their abilities to raise revenues.

**Prediction 2 (P2):** Rate covenants are disciplining if growth in O&M expenses is negatively related to previous period covenant tightness.

Budget discipline should be most pronounced in administrative and discretionary expenses where wasteful spending is more likely. I expect to see decreases in employment growth and decreases in the premium paid to administrators.²⁰

**Prediction 3 (P3):** Rate covenants are disciplining if growth in administrative and other expenses is negatively related to previous period covenant tightness. Employment growth and administrator wage premiums should also be negatively related to prior period tightness.

²⁰Because covenant tightness is significantly associated with lagged growth in these expense categories, including these additional outcome variables is necessary for ruling out a mechanical mean reversion effect.
Reductions in the quality of service for constrained utilities would imply limits on the role of rate covenants as a disciplinary mechanism. I test this hypothesis by examining how covenant tightness is related to water retail expenses and growth in system problems. If water utilities sacrifice water system quality as covenants become tighter, current period growth rates in expenditures on water treatment, transmission, and distribution should decrease. We would expect to see this develop into increasing system problems: covenant constrained utilities would see higher year over year growth in system problems, as current period expenses on maintenance are deferred for future years.

**Prediction 4 (P4):** If officials sacrifice water quality to comply with rate covenants, previous period covenant tightness will be negatively related to growth in water retail expenses. System problems will accelerate in response to covenant tightness.

In order to infer the preferences of officials regarding what is the most costly lever of adjustment, I test how the elasticity of these outcomes varies at different levels of covenant tightness. Budget outcomes that are more sensitive at lower levels of tightness should reflect lower priorities for officials. In the next section, I test how the slope of covenant tightness changes for observations in the top, middle, and bottom third of the distribution. This prediction describes the hierarchy of official preferences for budget cuts.

**Prediction 5 (P5):** Part 1: If rate covenants are disciplining, then administrative outcomes should be more sensitive to covenant tightness at lower levels of tightness, relative to other expenses. This outcome would reflect that officials are reducing overhead before sacrificing water system quality.

Part 2: If officials sacrifice water quality first, then water retail expenses should be more sensitive to covenant tightness at lower levels of tightness, relative to other expense categories.

In the next section, I test predictions P1-P5.

## 5 Testing the Pecking Order Hypothesis

In this section, I assess both whether bondholder protections like the rate covenant improve municipal governance and how officials prioritize budget cuts in response to approaching covenant thresholds by testing predictions P1-P5.

**Predictions 1 and 2.** First, I demonstrate in Figure 6 how water utilities adjust their budgets across the distribution of covenant tightness. The positive relationship between covenant tightness and revenue growth is very strong across all values of covenant tightness. The relationship between
expense growth and tightness is more nonlinear, with steep declines across the violation threshold.\textsuperscript{21} 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. This descriptive evidence is in line with Predictions 1 and 2.

To formalize this, I run the following regression at the utility \textit{i} county \textit{j} fiscal year \textit{t} level:

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

This specification exploits within-utility and within-year variation. The outcome \( Y_{it} \) represents the budget and operational outcomes of interest. My main specifications analyze changes in prices, gross revenues, and gross O&M expenses, testing predictions P1 and P2. The regressor of interest is the lagged covenant tightness measure, which is reported in standard deviations. The \( \beta \) coefficient thus has the interpretation of the elasticity of the change in outcome variables with respect to a one standard deviation increase in the covenant tightness measure in the prior year: as a utility becomes more constrained, the tightness measure increases; if a utility is less constrained, the measure decreases. I control for entity-level and fiscal year fixed effects to remove unobservable variation related to the financial health of each water utility and common macroeconomic factors. I also include county-level unemployment rates in \( X_{jt-1} \) 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 \( i \). The underlying assumption is that variation in covenant tightness is driven by shocks to the water utility.\textsuperscript{22}

I find that water utilities adjust both operating expenses and revenues in response to the tightness of their rate covenants. Increases in revenues are driven by price increases. Column 1 in Table 3 shows that a 1 standard deviation increase in covenant tightness is associated with a 4.9\% increase in prices over the next year. Similarly, column 2 in Table 3 demonstrates that a 1 standard deviation increase in covenant tightness is associated with a 2.9\% increase in gross revenues over the next year. Because the unconditional average growth rate in gross revenues is 2.7\%, the responsiveness of revenues to tight coverage ratios is economically significant. At the same time, water utilities decrease their operating and maintenance expenses by 4.4\% over the next year (as reported in column 2), which is double the

\textsuperscript{21}These plots also warrant caution. While the relationship between tightness and revenue growth is relatively similar at all levels of lagged covenant tightness, the large decreases in year-over-year operating expense growth for extreme values of covenant tightness could be indicative of either responses to covenant tightness or reversion to the mean. Because I find results consistent with an endogenous response in outcomes that are not constructed from financial data, I believe it is safe to conclude that these figures also reflect an endogenous response. I discuss this more in a following subsection.

\textsuperscript{22}I discuss in the next section threats to that assumption.
unconditional average growth rate of 2.7%. The evidence supports both P1 and 2.

**Prediction 3.** The crux of the disciplinary argument rests on how utilities adjust their expense budgets in response to tightness. I next test P3, using regression specification 6. The outcome of interest is the change in log administrative and other expenses. This category includes all expenses that are not chargeable to a particular water function, including general administrator wages and benefits. I interpret cuts to this budget as cuts to more discretionary spending, as they are not tied directly to particular water functions. Results are reported in the first column of Table 4. Utilities decrease their administrative expense growth rates by 5.1 percentage points for every standard deviation increase in the covenant tightness measure.

I link this to real outcomes in columns 2 and 3 of Table 4: column 2 reports the effect of lagged tightness on growth in the number of department employees and column 3 reports the effect on the premium paid to administrators in base wages over the median employee’s salary. I find that the reduction in administrative costs is reflected in both hiring freezes and cuts to administrator wages. Utilities slow employment growth by about 1.5% per standard deviation increase in the lagged covenant tightness measure. On average utilities are reducing employment by 1.2% per year; covenant tightening thus compounds this employment reduction. Water utilities also reduce the premium paid to the general manager of the utility over the median worker’s salary, albeit to a small extent. This markup decreases by 2.9 percentage points per standard deviation increase in covenant tightness, relative to an unconditional average markup of 118%. The results are consistent with prediction 3: when rate covenants are tight, utilities slim their discretionary budgets, cutting back on employment growth and rent extraction by administrators. These results so far are consistent with the disciplinary mechanism, implying that bondholder protections can improve municipal governance.

**Prediction 4.** I next test whether there are limits to this governance function. I test P4, using regression specification 6. The outcomes of interest are functional water expenses, specifically water source and water retail expenses. A utility that cuts these expenses in response to tightening rate covenants may be sacrificing water system quality in order to comply with covenants. While a reduction in water source expenses might imply cuts in the quantity of water procured, a reduction in water retail expenses implies cuts to items such as treatment facilities or pipe repair and replacement.

The effect of lagged covenant tightness on water source expenses is listed in column 2 of table 5, while the effect on water retail expenses is reported in column 1. I find that a one standard deviation increase in the covenant tightness measure is associated with decreases in water retail and water source expenses growth rates of 3.26 and 3.30 percentage points, respectively. This elasticity is lower than what was found with administrative growth, which suggests that utilities slim their administrative
budgets more than these expenses in response to covenant tightening.

To confirm this margin of adjustment, I also report the effect of lagged covenant tightness on year over year growth in reported system problems in the last column of table 5. System problems include water outages, boil water notices, as well as pipe breaks and leakages. A utility that is reducing water quality by deferring maintenance should experience greater increases in system problems over the next time period. However, I find an insignificant negative coefficient. This is consistent with the interpretation that utilities are slimming discretionary expenditures first, reflected in no change in system problems. These results do not imply strong support for prediction 4.

Overall, I find support for predictions 1-3, and little empirical evidence for prediction 4. Covenant constrained utilities increase prices and decrease their operating expenses. In particular they reduce administrative expenses, reflected in hiring freezes and a reduction in administrator wages. Utilities reduce functional water expenses in response to tightening, but I find little evidence that this has meaningful real effects for most of the distribution of tightness.

**Prediction 5.** Now I analyze the pecking order of budget cuts in response to tightening budgets. First, I split the covenant tightness distribution into thirds. Next, I run the following regression at the utility $i$ county $j$ fiscal year $t$ level:

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

(7)

Terccile$_{ij,t-1}$ 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 3, 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 $\beta$ is comparing 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 also include county-level unemployment rates in $X_{jt-1}$ 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 $i$.

I start by analyzing changes in the budget outcomes: gross revenues, administrative expenses, water retail expenses, and water source expenses. Results are displayed in Figure 7, with coefficients reported in Table 6. I group the outcomes in threes along the x-axis. The first three coefficients depicted are the $\beta$s for the top, middle, and bottom terciles of the distribution respectively for regression 7 with outcome variable change in log revenues. The next group of three coefficients is for the change in
log water retail expenses, the third group of three coefficients is for the change in log administrative expenses, and the final group of coefficients is for the change in log source expenses. $\beta$ is reported along the y-axis.

I arrange the outcomes in order of 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.

Returning to Prediction 5, the evidence presented suggests that while very constrained public officials reduce budgets related to both water system quality and administrative overhead, there is an order where these budgets become more sensitive to tightening. My findings suggest that water utility officials reduce expenses on treatment, transmission, and distribution to a larger extent than administrative overhead. I interpret this reduction in retail expenses as including the deferral of maintenance costs. Next, I examine the real outcomes and demonstrate that this pecking order has consequences for the water system.

I demonstrate that the real outcomes, including prices, employment, manager wage premiums, and growth in system problems follow a similar pattern. Figure 8 depicts the coefficients $\beta$ from regression 7 for the real outcomes of interest. I arrange the coefficients similarly to Figure 7: coefficients are ordered for the top, middle, and bottom third of the distribution and grouped by the real outcome, denoted along the x-axis. The y-axis is the $\beta$ coefficient. All of the coefficients are also reported in Table 6.

The first outcome is the change in log prices. Similar to the specification for gross revenues, I find
that the elasticity of prices to tightness is increasing across all parts of the distribution. However, the slopes between the middle and bottom terciles are much more similar, at 7.4% and 8.2% per standard deviation 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% 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 a 19% increase in system problem growth. The coefficients for the top and middle groups are negative and I cannot reject that they are zero.

My results overall are consistent with the second part of Prediction 5: adjusting administrative expenses and 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. At the point where utilities are very constrained, in the bottom third of the distribution, system problems accelerate per standard deviation in tightening.

To conclude this section, I find evidence consistent with a disciplinary role for covenants, in line with predictions 1, 2, and 3. When covenants tighten, utilities primarily reduce administrative expenses, cut employment growth, and reduce manager wages. However, this effect is concentrated in the most constrained utilities. I find evidence consistent with 5 part 2, that utilities begin reducing water retail expenses before adjusting their administrative budgets.

6 Budget Shocks and Droughts: A Natural Experiment

Underlying the analysis so far is an endogeneity problem. Because of the nature of the lien on net revenues in revenue bonds, covenant tightness is jointly determined with the outcomes of interest, revenue and expenditure choices. Covenant tightness may be related to time-varying skill or inattention by public officials, all of which is correlated with the budget decisions of the utility. An ideal experiment would randomly assign the binding constraint. In this section, I analyze a presumably exogenous fiscal shock to water utility budgets, the 2012-2016 California droughts, and examine implications for the behavior of large urban water suppliers.
Budget shocks and revenue constraints. Due to their large and diverse customer base, large urban water suppliers are likely to be able to freely adjust their rates and fees relative to smaller utilities. In this setting, I expect for the most covenant constrained utilities to respond to a budget shock by raising rates and fees, relative to an unconstrained group.

Prediction 6 (P6): Rate covenant constrained utilities will raise revenues more than a similar group of unconstrained utilities following a large budget shock.

The response of expenses depends on how budget-constrained this group of utilities is: if they have flexibility to adjust revenues, expenses should not change. If they are constrained on this dimension, we should see a reduction in expenses.

Prediction 7 (P7): Rate covenant constrained utilities will not reduce expenditures relative to unconstrained utilities following a large fiscal shock relative to so long as they are able to freely adjust revenues.

6.1 Droughts as Fiscal Shock

California experienced a historic drought between the years 2012 and 2016, which peaked in severity in the summer of 2014. California’s hydrology has always been marked by periods of prolonged scarcity or severe flooding, but the drought was severe enough to warrant state-level policy changes in 2014 and 2015. Over the course of the drought, the state of California issued multiple edicts on water use, varying in restrictiveness and enforcement intensity. 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. These 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. 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.
6.1.1 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 9. 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 9 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.\(^{23}\) Residential water usage dropped significantly after the imposition of mandatory restrictions in the second half of 2015. It has since recovered, but still remains significantly below 2014 levels.

Because residential water use is on average 70% of urban water suppliers total usage, the drought 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 subject to drought restrictions that are also in my main California sample in Figure 10. 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 were on average increasing. 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.

6.1.2 Specification

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.

\[
\Delta \log(Y_{ij}) = \gamma_j + \beta Constrained_i + \varepsilon_{ij} \tag{8}
\]

\(^{23}\)The year 2014 only includes months June through December, which includes the peak period of water consumption during the summer. In order to avoid overestimating consumption in 2014, I only analyze months June through December in all other years.
This is a first-difference specification, where I collapse outcome variables \( \log(Y_{ijt}) \) into their pre-period and post-period averages before taking 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). \( \text{Constrained}_i \) is my measure of rate covenant tightness, corresponding to a treatment designation: I sort urban water suppliers into the top and bottom 50% percentile based on the average covenant tightness measure in the pre-period.\(^{24}\) The constrained group are those with tight rate covenants in the top 50%; the control group is the bottom 50%. There are 93 utilities in the treated group and 92 utilities in the control group. One of the concerns of the analysis is that water utilities in some counties are more affected by the drought emergency, due to reliance on regional wholesalers. I therefore include county-level fixed effects, capturing any time-varying differences across counties that may bias the results, and cluster errors at the county-level. After controlling for county differences, I assume in this specification that all urban water suppliers are subject to the same large shock.

I report summary statistics in Table 8. The control group includes larger utilities with larger budgets. The populations are also slightly different, with larger and richer service areas in the control group. However, the treated group tends to have higher population growth and higher debt burdens than the control group. The first-difference specification should eliminate these utility-level fixed effects that might drive the differences. I demonstrate in the next paragraph that the treated and control group appear to have similar pre-trends after controlling for utility-level fixed effects. Treated utilities tend to have more stringent drought restrictions as well, sorting into slightly higher tiers. This bias is likely to work against my hypothesis: you would expect utilities in higher drought tiers to be more intensely exposed to the shock and have lower revenues following the emergency declaration.

The identifying assumption is parallel trends, conditional on observables. I examine how reasonable this assumption is in Figure 11 for a variety of outcomes. These figures all plot coefficients \( \beta_t \) from the regression:

\[
\log(Y_{ijt}) = \gamma_i + \delta_t + \beta_t \text{Constrained}_{ij} + \psi X_{jt-1} + \varepsilon_{ijt} \tag{9}
\]

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 11d and 11d. Because the water quantity data is only available starting in 2013, I also include log gross revenues and log gross O&M in Panels 11a and 11c and extend the pre-period to 2010. I also include the log amount of water delivered as an outcome variable in Panel 11e, in order to demonstrate

\(^{24}\) I recalculate the measure by using observations from 2003 to 2014 in the calculation of the standard deviation of the coverage ratio.
any variation in treatment intensity. The specification is the panel version of Equation 8: I include utility level fixed effects and time fixed effects. $Constrained_{it}$ is an indicator variable that takes a value of 1 if a utility is in the bottom 50% of the covenant tightness distribution from 2010 to 2014. To control for time-varying county-level differences, I include the lagged unemployment rate in $X_{jt-1}$. The coefficients are $\beta_t$, which is treatment effect of interest at each year $t$.

Panels 11a and 11b 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 11c, I show that this adjustment is not mechanically related to a change in the water provided: there is only one year in the post drought period where the constrained group is significantly different from the unconstrained group. In 2018, water provided by the constrained group is significantly lower than water delivered by the unconstrained group. I see an uptick in prices during that year in the constrained group, but prices for the constrained group increase significantly in both 2017 and 2019.

I also examine changes in operating and maintenance expenses in panels 11c and 11d. The left panel demonstrates the treatment effect in gross O&M and the right panel is the treatment effect for gross O&M 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, 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.

6.1.3 Findings

Results for regression specification 8 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. I include controls for pre-period log median household income and population of the service area in all specifications. The first three columns report results for the change in the log price, which is water purchase revenues over water delivered in million gallons. The last three columns report results for the change in O&M per million gallons of water. Columns 1 and 4 report heteroskedasticity-consistent errors; otherwise, I reported errors clustered at the county-level. Columns 3 and 6 include county-fixed
effects to control for unobservable time-varying differences at the county-level. I find that the average treatment effect on prices is consistent across the columns, ranging from .1 to .12. I can also reject no effect at the 5% level in all specifications. In the most conservative estimation, constrained utilities raised prices 10% relative to unconstrained utilities. I also fail to find an effect on O&M expense per million gallons in all specifications: I find a positive 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. All specifications include controls for population and income. The coefficients suggest that constrained utility gross revenues are 3.8 to 4.6% higher in the post period, although the specification with county fixed effects in column 3 is only marginally significant. In columns 1 and 2, I find that median household income is significantly related to the change in gross revenues: when household income increases by 1%, gross revenues increases by 5.9%. This suggests that richer areas have an easier time raising revenues than poorer areas. However, much of this variation is soaked up by the county-fixed effects. I also find a negative effect on gross O&M expenses in all specifications: expenses were on average 3% lower for the most constrained group of utilities. However, caution is warranted regarding these results: the coefficients are only marginally significant across specifications and there was evidence of a pre-trend. Overall, the results are consistent with the previous findings: constrained utilities raised their prices and increased 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 are obscuring 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 second 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 columns 1 and 2, but I cannot reject that the coefficients are zero. In column 3, when I compare utilities within counties, I find a statistically insignificant negative effect. In columns 4 and 5, I find that constrained water utilities reduced expenses on the water system on a per gallon basis by 12% compared to unconstrained utilities. However, this
result is only marginally significant. The effect is reduced by half when accounting for county fixed effects. Overall, this is weak evidence in support of the pecking order hypothesis: constrained utilities primarily account for a large budget shock by increasing prices charged. After they increase prices, there is weak support that they reduce expenses on the water system.

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 the distance to 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 bad fiscal shocks.
References


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Lian, Chen, and Yueran Ma, 2021, Anatomy of corporate borrowing constraints, Quarterly Journal of Economics.


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. 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 remain 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 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 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:

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

NBER Recession dates are indicated by the gray shaded region.
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:

\[
\text{Covenant Slack}_t = -1 \times \frac{\text{Distance to Threshold}_t}{SD(\text{Coverage Ratio})_t}
\]

The coverage ratio is defined as:

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

There is a significant spike in mass at the 0 threshold.
Figure 4: 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 $\beta_k$ from the regression:

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

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 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-fiscal year observations between 2003 and 2019 where: (1) a utility’s coverage ratio tightness measure is above 0 in time 0, representing a violation; (2) there were no covenant violations in the three years prior to the violation; and (3) there is 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, time 0, with 95% confidence intervals. Regressions adjust for utility and fiscal year fixed effects, and standard errors are clustered at the utility level.
Figure 5: 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 $\beta_k$ from the regression:

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

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 slack measure is below 0 in time 0, representing a violation; (2) there were no covenant violations in the three years prior to the violation; and (3) there is a full 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.
Figure 6: 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 operating and maintenance expenses (O&M) 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:

\[
\text{Coverage Ratio} = \frac{\text{Gross Revenues} - \text{O&M Costs}}{\text{Revenue Bond Principal and Interest Payments}}
\]
This figure plots the coefficients in Table 6. The y-axis represents the $\beta$s from the following regression:

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

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, Thirds$_{ij,t-1}$, 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 6 for each part of the Covenant Tight$_{ij,t-1}$ distribution separately. The coefficients are grouped in three by outcome variables, listed along the x-axis at the bottom of the figure. The first category represents $\beta$ for the bottom third of the distribution of Covenant Tight$_{ij,t-1}$, which are relatively unconstrained utilities. The middle category represents $\beta$ for the middle third of the distribution of Covenant Tight$_{ij,t-1}$. The third category is the $\beta$ for the top third of the distribution of Covenant Tight$_{ij,t-1}$, which are very constrained utilities. All specifications include utility-level $\gamma_i$ and fiscal year $\delta_t$ fixed effects, as well as the lagged county-level unemployment rate in vector $X_{jt}$. Standard errors are all clustered at the utility level. The first group of coefficients reports results for the change in log gross revenues. The second group reports results for the change in log water retail expenses, which combine treatment, transmission, and distribution costs into one category. The third column reports results for the change in administrative and other expenses, which includes all gross O&M expenses that cannot be chargeable to one of the water functions. The last group reports the change in log water source expenses, which combines water supply and pumping expense into one category.
Figure 8: Pecking Order: Heterogeneity in Real Outcomes

This figure plots the coefficients in Table 7. The y-axis represents the $\beta$s from the following regression:

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

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, Thirds$_{ij,t-1}$, 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 6 for each part of the Covenant Tight$_{ij,t-1}$ distribution separately. The coefficients are grouped in three by outcome variables, listed along the x-axis at the bottom of the figure. The first category represents $\beta$ for the bottom third of the distribution of Covenant Tight$_{ij,t-1}$, which are relatively unconstrained utilities. The middle category is the $\beta$ for the middle third of the distribution of Covenant Tight$_{ij,t-1}$. The third category is the $\beta$ for the top third of the distribution of Covenant Tight$_{ij,t-1}$, which are very constrained utilities. All specifications include utility-level $\gamma_i$ and fiscal year $\delta_t$ fixed effects, as well as the lagged county-level unemployment rate in vector $X_{jt}$. Standard errors are all clustered at the utility level. The first grouping reports results for the change in log “price”, which is defined as water sales revenue divided by million gallons water delivered. The second grouping reports results for the change in log number of department employees. The third grouping 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 grouping reports the change in log system problems, which includes pipe breaks, water outages, and boil water orders.
Figure 9: Drought Restrictions and Initial Outcomes: Quantities and Consumption

I plot average water quantity outcomes over the course of 2013 to 2019 the drought restrictions. 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 bottom panel plots average monthly residential gallons per capita daily (R-GPCD) and the bottom panel plots the log of monthly water produced. Data are from the California State Water Resources Control Board’s Urban Water Supplier Monthly Reports, available from 2014 through 2020. Because 2014 data only includes June through December, I only analyze the second half of each year in the data. This variable is total potable production plus agriculture, and includes all water that has entered a water supplier’s distribution system. 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

2014 R-GPCD: 121.3
Figure 10: 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 $\beta_t$ from running 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 11: Effect of Droughts on Water Utilities: Rate Covenants

This figure presents the coefficients $\beta_t$ from the regression:

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

Which is run at the utility $i$ fiscal 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. $\beta_t$ represents the differences-in-differences coefficients, with a base year of 2014, the last year in the pre period. Panel 11a depicts the coefficients $\beta_t$ for log gross revenues. Panel 11b depicts coefficients for outcome log price, which is water sales revenues per million gallons of water delivered. Panel 11c depicts $\beta_t$ for log gross O&M, with gross O&M on a per million gallon basis reported in Panel 11d. Finally, Panel 11e reports the log of water deliveries in million gallons. Panels 11a and 11b 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.
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 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 encompases all expenses that an entity reports chargeable to a particular function. Log General and Admin. Expenses is calculated as Gross O&M 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:

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

The coverage ratio is defined as:

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

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.

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<td>1.44</td>
</tr>
<tr>
<td>Log Water Source Expenses</td>
<td>8340</td>
<td>12.92</td>
<td>2.566</td>
<td>10.986</td>
<td>13.033</td>
<td>15.062</td>
</tr>
<tr>
<td>Log Census Population (Block-Level)</td>
<td>10557</td>
<td>8.937</td>
<td>2.193</td>
<td>7.217</td>
<td>9.09</td>
<td>10.633</td>
</tr>
<tr>
<td>Median Household Income</td>
<td>9295</td>
<td>64,173</td>
<td>27,101</td>
<td>45,430</td>
<td>58,318</td>
<td>77,388</td>
</tr>
<tr>
<td>Covenant Tightness</td>
<td>4351</td>
<td>-0.781</td>
<td>1.224</td>
<td>-1.473</td>
<td>-0.539</td>
<td>-0.026</td>
</tr>
<tr>
<td>Log Revenue Debt Outstanding</td>
<td>4472</td>
<td>15.311</td>
<td>3.063</td>
<td>14.159</td>
<td>15.782</td>
<td>17.112</td>
</tr>
<tr>
<td>Log # Employees</td>
<td>4594</td>
<td>48.486</td>
<td>88.204</td>
<td>7</td>
<td>17</td>
<td>48</td>
</tr>
<tr>
<td>Gen. Manager Wage Premium</td>
<td>2906</td>
<td>1.188</td>
<td>0.655</td>
<td>0.686</td>
<td>1.144</td>
<td>1.615</td>
</tr>
<tr>
<td>County Unemployment Rate</td>
<td>10574</td>
<td>8.422</td>
<td>4.002</td>
<td>5.2</td>
<td>7.6</td>
<td>10.6</td>
</tr>
<tr>
<td>System Problems</td>
<td>3798</td>
<td>3.095</td>
<td>1.776</td>
<td>1.609</td>
<td>3.178</td>
<td>4.382</td>
</tr>
</tbody>
</table>
Table 2: Revenues and Expenses Following Covenant Violations

This table reports coefficients $\beta$ 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 gross revenues in column 2 and operating and maintenance expenses in column 3, defined as total operating expenses minus depreciation expense. I also include the following operating expenses categories: water retail (treatment and transmission/distribution), water source (water supply and pumping), and administrative and other expenses (all non functional water expenses). To minimize the effect of reporting changes on results, I only analyze violations where there is a full 7 years of each expense sub-category for columns 3-5. The last column analyzes water revenue debt outstanding. I include utility level fixed effects $\gamma_i$ and fiscal year fixed effects $\delta_t$ in all specifications and cluster standard errors at the utility level. I also include the county-level lagged unemployment rate in all specifications. The sample consists of utility-fiscal year observations between 2003 and 2019 where: (1) a utility’s coverage ratio slack measure is below 0 in time 0, representing a violation; (2) there were no covenant violations in the three years prior to the violation; and (3) there is a full 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 is a full 7 years of the subcategory expense reported.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
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<tbody>
<tr>
<td></td>
<td>$\Delta \log$</td>
<td>$\Delta \log$</td>
<td>$\Delta \log$</td>
<td>$\Delta \log$</td>
<td>$\Delta \log$</td>
<td>$\Delta \log$</td>
</tr>
<tr>
<td></td>
<td>Gross Revenues</td>
<td>O&amp;M Expenses</td>
<td>Water Retail Expenses</td>
<td>Water Source Expenses</td>
<td>Admin/Other Expenses</td>
<td>Rev. Debt Outstanding</td>
</tr>
<tr>
<td>Post Violation</td>
<td>0.0638***</td>
<td>-0.0993***</td>
<td>-0.191***</td>
<td>-0.0631</td>
<td>-0.137***</td>
<td>-0.777***</td>
</tr>
<tr>
<td></td>
<td>(0.0147)</td>
<td>(0.0182)</td>
<td>(0.0473)</td>
<td>(0.0532)</td>
<td>(0.0499)</td>
<td>(0.252)</td>
</tr>
<tr>
<td>Unemploy. Rate$_{t-1}$</td>
<td>-0.0209***</td>
<td>-0.000889</td>
<td>-0.0163</td>
<td>-0.00467</td>
<td>0.0319</td>
<td>0.229*</td>
</tr>
<tr>
<td></td>
<td>(0.00682)</td>
<td>(0.0103)</td>
<td>(0.0267)</td>
<td>(0.0182)</td>
<td>(0.0291)</td>
<td>(0.124)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,046</td>
<td>1,046</td>
<td>781</td>
<td>745</td>
<td>1,044</td>
<td>952</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.175</td>
<td>0.135</td>
<td>0.135</td>
<td>0.097</td>
<td>0.074</td>
<td>0.194</td>
</tr>
<tr>
<td>FE</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
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<tr>
<td>Cluster</td>
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<td>Entity</td>
<td>Entity</td>
<td>Entity</td>
<td>Entity</td>
<td>Entity</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Table 3: Covenant Tightness and Operating Decisions: Prices, Revenues, and O&M Expenses

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

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

Covenant Tight$_{ij,t-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. The left hand side variables are first differences in log outcomes. All specifications include utility-level $\gamma_i$ and fiscal year $\delta_t$ fixed effects, as well as the lagged county-level unemployment rate in vector $X_{j,t-1}$. 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 revenues per million gallons of water delivered. The second column reports the results for the change in log gross revenues. The third column reports results for the change in log gross O&M expenses, which are operating expenses minus depreciation.

<table>
<thead>
<tr>
<th></th>
<th>(1) $\Delta$ Log “Price”</th>
<th>(2) $\Delta$ Log Gross Revs</th>
<th>(3) $\Delta$ Log O&amp;M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cov. Tight. (SDs)$_{t-1}$</td>
<td>0.0489***</td>
<td>0.0288***</td>
<td>-0.0444***</td>
</tr>
<tr>
<td></td>
<td>(0.0134)</td>
<td>(0.00256)</td>
<td>(0.00349)</td>
</tr>
<tr>
<td>County Unemploy. Rate$_{t-1}$ (%)</td>
<td>0.0293**</td>
<td>-0.00783***</td>
<td>-0.00981***</td>
</tr>
<tr>
<td></td>
<td>(0.0136)</td>
<td>(0.00262)</td>
<td>(0.00320)</td>
</tr>
</tbody>
</table>

Observations 1,140 4,096 4,094
R-squared 0.128 0.164 0.104
E[LHS] .039 .027 .027
FE Entity/Year Entity/Year Entity/Year
Cluster Entity Entity Entity

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Table 4: Covenant Tightness and Operating Decisions: Administrative Expenses and Outcomes

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

\[ Y_{ijt} = \gamma_i + \delta_t + \beta \text{Covenant Tight}_{ij,t-1} + \psi X_{j,t-1} + \varepsilon_{ijt} \]

\text{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. All specifications include utility-level \( \gamma_i \) and fiscal year \( \delta_t \) fixed effects, as well as the lagged county-level unemployment rate in vector \( X_{j,t-1} \). Standard errors are all clustered at the utility level. The first 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 second column reports the results for the change in log number of department employees. The last column reports results for the general manager’s wage mark-up over the median employee, which is expressed as a ratio.

<table>
<thead>
<tr>
<th></th>
<th>Column (1)</th>
<th>Column (2)</th>
<th>Column (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Delta Log Admin and Other Expenses</td>
<td>Delta Log # Employees</td>
<td>Gen. Manager Wage Premium</td>
</tr>
<tr>
<td>Cov. Tight. (SDs)_{t-1}</td>
<td>-0.0517***</td>
<td>-0.0152**</td>
<td>-0.0293**</td>
</tr>
<tr>
<td></td>
<td>(0.00855)</td>
<td>(0.00682)</td>
<td>(0.0132)</td>
</tr>
<tr>
<td>County Unemploy. Rate_{t-1} (%)</td>
<td>0.00218</td>
<td>0.000846</td>
<td>-0.00579</td>
</tr>
<tr>
<td></td>
<td>(0.00714)</td>
<td>(0.00924)</td>
<td>(0.0205)</td>
</tr>
<tr>
<td>Observations</td>
<td>4,076</td>
<td>2,125</td>
<td>1,526</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.050</td>
<td>0.071</td>
<td>0.803</td>
</tr>
<tr>
<td>E[LHS]</td>
<td>.026</td>
<td>-.012</td>
<td>1.188</td>
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<tr>
<td>FE</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
</tr>
<tr>
<td>Cluster</td>
<td>Entity</td>
<td>Entity</td>
<td>Entity</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

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

50
Table 5: Covenant Tightness and Operating Decisions: Functional Water Expenses and Outcomes

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

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

Covenant Tight$_{ij,t-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. The left hand side variables are first differences in log outcomes. All specifications include utility-level $\gamma_i$ and fiscal year $\delta_t$ fixed effects, as well as the lagged county-level unemployment rate in vector $X_{j,t-1}$. Standard errors are all clustered at the utility level. The first column reports results for the change in log water retail expenses, which combine treatment, transmission, and distribution costs into one category. The second column reports results for the change in log water source expenses, which combines water supply and pumping expense into one category. The last column reports the change in the log number of reported distribution problems, which includes breaks, leaks, water outages, and boil water orders.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta \log$ Water Retail Expenses</td>
<td>$\Delta \log$ Water Source Expenses</td>
<td>$\Delta \log$ Sys. Problems</td>
</tr>
<tr>
<td>Cov. Tight. (SDs)$_{t-1}$</td>
<td>$-0.0326^{***}$</td>
<td>$-0.0330^{***}$</td>
<td>$-0.00225$</td>
</tr>
<tr>
<td></td>
<td>(0.00652)</td>
<td>(0.00553)</td>
<td>(0.0223)</td>
</tr>
<tr>
<td>County Unemploy. Rate$_{t-1}$ (%)</td>
<td>$-0.00991$</td>
<td>$-0.0157^{*}$</td>
<td>$0.0533$</td>
</tr>
<tr>
<td></td>
<td>(0.00657)</td>
<td>(0.00930)</td>
<td>(0.0329)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,348</td>
<td>3,271</td>
<td>1,338</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.076</td>
<td>0.081</td>
<td>0.105</td>
</tr>
<tr>
<td>E[LHS]</td>
<td>.017</td>
<td>.009</td>
<td>-.006</td>
</tr>
<tr>
<td>FE</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
</tr>
<tr>
<td>Cluster</td>
<td>Entity</td>
<td>Entity</td>
<td>Entity</td>
</tr>
</tbody>
</table>

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:

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

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 6 for each part of the Covenant Tight$_{ij,t-1}$ distribution separately. The variable Top Third×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×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×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 first differences in log outcomes for financial variables. All specifications include utility-level $\gamma_i$ and fiscal year $\delta_t$ fixed effects, as well as the lagged county-level unemployment rate in vector $X_{j,t-1}$. 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 7.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta$ Log Gross Revs.</td>
<td>$\Delta$ Log Admin Exp.</td>
<td>$\Delta$ Log Water Retail Exp.</td>
<td>$\Delta$ Log Water Source Exp.</td>
</tr>
<tr>
<td>Bottom Third×Cov. Tight$_{t-1}$</td>
<td>0.0288*** (0.00274)</td>
<td>-0.0234*** (0.00883)</td>
<td>-0.0239*** (0.00768)</td>
<td>-0.0363*** (0.00648)</td>
</tr>
<tr>
<td>Middle Third×Cov. Tight$_{t-1}$</td>
<td>0.0506*** (0.00702)</td>
<td>-0.0405 (0.0322)</td>
<td>-0.0868*** (0.0236)</td>
<td>-0.0265 (0.0188)</td>
</tr>
<tr>
<td>Top Third×Cov. Tight$_{t-1}$</td>
<td>0.0329*** (0.00865)</td>
<td>-0.194*** (0.0409)</td>
<td>-0.0935*** (0.0265)</td>
<td>-0.0471** (0.0233)</td>
</tr>
<tr>
<td>County Unemploy. Rate$_{t-1}$ (%)</td>
<td>-0.00706*** (0.00255)</td>
<td>0.00177 (0.00730)</td>
<td>-0.0109 (0.00667)</td>
<td>-0.0158* (0.00939)</td>
</tr>
<tr>
<td>Observations</td>
<td>4,096</td>
<td>4,076</td>
<td>3,348</td>
<td>3,271</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.166</td>
<td>0.061</td>
<td>0.082</td>
<td>0.082</td>
</tr>
<tr>
<td>E[LHS]</td>
<td>.27</td>
<td>.26</td>
<td>.17</td>
<td>.09</td>
</tr>
<tr>
<td>FE</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
<td>Entity/Year</td>
</tr>
<tr>
<td>Cluster</td>
<td>Entity</td>
<td>Entity</td>
<td>Entity</td>
<td>Entity</td>
</tr>
</tbody>
</table>

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

52
This table reports coefficients from the following regression at the utility–county–year (ijt) level:

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

Covenant Tightness$_{ijt-1}$ is the measure of covenant tightness, reported in standard deviations and lagged by one period. I interact this with an indicator variable, Tercile$_{ijt-1}$, which is an indicator variable for the top, middle, and bottom thirds of the Covenant Tight$_{ijt-1}$ distribution. This regression is identical to running specification 6 for each part of the Covenant Tight$_{ijt-1}$ distribution separately. The variable Top Third$x$ 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$x$ 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$x$ 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 $\gamma_i$ and fiscal year $\delta_t$ fixed effects, as well as the lagged county-level unemployment rate in vector $X_{j,t-1}$. 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 in log system problems, which includes pipe breaks, water outages, and boil water orders. These coefficients are also depicted in Figure 8.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δ Log Price*</td>
<td>Δ Log # Employees</td>
<td>Δ Log Gen. Manager Wage Premium</td>
<td>Δ Log 1+ Sys. Problems</td>
</tr>
<tr>
<td>Bottom Third$x$ Cov. Tight$_{t-1}$</td>
<td>0.0452***</td>
<td>-0.0120</td>
<td>-0.0211</td>
<td>-0.0327</td>
</tr>
<tr>
<td></td>
<td>(0.0146)</td>
<td>(0.00808)</td>
<td>(0.0147)</td>
<td>(0.0252)</td>
</tr>
<tr>
<td>Middle Third$x$ Cov. Tight$_{t-1}$</td>
<td>0.0740**</td>
<td>-0.00216</td>
<td>-0.0263</td>
<td>-0.0211</td>
</tr>
<tr>
<td></td>
<td>(0.0336)</td>
<td>(0.0230)</td>
<td>(0.0332)</td>
<td>(0.0756)</td>
</tr>
<tr>
<td>Top Third$x$ Cov. Tight$_{t-1}$</td>
<td>0.0818**</td>
<td>-0.0293*</td>
<td>-0.0715**</td>
<td>0.193***</td>
</tr>
<tr>
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<td>(0.0371)</td>
<td>(0.0164)</td>
<td>(0.0349)</td>
<td>(0.0678)</td>
</tr>
<tr>
<td>County Unemploy. Rate$_{t-1}$ (%)</td>
<td>0.0289**</td>
<td>0.000767</td>
<td>-0.00587</td>
<td>0.0505</td>
</tr>
<tr>
<td></td>
<td>(0.0137)</td>
<td>(0.00925)</td>
<td>(0.0204)</td>
<td>(0.0331)</td>
</tr>
</tbody>
</table>

Observations: 1,140 2,125 1,526 1,338
R-squared: 0.129 0.072 0.803 0.112
E[LHS]: 0.039 -0.012 1.188 -0.006
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 and control 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 50% of the group. The treated are suppliers in the top 50%. The sample period is 2010 to 2019. Log Gross Revenues is the log of gross revenues as defined in the text. Log Gross O&M 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 minus all functional water expenses. This includes expenses that cannot be charged to a particular function as well as customer billing and sales expenses. 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. Population Growth 00-10 is calculated as the change in log population growth between 2010 and 2000. 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. County Unemploy. Rate is the county unemployment rate, from the Bureau of Labor Statistics. Covenant Tight. Pre-Period is the average covenant tightness for utilities that report revenue debt outstanding between 2010 and 2014. 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. Drought Tier is the state-assigned tier corresponding to drought restrictions. Higher numbers required larger cuts in residential consumption. Group 6 was required to cut water consumption by 24% relative to 2014 residential use.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Treated</th>
<th>All UWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Utilities</td>
<td>93</td>
<td>92</td>
<td>185</td>
</tr>
<tr>
<td>Log Gross Revenues</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>16.704</td>
<td>16.426</td>
<td>16.566</td>
</tr>
<tr>
<td></td>
<td>16.608</td>
<td>16.359</td>
<td>16.508</td>
</tr>
<tr>
<td>Log Operating Expenses ex. Depreciation</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>16.305</td>
<td>16.047</td>
<td>16.204</td>
</tr>
<tr>
<td>Operating Revenues/Gross O&amp;M Ratio</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>1.399</td>
<td>1.381</td>
<td>1.39</td>
</tr>
<tr>
<td></td>
<td>1.321</td>
<td>1.307</td>
<td>1.315</td>
</tr>
<tr>
<td>Log General and Admin. Expenses</td>
<td>926</td>
<td>913</td>
<td>1839</td>
</tr>
<tr>
<td></td>
<td>15.157</td>
<td>14.878</td>
<td>15.029</td>
</tr>
<tr>
<td>Log All Functional Water Expenses</td>
<td>929</td>
<td>920</td>
<td>1849</td>
</tr>
<tr>
<td></td>
<td>15.182</td>
<td>14.21</td>
<td>14.699</td>
</tr>
<tr>
<td></td>
<td>15.868</td>
<td>15.532</td>
<td>15.668</td>
</tr>
<tr>
<td>Log Water Source Expenses</td>
<td>835</td>
<td>680</td>
<td>1515</td>
</tr>
<tr>
<td></td>
<td>15.36</td>
<td>15.053</td>
<td>15.222</td>
</tr>
<tr>
<td></td>
<td>15.503</td>
<td>15.355</td>
<td>15.447</td>
</tr>
<tr>
<td>Log Water Retail Expenses</td>
<td>775</td>
<td>721</td>
<td>1496</td>
</tr>
<tr>
<td></td>
<td>14.8</td>
<td>14.876</td>
<td>14.836</td>
</tr>
<tr>
<td>Log Census Population</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>10.973</td>
<td>10.882</td>
<td>10.928</td>
</tr>
<tr>
<td></td>
<td>11.046</td>
<td>10.856</td>
<td>10.953</td>
</tr>
<tr>
<td>Population Growth 00-10</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>0.059</td>
<td>0.116</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td>0.023</td>
<td>0.09</td>
<td>0.051</td>
</tr>
<tr>
<td>Median Household Income</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>77549.716</td>
<td>74424.903</td>
<td>75995.755</td>
</tr>
<tr>
<td></td>
<td>72805.458</td>
<td>68624.312</td>
<td>70334.601</td>
</tr>
<tr>
<td>County Unemploy. Rate (%)</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>7.888</td>
<td>8.304</td>
<td>8.095</td>
</tr>
<tr>
<td></td>
<td>6.7</td>
<td>7.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Covenant Tight Pre-Period</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>-1.627</td>
<td>-0.036</td>
<td>-0.836</td>
</tr>
<tr>
<td></td>
<td>-1.592</td>
<td>-0.192</td>
<td>-0.73</td>
</tr>
<tr>
<td>Log Revenue Debt Outstanding</td>
<td>854</td>
<td>870</td>
<td>1724</td>
</tr>
<tr>
<td></td>
<td>16.104</td>
<td>16.526</td>
<td>16.317</td>
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<tr>
<td></td>
<td>16.369</td>
<td>16.844</td>
<td>16.625</td>
</tr>
<tr>
<td>Drought Tier</td>
<td>930</td>
<td>920</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>5.806</td>
<td>6.304</td>
<td>6.054</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>
Table 9: Effect of Rate Covenant Constraints and Droughts on Utilities: Outcomes per Million Gallons

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

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

$\Delta$ is the first difference operator: this specification collapses outcomes into pre and post period averages and takes the difference. $\text{Constrained}_i$ 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 $\beta$. 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. I control for median household income and population in the pre-period in all specifications. Columns 1 and 4 report estimates with heteroskedasticity-consistent standard errors. Columns 2, 3, 5, and 6 cluster standard errors at the county-level, to account for potential geographic correlations. Columns 3 and 6 include county fixed effects.

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.

<table>
<thead>
<tr>
<th></th>
<th>$\Delta$ Log Price*</th>
<th>$\Delta$ Log O&amp;M per MG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Constrained</td>
<td>0.120*** (0.0368)</td>
<td>0.120*** (0.0354)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log Med. House. Income (Pre)</td>
<td>-0.0207 (0.0507)</td>
<td>-0.0207 (0.0454)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log Pop. (Pre)</td>
<td>-0.00572 (0.0168)</td>
<td>-0.00572 (0.0184)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.402 (0.585)</td>
<td>0.402 (0.508)</td>
</tr>
</tbody>
</table>

| Observations         | 154                 | 154                     | 143 | 154 | 154 | 143 |
| R-squared            | 0.074               | 0.074                   | 0.262 | 0.007 | 0.007 | 0.271 |
| FE                   | No                  | No                      | County | No | No | County |
| Cluster              | No                  | County                  | County | No | County | County |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Table 10: Effect of Rate Covenant Constraints and Droughts on Utilities: Gross Revenues and Expenses

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

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

$\Delta$ is the first difference operator: this specification collapses outcomes into pre and post period averages and takes the difference. $\text{Constrained}_i$ 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 $\beta$. 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. I control for median household income and population in the pre-period in all specifications. Columns 1 and 4 report estimates with heteroskedasticity-consistent standard errors. Columns 2, 3, 5, and 6 cluster standard errors at the county-level, to account for potential geographic correlations. Columns 3 and 6 include county fixed effects. 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.

<table>
<thead>
<tr>
<th></th>
<th>$\Delta$ Log Gross Revenues</th>
<th>$\Delta$ Log Gross O&amp;M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Constrained</td>
<td>0.0467**</td>
<td>0.0467**</td>
</tr>
<tr>
<td></td>
<td>(0.0188)</td>
<td>(0.0174)</td>
</tr>
<tr>
<td>Log Med. House. Income (Pre)</td>
<td>0.0592**</td>
<td>0.0592**</td>
</tr>
<tr>
<td></td>
<td>(0.0268)</td>
<td>(0.0283)</td>
</tr>
<tr>
<td>Log Pop. (Pre)</td>
<td>-0.0130*</td>
<td>-0.0130</td>
</tr>
<tr>
<td></td>
<td>(0.00724)</td>
<td>(0.0103)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.434</td>
<td>-0.434</td>
</tr>
<tr>
<td></td>
<td>(0.297)</td>
<td>(0.313)</td>
</tr>
<tr>
<td>Observations</td>
<td>185</td>
<td>185</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.062</td>
<td>0.062</td>
</tr>
<tr>
<td>FE</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cluster</td>
<td>No</td>
<td>County</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Table 11: Effect of Rate Covenant Constraints and Droughts on Utilities: Admin and Water Expenses

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

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

$\Delta$ is the first difference operator: this specification collapses outcomes into pre and post period averages and takes the difference. $\text{Constrained}_i$ 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 $\beta$. 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. I control for median household income and population in the pre-period in all specifications. Columns 1 and 4 report estimates with heteroskedasticity-consistent standard errors. Columns 2, 3, 5, and 6 cluster standard errors at the county-level, to account for potential geographic correlations. Columns 3 and 6 include county fixed effects. 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.

<table>
<thead>
<tr>
<th></th>
<th>$\Delta$ Log Admin per MG</th>
<th>$\Delta$ Log Water Expense per MG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Constrained</td>
<td>0.0853</td>
<td>0.0853</td>
</tr>
<tr>
<td></td>
<td>(0.0882)</td>
<td>(0.0894)</td>
</tr>
<tr>
<td>Log Med. House. Income (Pre)</td>
<td>-0.0817</td>
<td>-0.0817</td>
</tr>
<tr>
<td></td>
<td>(0.109)</td>
<td>(0.122)</td>
</tr>
<tr>
<td>Log Pop. (Pre)</td>
<td>-0.0458</td>
<td>-0.0458</td>
</tr>
<tr>
<td></td>
<td>(0.0363)</td>
<td>(0.0366)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.720</td>
<td>1.720</td>
</tr>
<tr>
<td></td>
<td>(1.358)</td>
<td>(1.570)</td>
</tr>
<tr>
<td>Observations</td>
<td>147</td>
<td>147</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.024</td>
<td>0.024</td>
</tr>
<tr>
<td>FE</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cluster</td>
<td>No</td>
<td>County</td>
</tr>
</tbody>
</table>

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. 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.\textsuperscript{25} I also remove special districts that are unlikely to be water providers, by string searching specific words in the entity’s name.\textsuperscript{26} 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 reported operating expenses that are not included in the FTR operating expenses (primarily taxes). I construct the functional expenses using the relevant subcategory’s previous year share of total operating expenses excluding depreciation and multiple by the hand-collected CAFR operating expense minus depreciation.

Operating revenues similarly have a breakdown of customer type for special districts, and within/outside city limits for cities. Because city and special district revenue subcategories are incomparable for most

\textsuperscript{25}Infrequent reporters are also more likely to be inconsistent reporters of expense categories. This screen ensures that the sample consists of reliable reporters.

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 included 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

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. This occurred in both the special district and cities report forms.

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.
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 is 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 have plotted 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)