

The Politics of Local Service Provision in the United States

by

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University Program in Environmental Policy
Duke University

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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor
of Philosophy in Environmental Policy
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ABSTRACT

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Abstract

Local governments in the United States spend more than \$1.6 trillion annually on public service provision. Access to reliable public services is essential for health and wellbeing. But there are large disparities in access to services across the country. This dissertation asks why. Specifically, I examine the incentives and constraints that influence investment in services. Local governments fund service provision with revenue from local taxes, fees, and intergovernmental aid. The amount of revenue that local governments collect depends on the demographics of their jurisdiction. Demographics undergird the size of the revenue base, voter preferences over tax rates and fees, and the need and capacity to seek intergovernmental aid. Each standalone chapter of this dissertation examines one of these components. In the first chapter, I use data from the U.S. Census and Census of Governments to examine how income segregation between municipalities shapes local service expenditures in metropolitan areas. In the second chapter, my coauthors and I use data on water rates and local elections to test whether voters hold local elected officials responsible for increasing service fees. In the third chapter, I use data from service area shapefiles, the U.S. Census, and state agencies to assess whether resource-based differences in need and capacity correlate with the allocation of federal aid for water services. Understanding the politics of local service provision has important implications for equitable access to services.

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Dissertation Introduction

Access to public services—health care, housing, fire protection, libraries, parks, water and wastewater services, among others—improves quality of life. Local governments provide most public services in the United States. In aggregate, towns, cities, counties, school districts, and special districts spend more than \$1.6 trillion on services annually. But access to local public services varies dramatically across the country. Local governments in the Fort Knox, Kentucky metropolitan area spent less than \$5 per capita on housing and welfare in 2012, a vanishing fraction of the \$695 per capita local governments in the Santa Barbara, California metropolitan area spent on these services the same year.¹

Do theories in American politics explain the variation in local public services? Which incentives motivate local elected officials to invest in public services? And which constraints prevent them from doing so?

Local governments collect revenue from taxes, fees, and intergovernmental aid to fund service provision. The amount of revenue that local governments collect depends on the revenue base within their jurisdiction, tax rates, and service fees. On average, taxes account for 42 percent of local revenue, service fees account for 22 percent of local

¹ Author's calculation. Data from the 2012 Census of Governments.

revenue, and intergovernmental aid accounts for 36 percent of local revenue (Urban Institute 2020).

Many incentives and constraints to local service provision arise from the demographics within jurisdictions, as summarized in Figure 1. First, demographics largely determine the revenue base—property, sales, and income—within a jurisdiction. Local governments that serve jurisdictions with stronger revenue bases can collect more revenue. Second, demographics influence voter preferences over taxes and fees. Local elected officials have strong incentives to respond to voter preferences. Third, demographics undergird the need and capacity to apply for intergovernmental aid.

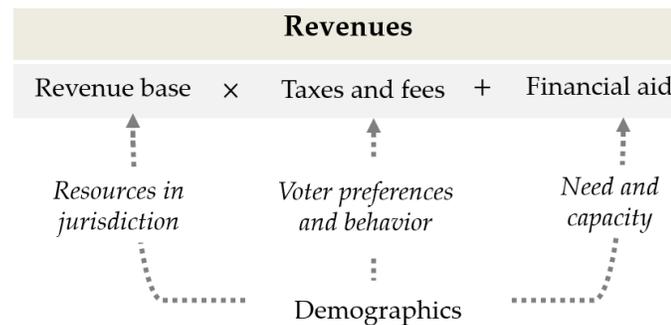


Figure 1: Incentives and constraints that influence local revenue collection

This dissertation examines incentives and constraints to local service provision in three stand-alone chapters. In the first chapter, I analyze how demographic shifts due to economic segregation between jurisdictions correlate with service expenditures in metropolitan areas. In the second chapter, my coauthors and I assess whether voters punish local elected officials for increasing service fees. In the third chapter, I examine

how demographics correlate with the likelihood of applying for and receiving intergovernmental aid.

In Chapter 1, I analyze how municipal-level economic segregation affects local service provision in metropolitan areas. Over the past half-century, U.S. households have increasingly sorted into separate towns and cities along class lines. Municipal-level economic segregation stratifies revenue bases and creates more homogeneous jurisdictions. Standard theories in public finance and political economy yield competing expectations about the effect of these shifts on revenue and expenditures. Using 30 years of panel data from 350 metropolitan areas, I assess the correlation between municipal-level economic segregation and service expenditures.

I find that local governments spend less as households segregate along jurisdictional boundaries. Economic segregation also changes the mix of services that local governments provide—decreasing overall spending on health and housing—and exacerbates disparities in service provision. As households segregate between municipalities, the state and federal government will need to pursue policies and provide aid to ensure all people have access to reliable service provision.

In Chapter 2, my coauthors and I assess whether voters punish politicians for increasing service fees. Concern about electoral punishment is considered a leading obstacle to collecting more revenue to fund service provision, but empirical evidence of such backlash is surprisingly sparse. Using election results and water rates for 165

municipalities in North Carolina from 2007 to 2017, my coauthors and I examine whether voters hold city council members accountable for local fee increases.

In contrast to political economic theory and politicians' expectations, we find the electoral risk of increasing water rates is low. The conditions under which increasing service costs matter are uncommon. Our work contributes to electoral accountability research by examining how cost, rather than the quality, of local service provision influences future political outcomes. The findings also have important practical implications: if politicians overestimate the threat of electoral punishment, they may provide public services at a level lower than what they and their constituents actually prefer.

In Chapter 3, I examine how demographics correlate with applications for and the allocation of federal financial assistance. Most political science and public administration research on federal aid focuses on members of Congress and bureaucrats while overlooking how communities may influence allocation. Greater need may spur low-resource communities to apply for assistance but limited capacity may prevent them from doing so. I study the allocation of federal aid for water systems provided through the Drinking Water State Revolving Fund (DWSRF). I combine data from the U.S. Census, maps of water service areas, annual DWSRF reports, the Project Benefits Reporting system, and the Safe Drinking Water Information System for eight states from

2015 to 2020 to assess the correlation between financial resources and the odds of applying for and receiving DWSRF assistance.

I show median household income is negatively correlated with DWSRF applications and awards. The proportion of the population living above 200% of the federal poverty line is not correlated with DWSRF applications and positively correlated with awards. This paper extends environmental justice research by examining the extent to which intergovernmental aid addresses disparities in water service.

The incentives and constraints that shape local service provision offer insights into broader political science questions about who gets what, when, and how. I draw on theories from local political economy, public finance, and public administration to explain the local revenue and expenditure decisions. Drawing these often separate literatures into conversation extends current theories on the the political, financial, and administrative determinants of local service provision. I also compile more comprehensive datasets to expand on the limited case study and cross-sectional evidence base on service provision.

Understanding the politics of local service provision has important implications for equitable access to services. Without policies that address constraints to investment, many local governments will struggle to sufficiently invest in services. Underinvestment in services threatens health and well-being.

1. Rising income segregation and local service provision in the United States

1.1 Introduction

Households have separated along class lines since the time of Plato, who observed in *The Republic* that all cities are “in fact divided into two, one [...] of the poor, the other of the rich.” But the scale of class-based segregation in the United States has shifted over the past several decades. Rather than separate neighborhoods, households have increasingly sorted along class lines into separate towns and cities (Fischer et al. 2004). Income segregation between municipalities has nearly doubled in the last 40 years.

Municipal-level segregation by class and race has serious consequences for local politics. Political economy research shows the demographics within a jurisdiction influence both individual behavior and collective decision-making. Compared to more integrated metropolitan statistical areas (MSAs), residents in economically segregated MSAs participate less in civic activities (Oliver 1999) and local governments in racially segregated MSAs cooperate less with nearby jurisdictions (Einstein 2012). In this paper, I examine how income segregation between municipalities influences another key function of local governments: the provision of local public services.

Local governments in the United States provide most public services, including highways, health care, and police, among others, with revenue from local taxes and fees. Public finance and political economy research shows that service provision varies with

the demographic composition of local jurisdictions. Municipal-level income segregation shifts the wealth and homogeneity within jurisdictions. Previous work suggests these demographic shifts should spur local governments to change their revenue collection and expenditures but yields mixed expectations about how.

Analyzing data on changes in municipal-level income segregation and service expenditures in 350 metropolitan areas from 1980 to 2010, I find local governments spend less on services as households sort between jurisdictions. Moving from the 10th to the 90th percentile in change in segregation is associated with a \$30 decrease in per capita expenditure. While modest, \$30 per resident is about the amount local governments in metropolitan areas spend on libraries. Income segregation also changes the types of services local governments provide. Rising income segregation is associated with a decrease in spending on health and housing.

This paper contributes to a broader understanding of political economy, public finance, and public administration research on why service provision varies across jurisdictions. Scholars have studied the links between demographics and local services for decades but the theories and empirical evidence from different subfields are often siloed. Political economy research on the political incentives to provide services often sidelines the fiscal constraints. Conversely, public finance research on the fiscal capacity to provide services largely overlooks the politics. I draw these literatures into conversation to examine how political incentives and fiscal constraints influence local

service provision in economically segregated metropolitan areas. In addition, much of the previous work is based on cross-sectional data (Hopkins 2009). I compile and analyze panel data to observe how local governments respond to demographic changes over time.

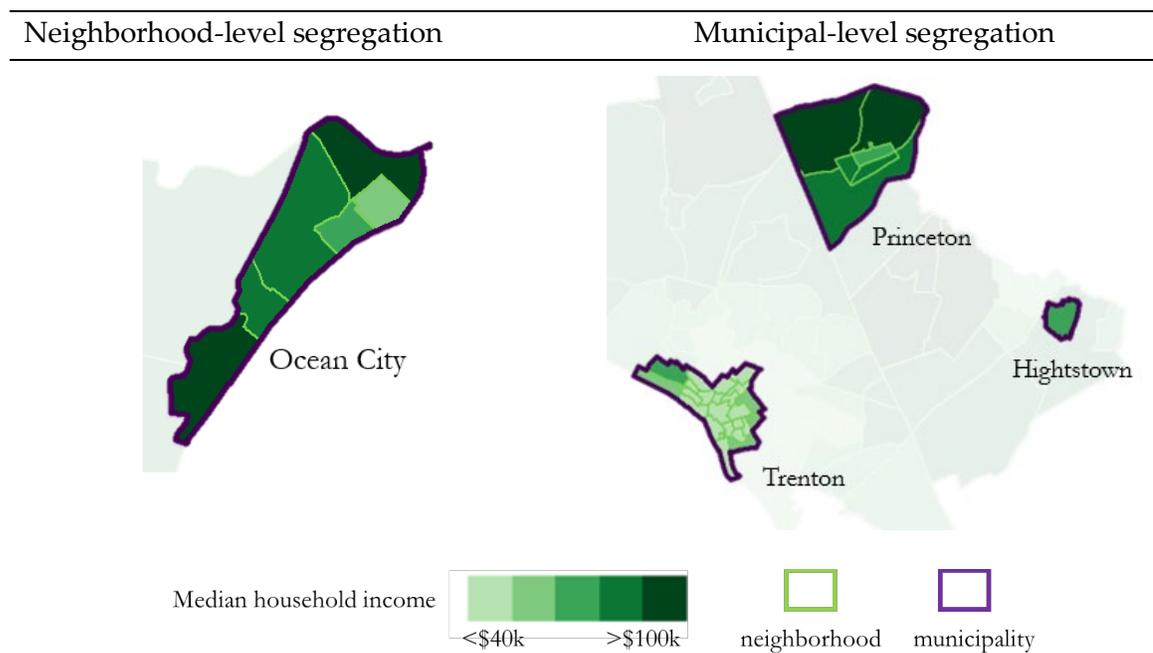
The amount local governments spend on services in economically segregated metropolitan areas has important policy implications. Since local governments rely on own-source revenue to fund provision, municipal-level income segregation creates disparities in their capacity to invest. Millions of US residents rely on local public services and lack of access has serious consequences for health and wellbeing. Local governments alone will be unable to remedy these disparities. The federal and state governments will need to pursue policies to address the drivers of municipal-level income segregation and provide aid to ensure adequate service provision.

1.2 Overview of segregation in the United States

1.2.1 Trends in segregation

Segregation refers to the spatial separation of social groups. Race, ethnicity, and class are the basis for most segregation in the United States, though theoretically social groups defined by any characteristic could spatially separate (Massey 2016). Segregation emerges at different geographic scales as households sort by race and class among blocks, neighborhoods, towns, and cities. For example, Figure 2 shows neighborhood- and municipal-level income segregation in two MSAs in New Jersey. Household sort by

class into relatively homogenous neighborhoods in Ocean City, New Jersey, as shown in the left panel of Figure 2. Municipal-level income segregation is more prevalent in the Trenton metropolitan area: Trenton, Hightstown, and Princeton, New Jersey are relatively homogenous municipalities within the economically diverse MSA, as shown in the right panel of Figure 2.



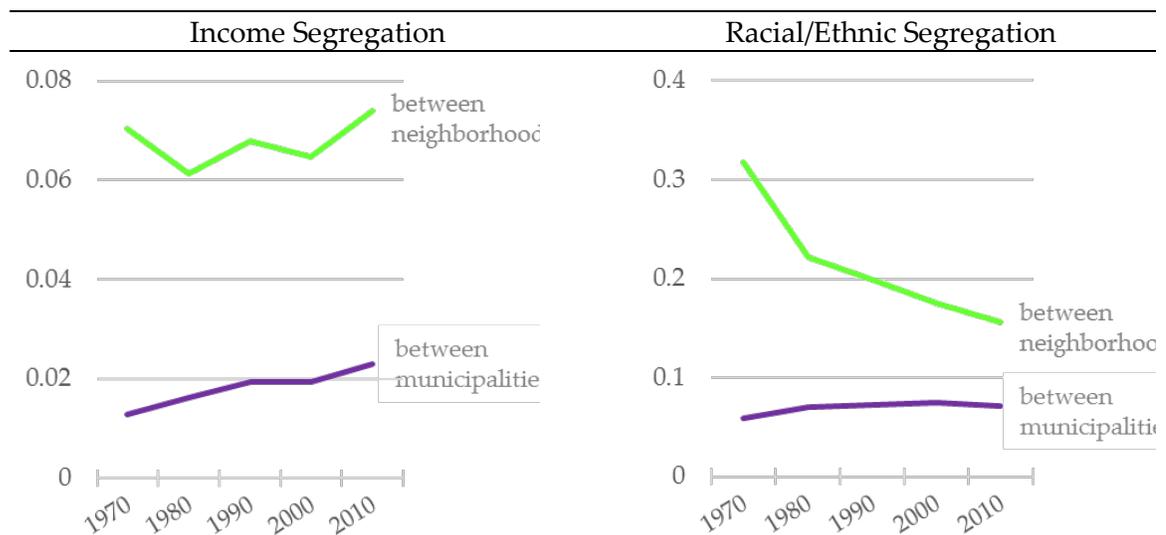
Note: Following standard practice, neighborhoods are approximated by U.S. Census tracts. Data are from the 2008–2012 ACS.

Figure 2: Income segregation between neighborhoods in Ocean City, New Jersey and incorporated municipalities in the Trenton, New Jersey metropolitan area.

Over the past 40 years, municipal-level income segregation has steadily increased. Figure 3 shows trends in segregation by class and race/ethnicity measured by standard entropy-based indexes that range from zero to one. Municipal-level income segregation, measured by the rank-order information theory index, rose by about 15

percent per decade from 1970 to 2010, as shown in the left panel of Figure 3.

Neighborhood-level income segregation accounts for more class-based spatial separation but fluctuated over this period (Davidoff 2005). Alternative measures of income segregation, such as Theil’s *H*-index, and class, such as home ownership or education, show similar trends (Fischer et al. 2004; Trounstein 2017).



*Note: Data from the U.S. Censuses (1970–2010) and ACS (2008–2012). Income segregation is measured by the rank-order information theory index and racial segregation is measured with Theil’s *H*-Index for five racial/ethnic groups. This figure shows the unweighted average across all MSAs designated in 1980 (350). Neighborhoods are approximated by U.S. Census tracts. The Y-axes have different scales.*

Figure 3: Segregation in US metropolitan areas between neighborhoods and incorporated municipalities by class and race/ethnicity, 1970–2010.

While municipal-level income segregation has increased, neighborhood-level segregation by race and ethnicity has declined precipitously (e.g., Massey, Rothwell, and Domina 2009). The right panel of Figure 3 shows racial/ethnic segregation between neighborhoods, measured by Theil’s *H*-Index, peaked at 0.32 in 1970 and fell to 0.15 in

2010. This decline was partially offset by rising racial/ethnic segregation at the municipal level in the 1970s (Boustan 2013; Lichter, Parisi, and Taquino 2015). The extensive research on US segregation largely focuses on the causes and consequences of these trends.

1.2.2 Causes of segregation

Social scientists have identified numerous factors that cause segregation in the US. Racism and discrimination are prominent drivers (Lamb 2014). For example, neighborhood associations adopted racially restrictive covenants in the mid-20th century to prohibit people of color from renting or buying property in white neighborhoods. The federal government furthered segregation through discriminatory housing policies, such as refusing to insure mortgages in multiracial neighborhoods. Although the 1968 Fair Housing Act prohibits housing discrimination, evidence from audits show people of color continue to face more hurdles in renting, purchasing, and financing homes than white people (Massey and Denton 1993; White 1987).

Restrictive land use regulations also cause segregation. Many local land use regulations—zoning ordinances, building codes, and other rules—restrict the amount and type of housing that can be built in an area (Pendall, Puentes, and Martin 2006; Trounstein 2020). For example, local governments ban multifamily housing or set minimum lot sizes within their jurisdictions. These restrictions typically increase housing cost, spurring subsequent class-based segregation as fewer low-income

households can afford to live in areas with high rents and mortgages (Glaeser, Gyourko, and Saks 2005). Recent evidence shows restrictive land use regulations contribute to segregation both within and between cities. Well-off households move to areas with restrictive land use regulations and then impose further restrictions to protect their exclusive enclaves (Lens and Monkkonen 2016; Trounstein 2020).

In addition to laws and regulations, individual preferences to sort by race, ethnicity, and class lead to segregation. Many people prefer to live near others with similar backgrounds. Homophilous preferences prompt individuals to leave diversifying neighborhoods or municipalities and relocate to more homogenous places. White people are more likely to perceive areas with high concentrations of people of color as “undesirable” and choose to move to whiter areas. Similarly, the wealthy tend to eschew areas with high concentrations of poverty and sort into wealthier areas (Weiher 1991; McKenzie 2012). Schelling (1971) shows even slight homophilous preferences can theoretically lead to complete spatial separation of social groups. Beyond sorting between existing jurisdiction, heterogeneity also spurs the formation of new jurisdictions (Alesina, Baqir, and Hoxby 2004; Miller 1981; Musso 2001).

Individual preferences over service provision also contribute to segregation. Tiebout (1956) argues preferences over taxes and services determine residential choice. In theory, Tiebout sorting should generate economic segregation if willingness to pay for quality services varies by income (Epple, Filimon, and Romer 1993; Nechyba 2010). The

empirical evidence linking variation in preferences over taxes and services by income and sorting is mixed (Epple and Sieg 1999; Rhode and Strumpf 2003). Apart from spatial sorting, income inequality exacerbates economic segregation (Watson 2009; Massey and Fischer 2000; Quillian 2014). Rising income inequality widens the gap between poor and rich places that have already stratified. Reardon and Bischoff (2011) estimate that rising inequality accounted for more than half of the increase in income segregation among neighborhoods in the largest US metropolitan areas from 1980 to 2010.

Feedback cycles perpetuate the concentration of wealth or poverty within jurisdictions. High-income towns attract wealthier residents. Demand drives up property values (Gyourko, Saiz, and Summers 2008). Boustan (2013) estimates that homeowners pay 7.4% more for similar housing to live in places where the median income is \$10,000 higher than surrounding jurisdictions. Local governments with stronger revenue bases can provide high-quality services at lower tax rates. The benefits of high-quality services and low tax rates are capitalized into property values. The opposite holds for low-income towns. Local governments in jurisdictions with low property values, income, and sales must either increase tax rates, take on debt, or cut spending to balance their budgets. Many local governments choose to defer capital projects. Poorly maintained roads, sewer systems, parks, and libraries make it harder to attract residents and businesses, furthering the cycle of decline.

Fragmentation facilitates municipal-level segregation. The wealthy can segregate along class lines by either moving to existing affluent enclaves or creating their own through incorporation. Fragmentation often changes the geographic scale of segregation. There is more neighborhood-level segregation within large jurisdictions, but the scale of segregation shifts to the municipal level as the wealthy create new, smaller jurisdictions within an area (Frankenberg 2009).

1.2.3 Consequences of segregation

Racial and economic segregation spatially concentrates poverty (Massey and Denton 1993). Subsequently, segregated neighborhoods have a higher prevalence of behavior and outcomes associated with poverty, such as substance abuse, single-parenthood, crime, and imprisonment (Massey, Gross, and Eggers 1991; Cutler and Glaeser 1997; Sampson 2012). More recent research shows that neighborhood-level racial/ethnic segregation also affects collective decision-making, such as zoning restrictions, investments in public housing, and lending practices (Massey, Rothwell, and Domina 2009; Rugh and Trounstine 2011; Trounstine 2016; 2020).

The consequences of segregation at the municipal level are not as well understood. A few studies provide evidence that political behavior and collective decisions change when residents sort between homogenous municipalities in diverse metropolitan areas. Oliver (1999) shows that residents in economically segregated MSAs are less likely to contact their local elected officials or vote in local elections. Local

governments in racially segregated MSAs collaborate less than those in more integrated MSAs (Amirkhanyan 2009; Einstein 2012). Municipal-level segregation amplifies political cleavages that erode the common ground for local governments to cooperate on policy (Dreier, Mollenkopf, and Swanstrom 2001; Weir, Wolman, and Swanstrom 2005). This paper extends this work to examine how municipal-level income segregation influences the provision of public services. The steady rise in municipal-level income segregation underscores the importance of understanding the consequences at this scale.

1.3 Municipal-level income segregation and service provision

Local governments spend more than \$1.6 trillion on public services annually. The quality and types of services that local governments provide vary widely across localities. In 2012, total expenditures on 10 local services—health care, highways, housing, libraries, fire protection, parks, police, sewers, trash removal, and welfare—ranged from less than \$500 per capita in the Fort Knox, Kentucky metropolitan area to more than \$3,000 per capita in the Santa Barbara, California metropolitan area. Local governments in Fort Knox spent less than \$5 per capita on housing and welfare in 2012, a mere fraction of the \$695 per capita local governments in Santa Barbara spent on these services the same year.¹

¹ Author's calculations. Data from the 2012 Census of Governments.

What explains the variation in local services? Standard theories in public finance and political economy often point to demographics. Municipal-level income segregation shifts the demographic composition of jurisdictions. Previous research suggests two demographic shifts—in wealth and economic homogeneity—should influence local service provision, but yield mixed expectations about how expenditures change.

I consider how municipal-level income segregation should theoretically change aggregate expenditures by all local governments in metropolitan areas. Overlapping local governments—municipalities, counties, special districts—provide services in any given MSA. Expenditures vary as local governments assume different functional responsibilities, fragment, and serve different areas over time. It is not possible to rule out variation from shifting functions, fragmentation, or service areas to assess the relationship between antecedents and expenditures by a single tier of government (Chernick, Langley, and Reschovsky 2015; Langley 2013). Examining aggregate expenditures by all local governments minimizes misleading comparisons.

1.3.1 Shifts in wealth

Local governments provide services with revenue from local taxes and fees. On average, local governments fund about two-thirds of local services with own-source revenue and one-third with intergovernmental aid. Most local own-source revenue in

metropolitan areas comes from property taxes (38 percent) or user fees (39 percent).² The amount local governments collect depends on their revenue base—the property, income, and sales within a jurisdiction—as well as their tax rates and service fees (Jacob and Hendrick 2012).

Local governments with weaker revenue bases typically spend less on services (Hill 1974; Schneider and Logan 1981; Ladd and Yinger 1991 though see Craw 2010). Since states require local governments to balance their budgets, local governments cannot spend more on services than they collect in revenue. Local governments with weaker revenue bases could compensate for lower property values by increasing tax rates and service fees. However, local elected officials are often hesitant to do so: increasing tax rates and service fees heightens concerns about affordability and political backlash. Many states also set tax limits that prevent local governments from increasing rates. Revenue-strapped jurisdictions often cut services, reduce the number of their employees, and defer maintenance to decrease expenditures (Bumgarner, Martinez-Vazquez, and Sjoquist 1991; Ladd and Yinger 1991).

Income segregation between municipalities stratifies local revenue bases. As households sort by class, the concentration of wealth strengthens some revenue bases

² Author's calculations. Data from the 2012 Census of Governments. Sales taxes account for about 14 percent of total own-source revenue and income taxes account for 5 percent. The minimal remaining own-source revenue comes from miscellaneous taxes, charges, and fees.

and weakens others. The revenue bases in places like Princeton, New Jersey, sometimes referred to “affluent enclaves” or “leafy suburbs,” grow as low-income households move out, high-income households move in, and income inequality rises. Conversely, the revenue bases in places like Trenton, New Jersey, sometimes referred to as “pockets of poverty” or “inner cities,” shrink. When households are segregated by class between municipalities, there is unequal capacity to fund service provision. Trounstein (2018) shows that economic segregation between incorporated municipalities increases variation in expenditures.

In aggregate, I expect shifts in local revenues bases from municipal-level economic segregation to reduce expenditures on services in metropolitan areas. Theoretically, higher expenditures in high-income places could offset lower expenditures in lower-income places. Many public services are normal goods, where demand increases with income. But the revenue shifts from stratification are likely unbalanced. Wealthy households cluster in a few localities and their exodus disproportionately drains the coffers of the many jurisdictions they leave behind. Households in the top income brackets often pay a large share of the property taxes. Moreover, tax and expenditures limits (TEEs) set a ceiling on the amount local governments can collect and spend (Jimenez 2018; Hoene and Pagano 2009). If only a small portion of jurisdictions have stronger revenue bases in economically segregated

metropolitan areas and TELs limit expenditures, increased spending in affluent municipalities should only partially offset decreases in less affluent jurisdictions.

1.3.2 Shifts in economic homogeneity

Fiscal capacity is only part of the story. Municipalities also become more economically homogenous as households sort between jurisdictions (Altshuler et al. 1999; Drier, Mollenkopf, and Swanstrom 2001). Public choice and political economy research suggests homogeneity is a key determinant of voter preferences over taxes and public goods provision (Borcherding and Deacon 1972; Bergstrom and Goodman 1973), assuming local elected officials respond to voter preferences to maximize their chances of reelection (Downs 1957) or revenue bases (Buchanan 1971; Peterson 1981). However, standard theories yield different expectations about how homogeneity might affect the levels and types of services local governments provide.

Public choice research suggests that local governments catering to median voters will spend less as their jurisdictions become more homogenous. In heterogeneous jurisdictions, median voters support higher expenditures because the taxes they pay are less than the benefits they receive from services (Romer, 1975; Meltzer and Richard 1981). Corcoran and Evans (2010) and Boustan et al. (2013) provide recent evidence of the correlation between inequality and service expenditures within municipalities. By this logic, median voters should prefer lower expenditures in more homogenous jurisdictions. In aggregate, local governments catering to the median voters of their

jurisdictions should spend less than they would if their jurisdictions had more economic heterogeneity.

Extending the logic of Meltzer and Richard (1981), municipal-level income segregation should also spur local governments to provide different types of services. In heterogeneous jurisdictions, lower-income median voters should seek services that disproportionately benefit them, such as health care, housing, and welfare. Expenditures on these services should decrease as jurisdictions become more homogenous. Voters in homogeneously low-income places have limited capacity to pay for services; voters in homogeneously high-income places have fewer needs for health care, housing, and welfare.

Conversely, political economy research on homogeneity and public services suggests that economic segregation should increase expenditures in metropolitan areas. The provision of public services requires consensus (Trounstine, 2018). Research on the correlation between racial/ethnic homogeneity and public services suggests homogenous communities are more likely to reach consensus for two main reasons. First, members of the same social group are more likely to agree on the services that governments should provide. Second, people support services that benefit other members of their social group (e.g. Alesina, Baqir, and Easterly 1999; Luttmer 2001; Habyarimana et al. 2007, though see Hopkins 2011). With greater consensus over provision, expenditures in homogeneous places are higher.

It is reasonable to expect that similar mechanisms boost expenditures in economically homogeneous places. People in the same income brackets are more likely to agree about the services that local governments should provide (Beach and Jones 2017; Flavin and Hartney 2017). Preferences converge as residents sort between jurisdictions (Benabou 1996; Lieberman and McClendon 2013). The wealthy also strongly resist redistribution, choosing to forgo, rather than subsidize, services that benefit low-income neighbors (Miller, 1981; Alesina and Giuliano, 2009; McCubbins and Seljan 2018). This resistance is often expressed as an unwillingness to use “our” tax dollars to fund “their” services. Economic segregation limits the scope of redistribution (Hamilton 1975). With greater preference convergence and perceived congruence between those who pay and benefit, voters should support more provision in economically homogeneous jurisdictions. In aggregate, service expenditures should increase as metropolitan areas segregate if this is the case.

In summary, previous research yields mixed expectations about the relationship between municipal-level economic segregation and the services that local governments provide. Based on shifts in wealth, aggregate expenditures should be lower as economic segregation constrains the capacity of most local governments to fund provision. Economic homogeneity could also affect service provision; standard theories yield competing hypotheses about whether aggregate expenditures should decrease or increase. Local governments may cater to median voters and spend less as their

jurisdictions grow more homogenous. But greater support for service provision in homogeneous jurisdictions, based on convergent preferences and in-group bias, may spur local governments to spend more in as residents sort between municipalities.

1.4 Income segregation and service expenditures data

I analyze how income segregation between municipalities influences local service expenditures in metropolitan areas. MSAs are a standard unit of analysis in segregation research and decent approximations of the aggregate areas that local governments serve. Municipalities and special districts routinely limit provision to particular areas in the city or extend service beyond city limits. While information on the boundaries of the area served is not readily available, it is reasonable to assume that service areas fall within the metropolitan area (Chernick, Langley, and Reschovsky 2011). To compare changes over time in a consistent geographic area, I create a static 30-year panel with MSA boundaries defined in 2013 based on the 2010 U.S. Census. I assign municipalities to MSAs using spatial packages in R. My sample includes 91 percent (350) of the MSAs delineated in 2013. I exclude MSAs that were either not designated or only had one incorporated place in 1980. By definition, segregation across places is not possible if there is only one city in the MSA.

In 2010, over 260 million people—roughly 85 percent of the US population—lived in metropolitan areas. The populations ranged from about 55,000 (Carson City,

Nevada) to about 19 million (New York City). The average number of municipalities in an MSA increased from 12 in 1980 to 40 in 2010.

1.4.1 Income segregation

To measure income segregation, I use nominally integrated data from the 1980, 1990, and 2000 decennial U.S. Census and 2008–2012 American Community Survey (ACS)³ compiled by the National Historical Geographic Information System (NHGIS) (Manson et al. 2020).⁴ The Census reports the distribution of income as the number of households in 10 to 25 annual income bins that range from less than \$10,000 to over \$200,000.

I use the rank-order information theory index to measure income segregation. The index compares the income distribution in each municipality to the income distribution of the MSA as a whole (Reardon 2006). Like the more common Theil index and information theory index, the rank-order information theory index is an entropy-based measure. But, unlike other measures, the rank-order information theory index is not affected by income inequality or other changes in the income distribution, so long as the rank is preserved. Reardon et al. (2006) show these properties ensure comparability

³ I use the ACS data because the 2010 Census did not publish household income data. Place-level data from the ACS are five-year moving averages.

⁴ Nominal integration is appropriate to analyze the distribution of income within places according to their legal definitions at the time, even as the boundaries change with incorporation, annexation, and secession (Minnesota Population Center 2019).

over time better than most other measures of income segregation. The rank-order information theory index ranges between zero and one, where zero represents no segregation and one represents complete segregation. In a MSA with no segregation, each municipality would have the same income distribution as the MSA as a whole. In a completely segregated MSA, all households in each municipality would fall in the same income bracket.

The rank-order information theory index is calculated in three steps. The first step is to calculate entropy, which measures the degree of randomness in the population, for each municipality and MSA at every threshold of income. Entropy, E , is based on the proportion of households, p , with incomes below each threshold of income, k , within each municipality, j , and the metropolitan area:

$$E_j(p_k) = p_k \log_2 \frac{1}{p_k} + (1 - p_k) \log_2 \frac{1}{(1 - p_k)} \quad (1)$$

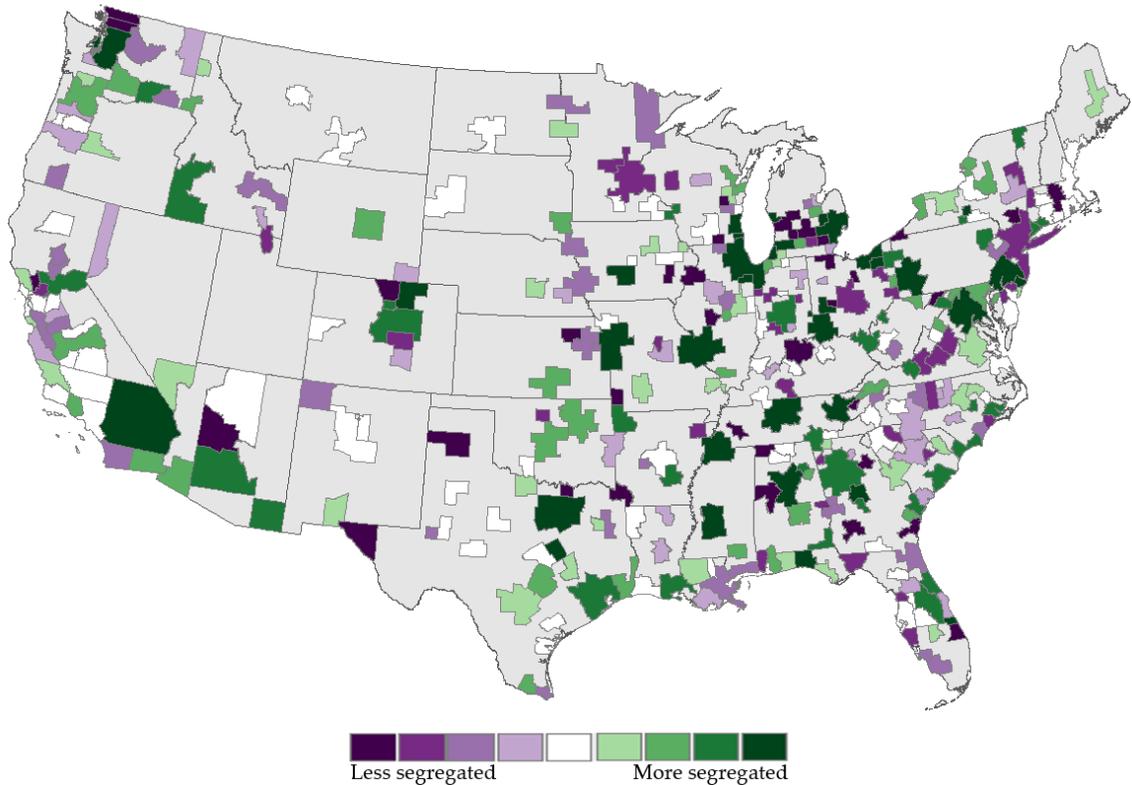
The second step is to calculate the H -Index, which measures how municipal entropies differ from the overall MSA entropy at each threshold of income. The H -Index is a fraction of each municipal entropy at each threshold of income, $E_j(p_k)$, from the overall MSA entropy at each threshold of income, $E(p_k)$, weighted by the share of the municipal population, t_j , over the total metropolitan population, T :

$$H(p_k) = 1 - \sum_j \frac{t_j E_j(p_k)}{T E(p_k)} \quad (2)$$

The third step is to calculate the rank-order information theory index, H , by taking the integral of a polynomial regression through the points $(p_k, H(p_k))$ (Reardon 2006; Reardon and Bischoff 2011).

Figure 3 shows the rise in income segregation between municipalities from 1980 to 2010. Income segregation in the average MSA increased from 0.0152 in 1980 to 0.022 in 2010. Economic growth and high employment rates slowed municipal-level segregation in the 1990s (Fischer, 2013), but the upward trend continued in the 2000s.

There is substantial variation in income segregation trends. Figure 4 shows the change in municipal-level income segregation between 1980 and 2010. Income segregation between incorporated places declined in 100 MSAs (28 percent) from 1980 to 2010 and increased more than twice the national average in 92 MSAs (25 percent). The largest decreases occurred in Louisville, Kentucky and Corpus Christi, Texas while the largest increases occurred in Bremerton-Silverdale, Washington and Muskegon, Michigan. Income segregation is lower and grew less in smaller MSAs, where limited geographic area constrains spatial separation (Reardon and Bischoff, 2011). High-income households are more likely to segregate in suburbs further from the city center in younger and more open MSAs in the Midwest and Southwest, but tend to segregate less in the older and denser MSAs in the Northeast (Fry and Taylor 2012). Tighter zoning rules in the Northeast limit concentrations of low-income households.



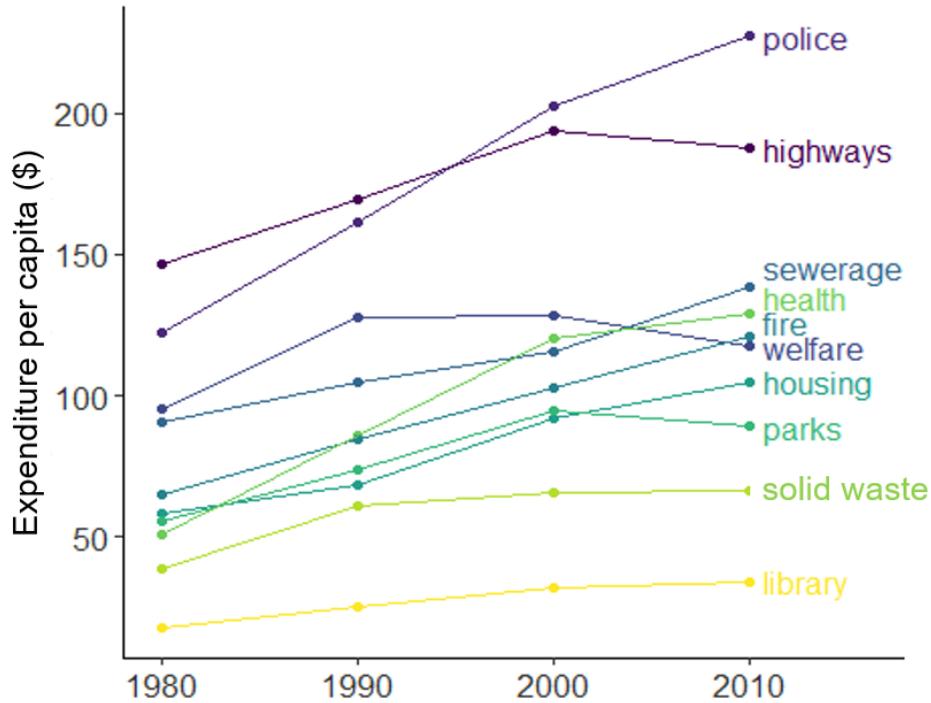
Note: Income segregation measured with the rank order information theory index. Data from the decennial Census and ACS

Figure 4: Change in municipal-level income segregation, 1980–2010

1.4.2 Local government expenditures

The data on expenditures in metropolitan areas are from the Census of Governments in 1982, 1992, 2002, and 2012. The Census of Governments reports total direct expenditures from all local governments. Figure 5 shows the per capita expenditures on various types of services in metropolitan areas from 1980 to 2010. All expenditures are adjusted for inflation to 2012 dollars. Total per capita service expenditures have increased over time, from \$700 in 1982 to \$1,165 in 2012. Local governments spend the most on police, highways, and sewerage and relatively little on

parks, trash removal, and libraries. Municipalities are the primary providers of most services, including police, highways, and sewerage. Counties are the primary providers of health and welfare.



Note: Data from the Census of Governments All dollars are inflated to 2012 dollars.

Figure 5 Average per capita expenditures in MSAs by service, 1980–2010.

I exclude education, water, electricity, and hospitals from the analysis because their budgets and boundaries of service differ from other local services. Single-purpose school districts are responsible for the vast majority of K-12 education in the United States. School districts have separate budgets to provide a single service. Utility providers fund water and electricity services with ring-fenced fees. Hospitals serve, and collect revenue from, very large regional areas that extend well beyond the metropolitan

area. With separate budgets and ring-fenced fees to provide a single service, school districts, utility providers, and hospitals do not assume other functions from municipal governments. Therefore, these expenditures are excluded from the analyses.

1.5 Empirical strategy

I estimate the relationship between income segregation and local government finances in a metropolitan area over time as:

$$\Delta y_{it} = \Delta \text{segregation}_{it} + \Delta \text{aid}_{it} + \Delta \mathbf{X}_{it} + \mathbf{R}_{it} + u_i \quad (3)$$

where i is the MSA in Census year t ; y is direct expenditures per capita; *segregation* is income segregation among municipalities measured by the rank-order information index; *aid* is intergovernmental aid from the federal and state governments; \mathbf{X} is a set of time-varying controls for observable metropolitan characteristics; and \mathbf{R} is a set of time-varying controls for the nine U.S. Census divisions.⁵ This model differences out the fixed characteristics that cause variation in expenditures across metropolitan areas, such as state mandates and costs (following Hopkins, 2011). I cluster standard errors by MSA. The estimates from this model show how changes in expenditures are associated with changes in income segregation in a metropolitan area.

⁵ A few MSAs are in multiple regions. In these cases, the MSA is assigned to the region where the majority of the population lives, assuming a uniform distribution throughout the county.

I control for several time-varying characteristics of metropolitan areas that are correlated with expenditures and income segregation. Table 1 summarizes the variables. First, I control for intergovernmental aid because local governments finance expenditures with federal and state aid in addition to own-source revenue. The data on intergovernmental aid are from the Census of Governments. Next, I control for four demographic characteristics: population, median household income (MHI), race/ethnicity, and need. I control for population because larger MSAs often have higher service costs (Boyne 1992) and are more likely to be segregated (Jargowsky 1996; Reardon and Bischoff 2011). MHI accounts for overall fiscal capacity in the MSA. I log population and MHI to correct for their skewed distributions. I control for race/ethnicity because whites are more reluctant to pay for services or live in jurisdictions where minorities are a sizable portion of the population. I measure race/ethnicity as the portion of the metropolitan population that identifies as either Black or Hispanic. Expenditures are partially a function of the need (Dye and MacManus 1990). I include the proportion of the population who are older than 65 in order to account for higher need. The demographic data are from the U.S. Census.

Finally, I include regional dummy variables for each decade. Regional dummies help isolate the impact of recent changes in segregation from broader patterns rooted in the history and environment of different regions. For example, local governments in the South spent less on service provision in previous decades (Boustan et al., 2013). A few

MSAs are in multiple regions. In these cases, the MSA is assigned to the region where the majority of the population lives, assuming a uniform distribution throughout the county.

Table 1: Summary statistics for service expenditures, income segregation, and MSA demographic characteristics, 1980–2010

	1980	1990	2000	2010
Per capita expenditure (\$)	734 (323)	957 (388)	1143 (424)	1210 (424)
Segregation index	0.016 (0.016)	0.019 (0.018)	0.019 (0.017)	0.022 (0.018)
MHI (\$)	45115 (6895)	48716 (8640)	52794 (8803)	52393 (8937)
Intergovernmental aid (\$)	434 (272)	441 (289)	546 (349)	552 (347)
Population	506470 (1264040)	564798 (1365980)	650306 (1531401)	720565 (1635894)
Proportion Black	0.099 (0.103)	0.101 (0.103)	0.105 (0.107)	0.108 (0.108)
Proportion Hispanic	0.052 (0.106)	0.065 (0.12)	0.092 (0.137)	0.123 (0.151)
Proportion over 65	0.109	0.126	0.128	0.136

Note: Means of demographic characteristics in MSAs from 1980 to 2010. Standard deviations are in parentheses. All dollar values are reported per capita and inflated to 2012 dollars. N = 350 MSAs. Demographic variables are from the decennial U.S. Census and the 2008–2012 ACS.

1.6 Results

1.6.1 Aggregate expenditures

The results in Table 2 show that local governments spend less in metropolitan areas as residents segregate by income among jurisdictions. The results are similar for the full sample in specification (1) and dropping outliers in specification (2) by excluding MSAs with the largest and smallest 1 percent of changes in either segregation or service

expenditures by decade (following Boustan et al., 2013). Each specification includes changes in the rank-order information theory index, intergovernmental aid, demographic controls, and dummy variables for the U.S. Census region by year.

On average, a change in income segregation is negatively correlated with a change in expenditures within metropolitan areas over time. A metropolitan area that experienced a change in the segregation index from the 10th to the 90th percentile lowered its per capita expenditure by \$30, based on the model in specification (2). Although relatively modest, this difference has a meaningful impact on public services that residents have can access: \$30 is about the average amount local governments spend per capita on libraries.

As expected, per capita expenditures increase with intergovernmental aid and household income. Per capita expenditures are lower in metropolitan areas with increasing populations. The point estimates on the shares of Black, Hispanic, and over 65 residents are not substantial or statistically significant. These results indicate the importance of segregation, not racial composition, in the spending changes.

Table 2: The estimated effect of municipal-level income segregation on total per capita service expenditure, 1980–2010

	Dependent Variable - Change in per capita expenditure:	
	Full Sample (1)	Drop Outliers (2)
Δ segregation	-1.40** (0.64)	-2.00*** (0.75)
Δ HH income (log)	1.03*** (0.17)	1.10*** (0.17)
Δ aid	0.40*** (0.08)	0.36*** (0.08)
Δ population (log)	-0.17* (0.09)	-0.19* (0.10)
Δ share Black	-0.57 (0.59)	-0.37 (0.61)
Δ share Hispanic	-0.06 (0.33)	-0.005 (0.33)
Δ share over 65	1.30 (0.89)	0.87 (0.82)
FE for Region-Year	X	X
Observations	1,050	963
R ²	0.51	0.54
Adjusted R ²	0.50	0.53

*Note: OLS estimates. Robust standard errors are clustered by MSA and shown in parentheses. All regressions are weighted by the time-average metropolitan population. All dollar values are adjusted for inflation and reported in '000s of 2012 dollars. The Drop Outliers sample drops MSAs with the smallest and largest 1 percent of changes in the rank-order theory information index or service expenditures per capita by decade. HH = Household. * $p < 0.1$; ** $p < 0.05$, *** $p < 0.01$*

1.6.2 Types of expenditures

Table 3 shows the relationship between income segregation and specific service expenditures with the same specification shown in model (2) in Table 2. Rising segregation leads to fewer expenditures on health and housing. Changes in aggregate spending on housekeeping functions—highways, sewerage, and solid waste—are unrelated to segregation patterns.

Table 3: The estimated effect of municipal-level income segregation on per capita service expenditure by type, 1980–2010

Changes in per capita expenditure				
Fire	Health	Highways	Housing	Library
-0.1	-0.78**	-0.48	-0.68**	-0.03
0.09	0.35	0.31	0.34	0.06
Parks	Police	Sewerage	Solid waste	Welfare
-0.35	-0.12	0	0.14	-0.29
0.28	0.19	0.41	0.17	0.25

*Note: OLS estimates. Robust standard errors are clustered by MSA and shown in parentheses. All regressions are weighted by the time-average metropolitan population. All dollar values are adjusted for inflation and reported in '000s of 2012 dollars. * $p < 0.1$; ** $p < 0.05$, *** $p < 0.01$*

The evidence on specific service expenditures provides some indication of the mechanism driving the changes in aggregate spending reported in Table 3. Redistributive expenditures, such as health and housing, should be lower if local governments cater to median voters in increasingly homogenous jurisdictions. Median voters would prefer lower expenditures as municipal-level economic segregation

hampers the scope for redistribution. Without wealthier households to subsidize provision, low-income median voters opt for lower property taxes and fewer expenditures. The lack of a correlation between changes in segregation and expenditures on housekeeping functions, such as highways, sewerage, and solid waste, is consistent with previous work. These services are subject to less political pressure (Hopkins, 2011).

1.6.3 Robustness checks

I examine the robustness of the relationship between income segregation and expenditures with alternative model specifications, shown in Table 4. I first repeat the main result with the sample that drops outliers from Table 2 for reference in specification (1). This specification includes the change in intergovernmental aid, population, percent Black, percent Hispanic, and percent over 65 as controls as well as region-year fixed effects and is weighted by the time-average metropolitan population. Specifications (2)–(7) are identical to specification (1) except for the noted substitutions, omissions, and alternative measures.

I substitute year fixed effects for region-year fixed effects in specification (2) and the results are substantively similar. I remove the population weights in specification (3). The relationship between income segregation and expenditures is much less pronounced, and loses statistical significance, without population weights. This signals that income segregation is more impactful in more populous MSAs. Specification (4) and (5) use different operationalizations of key variables that are also common in the

literature. In specification (4), I examine change in expenditures per household rather per capita. The point estimate is nearly twice as large.

Table 4: Robustness checks for the estimated effect of municipal-level income segregation on total per capita service expenditure, 1980–2010

	Dependent Variable - Change in expenditure:						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ income segregation	-1.99*** (0.74)	-2.55*** (0.79)	-0.65 (0.58)	-3.95** (1.81)	-1.84** (0.76)	-2.47*** (0.80)	-1.91*** (0.73)
Δ MHI (log)	1.10*** (0.17)	0.84*** (0.16)	0.57*** (0.09)	2.91*** (0.44)		1.10*** (0.17)	1.06*** (0.16)
Δ median HH value					0.40*** (0.06)		
Δ racial segregation						0.24*** (0.06)	
Δ racial diversity							0.65** (0.27)
FE for Region-Year	X		X	X	X	X	X
FE for Year		X					
Weighted by pop	X	X		X	X	X	X
Observations	963	963	963	957	963	927	963
R ²	0.54	0.49	0.37	0.61	0.55	0.55	0.55
Adjusted R ²	0.54	0.48	0.36	0.60	0.54	0.54	0.54

*Note: OLS estimates. Robust standard errors are clustered by MSA and shown in parentheses. HH = Household. FE=Fixed effects. * $p < 0.1$; ** $p < 0.05$, *** $p < 0.01$*

In specification (6) and (7), I test for the possibility that the relationship between economic segregation and expenditures is actually driven by race. Due to racial wealth gaps, MSAs with greater income segregation are also more segregated by race. Racial diversity also shapes both residential choices and expenditures. Racial segregation is measured with Theil's H -Index and diversity is measured with the Herfindahl Index for

five racial and ethnic groups (white, Black, Asian, Hispanic, and all other racial groups). The results show that income segregation is correlated with expenditures independent of race and ethnicity. The point estimates are always similar in size and significant in every specification.

1.6.4 Limitations

The main limitation of this analysis is the possibility that endogeneity may bias these results. The relationship between segregation and service provision likely moves in both directions. Services induce households to sort across jurisdictions as wealthy households, willing and able to pay for high-quality public services, move to places where local governments spend more on provision (Ellickson 1971; Boustan 2013). This simultaneous relationship biases estimates of the how income segregation influences service provision. I mitigate some of the bias by lagging expenditures two years behind the demographic measures, but that does not eliminate potential bias from reverse causality.

An instrumental variable approach could further mitigate concerns about endogeneity. Scholars have used waterways (Trounstine 2016), railroads (Ananat 2011), and topography to instrument for racial and economic segregation within and between jurisdictions. Although these instruments are relevant and plausibly exogenous, they do not change over time. I need an instrument that varies across MSAs over time to isolate how rising segregation affects changes in expenditures.

I considered court-mandated school finance reforms as an instrument for changes in municipal-level income segregation. State supreme courts mandated reforms to school finance systems in 28 states between 1971 and 2010, after ruling that differences in per pupil spending violated constitutional provisions to provide equal or adequate levels of education (Jackson, Johnson, and Persico 2016). School finance reforms reduced reliance on local taxes and made education expenditures somewhat more equitable (Evans, Murray, and Schwab 1997; Downes and Figlio 1997). Some empirical evidence showed that these reforms weakened the incentive to sort across districts (Aaronson 1999). However, I found the correlation between school finance reforms and changes in municipal-level income segregation was not strong enough to use school finance reforms as an instrument. The possibility that sorting according to preferences over service provision may drive the relationship between municipal-level income segregation and local expenditures remains the main limitation of this paper.

1.7 Discussion and conclusion

Municipal-level income segregation has nearly doubled in the past several decades. In this paper, I examine how rising income segregation influences the provision of local public services. I find changes in income segregation are negatively correlated with changes in per capita expenditures on services. These results are consistent with the expectation that local governments respond to voter preferences over taxation and

expenditures, which shift as economic segregation creates more homogenous jurisdictions.

This paper pulls the local public finance and political economy literatures into conversation. Research on the role of fiscal capacity within public finance often overlooks the political nature of service provision decisions. Alternatively, research on the willingness of voters to pay for services within political economy pays less attention to their ability to do so. The results presented here suggest these are oversights. Demographics largely determine the fiscal capacity of local governments to invest in services as well as the preferences of voters. Research on service provision must consider both.

A second contribution of this paper is examining segregation along different lines and at a different geographic scale than most previous work. The substantial literature on segregation in the United States largely focuses on the causes and effects of racial and ethnic segregation between neighborhoods. Segregation at the municipal scale will have different consequences. The fiscal and political constraints local government face fundamentally change as municipal-level segregation creates more homogenous communities.

Reductions in the amount local governments spend on services has important policy implications. Municipal-level income segregation will likely exacerbate disparities in public services. Local governments in high-income municipalities can provide high

quality public services at low tax rates. But local governments in low-income municipalities may be unable or unwilling to increase tax rates to compensate for shrinking revenue bases. Without sufficient revenue, local governments in increasingly cash strapped towns will struggle to provide adequate services to their residents. Disparities across jurisdictions has far-reaching effects as access to health, housing, transport, and other services is critical to health and well-being.

Policy makers can work to reduce municipal-level economic segregation and mitigate its negative effects. Municipal-level economic segregation increases with restrictive land use regulations and income inequality. States could moderate the authority of local governments to set restrictive land use regulations, such as revoking citywide bans on multifamily housing. For example, Oregon passed legislation in 2019 to eliminate single-family zoning in all towns and cities with more than 10,000 people. Investing in affordable housing is also a critical component of ensuring communities are mixed-income.

States can mitigate the consequences of municipal-level income segregation by incentivizing regional service provision. Municipal-level segregation has less pronounced consequences if the authority and mandate of service providers spans across the metropolitan areas. Regionalization is possible through a range of collaborative mechanisms, ranging from voluntary interlocal agreements to full consolidation. Another policy option is reallocate funds across municipalities. Like

school finance reforms, states can redress disparities by providing intergovernmental aid to local governments to provide services. Some regional revenue sharing have been also successful in this regard. For example, the Metropolitan Council shares revenue between towns in the Twin Cities metropolitan area.

These policy solutions will be politically fraught. The attitudes that drive segregation will also stand in the way of reforms. But addressing these challenges is essential to moving further away from separate and unequal outcomes.

2. Avoiding Punishment? Electoral Accountability for Local Fee Increases

with Shadi Eskaf and Megan Mullin

2.1 Introduction

A large body of political economy theory rests on the expectation that voters punish politicians for increasing taxes and service fees (e.g. Peltzman 1992; Case 1994). Local elected officials also circulate stories of electoral backlash, such as the 1977 recall of Tucson city council members after water rate hikes (Martin et al. 2015; Levin et al. 2002). The imposition of tax and user fee increases is visible and immediate; the benefits of investments in local services are often invisible and slow to manifest. Elected officials are therefore hesitant to increase taxes and fees, or so the political discourse implies. We test this notion empirically by examining whether local fee increases translate into electoral losses.

Research on electoral punishment for taxes and fees is surprisingly sparse across all levels of government. The literature on retrospective voting focuses on whether voters hold presidents and members of Congress accountable for their performance, especially with respect to economic conditions (Healy, Persson, and Snowberg 2017). More recent political economy research shows the *quality* of public services—e.g. education (Holbein 2016; Payson 2017) and transportation (Burnett and Kogan 2017; de Benedictis-Kessner 2018)—affect approval ratings and electoral outcomes at the local level. But less is known about how the *cost* of public services shapes election results.

Testing electoral punishment for taxes at the local level poses several challenges. Voters may support tax increases if they are associated with quality improvements (Besley and Case 1995). It is difficult to measure service quality and isolate how the quality of any one service correlates with costs among the bundle of services that municipalities finance with general funds. Estimating the effects of an increase for property taxes also requires accounting for property reassessments that, along with the tax rate, determine a property owner's overall tax burden. We circumvent these challenges by focusing on drinking water, a fee service with limited observable quality variation over time.

For revenue-driven local services, rate increases are essential. Local governments raise about \$370 billion in charges and fees each year to finance hospitals, water and sewer systems, trash collection, and parks, among others. Fees account for nearly a quarter of local annual own-source revenue (Tax Policy Center 2020). Local governments have increased fees over time, especially as revenue from property taxes and state and federal aid decline (Lincoln Institute 2015). Reluctance to collect sufficient revenue compels municipalities to scale back basic investments. Reductions in capital spending, typically a large portion of the cuts, destine infrastructure to deteriorate. The magnitude of unmet infrastructure needs is staggering: recent estimates suggest water systems alone need over \$470 billion over the next 20 years to provide safe drinking water (USEPA 2018). Inadequate investment can have drastic consequences. George

McCarthy, the president of the Lincoln Institute of Land Policy, recently explained, “[t]he costs of these choices are invisible until they erupt in dramatic ways - when bridges fall into the Mississippi, or buildings explode in Harlem as a result of hundred-year-old gas lines” (Lincoln Institute 2015).

City council members are responsible for approving water rate increases in municipalities that operate their own drinking water systems. Although water rates are lower and less salient than property taxes, local politicians still worry about electoral punishment for rate hikes. For example, a city council member in Westminster, Colorado acknowledged potential retaliation after supporting a 10% water rate increase, telling a constituent, “I have to do what I think is best for the long term health of my city [...] and if it costs me my job on council, I know you said you will recall me, that is a consequence I’m willing to pay” (CBS Broadcasting Inc. 2018). The belief that fear of electoral punishment is the reason rates are inadequate to maintain system operations is widespread in the water sector (Hughes, Pincetl, and Boone 2013; Teodoro, Zhang, and Switzer 2018; Levin et al. 2002).

We test whether voters hold city council members accountable for local fee increases using election results and water rates for 165 municipalities in North Carolina from 2007 to 2017. In contrast to political economic theory and politicians’ expectations, we find the electoral risk of increasing water rates is low. Our analyses offer no evidence that rate hikes are associated with subsequent losses in incumbent vote shares. Our

work contributes to electoral accountability research by examining how cost, rather than the quality, of local service provision influences future political outcomes. The findings also have important practical implications: if politicians overestimate the threat of electoral punishment, they may provide public services at a level lower than what they and their constituents actually prefer. The consequences could be insufficient funding for services that undergird economic development, public health, and well-being.

2.2 Electoral punishment for taxes, fees, and service provision

The notion of electoral punishment for increasing taxes and fees is widespread in political discourse. The basic theory is rooted in self-interest: if voters evaluate how policies affect their personal incomes, then elected officials who increase taxes and fees should receive fewer votes (see Healy et al. 2017 for a review). Elected officials worry about punishment at the ballot box (Jacobson 1987).

Empirical evidence of electoral punishment for increasing taxes and fees is surprisingly sparse. The research on electoral accountability for taxation in the U.S. focuses on statewide elections and yields mixed results. Some find tax increases harm incumbent governors, contributing to less support at the polls (Niemi, Stanley, and Vogel 1995) and lower reelection prospects (Nelson 2000). Others show the effects of tax changes on individual vote choice and aggregate outcomes only hold for some types of taxes (Stults and Winters 2005).

At the local level, behavioral patterns and institutional constraints may cloud accountability for taxes and service costs. Participation rates in local elections are very low: the average turnout in municipal elections is only 27% of eligible voters (Hajnal 2018). Local elections are also typically far less competitive than higher profile contests, which buoys incumbent re-election rates (Oliver and Ha 2007). The structure of local government—from fragmentation and nonpartisan elections to tax and expenditure limits—may also make voters less likely to attribute credit or blame for policy changes to local elected officials (Arceneaux 2006; de Benedictis-Kessner 2018).

Despite these patterns and constraints, the quality of services provided by local governments is increasingly recognized as an important component of local-level vote choice and electoral outcomes (James and John 2007; Boyne et al. 2009; Arnold and Carnes 2012; de Benedictis-Kessner 2018; Oliver and Ha 2007). School board members are more likely to win re-election when test scores improve (Berry and Howell 2007; Payson 2017). Crime rates (Arnold and Carnes 2012) and road conditions (Burnett and Kogan 2017) also affect voters' opinions of municipal governments. Anecdotes suggest that voters oust mayors and city council members for failing to pick up the trash or plow the streets (Hopkins and Pettingill 2017).

Less is known about electoral punishment for service costs. Comparative political economists show local taxes affect incumbent vote share in municipalities in England (Gibson 1988; Revelli 2002), Spain (Bosch and Solé-Ollé 2007), and Brazil

(Sakurai and Menezes-Filho 2008). Ours is the first study we are aware of on local electoral accountability for service costs in the U.S.

A challenge in studying electoral punishment for taxes and fees is disentangling quality improvements and the amount voters pay. Voters may willingly pay more for better services and support incumbents who invest in provision (Besley and Case 1995). Accounting for the quality of services is not straightforward. The data are coarse and piecemeal. Managers and researchers often rely on proxy indicators to measure service quality. Many local governments do not explicitly track or report quality measures. It is also difficult to isolate the links between quality and costs for the bundle of services financed with general funds. Finally, effective property taxes are difficult to compare across jurisdictions. Property tax obligations are a product of tax rates and the value of properties as assessed by the local government, which may differ markedly from real market values. We circumvent these challenges by focusing on a service fee. Unbundling one service from others makes it easier to control for quality and determine the full amount voters pay.

2.2.1 The case of water service

We use the case of drinking water to test electoral punishment for fee increases. Several features make water rates an apt case. Water service has limited observable quality variation over time. The quality of drinking water varies in important and significant ways across the U.S., but these differences are difficult for the general public

to detect without lab tests. The dominant form of information that consumers have about water quality is an annual report, called the Consumer Confidence Report (CCR), delivered by the provider. Research indicates the public often ignores this information: surveys show fewer than a fifth of respondents read their CCR (Means et al. 2002). Furthermore, water quality reports are hard to understand. Roy et al. (2015) find the readability of CCRs equivalent to that of the *Harvard Law Review*. Finally, any type of violation is relatively rare. Somewhere between 3 and 10% of community water systems violate federal health standards established in the Safe Drinking Water Act any given year (Allaire, Wu, and Lall 2018). This feature curtails the extent to which willingness to pay for improvements to the quality of water confounds the effect of rate increases on electoral outcomes.

The political context for water rate increases also makes it a policy choice suitable for testing electoral effects. Local politicians cite backlash as a main reason to resist raising water rates (Hughes, Pincetl, and Boone 2013; Teodoro, Zhang, and Switzer 2018). For the great majority of Americans who receive water from publicly-operated water systems, the attribution of credit or blame for water fees is straightforward. Unlike other public services where multiple levels of government fund and manage provision, clouding electoral accountability (de Benedictis-Kessner 2018), water supply is squarely in the domain of local government. Local governments account for more than 95% of government expenditures on water infrastructure (CBO 2018). Furthermore, drinking

water supply is broadly beneficial and relatively uncontroversial, as compared to other local services that many voters may not use or support. Partisan or ideological preferences may contribute to a city's choice about the progressivity of a water rate structure (Switzer 2020), but they are less likely to undergird electoral retaliation for water fee increases than for other local policies that have more starkly redistributive benefits.

Water rates are also visible. Unlike many performance measures, information on water fees is neither costly to obtain nor moderated by elites. Utilities send bills directly to ratepayers' homes; paying a water bill is a regular feature of day-to-day life. The community-wide imposition of rate changes and reporting in local news outlets heightens visibility (Niemi, Stanley, and Vogel 1995). Local newspapers often cover water fees with headlines such as "Utility pursuing water rate hike - Bills would climb 17% for some customers" (*The Morning Call*, Allentown, PA).

2.3 Water rates and election data in North Carolina

If voters do hold city council members responsible for local fees, incumbent council members should receive fewer votes in elections following rate hikes, other things equal. The correlation between water rate increases and subsequent vote shares should be negative. Rate increases should not be correlated with vote shares if council members do not experience electoral punishment for fee increases.

Our data to test electoral accountability for water rates are from North Carolina. Research on water rates is typically limited by cross-sectional data from a relatively small sample of large utilities. North Carolina has more extensive data than most other states, allowing us to leverage variation within municipalities over time to examine the correlation between fees and election outcomes. Importantly, water service in the state otherwise mirrors national patterns. The level and changes in water rates in North Carolina are similar to other municipal utilities. The state also has similar environmental, demographic, and economic drivers to those that typically spur rate increases across the country.

2.3.1 Change in water rates

Our analysis focuses on municipally-owned systems in North Carolina—a fifth of the state’s total number of water systems that collectively serve over 70% of the population connected to a community water system. City councils are responsible for setting rates for municipally-owned systems. Local water departments typically recommend changes, but these must be approved by the elected council members. Direct democracy does not shape or constrain the activities of council members as it does in other states. Water systems usually increase rates to pay for higher costs and

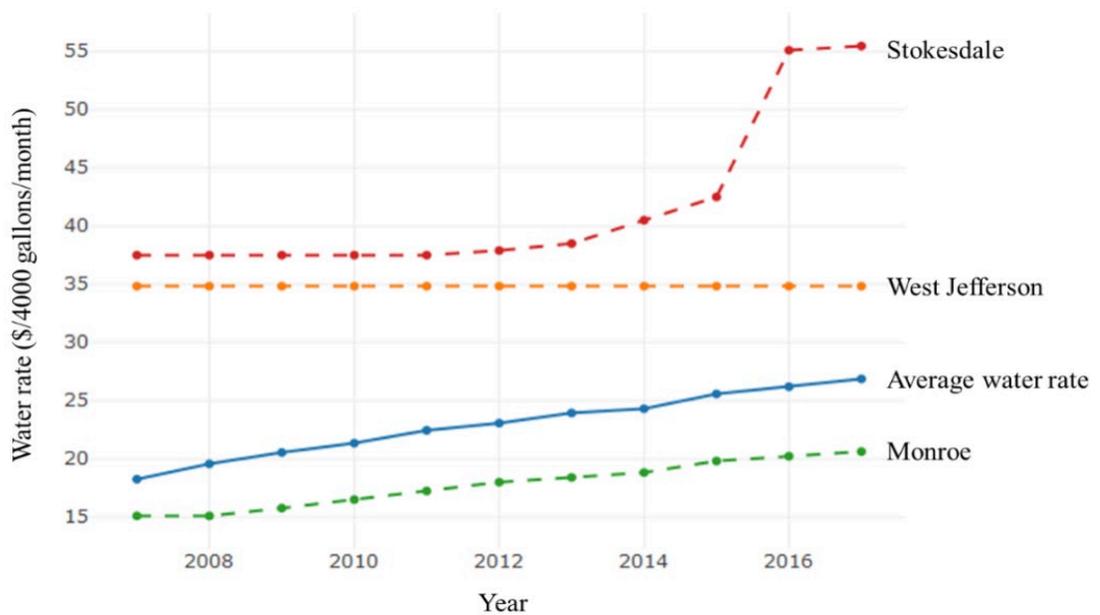
capital projects. About 25% water systems rely primarily on purchased water as their source of supply.⁶

Water rates vary by type of customer, volumetric use, and location. Most residential customers pay fixed and volumetric charges. We use the monthly water bill charged to residential customers within the city limits for 4,000 gallons, which is close to the median residential water use across utilities in the state. Most municipalities that change their rates do so on July 1. We measure the percentage change in water rates in the year preceding the election, because recent information has disproportionate weight in vote choice (Achen and Bartels 2004; Burnett and Kogan 2017). Nearly 95% of municipal water utilities collect monthly bills. Changes in billing frequency are rare: less than 5% of utilities modified their schedule between 2007 and 2017. The water rates data are from annual surveys of utilities conducted by the Environmental Finance Center (EFC) at the University of North Carolina-Chapel Hill from 2006 onwards (EFC 2019).

Figure 1 shows average water rates across North Carolina and in three illustrative municipalities—Stokesdale, West Jefferson, and Monroe—from 2007 to 2017. The monthly water rate in North Carolina increased steadily. By 2017, rates ranged from less than \$10 per month to over \$55 per month for 4,000 gallons. About half of the

⁶ Authors' calculations based on data from the SDWIS database. Households with private wells do not rely on a community water system for water service. In North Carolina, about 23% of households have private wells (NC DPH 2019).

municipally-owned utilities raised their water rates in any given year; the average change was 5% annually, as in Monroe, though most municipalities increased rates by more than 15% annually at least once. Constant water rates, as in West Jefferson, and larger rate hikes, as in Stokesdale, are rare. The magnitude of water rate increases are similar in election and non-election years, as shown in Table 10 in Appendix A.



Note: The average water rate is across the unbalanced sample of municipal-owned systems in North Carolina. Generally, utilities increase water rates at around 5% a year.

Figure 6: Water rates for residential customers inside the city limits, 2007–2017

2.3.2 Vote shares of incumbent city council members

Our dependent variable is the average vote share incumbent city council members receive in elections. City councils in North Carolina have between two and eleven members who serve two- or four-year terms. Most city councils have at-large

seats (86%) or a mix of at-large and single-member districts (11%) (Upshaw 2014). We aggregate incumbent vote shares in these multiple seat elections into municipal averages for the year.⁷ Municipal-level observations are appropriate because voters likely know that rates increased but not necessarily who voted for or against them. Individual incumbent outcomes of at-large elections are difficult to compare over time. With the municipality as the unit of analysis, we can use fixed effects to control for time-invariant municipal characteristics. Elections are held off-cycle from statewide and national elections in odd years.

The data are from county boards of elections from 2003 to 2007 and the North Carolina State Board of Elections from 2009 to 2017 (NCSBE 2019). We searched online and emailed all 100 counties in North Carolina for 2003-2007 election returns. After following up, we received data from 50 counties. The NCSBE has results from all counties from 2009 onwards. Table 8 in Appendix A compares demographic characteristics between the municipalities in our sample and all municipalities in North

⁷ We calculate incumbent vote share by dividing the number of votes each incumbent candidate received by the total number of votes cast for the available seat(s). We then calculate the average incumbent vote share across all available seats (at-large, district, or mixed). For example, in 2013 the two incumbent candidates running for 3 available at-large seats in Black Mountain received 23% (751/3261) and 10% (341/3261) of the vote share, respectively, for an average vote share of 16.5%. The four incumbent candidates running for 4 available district seats in Fayetteville received 58% (910/1571), 66% (1565/2372), 72% (1657/2298), and 87% (3886/4444) of the vote share, respectively, for an average vote share of 70.75%. The 2 incumbent candidates running for 4 available at-large seats and 1 incumbent running for a district seat in Charlotte received 13% (47296/357940), 15% (52772/357940), and 77% (7541/9739) of the vote share, respectively, for an average incumbent vote share of 35%.

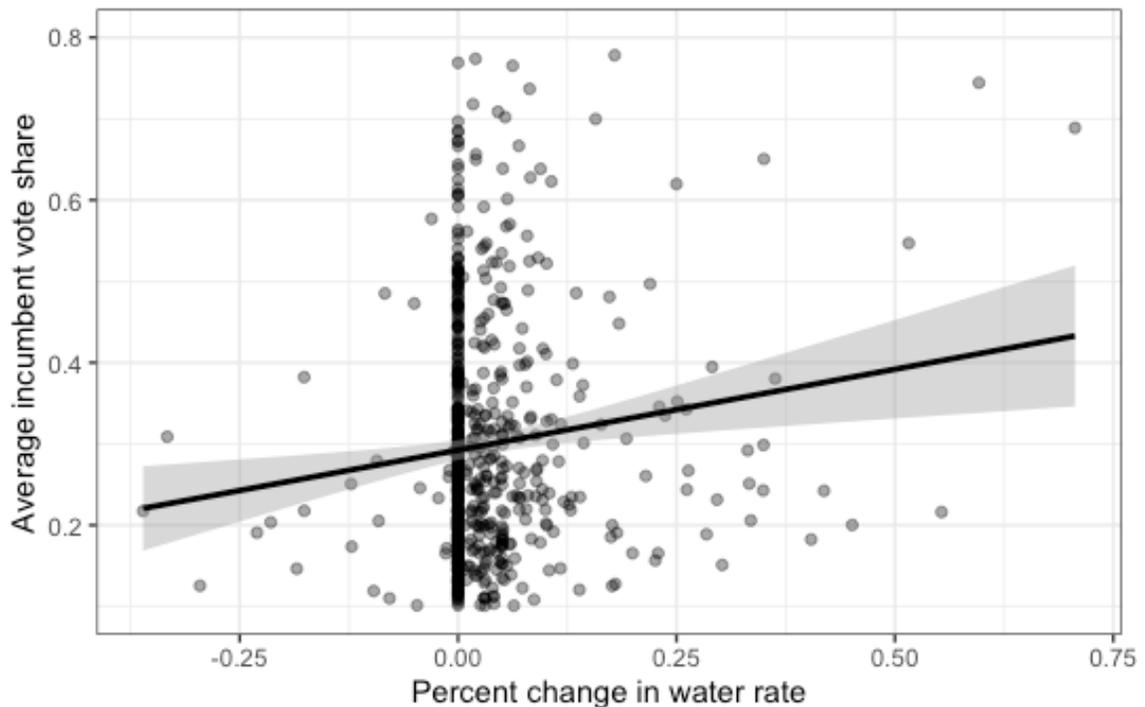
Carolina with their own water systems. We identify incumbents by combining candidate names and vote shares with data on the number of seats on the councils from the North Carolina City Government Index maintained by the UNC-Chapel Hill School of Government.

Our data includes elections in 178 municipalities between 2003 and 2017. Municipalities are observed at every election within our time period. Most municipalities hold a city council election every two years, resulting in a panel of 989 municipal-year elections. Incumbents ran in 837 (84%) of these, though we remove 118 elections (14%) where the incumbents stood unopposed and another 74 (8%) due to missing data.⁸ Including data from uncompetitive elections does not substantively change the results. Our complete data is an unbalanced panel of 647 municipal-year elections in 165 municipalities.

On average, two incumbents and three challengers vied for three available seats in each city council election. Incumbents received 28% of the vote share in competitive elections. There was considerable variation in vote share: in 2009, the average vote share of 3 incumbents in their race against 11 challengers for 3 available seats in Franklin, NC was 4%. The same year in Ayden, NC, the sole incumbent beat one challenger for one

⁸ Including elections where incumbents stood unopposed does not substantially change the results. The municipalities with complete elections and rates data are larger than municipalities with incomplete data, but otherwise have similar demographic characteristics, as shown in Table 8 in Appendix A.

available seat with 86% of the vote share. Figure 2 shows the bivariate plot of vote share and percent water rate increase for six election cycles for all municipalities in our sample. Contrary to theory, the correlation between vote share and changes in water rates is positive but not significant when municipal fixed effects are included.



Note: 647 municipal-year observations in 165 municipalities in North Carolina from 2007-2017

Figure 7: Pooled raw data and correlation between average incumbent vote share in city council elections and the percent change in water rates.

2.4 Empirical strategy

The unit of analysis is the municipality. We estimate the association between electoral outcomes and changes in water rates within municipalities over time as:

$$\text{vote share}_{it} = \Delta \text{rates}_{it} + X_{it} + \alpha_i + \tau_t$$

where i indexes the municipality in election year t , vote share_{it} is the average vote share of incumbent city council members, Δrates_{it} is the change in water rates, \mathbf{X}_{it} is a vector of controls for municipal-level characteristics, α_i represents municipal fixed effects to control for time-invariant characteristics in each municipality, and τ_t represents year fixed effects to control for shocks that affect all municipalities in a given year. Standard errors are clustered at the municipal level.

In estimating the effect of rate changes, we control for the potentially confounding influence of the baseline water rate prior to the rate increase. We also include the number of available seats on the city council, which affects the numbers of incumbents and challengers. The number of available seats alternates from year to year for councils with an odd number of members serving staggered terms; the average city council has five seats with two open seats in one election and three open seats the next. Lastly, we control for the baseline and the percent change in property tax rates, using data from the North Carolina Department of Revenue. Tax issues have high salience and shape the decision-making context when city council members consider costs for an individual service. Estimating the electoral effects of water rate increases requires ruling out the possibility that voters are responding to a contemporaneous change in property taxes. Our measure of property taxes serves as a decent proxy for this purpose, but because we cannot account for tax reassessments that influence the total tax paid, tax

rate increases cannot be used on their own to test for electoral accountability.

Descriptive statistics on all variables are shown in Table 5.

Table 5: Summary statistics for vote share, water rate change, electoral characteristics, and municipal characteristics, 2007–2017

	Mean	SD	Min	Max
Percent vote	28.61	14.68	5.88	77.82
Water rate change (\$)	0.72	2.06	-15.47	18.96
Percent rate change	3.85%	9.38%	-33.29%	70.61%
Water rate baseline (\$)	22.65	7.90	8.40	54.40
Number challengers	2.90	2.13	1.00	13.00
Number of candidate	4.91	2.56	2.00	16.00
Number of available seats	2.79	1.28	1.00	7.00
Tax rate	0.43	0.14	0.05	0.71
Percent tax rate change	1.30%	7.68%	-50.00%	123.97%
Population	24,804	86,796	113	731,424
Turnout	17.33%	13.52%	0.31%	99.80%

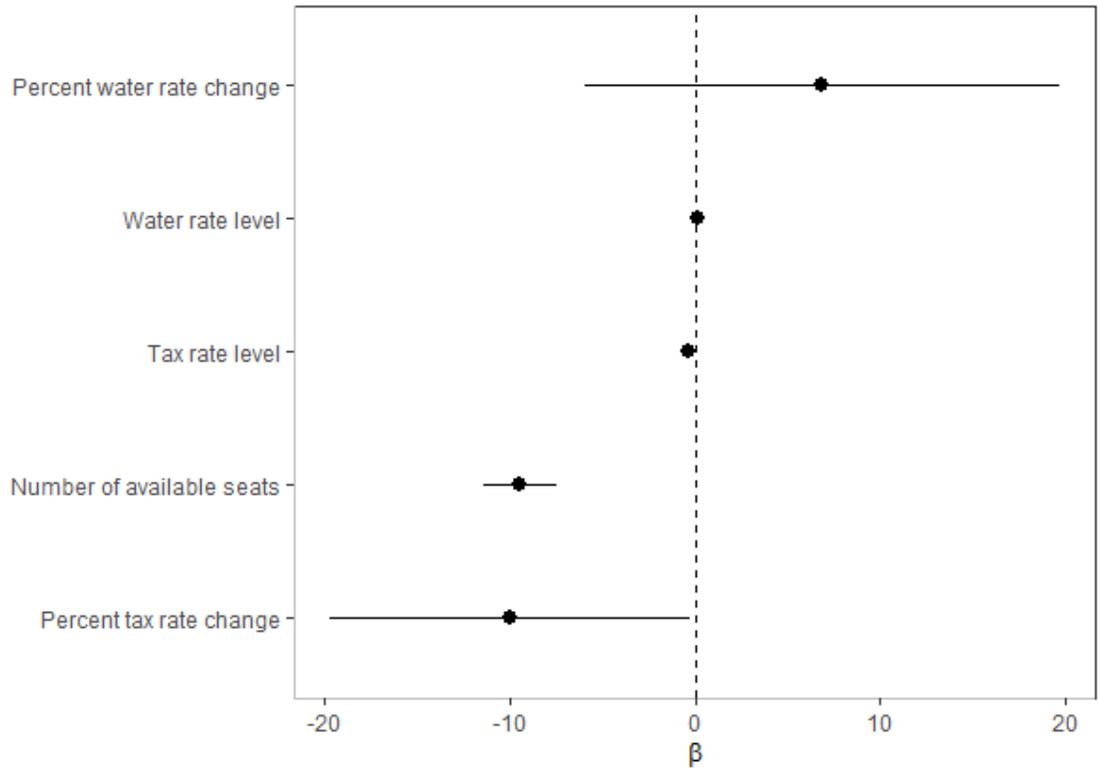
Municipal fixed effects account for time-invariant municipal characteristics that could moderate retrospective voting. These include demographic characteristics, such as population and income, and political institutions, such as nominating procedures or manager– versus mayor–council systems. We also consider water quality to be a time-invariant municipal characteristic. The only widely available measure of water quality over time is health-based SDWA violations. Only four municipalities in our sample had any health-based violations from 2007-2017. Our results are similar when we drop these observations.

2.5 Results

The results offer little evidence that voters punish incumbents who raise water rates. As shown in the top row of Figure 3, we find that an increase in water rates is associated with higher average vote shares for incumbent city council members—not lower, as electoral accountability theory would predict—but the relationship is not statistically significant. The results hold when we operationalize the dependent variable as the median, rather than mean, incumbent vote share, as shown in

Table 9 in Appendix A. Incumbents who oversee water rate increases seem to fare no worse in an election held within the next year than incumbents in communities where water rates remained unchanged.

The null result is not attributable to averaging out the large rate increases. Replacing the continuous measure of percentage change in rates, we ran the same model with a dichotomous indicator of rate increases and rate changes binned in 5% intervals (e.g. comparing constant water rates to 0.1-5%, 5-10%, and over 10% increases). These bins account for concerns that constant rates bias our estimates and that voters are unlikely to notice fine-grained differences or respond in a linear way (Boyne et al. 2009). We also measure the change in water rates binned in 10% intervals as an additional robustness check on the unspoken rule in the water sector of avoiding double-digit rate increases. Regardless of operationalization, the coefficient estimate for changes in water rates is not substantively large or statistically significant. Even unusually large increases in water rates—the type of increase that can fill local newspapers with residents’ complaints—appear not to reduce incumbents’ prospects for reelection.



Note: OLS coefficient estimates. Bars show the 95% confidence intervals. Standard errors clustered at the municipal level.

Figure 8: Estimated effect of water rate changes on incumbent vote share

Several additional robustness checks reinforce our null result, as shown in

Table 9 of Appendix A. Increasing rates for higher volumetric use could incite more electoral backlash, as income is highly correlated with water use and voting in local elections. Replacing the percentage change in monthly water rates for 4,000 gallons with 10,000 gallons in the same model does not substantively change the result. Many municipalities provide and bill for both drinking water and wastewater services together. City councils might opt to increase the rates for water, wastewater, or both. Contrary to electoral accountability theory, increases in water and wastewater rates are associated with higher average incumbent vote shares.

Another potential concern is whether city councils act strategically. Council members may only increase rates in non-election years to avoid electoral punishment (Philips 2016). The results hold when we measure water rate changes over the two years preceding the election instead of one year. Also, as shown in Table 10 of Appendix A, the likelihood and magnitude of water rate increases are somewhat similar across time: changes are 23% less likely in election years but nearly equal in magnitude. Differences in the magnitude of rate change are not substantively nor statistically significant between years. Decisions about whether, and how much, to raise rates may also depend on how safe councilmembers feel in their seat. However, as shown in Table 11 of Appendix A, a larger average incumbent vote share in the previous election only barely increases the likelihood of rate changes.

The effect of water rate increases could also be biased downward if service costs motivate challengers to enter the race or voters to turn out. We examine these post-treatment possibilities by regressing the number of challengers and turnout as a percentage of voting age population on changes in water rates. Neither candidate entry nor turnout are correlated with water rate increases at a significant level, as shown in Table 12 in Appendix A. The direction of relationship to vote share are opposite what strategic entry or motivated turnout would predict.

As expected, water rate levels are not associated with incumbent vote shares. The larger number of seats in a multi-candidate election reduces incumbent vote share, with each additional seat on the city council decreasing incumbent vote share by 9.5 percentage points. We also find evidence for lower incumbent vote shares following increases in property tax rates. Although the complexities of property taxation complicates interpretation of this result, it provides suggestive evidence for the possibility of electoral punishment for more burdensome, higher-salience local taxation decisions.

2.6 Discussion and conclusion

Electoral accountability theory predicts voters punish legislators for raising taxes and fees. Elected officials expect punishment for policies with immediate costs without immediate benefits. Drinking water, a service squarely in the domain of local government with limited variation in quality over time, is a strong case to test electoral

punishment for local service costs. We use municipal-level data on water rates and vote shares in North Carolina to examine whether voters hold city council members accountable for increasing water rates. We find no evidence of electoral punishment. Modest water rate increases—such as the 3-5% average increases amongst most municipal utilities in the state—should not incite backlash. These results are consistent across different model specifications and robustness checks.

There are several plausible explanations for the lack of punishment for local fees. Water rates might not be salient enough to affect vote choice. Even with a few more dollars tacked on, monthly water bills are relatively low cost for many. Higher rates to invest in drinking water service might also garner support. Voters who turnout for off-cycle local elections are more informed, educated, and likely to own a home than the electorate writ large (Oliver, Ha, and Callen 2012). These types of voters may be more concerned about infrastructure maintenance than the cost.

We expect these results are broadly applicable to local water provision across settings. The economic, demographic, and environmental challenges that municipalities in North Carolina face in providing safe, reliable drinking water are similar in other places across the country. The off-cycle, nonpartisan local elections are also typical. As compared across institutional settings, we expect direct municipal provision to provide the most favorable conditions for electoral accountability. Other arrangements, including privately owned water systems or systems operated by special districts or

county governments, make it more difficult for voters to trace responsibility for fee increases. Higher municipal reliance on wholesale water providers, as is more common in the arid West, may allow local officials to shift blame for rate hikes. One important distinction with less clear implications is the relative abundance of water resources in North Carolina. Water is likely to be a more salient issue in more arid and drought-prone regions (Mullin 2009); salience might make punishment more likely, as suggested in our result for property tax rates, or less likely, if it translates into higher voter awareness about investment need. But overall, the null result we find in the favorable setting of North Carolina municipal water provision lends doubt to the idea that local elected officials pay a price for rate increases.

Inaccurate notions of electoral punishment may undercut democratic representation and accountability. Ensuring access to adequate services, a primary purpose of local government, requires sufficient revenue to invest in provision. Surveys suggest voters prefer increased fees to higher taxes or spending cuts (Campbell and Sances 2013). Scared of local fee increases, elected officials may pursue policies that do not align with the preferences of their constituents. Mismatch between the boundaries of a local jurisdiction and the boundaries of service provision can present particularly troubling consequences for accountability (Mullin 2014). Unwilling to raise rates for their own voters, local officials might impose higher fees for services provided beyond

city boundaries, leaving no recourse at the ballot box for residents in unincorporated communities.

Fear of electoral punishment can also be an important barrier to service provision. In the case of water service provision, investment is necessary to provide clean, reliable drinking water. Infrastructure deteriorates without investment. Poorly maintained water systems pose significant public health risks, with disparate outcomes by race and class (Switzer and Teodoro 2017). Future work on local electoral accountability could examine different costs and contexts. Research on punishment for raising taxes and fees that incorporates measures of service quality and property assessments would be an important contribution. Electoral accountability for fees may differ in places with lower household incomes, where water affordability is a more widespread concern, or a higher proportion of renters who might not be billed directly for their water use.

Electoral punishment for tax and fee increases is an important component of understanding the politics of service provision. Local politicians must balance the burden of taxes and fees with the need to invest in public services. As revenues from property taxes and state aid decline, other sources of revenue are more vital. But elected officials will be hesitant to raise fees as long as the threat of electoral punishment lingers.

3. Allocation of Drinking Water State Revolving Funds

3.1 Introduction

Community water systems (CWSs), which provide drinking water to most US residents, rely on service fees to fund capital projects, operations, and maintenance. This reliance on own-source revenue creates disparities in water services across the country. CWSs serving low-resource communities often collect and spend less. Without sufficient investments in infrastructure, CWSs cannot provide reliable, safe drinking water (Olmstead 2004; Vanderslice 2011).

Financial assistance from the federal and state governments can reduce disparities in water service. The largest source of intergovernmental aid for water services, the Drinking Water State Revolving Fund (DWSRF), is a loan program administered by the states. Each state receives a grant to capitalize their revolving fund and then allocates assistance to communities. Within the statutory requirements to finance projects that improve water quality and public health, states have considerable discretion in how they administer the program and allocate assistance. Since 1997, DWSRFs have financed more than 14,090 projects nationwide (Tiemann 2018).

This paper examines the allocation of DWSRF assistance. Specifically, I assess how resource-based differences in need and capacity correlate with community decisions to apply for DWSRFs and state decisions to provide assistance. Low-resource communities tend to need more assistance to access capital and invest in infrastructure.

Financial resources would be negatively correlated with allocation if need spurs communities to apply and states to provide assistance. But low-resource communities also have less capacity to apply, implement projects, and repay loans (Daley, Mullin, and Rubado 2013). Financial resources would be positively correlated with allocation if capacity facilitates participation.

To estimate how financial resources correlate with applications for and the allocation of DWSRF assistance, I combine maps of CWS service areas, demographic data from the U.S. Census, project-level data from annual reports submitted by state agencies to the EPA, and water quality data from the Safe Drinking Water Information System (SDWIS). The maps of CWS service areas and project-level reports are not readily available. Compiling these data is one of the main contributions of this paper.

I use probit models to assess the correlation between financial resources and DWSRF applications and awards. I measure financial resources with median household income (MHI) and the share of the population living above 200 percent of the federal poverty line. I show that MHI is negatively correlated with both applications and assistance. A \$10,000 increase in MHI is associated with a 1.8 percentage point lower likelihood of applying and 3.0 percentage point lower likelihood of receiving DWSRF assistance. The proportion of the population living above 200 percent of the federal poverty line is not correlated with DWSRF applications and positively correlated with awards. A 10 percent increase in the share of the population living above the poverty

line is associated with a 4.6 percentage point higher likelihood of receiving DWSRF assistance

This paper contributes to research on class-based disparities in public services. Environmental justice research shows that low-resource communities are disproportionately exposed to environmental burdens and excluded from environmental benefits (Bryant 1998; Bullard 1993). Within the water sector, there are resource-based disparities in access to and the quality of services. Addressing these disparities requires designing and implementing environmental policies and programs equitably. Previous research shows that monitoring and enforcement efforts are often unequal (Konisky 2009; Switzer and Teodoro 2018), but relatively little is known about whether similar inequities emerge in the allocation of federal funding.

3.2 Funding water service provision

About 86 percent of US residents rely on community water systems for drinking water service (Kenny et al. 2009).¹ A CWS is a system that provides drinking water to at least 25 people or 15 connections for at least 60 days per year (U.S. EPA 2017). There are more than 52,000 CWSs in the United States. The vast majority are small; 80 percent of CWSs serve fewer than 3,300 people. CWSs are owned and operated by local

¹ The remaining 14 percent rely on wells.

governments, non-profits, and for-profit companies. Although the number of publicly and privately owned CWSs is evenly split, publicly owned CWSs provide 92 percent of drinking water (Mullin 2020).

CWSs use treatment plants, pumps, and pipes to treat and deliver water. This infrastructure is very expensive to maintain. The Environmental Protection Agency (EPA) estimates maintaining CWSs will cost more than \$472 billion over the next 20 years (U.S. EPA 2018).

Local communities fund water services. On average, CWSs pay nearly 90 percent of their operations, maintenance, and capital expenditures with revenue from service fees (U.S. EPA 2009). The financial resources within the community determine the amount of revenue that CWSs can collect. CWSs serving high-income residents can increase water rates to collect more revenue, but those serving low-income communities are often hesitant to do so (Fankhauser and Tepic 2007). Increasing water rates can cause undue hardship for low-income residents. If residents are unable to pay their bills, the CWS may disconnect the water service. Lack of access to water service threatens public health and safety. In extreme cases, failing to pay a water bill and maintain access to water service can also lead to liens on homes, removal of child custody, and criminal charges. Keeping water rates low ensures more water bills are affordable but entails tradeoffs: CWSs that charge less forego revenue to invest in infrastructure.

Insufficient funding for water service threatens public health. Low-income communities are less likely to have adequate water infrastructure (Teodoro, Haider, and Switzer 2018), comply with health-based drinking water standards (U.S. EPA 2015), or respond to regulatory violations (Scott, Moldogaziev, and Greer 2018). Residents who do not have access to an adequate quantity and quality of drinking water risk contracting waterborne diseases and experiencing other adverse health outcomes (Olmstead 2004).

Intergovernmental aid plays an important role in financing water (Knopman et al. 2017). In the 1970s, Congress provided grants for water infrastructure through the Construction Grants program (Travis, Morris, and Morris 2004). In 1987, Congress replaced the grants program with the Clean Water State Revolving Fund to shift the primary form of assistance from grants to loans. Congress created the Drinking Water State Revolving Fund in the 1996 amendments to the Safe Drinking Water Act (SDWA) to finance projects that improve water quality and public health.

DWSRFs have two main sources of capital: federal grants and state contributions. Congress appropriates funds to capitalize a revolving fund in each state. The annual appropriations typically range from \$820 million to \$1.39 billion, although Congress increased the appropriation for DWSRFs to \$2.8 billion in the 2009 American Recovery and Reinvestment Act (Humphreys 2019). The EPA allots a capitalization grant to each state according to a formula based on estimated capital needs. States add a statutorily

required 20 percent match. SRFs revolve as borrowers repay the principal and interest on their loans and states use the repayments to issue new loans. If borrowers do not default and states can cover the administration costs, SRFs should provide a source of capital in perpetuity (Travis, Morris, and Morris 2004).

Within the broad statutory criteria, states have considerable discretion in how they allocate DWSRF assistance. The economic, environmental, and public health challenges that states address with DWSRF-financed projects vary across the country. States engage in various outreach efforts; establish eligibility, application, and implementation criteria; provide technical assistance to applicants; determine which projects to finance; and set the terms of the assistance (Daley, Mullin, and Rubado 2013; Morris 2010; Mullin and Daley 2018; Travis, Morris, and Morris 2004).

States provide different forms of financial assistance with DWSRFs. Typically, they provide low-interest, 20-year loans. But states may use up to 30 percent of their capitalization grant to provide other forms of assistance, such as principal forgiveness, loans with lower or negative interest rates, and extended repayment periods (Humphreys 2019). The EPA encourages states to use other forms of assistance to fund projects in economically disadvantaged communities.

3.3 Determinants of federal aid allocation

3.3.1 Roles of elected officials, bureaucrats, and recipients

Which factors influence the allocation of federal aid? Most political science and public administration research on federal aid focuses on whether and how elected officials affect allocation. Elected officials jockey to secure funding for their districts in order to bolster electoral support (Shepsle and Weingast 1994; Owens and Yuen 2012), either by rewarding supporters (Cox and McCubbins 1986) or wooing swing voters in upcoming elections (Dixit and Londregan 1996). Overall, the empirical evidence shows that the amount of funding members of Congress secure for their districts increases with seniority, positions on influential committees, or status in the majority party (Ferejohn 1974; Levitt and Poterba 1999; Lazarus 2009; Berry and Fowler 2016). The bureaucrats who administer intergovernmental aid programs also influence allocation (Lipsky, 1980; Schneider and Jacoby 1996). While responsive to the preferences of elected officials, bureaucrats also weigh other considerations in setting rules and procedures (Meier and O'Toole 2006). Evidence shows that bureaucrats develop strategies to reduce their administrative burden, advance their personal agendas and mission of their agencies, and serve the public interest (Protas 1979).

Though central, the incentives of elected officials and bureaucrats only partially explain the allocation of federal aid (Lowe, Reckhow, and Gainsborough 2016). The communities that receive assistance also play an important role. Previous research

shows that certain characteristics make some communities more likely to receive aid than others (Hall 2008). Specifically, financial, administrative, technical, and political capacity to pursue assistance influences aid allocation (Collins and Gerber 2006; Hedge 1981; Stein 1979; 1981; Sprague, Wilson, and Cain 2019). Some evidence suggests that community characteristics may account for more variation in intergovernmental aid allocation than electoral incentives and bureaucratic discretion (Moynihan, Herd, and Ribgy 2016; Stein 1981).

3.3.2 Resource-based differences in need and capacity

Among the community characteristics that influence aid allocation, financial resources are arguably the most important (Collins and Gerber 2006; Stein 1979; 1981; Sprague, Wilson, and Cain 2019). Financial resources affect the need and capacity to participate in federal aid programs. While both indicate whether organizations have resources to pursue their goals, the concepts are inversely correlated: need refers to a lack of resources and capacity refers to a sufficiency of resources (Honadle, 1981, see Hall, 2008 for a review).

As shown in Figure 9, resource-based differences in need and capacity potentially shape community decisions to apply and state decisions to provide intergovernmental aid. Need may spur applications. Low-resource communities need more assistance to fund projects; high-resource communities can invest in service provision on their own (Rich 1989; 1991; Stein 1979; 1981).

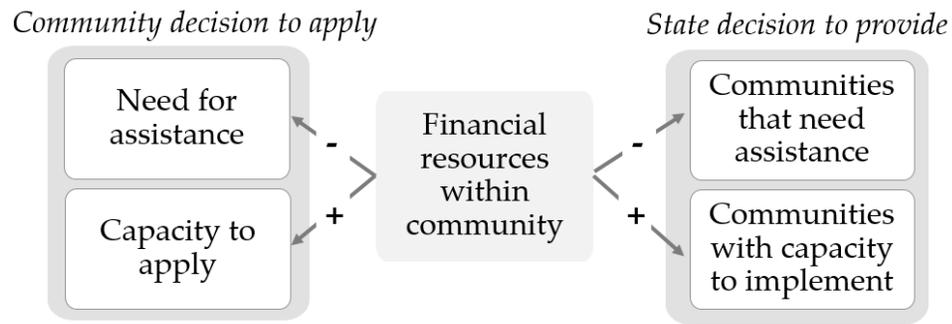


Figure 9: Resource-based differences in need and capacity potentially shape community decisions to apply and state decisions to provide intergovernmental aid.

Alternatively, capacity constraints may prevent low-resource communities from applying for intergovernmental aid. Participating in federal programs often requires considerable financial resources (Collins and Gerber 2006; 2008; Stein 1981; Rich 1989; Hall 2008). Applicants must search for opportunities, determine whether they are eligible to apply, and hire staff or consultants with technical expertise to complete applications and implement projects. Recipients must comply with several federal regulations, such as procurement, monitoring, and reporting requirements. In addition, many intergovernmental aid programs require recipients to match a certain percentage of the award. Matching requirements can effectively eliminate communities with limited financial resources from receiving assistance.

Resource-based differences in need and capacity also shape how states allocate intergovernmental aid. States might prioritize communities with greater need. Several federal aid programs target allocation to low-resource communities through legislative formulas and outreach efforts (Pelissero 1985; Morgan and Pelissero 1989). For example,

some empirical evidence shows that communities with lower MHI are more likely to receive community block grants (Rich 1989), but not always (Collins and Gerber 2006; 2008).

Alternatively, states may be less likely to provide assistance to low-resource communities due to capacity constraints. Public administration research demonstrates that administrators prefer assisting communities with sufficient resources to carry out the goals of the program (Carley, Nicholson-Crotty, and Fisher 2015; Terman and Feiock 2015).

3.3.3 Theoretical expectations for the allocation of DWSRFs

Resource-based differences in need and capacity are likely very important factors in DWSRF allocation. Low-resource communities tend to have particularly high water infrastructure needs. Smaller revenue bases in low-resource communities limit access to credit and investment, often leading to backlogged maintenance. If need spurs communities to apply, financial resources would be negatively correlated with applications for DWSRFs.

However, applying for DWSRF assistance likely requires greater capacity than applying for many other federal programs. Applications to finance infrastructure usually require technical designs and cost-benefit analyses that are expensive to conduct (Sprague, Wilson, and Cain 2019). Communities with limited technical staff turn to private consultants for help. The Roundtable of Regions (2011) estimates that the

average cost to apply for state aid to finance water infrastructure in California was \$17,000. In addition, all DWSRF-financed projects must comply with a number of regulations that increase project costs. For example, recipients must use iron and steel produced in the United States to comply with the American Iron and Steel Requirement and pay higher minimum wages to comply with the Davis-Bacon Act. If capacity undergirds community decisions to apply, financial resources would be positively correlated with applications for DWSRFs.

Resource-based differences in need and capacity could also influence how states allocate DWSRFs. States may prioritize communities with greater needs. Most states take financial resources into account when ranking project applications. The authorizing legislation allows states to provide economically disadvantaged communities with different forms of assistance and the EPA encourages states to do so. If states prioritize communities that need more assistance, financial resources would be negatively correlated with DWSRF awards.

However, states may rather allocate DWSRFs to communities with capacity to apply and implement projects. States face tremendous pressure to reduce unspent funds, or the amount of capital that has not been loaned out. Congress and the EPA strongly discourage unliquidated obligations (ULO). States can reduce ULOs by issuing large loans to high-resource communities with the capacity to take on large capital projects within a short amount of time. These projects are often referred to as “shovel-ready.”

Providing assistance to low-resource communities can take much more time and effort. Low-resource communities often seek assistance for projects that are smaller and not shovel-ready. Low-resource communities are also more vulnerable to fluctuating economic conditions and more likely to default on loans. Administrators may decide to minimize risk by providing loans to CWSs with more financial resources (Daley, Mullin, and Rubado 2013).

In summary, the correlation between financial resources and applications for DWSRFs should be negative if need spurs low-resource communities to apply but positive if capacity constrains them from doing so. Resource-based differences in need and capacity could similarly shape state decisions. The correlation between financial resources and DWSRF awards should be negative if states assist communities with greater need but positive if states prioritize communities with greater capacity.

3.4 Financial resources and DWSRF data

To assess the correlation between financial resources and DWSRF assistance, I collected data from several sources. The unit of analysis is the community served by a water system. My sample consists of 15,626 communities in eight states: Arkansas, California, Connecticut, Kansas, New Jersey, Pennsylvania, Texas, and Washington. As explained below and in Appendix B, only ten states have publicly available maps of CWS service areas and data on DWSRF applicants. Among the states with sufficient data, I selected states to maximize variation in geography, the number of CWSs, and

percent of the CWSs with maps of the service areas. These considerations are summarized in Table 6. I selected up to two states from each regional division, as defined by the United States Census Bureau. I dropped Rhode Island because it has very few CWSs. I dropped Oklahoma, the state with the lowest coverage of CWS service area maps in the region, to avoid overrepresentation in the West South Central division.

Table 6: Summary of DWSRF allocation case selection considerations

State	Select	Regional division	% CWSs with maps
Connecticut	Yes	New England	94.5%
Rhode Island	No	New England	26.4%
New Jersey	Yes	Middle Atlantic	97.0%
Pennsylvania	Yes	Middle Atlantic	93.2%
Kansas	Yes	West North Central	90.2%
Arkansas	Yes	West South Central	95.2%
Oklahoma	No	West South Central	77.7%
Texas	Yes	West South Central	97.2%
California	Yes	Pacific	97.3%
Washington	Yes	Pacific	72.5%

3.4.1 Financial resources of communities

I measure financial resources with median household income (MHI) and the share of the population living above 200 percent of the federal poverty line. MHI is a common measure of financial resources in the public administration research on federal aid. Following Konisky (2009), I also include the share of the population living above the poverty line. Service areas with average median household incomes may mask large portions of the population living in poverty. The MHI and poverty data, reported by the block group, are from the 2008–2012 American Community Survey (ACS).

I aggregated the block group data to estimate the MHI and poverty prevalence in the community served by a CWS in three steps. First, I collected statewide shapefiles of CWS service areas. Second, I used the `sf` package in R to calculate the portion of each block group that fell inside a service area. Third, I calculated the population-weighted average MHI and poverty prevalence for each CWS service area based on the overlap of the block group and service area. I assume the population distribution within each block group is homogenous. Figure 10 shows the MHI of block groups around the CWS serving State College, Pennsylvania. The population-weighted MHI of the State College service area is \$47,817.

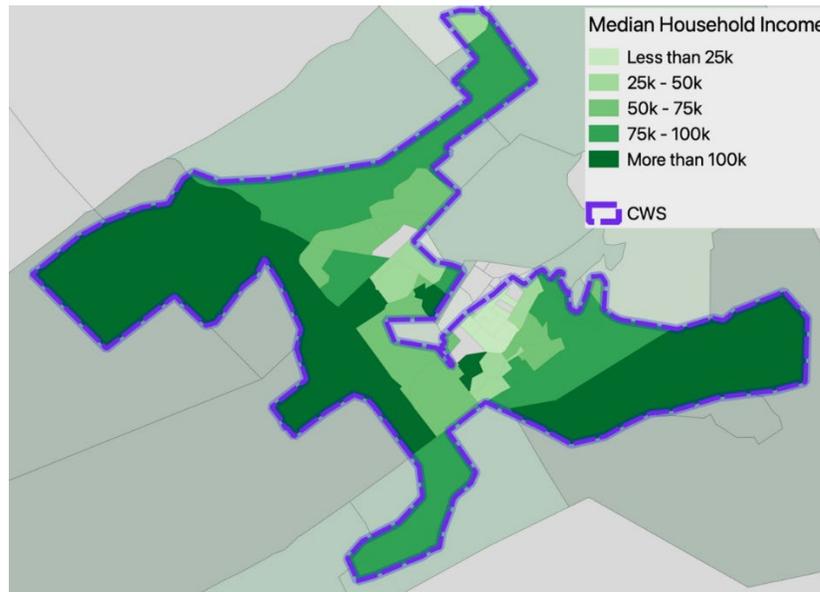


Figure 10: CWS service areas and block groups around State College, Pennsylvania

Most states do not have shapefiles of CWS service area, as shown in Table 13 of Appendix B. A few states have shapefiles that are not publicly available due to security

concerns. None of the CWS service area shapefiles have complete data. Most statewide shapefiles are digitized from individual maps of CWS boundaries (see Gonsenhauser et al., 2020 for an overview). The coverage of the statewide shapefiles ranges from 72 percent of CWSs in Washington to 97 percent of CWSs in New Jersey, as shown in Table 6. I removed 2,350 (15 percent) CWSs due to missing service areas data and 23 (.001 percent) CWSs due to missing demographic data. After removing these CWSs, my sample includes 13,253 communities. The limited and incomplete spatial data is one of the main limitations of this study.

3.4.2 DWSRF applications and awards

The data on DWSRF applicants are from annual reports, called Intended Use Plans (IUPs), issued by the state agencies that administer DWSRF programs. Although most states do not include applicant data in their IUP, some list the CWSs that apply. I compiled IUPs by searching on state websites, downloading files from the Southwest Environmental Finance Center's SRF switchboard, and emailing state administrators to request data.

The data on DWSRF recipients are from a database called the Project Benefits Reporting (PBR) system. The EPA compiles DWSRF assistance data from annual reports submitted by state agencies in the PBR database. I obtained the PBR data released under the Freedom of Information Act.

From 2015 to 2020, 11,798 (89.1 percent) of the 13,253 communities in my sample did not apply for DWSRF assistance; 817 (6.2 percent) applied for, but did not receive, DWSRF assistance; and 638 (4.8 percent) received DWSRF assistance over the period. There is a considerable variation in the number of CWSs, applicants.

3.5 Empirical strategy

I use probit models to estimate how financial resources correlate with DWSRF assistance. I assess decisions by communities to apply for assistance separately from decisions by states to provide assistance to communities that have applied. The dichotomous dependent variables in the two models indicate whether a CWS applied for DWSRF assistance and whether a CWS received DWSRF assistance. I leverage variation in financial resources, applications, and awards across communities. These estimates indicate correlations between community characteristics and DWSRF assistance but do not provide causal evidence.

Although communities apply and states provide awards annually, I collapse the DWSRF applicant and award data from 2015 to 2020 to single observations for each CWS. A community is an applicant if it ever applied for DWSRF assistance and a recipient if it ever received a DWSRF award at any point, or any number of times, over the six-year period. Collapsing the panel data is appropriate because there is redundancy in applications and awards from year to year. For example, initially unsuccessful CWSs may work with CWS staff, state administrators, and other technical

experts to fix previous mistakes and reapply. CWSs amend and resubmit applications for the same project in the following years. Similarly, some states place initially unsuccessful CWSs on a waiting list to receive assistance later. States also list communities as recipients for several years. For example, it may take a few years for the paperwork to clear before a state issues an award or states may disburse capital in phases. My aim is to assess how community characteristics correlate with whether a community applied for or received assistance at any time during my sample period, not the average or the total number of times it did so. Cross-sectional studies are common in research on federal assistance programs (Bickers and Stein 2004; Collins and Gerber 2006).

I control for the total population (logged) served by the CWS and water quality violations. Population is likely correlated with DWSRF assistance. CWSs serving larger populations benefit from economies of scale, spread the high fixed costs of capital projects over more ratepayers, and borrow capital at lower interest rates. Larger CWSs are also likely to have more technically trained staff to apply for assistance and manage projects (McGuire et al. 1994). I cannot include the number of technically trained staff as a control because these data are not widely available, but total population is a decent proxy (Scott, Moldogaziev, and Greer 2018; Teodoro and Switzer 2016). The population data, reported by block, are from 2010 decennial census. I calculate the total population

served by each CWS based on the overlap between blocks and the service area, using the same method for as the financial resource measures described above.

In addition to the demographic characteristics of the community served by a CWS, the allocation of the DWSRF also likely depends on drinking water quality. Water quality violations correlate with community demographics (Teodoro et al, 2018) and improving water quality is a primary aim of the DWSRF program. I measure water quality as an ordinal variable based on the sum of health-based violations to SDWA regulations during the period. I use the sum to create an ordinal variable with four categories: zero violations, one violation, two violations, and more than two violations. Plot of the distribution of violations, in total and by category, are shown Figure 13 and Figure 14 in Appendix B, respectively. I compiled data on health-based water quality violations from the EPA’s Safe Drinking Water Information System (SDWIS).

Finally, I include state fixed effects to control for politics and program administration that influence DWSRF allocation. The number of CWSs in the sample also vary by state. I cluster the standard errors at the state level. The descriptive statistics are reported in Table 7.

Table 7: Summary statistics for community characteristics

Variable	<i>mean</i>	<i>std. dev.</i>	<i>min</i>	<i>max</i>
MHI (\$)	60,000	24,698	11,905	250,000
Proportion of the population living above 200% the federal poverty line	67.8	15.7	7.4	100
Total population (logged)	5.7	2.14	-11	14.47
Number of violations	2.42	9.72	0.00	415.00

3.6 Results

The correlations between community characteristics and the predicted probability of applying for DWSRF assistance are shown in Figure 11 and reported in Table 14 in Appendix B. On average, the probability of applying for DWSRF assistance is 11.0 percent. Income is negatively correlated with applications. An additional \$10,000 in median household income is associated with a 1.8 percentage point lower likelihood of applying, holding all other variables at their means. The proportion of the population living above 200 percent of the poverty line is not correlated with the likelihood of applying. Both population and violations are positively correlated with DWSRF applications.

The correlations between community characteristics and the predicted probability of receiving DWSRF assistance are shown in Figure 12 and Table 15 in Appendix B. Among applicants, the average probability of receiving an award is 38.7 percent. Income is negatively correlated with DWSRF awards. Among applicants, an additional \$10,000 in median household income is associated with a 3.0 percentage point lower likelihood of receiving assistance, holding all other variables at their means. However, the population living above 200 percent the poverty line is positively correlated with DWSRF awards. A 10 percent increase in the proportion of the population living above the poverty line is associated with a 4.6 percentage point higher likelihood of receiving assistance, holding all other variables at their means.

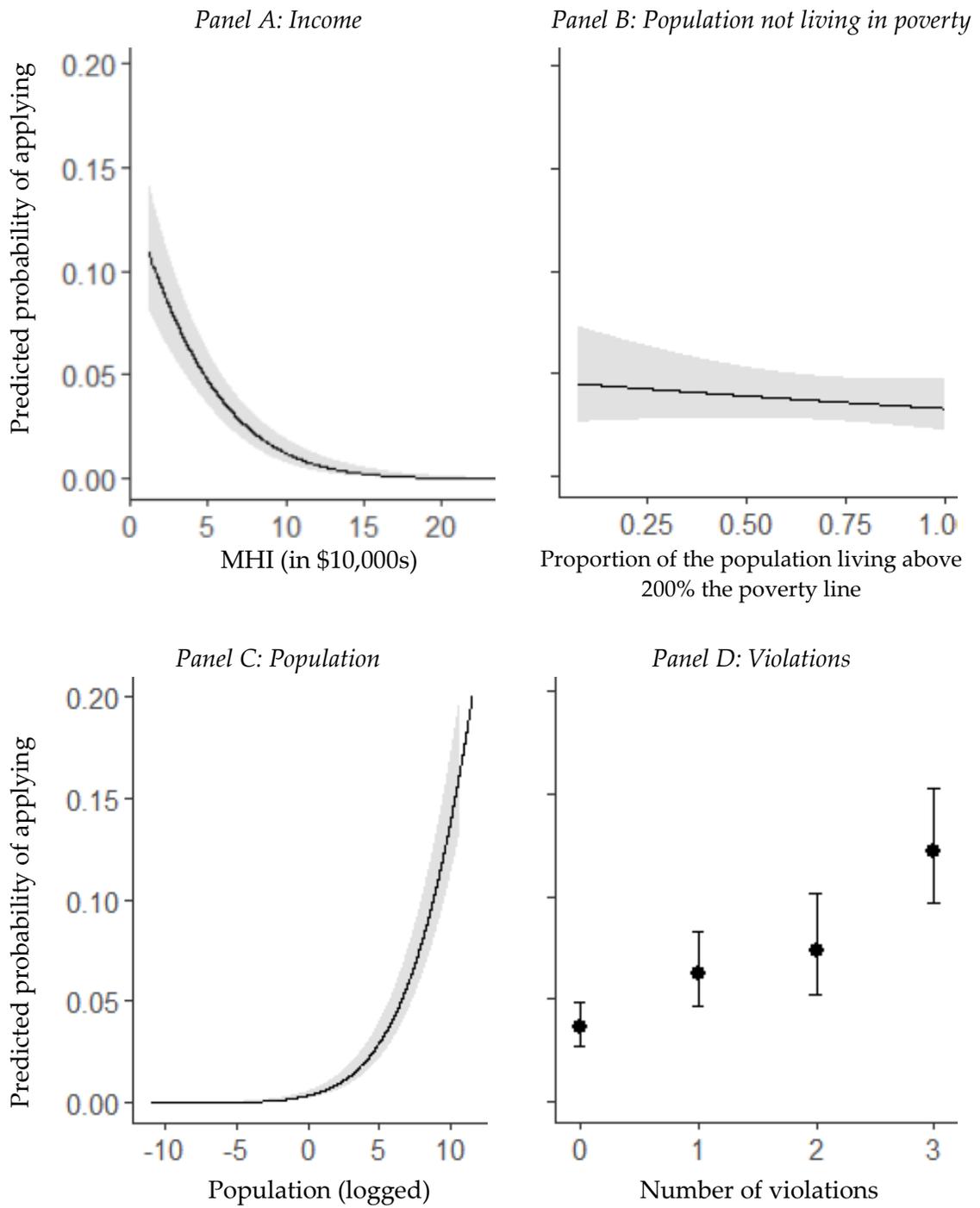


Figure 11: Predicted probability of applying for DWSRF assistance

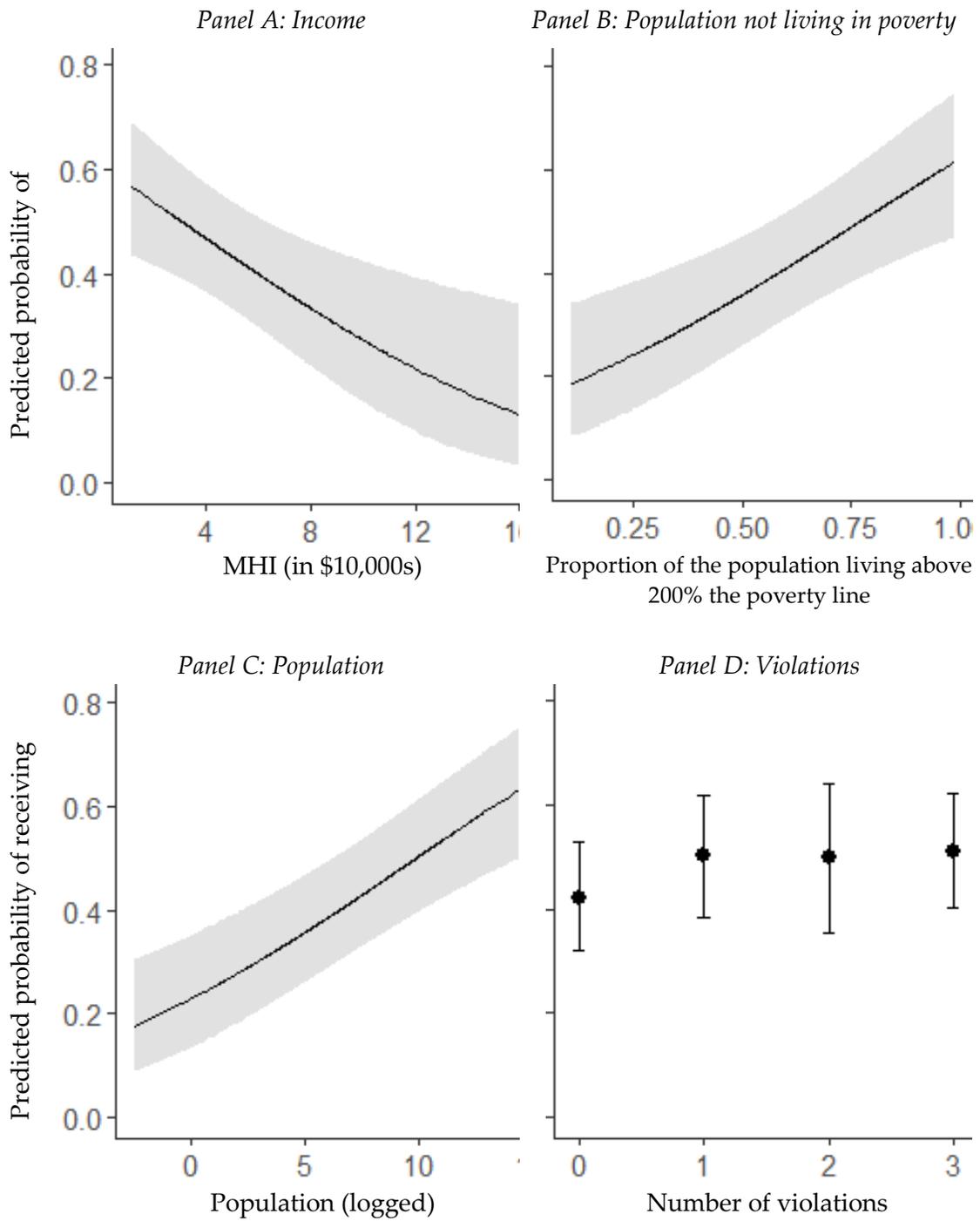


Figure 12: Predicted probability of receiving DWSRF assistance

Population is positively correlated with DWSRF awards and violations are not correlated with DWSRF awards. The standard deviations are wider in the recipient model because the sample is smaller.

Receiving a DWSRF award is conditional on applying. Some unobservable characteristics of applicants and recipients are correlated in the two separate models, but the direction of the bias is difficult to determine in most cases. For example, a highly motivated applicant is more likely to submit a strong application, contact state administrators, and advocate for their community. States likely recognize the value of providing assistance to CWSs with motivated staff. High-resource communities may be more likely to recruit and reward highly motivated employees, which would bias the estimate of the correlation between resources and awards upwards. But low-resource communities that surpass multiple hurdles to successfully apply for assistance are also likely quite motivated, which would bias the estimate of the correlation downwards.

I conduct two robustness checks, shown in specifications (2) and (3) Table 14 and Table 15 in Appendix B. First, I test whether the results hold when I measure MHI and population as categorical rather than continuous variables. Communities in the upper quintiles of MHI can more easily finance infrastructure with loans from private credit markets and may be less likely to apply for DWSRFs. Some states may prioritize allocation to CWSs based on population cutoffs tied to SDWA regulations (<500, 500–3,300, 3,300–10,000, 10,000–50,000, and more than 50,000). The sign and magnitude of the

estimates with the categorical MHI and population are similar to the estimates with the continuous variables in both the applicant and recipient model, though the categorical MHI estimates are not statistically significant in the recipient model due to the smaller sample size. Overall, these results show that communities with higher incomes and larger populations are associated with a higher likelihood of applying for and receiving DWSRF assistance.

In the second robustness check, I add the total square miles of the service area (logged). Community water systems with large service areas face different types of infrastructure challenges. Together with the total area (logged), the total population (logged) also accounts for how population density may correlate with the likelihood to apply for or receive DWSRF assistance. Including the service area does not change the sign or magnitude of the correlation between the financial resources measures and DWSRF applications or awards. Larger service areas are positively correlated with DWSRF assistance.

This study has some notable limitations. There is tremendous variation in how states administer their DWSRF programs. The states included in this study may not be representative of DWSRF programs across the country. I was not able to include states from every Census division due to data constraints. The results may be different, and more generalizable, if states from the East Central, Mountain, or South Atlantic divisions

were included in the analyses. Even so, these are the best available data and the results have important implications for several regions of the country.

3.7 Discussion and conclusion

This analysis shows community characteristics correlate with DWSRF applications and awards in eight states between 2015 and 2020. The correlation between the two measures of financial resources and awards move in different directions: median household income is negatively correlated with awards but the proportion of the population living above poverty is positively correlated with awards. Population is positively correlated with applications and awards and water quality violations are positively correlated with applications. These results are robust across different specifications.

The negative correlation between MHI and DWSRFs is consistent with the expectation that need spurs applications and assistance. Communities with lower MHI tend to have fewer resources to invest in infrastructure. The negative correlation between MHI and awards suggests that communities with greater need are more likely to apply and receive assistance. Federally-financed loans help low-income communities, which often need to invest in infrastructure but have limited ability to do so. Allocating DWSRFs to low-income communities can reduce disparities in investment in water infrastructure and access to safe drinking water.

However, the positive correlation between the proportion of the population living above poverty and awards suggest states also consider capacity in allocating assistance. Unlike grant programs, the DWSRF is primarily a loan program. Nearly all recipients must repay the amount they borrow with interest. Communities often need to increase water rates to repay loans. While higher utility bills can cause hardship for all low-income residents, those living below the poverty line have the least ability to pay. It is less clear whether issuing loans to communities with higher prevalence of poverty advances equity and environmental justice. States may not provide assistance to communities with a higher poverty prevalence due to concerns over their capacity to increase rates and repay loans.

Communities with low median household income and high poverty rates drive some of the divergence between the financial resource correlations. Poverty is not correlated with the likelihood of applying for a DWSRF. But a disproportionate number of the low-income, high-poverty communities that apply do not receive an award. These patterns could result from communities applying for grants and then declining assistance if states only offer loans. Low-income, high-poverty communities hesitate to take loans due to affordability concerns. Communities with a higher proportion of the population living above the poverty line have more capacity to increase water rates and repay loans.

The results underscore that income and poverty are fundamentally different measures of financial resources. Whereas median household income is a good measure of the resources within the community, poverty measures household level resources. Median income can mask poverty. The distinction between community level resources, measured with MHI, and household level resources, measured with poverty prevalence, yields nuance to parse the relationship between financial resources and aid.

The MHI and water quality correlations suggest that states adhere to program objectives when allocating DWSRF assistance. Congress established the DWSRF to finance projects in communities that need assistance and fail to meet water quality standards. States typically use MHI to measure need. The results show that a lower MHI and more violations are associated with an increase in applications and awards.

Congress, the EPA, and states could pursue several reforms to further increase equity in allocation. First, states could provide different forms of assistance. Communities that cannot take on loans need grants to fund water infrastructure. Congress could also waive the American Iron and Steel Requirement and the Davis-Bacon Act for communities with low capacity. Low-resource communities struggle to pay for iron and steel produced in the US and higher minimum wages. Both of these reforms would help small, low-income, and high-poverty communities.

The EPA and state administrators could also work to ensure that communities with smaller populations have equitable access to assistance. The bias against small

communities, indicated by the positive correlation between population and assistance, is likely rooted in the administrative burden of providing small loans to low capacity communities. Administrators can ease their workload by funding larger communities with more capacity to complete applications, comply with requirements, and repay loans. Providing assistance to smaller communities requires more effort.

To address the bias against small communities, states could encourage joint applications. Small communities could pool their resources and apply together rather than separately. Jointly navigating the process and paperwork could be less costly. For example, the engineering firms that design projects and conduct preliminary environmental reviews (PERs) will often not accept projects under a certain amount. Small project designs and PERs cost less to complete but each community pays the minimum cost regardless. Communities could benefit from economies of scale with joint applications.

The relative importance of need and capacity in intergovernmental aid allocation is an important topic for future research. In the water sector, researchers use both income and population size to proxy for need and capacity. The results from this analysis suggest both matter. More work is necessary to determine how. Future research could also examine the differences in state legislation, codes, and practices that lead to variation in allocation. States set different priorities and processes to accommodate needs. Some target assistance to small and low-income communities better than others.

Understanding the differences in eligibility requirements, application processes, forms of assistance, and implementation requirements that lead to variation across states would be valuable. Policy makers could use these lessons to improve DWSRFs and other intergovernmental aid programs.

Revolving loan funds are a popular alternative to federal grants. Recent legislative proposals include dramatic increases to the annual appropriation for DWSRFs and the creation of different revolving loan funds for other purposes. Practitioners and policy makers should continue to center the needs of underinvested in communities in policy design and implementation. Ensuring federal programs benefit disadvantaged communities is crucial for furthering environmental justice.

Dissertation Conclusion

In this dissertation, I examine incentives and constraints to local service provision. Understanding how demographic, financial, political, and administrative determinants influence local revenue and expenditure policies has important theoretical implications. The three chapters of this dissertation offer insight about policies to spur more investment in services.

In Chapter 1, I show increasing economic segregation between jurisdictions decreases service expenditures in metropolitan areas. Using data from the U.S. Census and Census of Governments, I find that increasing economic segregation from the 10th to the 90th percentile decreases expenditures by \$30. While modest, \$30 is the average amount local governments spend on libraries in metropolitan areas. These results suggest local governments respond to voter preferences over service provision, which shift as economic segregation creates more homogenous jurisdictions.

In Chapter 2, my coauthors and I show rate increases are not correlated with average vote shares for incumbent city council members. Electoral accountability theory predicts voters punish legislators for raising taxes and fees. Analyzing data on water rates and vote shares for 165 municipalities in North Carolina from 2007 to 2017, we find no evidence of electoral punishment for rate increases. The type of modest water rate increase that local officials typically consider should not incite backlash. Inaccurate

notions of electoral punishment may prevent local elected officials from collecting sufficient revenue to provide adequate services.

In Chapter 3, I show the allocation of intergovernmental aid correlates with the financial resources of the communities that apply for and receive assistance. I compile data from maps of water service areas, the U.S. Census, annual DWSRF reports, and EPA databases for eight states from 2015 to 2020. The correlation between DWSRF assistance and two measures of financial resources—median household income and the proportion of the population living above 200 percent of the federal poverty line—have different signs. While income is negatively correlated with DWSRF assistance, the proportion of the population living above the poverty is positively correlated with DWSRF assistance. These results suggest policy makers must consider the nuanced distinction between the ability of residents to pay their water bills and the ability of CWSs to invest in infrastructure when designing and implementing programs to provide financial assistance for service provision.

By pulling the local political economy, public finance, and public administration literatures into conversation, I draw attention to the multiple constraints that influence service provision. Research about who gets what, when, and why from siloed subfields tends to overlook the interplay between the demographic, financial, political, and administrative constraints that local elected officials face.

Several constraints to service provision are rooted in the demographics of local jurisdictions. Demographics undergird the revenue base, voter preferences, and capacity to apply for intergovernmental aid. Countering the influential role of demographics in local service provision requires policy responses. In particular, policy makers should focus on addressing the causes and consequences of economic sorting, fragmentation, and reliance on own-source revenue. As described in Chapter 1, economic sorting between jurisdictions shifts demographics. Restrictive land use regulations and income inequality increase economic sorting. States could slow the pace of economic sorting by revoking the authority of local governments to impose restrictive land use regulations, such as citywide bans on multifamily housing, and investing in affordable housing.

States could also reduce disparities by incentivizing regional service provision. Economic sorting between highly fragmented jurisdictions drives disparities in service provision. Unequal resources and revenue bases are less detrimental if provision spans across jurisdictions. States can incentivize service provisions to consolidate through financial assistance and regulatory pressure. For example, some states use DWSRFs to incentivize consolidation in water service.

Funding more services with revenue from states and the federal government would also reduce disparities. The analysis of DWSRFs allocation in Chapter 3 provides insights on the design and implementation of intergovernmental aid programs. Specifically, policy makers must accommodate differences in capacity. The explicit, and

successful, efforts to target DWSRF assistance to low-income communities could serve as a model for other programs. Ensuring federal programs benefit disadvantaged communities is important for furthering environmental justice.

Together, reducing economic sorting between jurisdictions, regionalization, and more federal and state aid will help reduce disparities in service provision. These efforts will have far-reaching effects on quality of life. Access to public services is essential for public health, economic growth, and wellbeing. By explaining some of the incentives and constraints that local governments face, this dissertation offers insights on how to move forward.

Appendix A: Additional tables for Chapter 2

Table 8: Comparison between demographic characteristics for municipalities in sample and all municipalities in North Carolina

	Complete data	Partial data	All municipalities with water system
% white	73%	72%	68%
% Black	17%	18%	22%
% Hispanic	7%	7%	6%
% with bachelor's degree	19%	18%	14%
Median HH Income (\$)	49,909	47,922	42,594
% own home	66%	66%	67%
% below the poverty line	15%	15%	18%

Table 9: The estimated effects of one-year changes in water rates on incumbent vote share in municipal election

	<i>Dependent variable:</i>								
	Average incumbent vote share, unless noted								
	Median		(3)	(4)	(5)	(6)	(7)	(8)	(9)
	(1)	(2)							
Percent water rate change	6.86 (6.50)	9.29 (6.66)							
Dichotomous (Y)			0.49 (0.82)						
-5-0 percent decrease				-0.15 (2.01)					
0-5 percent increase				-0.34 (0.93)					
5-10 percent increase				1.93 (1.36)					
over 10 percent increase				0.10 (1.51)					
-10-0 percent decrease					-0.26 (2.00)				
0-10 percent increase					0.62 (0.99)				
10-20 percent increase					-0.71 (2.00)				
over 20 percent increase					0.95 (2.32)				
Percent water rate change (10k)						8.55 (6.06)			
Percent water and sewer rate change (4k)							8.28* (4.78)		
Percent water and sewer rate change (10k)								12.29** (5.60)	
Two-year percent water rate change									2.42 (3.65)
Water rate level	0.13 (0.10)	0.13 (0.11)	0.05 (0.11)	0.04 (0.12)	0.06 (0.11)	0.10 (0.06)	0.03 (0.13)	0.07 (0.07)	0.05 (0.12)
Sewer rate level							0.06 (0.08)	0.01 (0.04)	
Percent tax change	-9.94** (4.92)	-9.95** (4.70)	-10.18** (5.08)	-10.62** (5.35)	-10.19** (5.13)	-9.97** (4.79)	-10.64* (6.05)	-10.69* (5.90)	-11.11* (5.74)
Tax rate	-0.35*** (0.13)	-0.35*** (0.13)	-0.35*** (0.13)	-0.34*** (0.13)	-0.35*** (0.13)	-0.33*** (0.12)	-0.32** (0.14)	-0.33** (0.13)	-0.31** (0.13)
Number of available seats	-9.41*** (0.99)	-10.79*** (1.09)	-9.57*** (0.98)	-9.65*** (0.96)	-9.57*** (1.00)	-9.23*** (0.96)	-9.48*** (1.00)	-9.37*** (0.97)	-9.38*** (0.93)
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Municipal FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
	N = 645	N = 645	N = 645	N = 645	N = 645	N = 645	N = 590	N = 590	N = 610

Note: OLS estimates. Standard errors clustered by municipality. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 10: Likelihood and magnitude of water rate increases in election year

	<i>Dependent variable:</i>	
	Likelihood	Magnitude
	(1)	(2)
Election year	-0.214** (0.099)	-0.008 (0.005)
<i>Note:</i>	* p<0.1; ** p<0.05; *** p<0.01	

Table 11: Likelihood and magnitude of rate increases with lagged vote share

	<i>Dependent variable:</i>	
	Likelihood	Magnitude
	(1)	(2)
Vote share (lagged)	0.0003** (0.0001)	0.0000 (0.0000)
<i>Note:</i>	* p<0.1; ** p<0.05; *** p<0.01	

Table 12: Post-treatment DVs: number of challengers and turnout

	<i>Dependent variable:</i>	
	Challengers	Turnout
	(1)	(2)
One-year percent water rate change	-1.181 (0.734)	-0.117 (0.251)
Water rate	-0.027 (0.023)	-0.005 (0.007)
Percent tax change	1.341** (0.674)	0.806*** (0.162)
Tax rate	0.024 (0.026)	0.009 (0.007)
Number of open seats	1.760*** (0.158)	0.026 (0.056)

*Note: Voting age turnout is the effective number of votes (total votes cast/number of seats) divided by the voting age population. Standard errors clustered at the municipal level. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

Appendix B: Additional tables and figures for Chapter 3

Table 13: Availability of service area and applicant data

<i>State</i>	<i>Service area map</i>	<i>Data on applicants</i>	<i>Select case</i>
Alabama	-	-	-
Alaska	-	-	-
Arizona	Yes	-	-
Arkansas	Yes	Yes	Yes
California	Yes	Yes	Yes
Colorado	-	-	-
Connecticut	Yes	Yes	Yes
Delaware	Yes	No	-
Florida	-	-	-
Georgia	-	-	-
Hawaii	-	-	-
Idaho	-	-	-
Illinois	-	-	-
Indiana	-	-	-
Iowa	-	-	-
Kansas	Yes	Yes	Yes
Kentucky	-	-	-
Louisiana	-	-	-
Maine	-	-	-
Maryland	-	-	-
Massachusetts	-	-	-
Michigan	-	-	-
Minnesota	-	-	-
Mississippi	Partial	-	-
Missouri	Partial	-	-
Montana	-	-	-
Nebraska	-	-	-
Nevada	-	-	-
New Hampshire	-	-	-
New Jersey	Yes	-	Yes
New Mexico	Yes	-	-
New York	-	-	-

North Carolina	Yes		-
North Dakota	-		-
Ohio	-		-
Oklahoma	Yes		Yes
Oregon	-		-
Pennsylvania	Yes		Yes
Rhode Island	Yes		Yes
South Carolina	-		-
South Dakota	-		-
Tennessee	-		-
Texas	Yes		Yes
Utah	Yes		No
Vermont	-		-
Virginia	-		-
Washington	Yes		Yes
West Virginia	-		-
Wisconsin	-		-
Wyoming	-		-

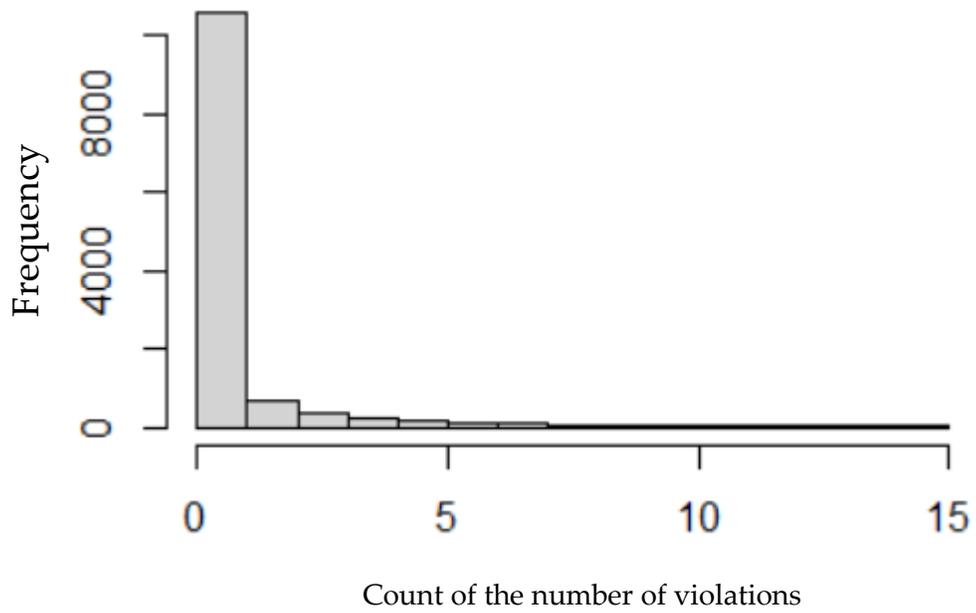


Figure 13: Distribution of health-based water quality violations by count

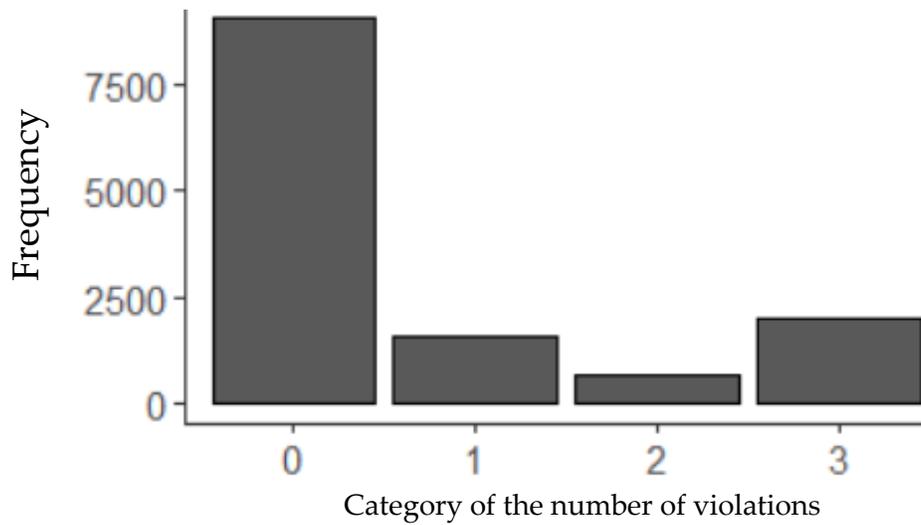


Figure 14: Distribution of health-based water quality violations by category

Table 14: Probit model estimates of DWSRF application

	(1)	(2)	(3)
MHI	-0.12 ^{***} (0.01)		-0.11 ^{***} (0.01)
MHI Q2		-0.24 ^{***} (0.05)	
MHI Q3		-0.37 ^{***} (0.06)	
MHI Q4		-0.63 ^{***} (0.07)	
MHI Q5		-0.84 ^{***} (0.09)	
Proportion above poverty	-0.16 (0.17)	0.01 (0.17)	-0.33 [*] (0.17)
Total population (log)	0.16 ^{***} (0.01)		0.10 ^{***} (0.01)
Population 500-3300		0.60 ^{***} (0.04)	
Population 3300-10k		0.79 ^{***} (0.05)	
Population 10k-50k		0.91 ^{***} (0.06)	
Population over 50k		1.16 ^{***} (0.08)	
1 violation	0.26 ^{***} (0.05)	0.23 ^{***} (0.05)	0.25 ^{***} (0.05)
2 violations	0.34 ^{***} (0.07)	0.32 ^{***} (0.07)	0.32 ^{***} (0.07)
More than 2 violations	0.62 ^{***} (0.04)	0.60 ^{***} (0.04)	0.60 ^{***} (0.04)
Service area m2			0.07 ^{***} (0.01)
FE for State	X	X	X
Observations	13,253	13,253	13,253

Note: Probit regression model estimates. Standard errors clustered by state. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 15: Probit model estimates of DWSRF awards

	(1)	(2)	(3)
MHI	-0.09 ^{***} (0.03)		-0.08 ^{***} (0.03)
MHI Q2		-0.05 (0.04)	
MHI Q3		-0.003 (0.05)	
MHI Q4		0.0004 (0.06)	
MHI Q5		-0.10 (0.07)	
Proportion above poverty	1.34 ^{***} (0.39)	0.22 (0.14)	1.23 ^{***} (0.39)
Total population (log)	0.07 ^{***} (0.02)		0.03 (0.03)
Population 500-3300		0.04 (0.03)	
Population 3300-10k		0.06 (0.04)	
Population 10k-50k		0.05 (0.04)	
Population over 50k		0.22 ^{***} (0.05)	
1 violation	0.20 [*] (0.11)	0.07 [*] (0.04)	0.20 [*] (0.11)
2 violations	0.19 (0.16)	0.06 (0.06)	0.19 (0.16)
More than 2 violations	0.23 ^{***} (0.09)	0.07 ^{**} (0.03)	0.22 ^{**} (0.09)
Service area m2			0.06 ^{**} (0.03)
FE for State	X	X	X
Observations	1,332	1,332	1,332

Note: Probit regression model estimates. Standard errors clustered by state. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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Biography

Katy Hansen graduated from Montana State University with a B.S. in Industrial and Management Engineering in 2010. After graduation, she worked as a research assistant for Dr. Clive Lipchin at the Arava Institute for Environmental Studies on Kibbutz Ketura, Israel. Katy received her MSc in Water Science, Policy, and Management at Oxford University in 2012, where she was a Rhodes Scholar. From 2013 to 2015, Katy worked as a research assistant for Dr. Sharon Pollard at the Association for Water and Rural Development in Hoedspruit, South Africa.

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