Overlapping Jurisdictions and the Provision of Local Public Goods in U.S. Metropolitan Areas*

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Abstract

Local governments in the United States are vertically differentiated: in a given location, multiple overlapping jurisdictions provide distinct local public services and draw revenue from shared portions of the property tax base. This paper estimates the fiscal spillovers generated by this structure and proposes a mechanism that internalizes them in local policy choice. I assemble a new georeferenced dataset covering the universe of local government boundaries and nominal property tax rates nationwide over the past two decades. Using a dynamic regression discontinuity design, I estimate fiscal spillovers from narrowly approved property tax referenda. To extrapolate beyond effects identified at the approval threshold, I develop a spatial equilibrium model with overlapping jurisdictions and majority voting over the provision of local public goods. I use the model to quantify spillovers for all school districts and municipal governments in the United States and find sizable effects. I then evaluate a policy that (i) informs voters about cross-jurisdiction spillovers and (ii) applies symmetric intergovernmental transfers (taxes or subsidies) upon approval of a spending change. The counterfactual regime yields aggregate welfare gains.

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1 Introduction

Local governments play a central role in the provision of public services in the United States. They are responsible for delivering a wide range of functions, including K–12 education, public safety, sanitation, transportation, and utilities. Since Tiebout (1956), economists have viewed local jurisdictions as differentiated providers of public services among which households sort to "purchase" their preferred bundles of amenities.

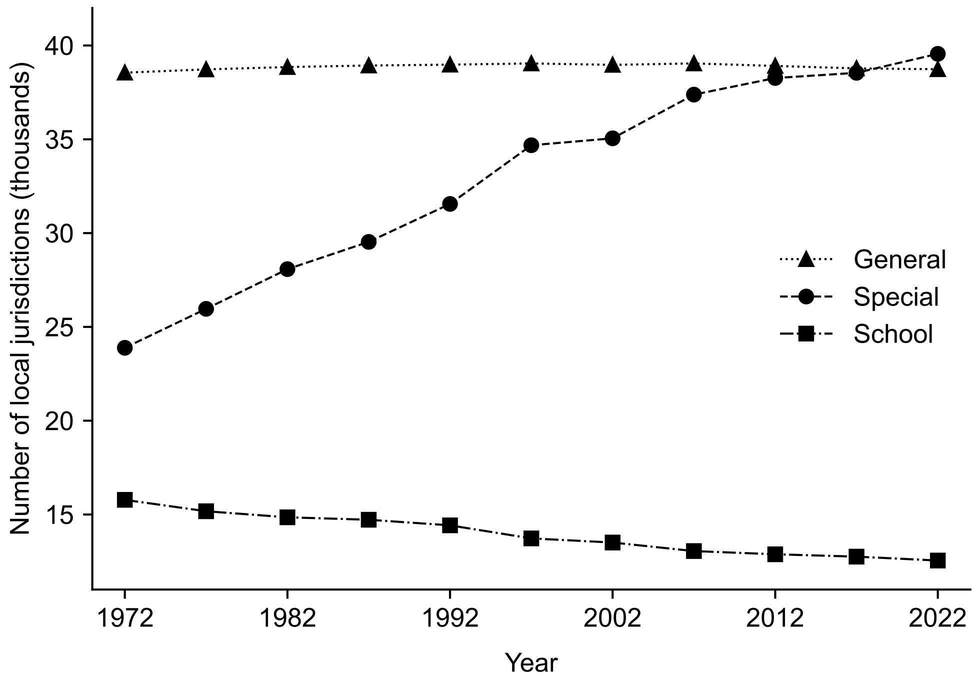
In practice, however, local governments only partially reflect the structure envisioned by Tiebout and subsequent models of local public goods provision.[1] Rather than a system of general purpose jurisdictions offering distinct bundles of services, the modern local public sector consists of a dense and expanding network of specialized entities—counties, municipalities, school districts, and special purpose districts—each responsible for a limited number of functions. In most states, any given location is therefore served by several overlapping jurisdictions that share a tax base.

In this paper, I study how this institutional structure gives rise to vertical fiscal spillovers, focusing on those arising from property taxation, which accounts for nearly 70 percent of local own-source revenue (U.S. Census Bureau 2022). I first show that changes in school district spending shift housing prices and, via capitalization, alter the property tax revenues of overlapping municipalities and special purpose districts. I then develop and estimate a spatial equilibrium model of residential choice to generalize these effects to the broader population of local governments. Finally, I use the model to evaluate a regime that internalizes cross-jurisdiction spillovers through symmetric intergovernmental transfers, and I quantify its implications for spending levels, tax rates, and welfare.

When local governments are only *horizontally* differentiated, spillovers operate through migration of residents (Oates 1972; Hamilton 1975; Wilson 1999; Agrawal, Hoyt and Wilson 2022). For example, a school district that invests in new facilities may attract households who value education services, thereby expanding its own tax base while contracting those

[1] A non-exhaustive list: Ellickson (1971); Hamilton (1975); Stiglitz (1977); Westhoff (1977); Brueckner (1979*a*); Brueckner (1979*b*); Brueckner (1979*c*); Rose-Ackerman (1979); Brueckner (1983); Epple, Filimon and Romer (1984); Epple and Romer (1991); Epple and Platt (1998); Epple and Sieg (1999); Brueckner (2000); Epple, Romer and Sieg (2001); Calabrese et al. (2006); Epple, Gordon and Sieg (2010); Calabrese, Epple and Romano (2012); Brueckner (2023).

Figure 1: Number of Local Jurisdictions by Type in 1972-2022



Notes: The figure displays the number of general purpose jurisdictions, special purpose jurisdictions, and school districts active in the United States from 1972 to 2022. General purpose jurisdictions include counties, municipalities, and townships. Special purpose districts include all other jurisdictions except for school districts. Source: author's own calculations based on data from the 2022 Census of Governments (U.S. Census Bureau 2022).

of neighboring districts. When local governments are also *vertically* differentiated, spillovers can arise because changes in the composition or size of one jurisdiction's tax base affect overlapping jurisdictions (Oates 1972; Boadway and Keen 1996; Besley and Rosen 1998; Berry 2008). If a school district invests in new facilities and attracts new residents, this inflow may expand not only its own base but also that of other jurisdictions that serve, at least in part, the same area. Yet, in general, whether spillovers are positive or negative depends on how residential mobility interacts with shared tax bases.

This ambiguity matters in light of recent institutional changes. Over the past fifty years, the number of local governments in the United States has risen steadily, driven largely by the creation of special purpose districts (Figure 1). These entities now account for most new local governments and typically overlap with existing municipalities and school districts. New jurisdictions also tend to form in communities that are relatively homogeneous in income and housing values (Ruggieri 2024). If new, overlapping jurisdictions reallocate fiscal capacity toward narrow constituencies, vertical spillovers may be negative; if investments raise housing demand in shared areas, spillovers may be positive. This raises the policy question of whether continued layering improves the provision of broadly valued public goods or primarily reflects efforts to tailor services to specific groups (Berry 2009).

I begin my analysis by estimating fiscal spillovers across jurisdictions that share a common property tax base. To do so, I assemble a novel georeferenced dataset covering the universe of local governments in the United States and their property tax rates since the early 2000s. This is the first nationwide dataset to report nominal property tax rates together with the boundaries of all special purpose jurisdictions. Using a dynamic regression discontinuity design that exploits closely contested school district referenda to increase local spending (Cellini, Ferreira and Rothstein 2010; Biasi, Lafortune and Schönholzer 2025) and an accompanying identification strategy developed in Ruggieri (2025), I show that such fiscal changes affect the tax revenues of overlapping municipalities and special districts. Specifically, approved bond referenda are capitalized into housing prices, leading the spending of overlapping municipalities and special districts to rise by approximately 4 percent. These positive spillovers reflect the shared property tax base from which multiple jurisdictions draw revenue.

A key limitation of relying on marginally approved referenda to measure fiscal spillovers is that jurisdictions far from the approval threshold may differ systematically in both observable and unobservable characteristics. This concern is particularly salient because the local provision of public goods reflects residents' heterogeneous valuation of government spending relative to taxation. For example, in school districts where many households place low value on new educational facilities, capitalization of additional school spending is likely to be smaller, or even negative, because higher property taxes may induce some residents to relocate (Feng and Ruggieri 2025). Consequently, estimating fiscal spillovers at the national level requires extrapolating the effects identified around the threshold to the broader population of jurisdictions.

To address this limitation and formalize the mechanism behind these spillovers, I develop a spatial equilibrium model of a metropolitan area in which households with heterogeneous preferences for local public goods sort across locations. The key distinction between this framework and prior models of equilibrium among jurisdictions lies in the mapping between *locations* and *jurisdictions*. In previous models, this mapping is one-to-one: each location is served by a single jurisdiction that provides a bundle of local public services. In contrast, in my framework, each location is served by multiple overlapping jurisdictions, each levying its own property tax rate and providing a distinct service. Conversely, each jurisdiction typically encompasses multiple locations. As a result, areas within the metropolitan economy are interconnected through shared tax bases, and fiscal decisions by one jurisdiction generate spillovers for others.

In this environment, household sorting is the primary channel through which fiscal spillovers arise. When a jurisdiction changes its expenditure–tax mix, the resulting inflow or outflow of residents alters local housing demand and equilibrium prices, thereby changing the tax base. Because overlapping jurisdictions tax partially overlapping sets of properties, capitalization effects transmit fiscal shocks across governments: when a policy increases property values, the revenues of overlapping jurisdictions rise with the extent of overlap, holding tax rates fixed. Within the model, I define the fiscal spillover from Jurisdiction A to Jurisdiction B as the change in B's property tax base, valued at its current tax rate and holding B's own expenditure and rate fixed, induced by a marginal change in A's spending.

The determination of fiscal policy in this setting follows a political process. I model local spending and taxation as outcomes of majority voting among residents, following the tradition of Tiebout frameworks with endogenous public good provision through collective choice (Westhoff 1977; Rose-Ackerman 1979; Epple, Filimon and Romer 1984; Epple and Romer 1991; Epple, Filimon and Romer 1993; Epple and Platt 1998; Epple, Romer and Sieg 2001; Calabrese et al. 2006; Epple, Gordon and Sieg 2010). This contrasts with approaches that model local governments as unitary decision-makers maximizing an explicit objective, such as aggregate resident welfare (Zodrow and Mieszkowski 1986; Wilson 1986) or total land value (Brueckner 1982). I extend this voting-based framework by incorporating selective turnout: residents differ not only in how they value additional public spending relative to the higher property taxes required to finance it, but also in their perceived costs and benefits of political participation. This feature introduces a selection mechanism that captures a key characteristic of local elections in the United States, namely low and highly selective turnout (Berry 2024).

The specification of a voting model has the additional advantage of forming a tight link between the spatial equilibrium framework and the regression discontinuity design used to measure fiscal spillovers. I leverage this connection to develop an identification argument that recovers the model's household preference and housing market parameters solely from reduced-form RDD estimands.

I estimate a set of dynamic RDD parameters that capture the long-run effects of property tax changes on housing stock, population composition, and several fiscal outcomes. Marginally approved referenda increase the number of housing units and housing prices by approximately 2 and 6 percent, respectively, which implies an elasticity of housing supply of about 0.33. The local composition of residents also adjusts in response to changes in the local expenditure-tax mix. Within five years of approval, the share of high-income families with children rises by roughly 7 percent, while the share of low-income families without children declines by about 6 percent. Effects for households without children exhibit the same sign but are smaller in magnitude.

These sorting responses provide the key moments for estimating preference heterogeneity in the structural model. In particular, they identify the parameters governing households' marginal willingness to pay for education and municipal services. Consistent with the reduced-form results, the estimated willingness to pay for education is highest among households with above-median income and at least one child. This finding aligns with recent evidence from Biasi, Lafortune and Schönholzer (2025), who show that increases in school district spending change the socioeconomic composition of the student body, specifically reducing the share of students below the poverty line and those eligible for free or reduced-price lunch. By contrast, the estimated willingness to pay for municipal services is smaller in magnitude and exhibits weaker heterogeneity across households.

I next estimate the parameters governing turnout behavior. I propose a model, in the spirit of Downs (1957) and Riker and Ordeshook (1968), in which residents participate in a local referendum when the perceived benefit of voting exceeds an unobserved cost of participation, such as the cost of attention, information acquisition, or time. The benefit captures the perceived salience of the ballot measure: individuals who anticipate that approval would meaningfully affect their utility are more likely to turn out. I estimate the parameters of the participation cost distribution by matching referendum data with voter registration records that report the demographic and socioeconomic characteristics of resident voters. The results indicate that households without children, a group that includes a large share of elderly residents, incur lower participation costs and are therefore more likely to vote. This pattern is consistent with the evidence summarized by Berry (2024) on the overrepresentation of older and more affluent households in local elections in the United States.

With the estimated parameters in hand, I conduct two complementary counterfactual exercises. The first quantifies the magnitude and distribution of fiscal spillovers implied by hypothetical spending changes across all school districts and municipal governments in the United States. The second evaluates how incorporating information about these spillovers into the design of local referenda would affect voting outcomes.

In the first exercise, I use the boundaries implied by the current configuration of local jurisdictions to compute the fiscal spillovers that would result from infinitesimal spending changes by all school districts and municipal governments. This exercise extends beyond the regression discontinuity estimates from the reduced-form analysis, as it leverages the model structure and estimated parameters to compute fiscal effects for jurisdictions that either did not hold referenda during the sample period or held referenda with nonmarginal outcomes. I conduct this analysis separately for school districts and municipalities and find that most cross-jurisdictional effects lie between -0.1 and $+0.1$ dollars per dollar of spending. For school districts, the estimated spillover is statistically significantly positive in 55 percent of cases and negative in 12 percent; for municipalities, the corresponding shares are 42 percent and 43 percent, respectively.

The second exercise introduces a counterfactual institutional design in which the anticipated fiscal spillovers are explicitly disclosed to voters. I consider hypothetical referenda in which each jurisdiction votes on whether to increase local spending by 5 percent, corresponding to the median amount in school district referenda in the sample period. The planner incorporates the estimated cross-jurisdictional effects into the ballot proposition: if the projected effect is negative, the proposal includes a compensating transfer to overlapping jurisdictions; if positive, the transfer is reversed. This design captures a scenario in which voters internalize fiscal linkages across governments when casting their ballots. According to the model, such an arrangement would alter the outcome of a sizable share of referenda. For school districts, incorporating these transfers would reverse 6.5 percent of referenda that would otherwise be approved and 22.9 percent that would otherwise be rejected. For municipal governments, the corresponding figures are 11.8 and 5.6 percent. As a result, aggregate household welfare would increase by 0.25 percent.

This paper contributes to three main strands of research.

First, it advances the long-standing literature on equilibria among local jurisdictions by incorporating the institutional reality that local governments in the United States are vertically differentiated and overlapping. Earlier models typically assume a one-to-one mapping between locations and general purpose jurisdictions, an assumption that has led researchers to rely on data from Massachusetts, one of the few states where this structure is closely approximated (Epple and Sieg 1999; Epple, Romer and Sieg 2001; Calabrese et al. 2006; Calabrese, Epple and Romano 2012). In contrast, the framework developed here accommodates multiple jurisdictions that levy distinct property tax rates and supply different services. This specification provides a more representative depiction of the U.S. local public sector.

Second, the analysis contributes to research on fiscal interactions across governments. A large empirical literature examines horizontal linkages among jurisdictions providing similar services, such as municipalities (Brueckner and Saavedra 2001; Buettner 2003; Bordignon, Cerniglia and Revelli 2003; Brülhart and Jametti 2006), school districts (Millimet and Rangaprasad 2007), or both (Isen 2014). By contrast, studies of vertical spillovers have largely focused on concurrent taxation between federal and state authorities (Johnson 1988; Boadway and Keen 1996; Besley and Rosen 1998; Hoyt 2001; Albouy 2009). Evidence on vertical linkages among local governments remains limited (Greer 2015; Jimenez 2015; Agrawal 2016; Brien and Yan 2020), and existing analyses of property tax interactions reach differing conclusions (Choi 2022; Yang, Yu and Chen 2025). This study contributes by developing a structural model that quantifies the transmission of property tax changes across overlapping local jurisdictions.

Third, the paper connects to the literature that infers the willingness to pay for local public goods from housing market outcomes (Oates 1969; Gyourko and Tracy 1991; Black 1999; Ross and Yinger 1999; Barrow and Rouse 2004; Bayer, Ferreira and McMillan 2007; Cellini, Ferreira and Rothstein 2010; Neilson and Zimmerman 2014; Collins and Kaplan 2017; Lafortune and Schönholzer 2022; Zheng 2022; Biasi, Lafortune and Schönholzer 2025; Schönholzer 2025). Leveraging property tax referenda, the analysis combines reduced-form estimates from a dynamic regression discontinuity design with a spatial equilibrium model in which school districts and municipal governments supply services. This approach makes it possible to identify structural parameters governing households' marginal willingness to pay for local expenditures using quasi-experimental variation.

Finally, the analysis relates to the growing field of quantitative spatial economics (Redding and Rossi-Hansberg 2017) by embedding the political determination of fiscal policy through majority-rule voting into a model of residential sorting within a metropolitan area. In this respect, it connects to Bordeu (2025), which models local infrastructure investment in Santiago within a framework where local governments act as unitary decision-makers.

The remainder of the paper is organized as follows. Section 2 provides an overview of local governments in the United States. Section 3 describes the data sources, including a new georeferenced dataset on jurisdictional boundaries and property tax rates. Section 4 presents reduced-form estimates of fiscal spillovers from marginally approved school district referenda. Section 5 develops the spatial equilibrium model. Section 6 establishes the identification of structural parameters using RDD estimands. Section 7 reports parameter estimates for household preferences, the housing market, and turnout behavior. Section 8 quantifies fiscal spillovers across all jurisdictions in the U.S. and evaluates counterfactual referenda in which these effects are offset through transfers. Section 9 concludes.

2 Local Governments in the United States

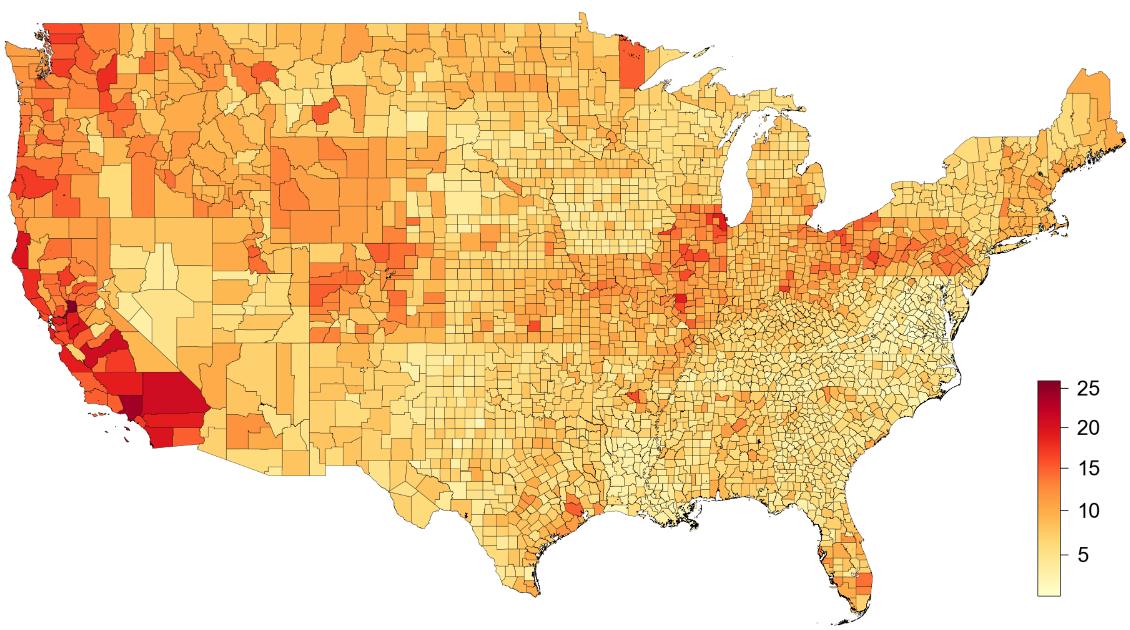
In 2022, approximately 91,000 local governments in the United States spent \$1.86 trillion (U.S. Bureau of Economic Analysis, 2023*a*) and employed 12.2 million full-time equivalent units (U.S. Census Bureau, 2022). The local government sector as a whole employs a workforce roughly 40 percent larger than that of federal and state governments combined (U.S.

Bureau of Economic Analysis, 2023*b*).

Local governments vary substantially in scope. General purpose jurisdictions—a category that includes counties and municipalities—provide broad bundles of services such as law enforcement, election administration, urban planning, the court system, and housing assistance. Special purpose jurisdictions, such as fire protection districts, library districts, and water conservation districts, instead specialize in the provision of a single local public good. In most states, unified school districts provide education services from kindergarten through grade 12. In others, elementary and secondary education are administered by separate districts, reflecting historical differences in consolidation and governance.[2]

Local governments also differ greatly in size. Some special purpose districts encompass multiple counties, whereas others cover only a few urban blocks. Jurisdiction boundaries are fixed upon creation, but annexations and secessions occur with some frequency.

Figure 2: Number of Local Government Types by County



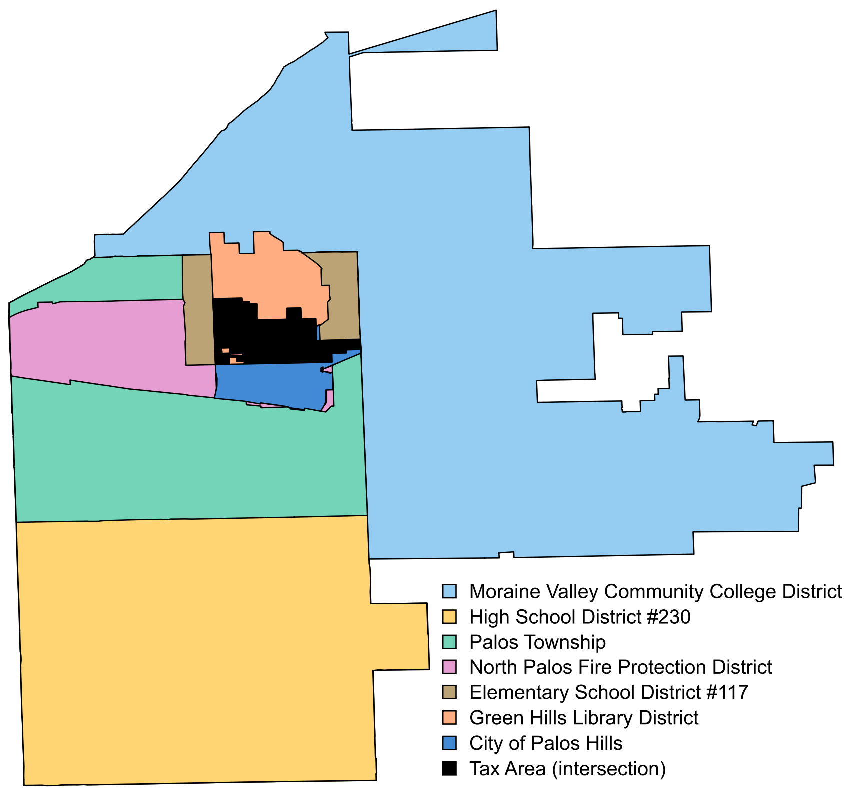
NOTES: This map displays the number of distinct local government types that overlapped in U.S. counties in 2022. Local government "types" are counties, municipalities, townships, school districts, community college districts, fire protection districts, emergency medical services districts, park and recreation districts, as well as several other special purpose districts. Alaska and Hawaii are omitted. Source: author's own calculations based on data from the 2022 Census of Governments (U.S. Census Bureau 2022).

[2]States that feature this distinction across a large portion of their territory include Arizona, California, Illinois, Montana, New York, Oregon, Washington, and Wisconsin.

Figure 2 reports the number of distinct local government types overlapping within each U.S. county. For example, a county that contains a county government, several municipalities, several K-12 school districts, multiple fire protection districts, and a few park districts would be classified as having five distinct jurisdiction types. The degree of overlap varies markedly across states, with the highest levels in the Mountain and Pacific regions and in parts of the Midwest.

Local governments finance their services primarily through property and sales taxes, as well as user fees tied to specific services such as utilities (U.S. Bureau of Economic Analysis, 2023*a*). Each jurisdiction maintains an independent budget and determines its planned level of expenditure annually. County governments are typically responsible for assessing property values and for computing each jurisdiction's property tax rate, that is, the ratio of projected

Figure 3: Overlapping Jurisdictions and Tax Areas



Notes: This figure displays overlapping jurisdictions in a southwestern suburb of Chicago. A tax area is defined as the unique combination of jurisdictions covering a location.

expenditures to the aggregate assessed value of residential property within its boundaries.[3] A typical property tax bill lists all jurisdictions to which a parcel is subject. The unique combination of overlapping jurisdictions in a given location defines a Tax Code Area (or Tax Rate Area).

Figure 3 illustrates overlapping jurisdictions in a southwestern suburb of Chicago. The black tax area is the intersection of eleven jurisdictions: three general purpose governments (Cook County, Palos Township, and the City of Palos Hills), two school districts (Elementary School District #117 and High School District #230), and several special purpose districts, including a community college district, a fire protection district, a library district, and additional (not shown) larger districts for forest preservation, water reclamation, and mosquito abatement.

Local governments are administered by democratically elected representatives or, in a small number of cases, by state-appointed officials. In addition to electing representatives, residents frequently vote in referenda that authorize local governments to exceed statutory limits on tax rates or spending. These referenda have been widely used in empirical public finance to estimate the effects of increased local expenditure on student achievement and housing market outcomes (Cellini, Ferreira and Rothstein, 2010; Darolia, 2013; Hong and Zimmer, 2016; Martorell, Stange and McFarlin, 2016; Abott et al., 2020; Baron, 2022; Enami, Reynolds and Rohlin, 2023; Baron, Hyman and Vasquez, 2024; Biasi, Lafortune and Schönholzer, 2025).

3 Data

Accurate measurement of fiscal spillovers requires knowledge of the boundaries of all overlapping jurisdictions and their tax bases, whose size depends critically on the tax rates they levy. In this section, I describe the data I assembled to meet these requirements. I also document sources for housing prices, local government finances, and population composition, which I later use to estimate the parameters of the spatial equilibrium model.

[3] In most, but not all, states, residential property is appraised annually.

3.1 Property Tax Rates

As outlined above, the determination of local property tax rates is highly decentralized. Consequently, there is no single dataset reporting rates for overlapping jurisdictions. State departments of revenue, finance, or local affairs typically compile county-level information on assessed values and jurisdiction tax rates and often publish annual reports with varying detail on local finances. Wherever possible, I obtained or requested state-level files on jurisdiction- or area-level property tax rates. Where such granular data were not publicly available, I assembled comparable information county by county.[4] Appendix A lists all sources by state.

3.2 Local Jurisdiction Boundaries

The U.S. Census Bureau's TIGER/Line dataset provides annual shapefiles for major legal boundaries, including counties, municipalities, townships, and school districts. For each state and year from 2008 to 2022, I intersected the relevant TIGER/Line layers to construct "tax code areas" defined by unique combinations of general purpose governments and school districts. Because TIGER/Line does not include special purpose districts, I gathered additional shapefiles from state GIS repositories, state and county mapping portals, and municipal codes specifying district boundaries. In Florida and Texas, I constructed boundaries from parcel data: county assessors (Florida) and county appraisal districts (Texas) provide parcel-level shapefiles with unique identifiers linked to annual appraisal rolls. This linkage assigns each parcel in a county to the jurisdictions that overlap in that location. I then constructed each special purpose district's boundary by dissolving the geometries of parcels recorded as belonging to that district. The final shapefile coverage spans all fifty states and the District of Columbia and comprises roughly 187,000 tax areas.

3.3 Comparison with Other Property Tax Datasets

This dataset differs from existing compilations of local property tax rates in two respects.

First, it provides rates at the finest geographic resolution, including special purpose districts. Prior studies (e.g., Baker, Janas and Kueng 2025) aggregate rates from general

[4]Data were collected county by county in Arizona, California, Kansas, and Washington.

purpose jurisdictions and school districts to the county level to maintain a stable unit of analysis. However, within-county heterogeneity is substantial: as reported in Table A2, the within-county share of variance in property tax rates is typically large, exceeding fifty percent in thirty states.

Second, it reports *nominal* property tax rates. Recent studies (e.g., Avenancio-León and Howard 2022; Diamond and Diamond 2025) rely on *effective* rates, typically computed at the parcel level as taxes paid divided by assessed or market value. Although effective rates can approximate nominal rates, state policies—including homestead exemptions, targeted tax limits for elderly residents, and assessment freezes for long-term homeowners—often induce nonlinear wedges between the nominal and effective rates observed for affected properties.

3.4 Local Government Finances

A key outcome for measuring fiscal spillovers is the revenue of overlapping jurisdictions. I assemble school district finances from the National Center for Education Statistics (NCES), extracting each district's annual property tax revenue and total revenue for fiscal years 1990-91 through 2021-22. I supplement these data with quinquennial information on other local governments from the Census of Governments (1992-2022), which I use to track property tax revenues and total revenues for municipalities, counties, and special purpose districts.

3.5 Housing Prices

As vertical spillovers operate through capitalization into housing prices, accurate price measurement is essential. I follow the approach in Biasi, Lafortune and Schönholzer (2025) and Ruggieri (2025) and rely on the repeat-sales house price index of Contat and Larson (2024), which covers all Census tracts in Core-Based Statistical Areas from 1989 to 2021.[5] The index is normalized to 100 in 1989, enabling within-tract comparisons over time but not level comparisons across tracts. To recover cross-sectional levels, I incorporate tract-level data on the average value of owner-occupied single-family homes from the 2000 Decennial Census.[6]

[5]The term "Core-Based Statistical Area" refers to both Metropolitan and Micropolitan Statistical Areas (U.S. Census Bureau 2025).

[6]Collection of this variable was discontinued beginning with the 2010 Decennial Census.

For each tract, I compute a calibration factor equal to the ratio of the 2000 Census home value to the tract's 2000 value of the Contat and Larson (2024) index and apply this factor to the full tract-level time series.

I then assign each Census tract to the tax area that contains its centroid, based on a point-in-polygon overlay with the shapefiles described in Section 3.2. For each tax area and year, I compute a housing-unit-weighted average of tract-level prices across its constituent tracts.[7] The resulting panel supports both cross-sectional and intertemporal comparisons.

3.6 Population Composition

To capture sorting responses to local property tax changes, I complement the housing price panel with household-group-specific population counts from the 2000 Decennial Census and the five-year American Community Surveys (ACS) from 2005-2009 through 2019-2023. Section 6 provides additional details on the subpopulations used in estimation.

4 Evidence on Spillovers of Property Tax Changes

In this section, I present motivating evidence that fiscal policy changes in one local jurisdiction spill over—via capitalization into housing prices—to other jurisdictions that tax many of the same properties.

4.1 Property Tax Referenda

Local governments fund a large portion of their operations with property tax revenue, accounting for almost 70 percent of receipts from local sources (U.S. Census Bureau 2022). State constitutions and statutes frequently impose limits on tax rates, on the annual growth of tax revenues, or on the annual growth of assessed values, thereby constraining how much local jurisdictions can levy (Lincoln Institute of Land Policy and George Washington Institute of Public Policy 2025). In several states, these limits can be exceeded if a majority of

[7] Census tracts are designed to contain roughly 4,000 residents (U.S. Census Bureau 2025), so the choice of housing-unit weights has limited influence on results.

voters approves a spending initiative in a local referendum. Such initiatives are often intended to finance large capital projects, most commonly school construction and renovation (Fischer, Duncombe and Syverson 2023), and analogous investments in hospitals or fire protection facilities. When a referendum passes, jurisdictions typically issue general obligation bonds and repay principal and interest over a fixed horizon with additional property tax revenue.

Beginning with Cellini, Ferreira and Rothstein (2010), researchers in empirical public finance have leveraged school district referenda to estimate the effects of improved education facilities on housing prices, student achievement, and related outcomes. Identifying causal parameters in this context is inherently challenging: property tax rates are likely to be systematically related to unobserved determinants of both educational and housing market outcomes. For example, households that place a high value on public education may be more likely to sort into well-funded districts (Poterba 1997) and to invest more heavily in their children's academic success outside of school (Guryan, Hurst and Kearney 2008). Likewise, cross-district heterogeneity in property tax rates may reflect unobserved differences in housing market fundamentals: areas with better natural amenities may both command higher housing prices and enable greater fiscal extraction by local governments (Brueckner and Neumark 2014, Diamond 2017). Because property tax rates are equilibrium outcomes of collective choice, simple comparisons of conditional means generally lack a causal interpretation. Regression discontinuity designs that exploit variation in the outcome of referenda address these concerns by comparing jurisdictions that narrowly approved with those that narrowly rejected their ballot measures.

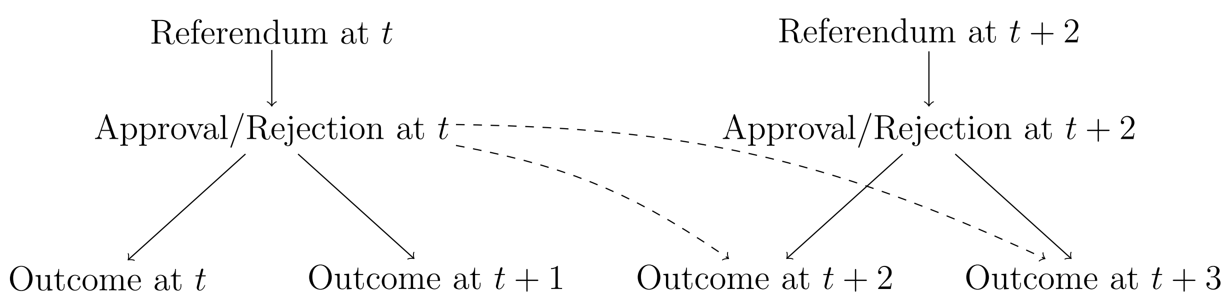
In the remainder of this section, I use the school district referendum data assembled by Biasi, Lafortune and Schönholzer (2025) to estimate the effect of approval on housing prices and on the tax revenues of other local jurisdictions that, in whole or in part, levy property taxes on the same properties as those school districts.[8]

[8] A long tradition in local public finance treats capitalization into house prices as an informative measure of the efficiency of local public goods provision (Bickerdike 1902; Marshall 1948; Oates 1969; Brueckner 1982; Cushing 1984; Barrow and Rouse 2004; Figlio and Lucas 2004; Cellini, Ferreira and Rothstein 2010; Biasi, Lafortune and Schönholzer 2025). Evidence of positive capitalization following an expenditure increase is typically interpreted as indicating that prospective buyers value the associated service improvements more than the additional tax burden.

4.2 Dynamic Regression Discontinuity

In a standard regression discontinuity design, treatment assignment is determined by whether an observed running variable crosses a known, nonstochastic threshold (Thistlethwaite and Campbell 1960). In the setting of local referenda, the running variable is the approval margin, and a proposition passes if this margin is positive. A dynamic RDD extends this setup by allowing the treatment state to evolve over time: treatment status is indexed by period and, in each period, depends on whether the contemporaneous referendum clears the threshold. Outcomes may therefore depend on the entire sequence of period-specific assignments rather than a single decision.

Figure 4: Stylized Representation of the Identification Challenge in Dynamic RDDs



Notes: This figure offers a stylized depiction of the identification challenge in dynamic regression discontinuity designs. The referendum result in year t affects both short-term outcomes (years t and $t+1$) and longer-term outcomes (years $t+2$ and $t+3$). However, if the referendum result in year $t+2$ differs from that in year t, the treatment state changes, making it difficult to disentangle the long-term effects of the year-t referendum from the effects of the subsequent referendum.

Jurisdictions often hold multiple referenda over time—for example, one in year t and another in year $t+2$. The outcome in year t governs policy implementation in t and $t+1$ (e.g., authorization, bond issuance, or tax rate changes), enabling identification of short-run effects at the approval threshold.[9] Estimating effects on outcomes in $t+2$ and beyond presents a challenge because a subsequent referendum may overturn or reinforce the initial decision. These repeated ballots introduce dynamic fuzziness: future treatment states need not align with the initial assignment, and the treatment path need not be monotone. As a result, long-horizon outcomes can conflate the effect of the year-t referendum with the effects of later referenda. Figure 4 provides a stylized representation of this identification challenge

[9]This example assumes that referenda occur at the beginning of a calendar year and that outcomes are observed at the end of it.

in dynamic RDDs.

Most empirical studies employing a dynamic regression discontinuity design adopt the so called "one-step" approach proposed by Cellini, Ferreira and Rothstein (2010). This method relies on the following dynamic two-way fixed effects specification:

$$Y_{it} = \alpha_i + \beta_t + \sum_{s=0}^{\bar{s}} \left(\theta_s D_{i,t-s} + \gamma_s Q_{i,t-s} + p_g\left(\delta_s, S_{i,t-s}\right)\right) + U_{it} \tag{1}$$

where D is a binary treatment indicator, Q is an indicator for whether a referendum is held, and $p_g(\cdot)$ represents a gth-degree polynomial of the approval vote share S. This specification is typically estimated without bandwidth restrictions, allowing researchers to flexibly control for both current and past treatment states, as well as for current and past realizations of the running variable (Darolia 2013, Hong and Zimmer 2016, Martorell, Stange and McFarlin 2016, Baron, Hyman and Vasquez 2024).

In an accompanying paper, Ruggieri (2025), I develop an identification argument that delivers interpretable long-horizon average effects while preserving the cutoff-specific nature of standard RDD estimands. As in prior literature on dynamic RDDs, I focus on causal parameters that trace out the impulse response of the outcome to the discrete change in treatment assignment induced by a focal referendum. I refer to these parameters as Average Direct Treatment Effects (ADTEs): economically, they correspond to the cutoff-specific average effect of the focal period's assignment under the counterfactual in which exposure to treatment is set to "no approval" in all subsequent periods.

Throughout this section, I estimate ADTEs with local linear regression. For statistical inference, I construct robust bias-corrected confidence intervals by adapting the procedure of Calonico, Cattaneo and Titiunik (2014) to my estimator, and I select mean-squared-error-optimal bandwidths following Imbens and Kalyanaraman (2012). For more details on implementation, I refer to the accompanying paper and the related statistical package `dynrd`.[10]

[10] More information on the package can be found at `https://francescoruggieri.github.io/dynrd/`.

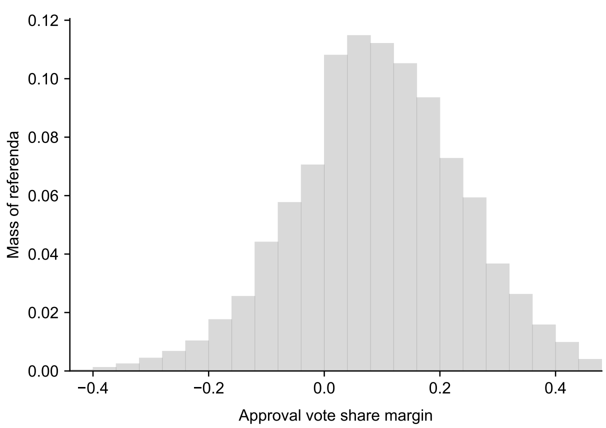
4.3 Results

I draw on referendum data compiled by Biasi, Lafortune and Schönholzer (2025) and impose one sample restriction motivated by the research question. Specifically, I exclude referenda held in states where K-12 education is provided by county or municipal governments, so that the overlapping structure of local governments is not informative for spillovers from school district spending changes.[11]

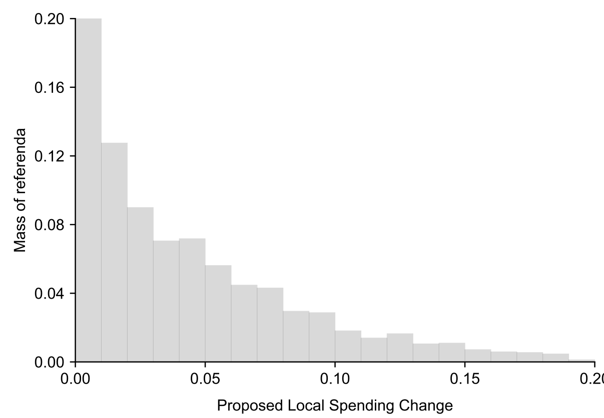
The final sample includes 16,196 referenda, of which 75.7 percent were approved. Panel (a) of Figure 5 displays a histogram of the approval vote share margin. The average approval vote share margin is 2.22 percentage points, with an average of 15.5 percentage points among approved referenda and –9.57 percentage points among those that were rejected.

Panel (b) reports the distribution of the proposed expenditure change as a share of the district's revenue in the referendum year. To place proposals on a comparable annual basis, I divide the proposed amount by the stated duration of the property tax increase (typically

Figure 5: Descriptive Statistics on School District Referenda



(a) Approval Vote Share Margin



(b) Proposed Expenditure Change

Notes: Panel (a) displays a histogram of the approval vote share margin, defined as the difference between the share of votes in favor of the proposed expenditure measure and the approval threshold, for 16,196 referenda held by U.S. school districts between 1990 and 2017. Panel (b) displays a histogram of the expenditure change proposed in a ballot measure as a share of the school district's total revenue in the same year, for 13,045 referenda held by U.S. school districts between 1990 and 2017. In both panels, data are from Biasi, Lafortune and Schönholzer (2025).

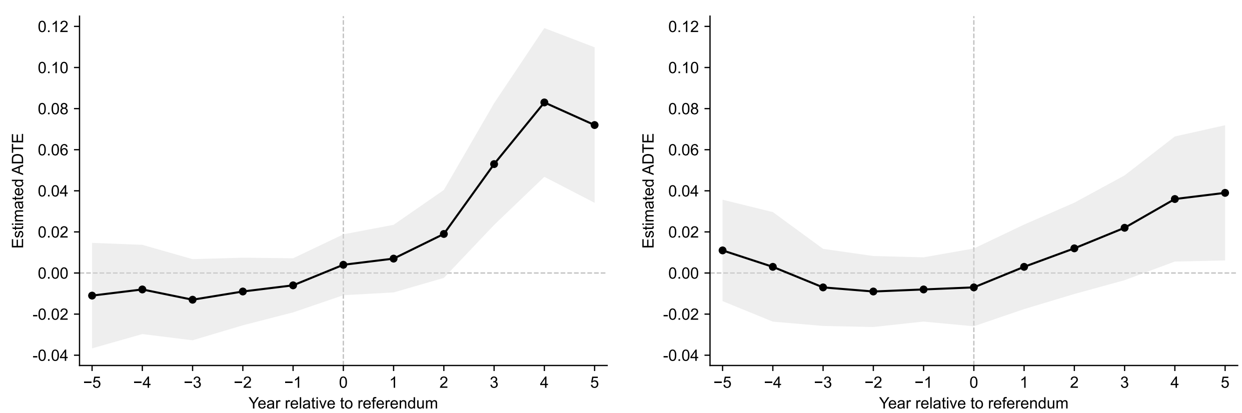
[11] The excluded states are Connecticut, Maryland, Massachusetts, North Carolina, Rhode Island, Virginia, and West Virginia.

20 years for general obligation bonds and shorter horizons for smaller capital projects). The median referendum implies an increase in annual expenditures of approximately 5.67 percent of baseline revenue.

Given these data, I estimate ADTEs for marginally approved referenda on the property tax revenue of overlapping jurisdictions. As a preliminary step, I examine housing prices. Consistent with prior research (Cellini, Ferreira and Rothstein 2010; Biasi, Lafortune and Schönholzer 2025), the estimates indicate positive capitalization: panel (a) of Figure 6 shows an increase of approximately 6 percent within five years following approval. Placebo estimates for relative years prior to the referendum are close to zero and statistically indistinguishable from zero, which supports the design's validity.

Panel (b) reports the central result. Approval of a school district referendum increases the property tax revenue of municipalities and special purpose districts that tax many of the same properties as the district. The five-year effect is approximately 4 percent. Placebo

Figure 6: ADTEs of Referendum Approval on Housing Prices and Revenue of Overlapping Jurisdictions



(a) Housing Prices

(b) Tax Revenue of Overlapping Jurisdictions

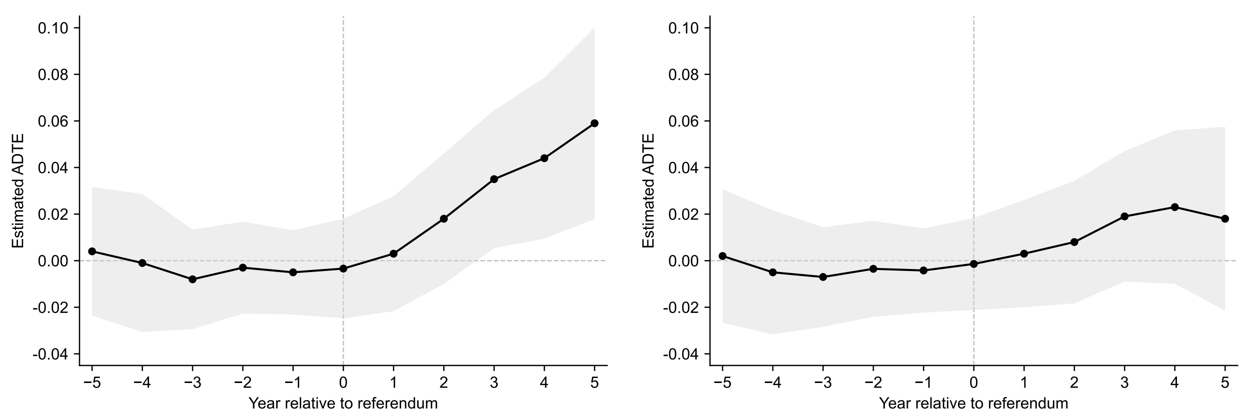
Notes: This figure displays estimates of average direct treatment effects (ADTEs) of approving school district expenditure referenda. In panel (a), the outcome is housing prices. In panel (b), the outcome is the property tax revenue of jurisdictions that overlap with the school district. Estimates for relative years 1 through 5 correspond to the estimand reported in equation (30) in Ruggieri (2025). Estimates for relative years –5 through 0 are based on standard (i.e., static) local linear regression discontinuity estimators; those for years –5 to −1 serve as placebo tests. In both panels, estimates are from a pooled specification in which a single parameter is estimated for each relative year, using data from all referendum cohorts combined. Shaded gray areas denote 95 percent confidence intervals. Standard errors are computed using the nearest-neighbor method described in Calonico, Cattaneo and Titiunik (2014), with tuning parameter $j^* = 3$.

estimates for negative relative years are small and not statistically significant. The smaller revenue effect relative to the housing price effect is consistent with two features: imperfect geographic overlap across jurisdictions and expansion of the tax base, through new construction or population inflows, rather than a one-for-one pass-through. Further details on this mechanism are provided in Section 7.

To assess the capitalization channel more directly, I examine heterogeneity by the extent to which jurisdictions tax the same properties as the district. Figure 7 partitions the sample at 50 percent shared assessed value. For jurisdictions that share at least half of the district's assessed properties, panel (a) shows a five-year effect of roughly 6 percent, which exceeds the pooled estimate in panel (b) of Figure 6. For jurisdictions that share less than half, the estimated effects are smaller and not statistically distinguishable from zero at conventional levels.

Taken together, the evidence indicates that a school district's fiscal policy generates

Figure 7: ADTEs of Referendum Approval on Revenue of Overlapping Jurisdictions: Heterogeneity



(a) At Least Half of Shared Tax Base

(b) Less than Half of Shared Tax Base

NOTES: This figure displays estimates of average direct treatment effects (ADTEs) of approving school district expenditure referenda on the property tax revenue of jurisdictions that overlap with the school district. Panel (a) restricts the sample to jurisdictions that share at least 50 percent of their property tax base. Panel (b) restricts the sample to those that share less than 50 percent. Estimates for relative years 1 through 5 correspond to the estimand reported in equation (30) in Ruggieri (2025). Estimates for relative years –5 through 0 are based on standard (i.e., static) local linear regression discontinuity estimators; those for years –5 to –1 serve as placebo tests. In both panels, estimates are from a pooled specification in which a single parameter is estimated for each relative year, using data from all referendum cohorts combined. Shaded gray areas denote 95 percent confidence intervals. Standard errors are computed using the nearest-neighbor method described in Calonico, Cattaneo and Titiunik (2014), with tuning parameter $j^* = 3$.

spillovers onto other local governments, particularly where the overlap in taxed properties is substantial.

4.4 Limitations of Dynamic RDD Estimates

Districts with narrowly approved referenda are not necessarily representative of the broader population, particularly those that did not hold referenda in the sample period or experienced decisive referendum outcomes. Such districts may differ systematically in political participation, in underlying housing demand, or along other unobserved dimensions.

To learn the sign and magnitude of fiscal spillovers for all U.S. jurisdictions, I extend the analysis beyond reduced-form estimates and adopt a structural approach that leverages dynamic RDD estimates to quantify spillovers for nonmarginal referenda.

5 A Spatial Equilibrium Model with Overlapping Jurisdictions

The running variable—the approval vote share—aggregates heterogeneous preferences over school spending relative to the tax burden. To microfound this mapping, I develop a model of housing markets and residential sorting across jurisdictions that disciplines how approval margins translate into outcomes away from the cutoff. The model characterizes the primitives that govern the extrapolation of fiscal spillovers.

Three forces are central. First, the strength of preferences for publicly provided services relative to private housing consumption. Second, the extent to which fiscal policy is capitalized into housing prices, which depends on local housing market conditions, including the elasticity of supply. Third, openness to migration: prospective residents may move into a district that authorizes additional spending, while current residents who do not value the change may exit. These considerations motivate a spatial equilibrium framework with multiple jurisdictions and locations, in which voting, mobility, and housing market responses jointly determine outcomes.

5.1 Environment

In line with a long tradition of modeling equilibria across local jurisdictions, I consider a metropolitan area in which households choose where to live, housing prices adjust locally, and public goods are provided through majority voting.[12] The model is repeated static: agents optimize myopically, with no forward- or backward-looking behavior. Each period yields an allocation of households, government spending, tax rates, and housing prices across jurisdictions. For notational simplicity, I omit time subscripts throughout.

I consider a unit mass of households indexed by i, each choosing to reside in one of a discrete set of areas indexed by $a \in \mathcal{A}$, or outside the metropolitan area altogether. In each location, public services are provided by jurisdictions indexed by $j \in \mathcal{J}$, which need not coincide with localities since jurisdictions of different types may overlap arbitrarily. The set of jurisdictions overlapping in community a is denoted $\mathcal{J}_a$, and symmetrically, the set of areas spanned by jurisdiction j is denoted $\mathcal{A}_j$. Jurisdiction boundaries are fixed, and the model abstracts from commuting and the labor market. Income is treated as an endowment, reflecting the assumption that local fiscal policy does not influence firm location decisions. Consequently, any value of geographic proximity between residential and workplace locations is subsumed into the area-specific amenity component of household utility.

5.2 Households

The household residential choice problem builds on the framework of Epple and Platt (1998), with one important modification. Specifically, I augment households' utility function with an additive idiosyncratic preference shock for locations. This assumption aligns with standard approaches in urban economics that incorporate random utility components in neighborhood choice models (Bayer, Ferreira and McMillan 2007, Ahlfeldt et al. 2015, Almagro and Domínguez-Iino 2025), as well as in models of worker and firm location in public finance (Busso, Gregory and Kline 2013, Kline and Moretti 2014, Suárez Serrato and Zidar 2016, Fajgelbaum et al. 2019) and labor economics (Moretti 2011, Moretti 2013, Diamond 2016,

[12] See Ellickson 1971, Hamilton 1975, Stiglitz 1977, Westhoff 1977, Brueckner 1979*a*, Brueckner 1979*b*, Brueckner 1979*c*, Rose-Ackerman 1979, Brueckner 1983, Epple, Filimon and Romer 1984, Epple and Romer 1991, Epple and Platt 1998, Epple and Sieg 1999, Brueckner 2000, Epple, Romer and Sieg 2001, Calabrese et al. 2006, Epple, Gordon and Sieg 2010, Calabrese, Epple and Romano 2012, Brueckner 2023.

Diamond and Gaubert 2017).

In location a, households' utility is log-additive in exogenous location amenities A_a, housing floor space H, a composite numeraire consumption good X, and a bundle of local public expenditures $\{G_j\}_{j \in \mathcal{A}}$. To capture congestion in the consumption of public services, I follow Fajgelbaum et al. (2019) and scale each G_j by $N_j^{\chi_j}$, where N_j denotes the mass of residents in jurisdiction j and $\chi_j \in [0,1]$ governs the degree of rivalry in utility from public services. When $\chi_j = 0$, households perceive jurisdiction j's good as purely nonrival and derive utility from aggregate expenditures. When $\chi_j = 1$, utility depends solely on per-capita expenditures, reflecting fully rival consumption of services despite their public provision.

The price of the numeraire good is normalized to one and households are endowed with income Y_i. As in Busso, Gregory and Kline (2013) and Gaubert et al. (2025), they demand one unit of housing inelastically and rent housing space at rate P_a. They also pay property taxes to finance the provision of local public services, with the property tax rate in area a being the sum of the rates levied by the jurisdictions that overlap there:

$$\tau_a \equiv \sum_{j \in \mathcal{J}_a} \tau_j \tag{2}$$

Formally, in any location a, household i demands housing space and the numeraire to maximize their utility subject to a budget constraint:

$$\begin{aligned} &\max_{H,X} \left\{ A_{ia} + \sum_{j \in \mathcal{J}_a} \alpha_{ij} \log \frac{G_j}{N_j^{\chi}} + \beta_i \log H + \gamma_i \log X \right\} \\ &\text{s.t.} \quad X + P_a H \left(1 + \tau_a\right) \leq Y_i \quad \text{and} \quad H = 1 \end{aligned} \tag{3}$$

Household i's indirect utility stemming from this utility maximization problem is

$$V_{ia} = \sum_{j \in \mathcal{J}_a} \alpha_{ij} \left(\log G_j - \chi_j \log N_j\right) + \gamma_i \log \left[Y_i - P_a \left(1 + \tau_a\right)\right] + A_{ia} \tag{4}$$

I model the amenity component of utility as the sum of a location-specific mean and a random variable that follows a Gumbel distribution with scale parameter θ,

$$A_{ia} = \overline{A}_a + U_{ia} \quad \text{with} \quad U_{ia} \sim \text{Gumbel}(0, \theta) \tag{5}$$

Households sort into the location that yields the highest indirect utility or opt to reside outside the metropolitan area, in which case their utility is normalized to zero. As in McFadden (1974), the parametric assumption on the idiosyncratic component of utility implies a closed-form expression for the probability that household i chooses area a:

$$N_{ia} = \frac{\exp(v_{ia}/\theta)}{1 + \sum_{\ell \in \mathcal{A}} \exp(v_{i\ell}/\theta)} \tag{6}$$

where the nonstochastic component of utility is $v_{ia} \equiv \overline{A}_a + \sum_{j \in \mathcal{J}_a} \alpha_{ij} [\log G_j - \chi_j \log N_j] + \gamma_i \log [Y_i - P_a (1 + \tau_a)]$. Letting $\delta_{ia} \equiv \left[[\alpha_{ij}]_{j \in \mathcal{J}_a}, \gamma_i, Y_i \right]'$ be a random vector whose joint probability distribution and support are denoted with F and $\mathcal{D}$, respectively, the expected mass of households who sort into location a is $N_a = \int_{\mathcal{D}} N_{ia}(\delta_{ia}) \, dF(\delta_{ia})$.

Jurisdictions primarily differ in their function. Counties, municipalities, school districts, and special purpose districts each deliver distinct services. Consequently, jurisdictions performing the same function do not overlap. Given a jurisdiction j, such as "Chicago Public Schools", let F denote a categorical variable indicating the jurisdiction's function. In this example, $\mathrm{F}(j) = \textsc{school}$. To limit the dimensionality of the parameters capturing preferences for local government spending, I assume that the marginal value households assign to a given class of public goods (e.g., K-12 education, fire protection) does not vary across jurisdictions within that class. Formally, for any household i and any pair of jurisdictions (j, j') such that $\mathrm{F}(j) = \mathrm{F}(j')$, then $\alpha_{ij} = \alpha_{ij'}$. This restriction allows α_{ij} to be interpreted as the incremental utility household i derives from a marginal log change in government spending on good j.

5.3 Housing Market

In each location, housing space is supplied competitively. Firms in the construction sector produce with homogeneous technology that exhibits decreasing returns to scale because land is a fixed input (Kline and Moretti 2014, Suárez Serrato and Zidar 2016). Thus, the marginal cost of housing space is strictly increasing in the output. For rental rates above the average cost, the housing supply function is

$$\log H_a^{\mathrm{S}} = \lambda + \eta \log P_a + B_a \tag{7}$$

where λ is a deterministic constant, $\eta > 0$ denotes the elasticity of housing supply, and B_a is a random variable that captures idiosyncratic productivity shocks in the construction sector. Moreover, the utility maximization and location choice problems jointly yield the aggregate demand for housing in location a,

$$H_a^{\mathrm{D}} = N_a \tag{8}$$

Absentee landowners earn positive profits because the equilibrium housing price exceeds the marginal cost of construction for inframarginal units.

5.4 Provision of Local Public Goods

This section describes the mechanism through which local fiscal policy is set. Jurisdictions hold referenda on whether to change their expenditure level by an amount ΔG_j. The size and timing of these proposed changes are taken as exogenous. When a referendum occurs, residents vote to approve or reject a new expenditure level G_j, simultaneously determining the property tax rate τ to finance it. Each jurisdiction receives a lump-sum transfer I_j from the state government and must satisfy a balanced budget constraint,

$$G_j = \tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell H_\ell + I_j \tag{9}$$

The remainder of this section examines the collective decision process that aggregates individual preferences into a jurisdiction's expenditure-tax mix. I first describe how households weigh the benefit of higher public spending against the cost of higher tax liabilities. I then model voter participation in local referenda and discuss how selective turnout influences the resulting level of public expenditures.

5.4.1 The Trade-off Between Higher Local Spending and Higher Property Taxes

Households differ in their preferences for public spending and private consumption of non-housing goods and services. Formally, for any jurisdiction $j \in \mathcal{J}_a$, the level of spending preferred by household i residing in location a is defined as the level of G_j that maximizes their indirect utility,

$$G_{iaj} \equiv \arg\max_{G_j} V_{ia} \tag{10}$$

Because utility depends on several endogenous variables, such as population composition, housing prices, and tax rates, it is necessary to specify which of these the voter perceives as relevant when choosing. In particular, the analysis must clarify the extent to which voters recognize the mobility and housing price responses that accompany changes in local government spending.

The literature distinguishes two broad types of voter behavior in models of interjurisdictional equilibrium. *Sophisticated* voters fully understand that changes in local spending can attract new residents or induce some to leave, thereby affecting local housing prices and the tax base (Epple and Romer 1991, Epple, Romer and Sieg 2001). In contrast, *myopic* voters take jurisdictional boundaries as fixed and disregard how changes in the expenditure–tax mix influence migration. They perceive an increase in local spending to affect their utility only through the direct benefit of higher public services and the higher property tax rate required to finance them (Westhoff 1977, Epple, Filimon and Romer 1984, Calabrese et al. 2006). This behavior captures the perceived first-order effect of referendum approval on individual utility. I adopt the myopic voting assumption in the main analysis and present a version of the model with sophisticated voters in Appendix B.3.

Under myopic voting, households internalize the government's budget constraint: they understand that higher spending necessitates a higher property tax rate to maintain balance. The first-order condition determining the preferred level of spending by household i in location a for jurisdiction j is therefore

$$\underbrace{\alpha_i}_{\text{marginal benefit}} = \underbrace{\gamma_i \rho_{ia} \frac{1+\tau_j}{1+\tau_a} \frac{d\log(1+\tau_j)}{d\log G_j}\bigg|_{G_j = G_{jia}}}_{\text{marginal cost}} \tag{11}$$

where $\rho_{ia} \equiv \frac{P_a(1+\tau_a)}{Y_i - P_a(1+\tau_a)}$ denotes the share of gross-of-tax housing expenditures in disposable income available for nonhousing consumption.[13] Intuitively, the left-hand side captures the marginal utility of public spending, while the right-hand side captures the marginal disutility associated with the higher property tax rate required to finance it.

Given a proposed spending change ΔG_j, each voter compares the perceived utility gain from higher local expenditures with the perceived utility cost of the corresponding tax increase. Formally, household i votes in favor of the proposal if

$$V_{ia}(\Delta G_j) - V_{ia}(0) > 0 \tag{12}$$

Because residents vote on a unidimensional policy variable, ΔG_j, and preferences are single-peaked owing to the global concavity of the indirect utility function, the conditions for Black (1948)'s median voter theorem are satisfied. Consequently, if all residents participated in the referendum, ΔG_j would be approved whenever the resident with the median preferred level of government spending in the community favored the proposed change.

5.4.2 Selective Turnout

Participation in local referenda is, however, imperfect. As documented by Berry (2009), turnout in local elections in the United States is typically low, especially when referenda are scheduled outside general elections in November (Kogan, Lavertu and Peskowitz 2018).[14] The few participants are extremely selected: turnout is disproportionately driven by white, affluent, and elderly voters (Berry 2024). In addition, special interest groups play a sizable role in shaping the outcome of local consultations (Anzia 2014).

Motivated by this evidence, I propose an economic model of the individual decision to participate in the referendum.[15] Specifically, household i chooses to vote in the referendum held by jurisdiction j if the perceived benefit from participating exceeds the associated

[13] In Appendix B.4.3, I prove that the objective function is strictly concave in $\log G_j$, ensuring that G_{jia} is a global maximizer.

[14] Drawing on a complete census of school district tax and bond referenda held in California, Ohio, Texas, and Wisconsin from 2000 to 2015, Kogan, Lavertu and Peskowitz (2018) find that average turnout does not exceed 30 percent in any of the four states and falls below 20 percent of the voting-age population in California and Texas.

[15] Feng and Ruggieri (2025) apply a similar framework to school expenditure referenda in Wisconsin.

cost. The benefit is a household- and location-specific function of the proposed change in government expenditure, denoted $R_{ia}(\Delta G_j)$. The cost of participation is an unobserved random variable C_i with support on the positive real line. It captures both monetary and non-monetary costs of voting, including the time and effort required to acquire information about the referendum and the opportunity cost of casting a ballot. The participation decision is therefore expressed as

$$T_{ia}(\Delta G_j) = \mathbb{I}\left[C_i \leq R_{ia}(\Delta G_j)\right] \tag{13}$$

As a result, the individual probability of turnout is $\mathbb{P}(T_{ia} = 1) = F_C(R_{ia})$, where F_C denotes the cumulative distribution function of C_i. A jurisdiction's turnout is defined as the ratio of the expected mass of voters to the expected mass of residents:

$$T_j(\Delta G_j) \equiv \frac{\overbrace{\sum_{a \in \mathcal{A}_j} \int_{\mathcal{D}} N_{ia}(\delta_{ia}) \, \mathbb{P}(T_{ia}(\Delta G_j) = 1; \delta_{ia}) \, dF(\delta_{ia})}^{\text{expected mass of resident voters in } j}}{\underbrace{\sum_{a \in \mathcal{A}_j} \int_{\mathcal{D}} N_{ia}(\delta_{ia}) \, dF(\delta_{ia})}_{\text{expected mass of residents in } j}} \tag{14}$$

Next, let W_{ia} denote a Bernoulli random variable equal to one if household i approves the proposed change in government spending:

$$W_{ia}(\Delta G_j) \equiv \mathbb{I}\left[v_{ia}(\Delta G_j) > v_{ia}(0)\right] \tag{15}$$

The expected approval vote share in jurisdiction j is given by the ratio of the expected mass of approving voters to the expected mass of voters. The proposed expenditure change is authorized if the approval vote share exceeds a predetermined threshold $\underline{s}$.[16] Thus, I define

[16] In most states, the approval threshold is 50 percent. However, ten states impose supermajority requirements for referenda authorizing capital investments (Biasi, Lafortune and Schönholzer 2025). For example, California requires 55 percent, Washington 60 percent, and Idaho 67 percent.

the approval vote share margin as

$$S_j(\Delta G_j) \equiv \frac{\overbrace{\sum_{a \in \mathcal{A}_j} \int_{\mathcal{D}} N_{ia}(\delta_{ia}) \mathbb{P}(T_{ia}(\Delta G_j) = 1; \delta_{ia}) W_{ia}((\Delta G_j); \delta_{ia}) \, dF(\delta_{ia})}^{\text{expected mass of resident voters approving in } j}}{\underbrace{\sum_{a \in \mathcal{A}_j} \int_{\mathcal{D}} N_{ia}(\delta_{ia}) \mathbb{P}(T_{ia}(\Delta G_j) = 1; \delta_{ia}) \, dF(\delta_{ia})}_{\text{expected mass of resident voters in } j}} - \underline{s} \tag{16}$$

5.5 Definition of Equilibrium

An equilibrium consists of a finite set of jurisdictions indexed by $j \in \mathcal{J}$ that overlap into a finite set of locations indexed by $a \in \mathcal{A}$; a unit mass of households indexed by i, each endowed with strictly positive income Y_i; a partition of households across locations such that each has strictly positive population N_a; a set of stochastic location amenities $\{\overline{A}_a\}_a$; a set of stochastic productivity shocks in the residential construction sector $\{B_a\}_j$; a set of rental rates of housing $\{P_a\}_a$; a set of property tax rates $\{\tau_j\}_j$; an allocation of local government spending $\{G_j\}_j$; an allocation of housing space $\{H_i\}_i$ and numeraire consumption good $\{X_i\}_i$ such that the following conditions are satisfied:

(a) In every area, households choose housing space and the numeraire consumption good to maximize utility subject to a budget constraint, as given in equation (3).

(b) Each household resides in the location that yields the highest indirect utility, as defined in equation (4), with idiosyncratic location preference shocks parameterized according to equation (5).

(c) The supply of housing units in each location follows the specification in equation (7).

(d) The housing market clears in every location, as described in equation (8).

(e) Each jurisdiction satisfies a balanced budget constraint, as given by equation (9).

(f) Each jurisdiction's level of government spending is determined according to majority-rule voting among residents. If a referendum is held, a proposed spending change ΔG is authorized if the approval vote share margin, defined in equation (16), is positive.

5.6 Welfare

I compute household welfare by exploiting the parametric assumption on the stochastic component of utility. As in Williams (1977) and Small and Rosen (1981), aggregate household welfare is

$$\mathbb{E}\left[\max_{a\in\mathcal{A}}\left\{v_{ia}+A_{ia}\right\}\right]=\theta\log\left(1+\sum_{a\in\mathcal{A}}\exp\left(v_{ia}/\theta\right)\right) \tag{17}$$

where the expectation is taken with respect to the probability distribution of A_{ia}.

5.7 Fiscal Spillovers

Given the model, the remaining ingredient is a formal definition of fiscal spillover across local governments. Consider two jurisdictions, j and m. Jurisdiction m's budget is

$$G_m=\tau_m\sum_{\ell\in\mathcal{A}_m}P_\ell N_\ell+I_m \tag{18}$$

where $\mathcal{A}_m$ denotes the set of areas served by m.

In defining the fiscal spillover from j to m, G_m and I_m are held constant. Totally differentiating equation (18) with respect to G_j and imposing $dG_m=dI_m=0$ yields

$$\underbrace{\frac{dG_m}{dG_j}}_{=0}=\underbrace{\frac{d\tau_m}{dG_j}\sum_{\ell\in\mathcal{A}_m}P_\ell N_\ell}_{\text{rate response}}+\underbrace{\tau_m\sum_{\ell\in\mathcal{A}_m}\left(N_\ell\frac{dP_\ell}{dG_j}+P_\ell\frac{dN_\ell}{dG_j}\right)}_{\text{base response}}+\underbrace{\frac{dI_m}{dG_j}}_{=0} \tag{19}$$

Rearranging terms,

$$-\frac{d\tau_m}{dG_j}\sum_{\ell\in\mathcal{A}_m}P_\ell N_\ell=\tau_m\sum_{\ell\in\mathcal{A}_m}\left(N_\ell\frac{dP_\ell}{dG_j}+P_\ell\frac{dN_\ell}{dG_j}\right) \tag{20}$$

I define jurisdiction j's fiscal spillover onto jurisdiction m as the change in m's property tax base, valued at its current tax rate and holding τ_m, G_m, and I_m fixed, induced by a marginal spending change in j. Formally,

$$Z_{j\to m} \equiv \tau_m \sum_{\ell\in\mathcal{A}_m} \left(N_\ell \frac{dP_\ell}{dG_j} + P_\ell \frac{dN_\ell}{dG_j} \right) \tag{21}$$

Hence, the spillover can be interpreted either as (i) the required change in m's property tax rate holding its base fixed, or (ii) the induced change in m's base holding its rate fixed. The second expression makes clear that spillovers are driven by changes in local equilibrium prices $\{dP_\ell/dG_j\}_{\ell\in\mathcal{A}_m}$ and in the resident population masses $\{dN_\ell/dG_j\}_{\ell\in\mathcal{A}_m}$ across the areas served by m.

Summing across all other jurisdictions in the same metropolitan area that directly or indirectly tax some of the same properties as j, the aggregate fiscal spillover of j is

$$Z_j \equiv \sum_{m\neq j} Z_{j\to m} \tag{22}$$

6 Identification of Structural Parameters

In the previous section, I defined fiscal spillovers across jurisdictions within a spatial equilibrium model of residential sorting and voting. To measure these spillovers, the structural parameters must be identified and estimated. This section develops an identification argument that recovers the model parameters using only regression discontinuity estimands, analogous to those in Section 4.

I work with a version of the model that allows for finite heterogeneity in household preferences and income. The unit mass of households is partitioned into a finite set of observable types indexed by $k \in \mathcal{K} = \{1, \ldots, \overline{k}\}$, each with positive mass σ^k. The random vector $\delta_{ia} \equiv \left[[\alpha_{ij}]_{j\in\mathcal{J}_a}, \gamma_i, Y_i \right]'$ is therefore discrete with support $\left\{ \left[[\alpha^k_j]_{j\in\mathcal{J}_a}, \gamma^k, y^k \right]' \right\}_k$. Accordingly, the spatial equilibrium is characterized by $|\mathcal{A}| \times |\mathcal{K}|$ expected population masses $\{N^k_a\}_{a,k}$. I also assume that local public goods are rival in consumption, implying $\chi_j = 1$ for all $j \in \mathcal{J}$. Finally, to preserve comparability across metropolitan areas in states with different overlapping structures, I partition local public services into two categories: education services (supplied by school districts) and municipal services (supplied by municipal governments and special purpose districts). Hence, $|\mathcal{J}_a| = 2$ for all $a \in \mathcal{A}$.

I begin by revisiting the indirect utility function V_{ia} and applying two normalizations. First, I divide all terms in the utility function by the strictly positive parameter γ^k. This transformation allows me to express the preference parameters α_j^k/γ^k as the marginal utility of local government expenditure in units of income rather than in utils, thereby facilitating interpretation. With a slight abuse of notation, I denote the rescaled indirect utility of household i in area a as

$$V_{ia} = \frac{\overline{A}_a}{\gamma^k} + \sum_{j \in \mathcal{J}_a} \frac{\alpha_j^k}{\gamma^k} \log \frac{G_j}{N_j} + \log \left[y^k - P_a \left(1 + \tau_a\right) \right] + U_{ia} \tag{23}$$

where the idiosyncratic component U_{ia} follows a Gumbel distribution with scale parameter θ^k/γ^k. Second, I impose the normalization $\theta^k/\gamma^k = 1$, which, while affecting the scale of utility, does not alter the choice probabilities. Since my analysis does not involve computing cardinal welfare measures, this normalization is without loss of generality.

6.1 Household Preferences and Elasticity of Housing Supply

The approval of a referendum induces a change in local public spending of known magnitude, denoted ΔG_j for jurisdiction j. I characterize the equilibrium response of the model's endogenous variables to this policy shock by working with potential outcomes. For any endogenous variable Y_ℓ in location $\ell \in \mathcal{A}$, let $Y_\ell\left(0\right)$ denote the potential outcome under the status quo (i.e., absent referendum approval), and let $Y_\ell\left(\Delta G_j\right)$ denote the potential outcome under the approved expenditure change. The effect of approval on Y_ℓ is defined as

$$\Delta Y_\ell \equiv Y_\ell\left(\Delta G_j\right) - Y_\ell\left(0\right) \tag{24}$$

While ΔY_ℓ captures the causal response of a single outcome to the spending shock, the structure of the model allows me to go further. Rather than analyzing each outcome in isolation, the spatial equilibrium imposes a system of interdependent equations that jointly determine how all endogenous variables adjust to the shock. This structure allows causal responses to be related across outcomes. The nonredundant equilibrium conditions are:

(a) The mass of type-k households sorting to area $\ell \in \mathcal{A}$:

$$N_\ell^k = \sigma^k \frac{\exp v_\ell^k}{1 + \sum_{a' \in \mathcal{A}} \exp v_{a'}^k} \tag{25}$$

with $v_\ell^k \equiv \overline{A}_\ell + \sum_{m \in \mathcal{J}_\ell} \alpha_m^k / \gamma^k \left[\log G_m - \log N_m\right] + \log\left[y^k - P_\ell \left(1 + \tau_\ell\right)\right]$.

(b) The equilibrium housing price in location $\ell \in \mathcal{A}$: $\log P_\ell = \frac{1}{\eta} \log \sum_{k \in \mathcal{K}} N_\ell^k - \frac{\lambda}{\eta} - \frac{B_\ell}{\eta}$. Equivalently, the equilibrium quantity of housing space in area $\ell \in \mathcal{A}$:

$$\log H_\ell = \lambda + \eta \log P_\ell + B_\ell \tag{26}$$

(c) The balanced budget run by jurisdiction $m \in \mathcal{J}$: $G_m = \tau_m \sum_{\ell \in \mathcal{J}_m} P_\ell H_\ell + I_m$.

For each condition, I consider the effect of the policy shock and collect the resulting relationships.

6.1.1 Elasticity of Housing Supply

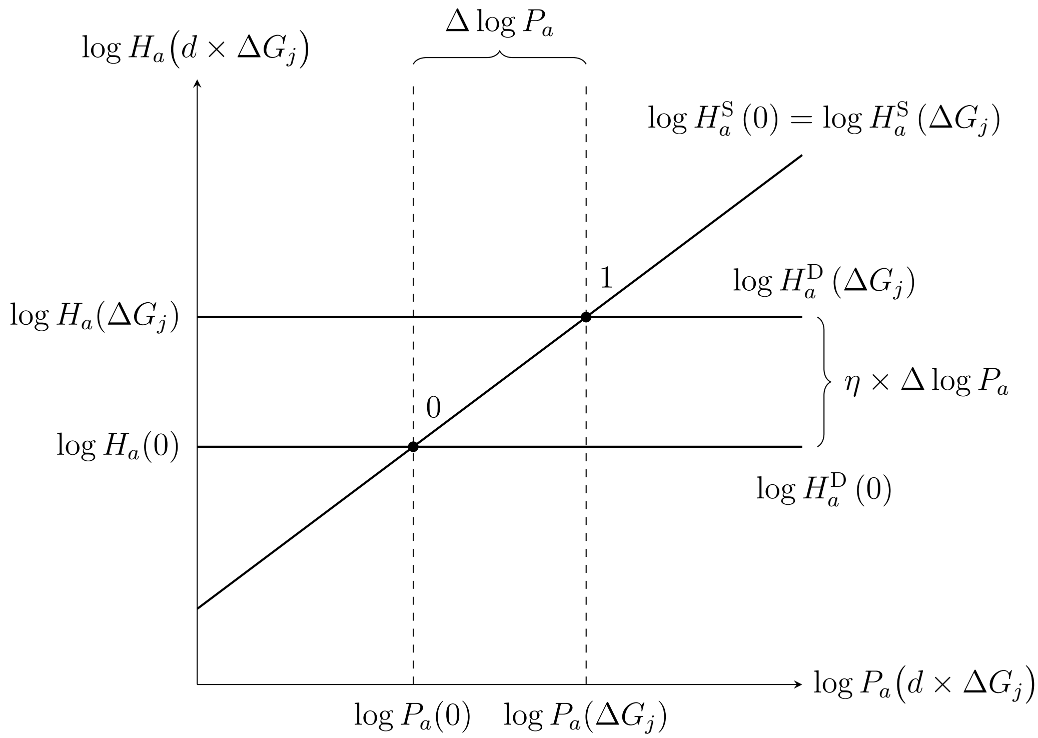
To begin with, consider a shock to the housing supply equation (26),

$$\Delta \log H_\ell = \eta \Delta \log P_\ell \tag{27}$$

This proportionality links quantity and price responses in area ℓ. It reflects that the spending shock shifts housing demand through residential reallocation, while the supply function is unchanged. The induced price adjustment, together with the quantity response, identifies the elasticity η. Figure 8 illustrates the equilibrium in location a's housing market under both referendum rejection and approval, showing how differences in potential outcomes map into the structural parameter of interest.

Although the potential outcome differences in equation (27) are not observed, they are point identified in expectation at the approval threshold using a regression discontinuity design. Taking expectations of both sides of equation (27) conditional on $S_j = 0$ and integrating over the joint probability distribution of unobservables (i.e., the valuation of

Figure 8: Equilibria in the Local Housing Market



Notes: This figure illustrates two equilibria in location a's housing market. The horizontal axis measures the logarithm of potential housing prices and the vertical axis measures the logarithm of potential housing space. Point 0 corresponds to the equilibrium under referendum rejection, with untreated potential outcomes $\log P_a(0)$ and $\log H_a(0)$ observed. Point 1 corresponds to the equilibrium under referendum approval, which increases housing demand and leads to the treated potential outcomes $\log P_a(\Delta G_j)$ and $\log H_a(\Delta G_j)$ being observed. The slope of the chord connecting points 0 and 1, i.e., the ratio $\Delta \log H_a / \Delta \log P_a$, equals the elasticity of housing supply η.

location amenities $\{\overline{A}_a\}_{a \in \mathcal{A}}$ and the productivity shocks $\{B_a\}_{a \in \mathcal{A}}$) yields

$$\mathbb{E}\left[\Delta \log H_\ell \middle| S_j = 0\right] = \eta \times \mathbb{E}\left[\Delta \log P_\ell \middle| S_j = 0\right] \tag{28}$$

Since both conditional expectations are identified, equation (28) can be used to recover the structural parameter η.

6.1.2 Marginal Willingness to Pay for Local Public Services

Starting from the household choice probability equation (25), a first-order approximation to the effect of referendum approval on the mass of type-k households in location a is

$$\begin{aligned}&\Delta \log N_a^k \\ &\approx \left(1-\frac{N_a^k}{\sigma^k}\right)\left(\sum_{m\in\mathcal{J}_a}\frac{\alpha_m^k}{\gamma^k}\Delta \log\frac{G_m}{N_m}-\rho_a^k\Delta\log P_a-\rho_a^k\sum_{m\in\mathcal{J}_a}\frac{1+\tau_m}{1+\tau_a}\Delta\log\left(1+\tau_m\right)\right)\end{aligned} \tag{29}$$

This expression contains two preference ratios, i.e., $\left\{\alpha_m^k/\gamma^k\right\}_{m\in\mathcal{J}_a}$.[17] As assumed in Section 5.2, for a given type k the preference weight on school services is invariant across school districts and the preference weight on municipal services is invariant across municipalities. Accordingly, the unknowns reduce to two parameters for each type.

Identification exploits the overlapping jurisdictional structure. Consider a school district j that overlaps at least two municipalities, thereby generating two locations, a_1 and a_2, each served by the same school district but by different municipalities. Referendum approval in school district j induces a common school-sector shock across a_1 and a_2 (through G_j, N_j, and τ_j), whereas the municipal responses and the local price adjustments generally differ because of location fundamentals.

Analogous to the identification of the housing supply elasticity, take expectations of (29) at the approval threshold $S_j = 0$ and integrate over the joint distribution of unobservables. This operation yields conditional average treatment effects that are identified by regression discontinuity estimands. Applying it separately to locations a_1 and a_2 produces two linear equations in the two unknown preference ratios. Identification follows from a standard rank condition: the two equations are nonredundant whenever the RD-identified changes in housing prices, per-capita municipal services, and municipal tax rates differ sufficiently across a_1 and a_2 so as not to be collinear. More details about the identification strategy are provided in Appendix C.

To conduct statistical inference on the structural parameters, I compute analytical stan-

[17] For tractability, this first-order approximation omits the components of the denominator of the household choice probability N_a that are not specific to location a. These terms are typically small because they reflect only second-order effects of ΔG_j on areas *outside* jurisdiction j.

dard errors with the delta method, which requires estimates of the pairwise covariances among the dynamic RDD coefficients. I estimate these covariances between bias-corrected local linear estimators within the subsample defined by each outcome's MSE-optimal bandwidth. After assembling the full variance covariance matrix of the RDD parameters, I apply Ledoit–Wolf shrinkage to the associated correlation matrix (Ledoit and Wolf 2004) to regularize the estimates and improve the stability of subsequent inference.

6.2 Selection into Voting

I maintain the assumption that the unobserved cost of participating in the referendum varies across households and locations. Households of the same type are not assumed to face identical voting costs. I model the benefit of participation as the absolute value of the anticipated utility gain (or loss) from the proposed change in government spending. Intuitively, when ΔG_j represents a "high-stakes" proposal for a household, that household is more likely to turn out, all else equal. Formally, the benefit is parameterized as

$$R_{ia}\left(\Delta G_j\right) \equiv \left|v_a^k\left(\Delta G_j\right) - v_a^k\left(0\right)\right| \tag{30}$$

where the superscript k denotes the household's type, $k = k(i)$.

The participation decision is then given by $T_{ia}\left(\Delta G_j\right) = \mathbb{I}\left[C_i \leq \left|v_a^k\left(\Delta G_j\right) - v_a^k\left(0\right)\right|\right]$. Accordingly, the individual probability of turnout is $\mathbb{P}\left(T_{ia}\left(\Delta G_j\right) = 1\right) = F_C\left(\left|v_a^k\left(\Delta G_j\right) - v_a^k\left(0\right)\right|\right)$. Because the benefit does not vary across households of the same type, I compactly denote the probability of voting among type-k households in location a as $T_a^k\left(\Delta G_j\right) \equiv F_C\left(\left|v_a^k\left(\Delta G_j\right) - v_a^k\left(0\right)\right|\right)$. As in the general case, expected turnout in jurisdiction j is defined as the ratio of the expected mass of voters to the expected mass of residents: $T_j\left(\Delta G_j\right) \equiv \sum_{a\in\mathcal{A}_j}\sum_{k\in\mathcal{K}} N_a^k T_a^k\left(\Delta G_j\right) / \sum_{a\in\mathcal{A}_j}\sum_{k\in\mathcal{K}} N_a^k$.

Finally, I define the Bernoulli random variable $W_a^k\left(\Delta G_j\right) = \mathbb{I}\left[v_a^k\left(\Delta G_j\right) > v_a^k\left(0\right)\right]$ to indicate whether type-k households prefer the proposed spending change in area a. As in the general model, the expected approval vote share margin is defined as the difference between the expected mass of approving voters and the cutoff for passage:

$$S_j\left(\Delta G_j\right) \equiv \frac{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k\left(\Delta G_j\right) W_a^k\left(\Delta G_j\right)}{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k\left(\Delta G_j\right)} - \underline{s} \tag{31}$$

6.3 Turnout Parameters

A central objective of the paper is to test whether internalizing fiscal spillovers in local referenda alters passage outcomes and moves jurisdictions toward a more efficient expenditure-tax mix. Doing so requires recovering, for any counterfactual proposal ΔG_j. the approval vote share under the status quo and under the regime that internalizes spillovers. Because the approval share depends on both who turns out to vote and how those voters value the proposal, turnout must be modeled explicitly.

I therefore specify a structural model of turnout in which each household type decides whether to vote based on participation costs and the expected utility difference between approval and rejection. The parameters are estimated to match documented participation patterns across household types in United States local elections (Anzia 2014; Berry 2024). Combined with the preference and housing market parameters estimated earlier, this turnout model maps any ΔG_j into a predicted approval vote share under alternative policy regimes, allowing direct evaluation of the counterfactual policy that internalizes spillovers.

To this end, I parameterize the probability distribution of the unobserved cost of participation. Specifically, I assume that C is log-normally-distributed with a type-specific mean and common variance:

$$\log C_{ij} \sim \mathcal{N}\left(\mu_0^k + \mu_1 \Delta \log G_j, \left(\sigma_0\right)^2\right) \tag{32}$$

The parameters $\left\{\mu_0^k\right\}_{k \in \mathcal{K}}$ are constant across locations and capture intrinsic differences in participation costs across household types. The slope parameter μ_1 and variance σ_0 are likewise location-invariant, but measure the sensitivity of each group's expected participation cost to the proposed change in spending. This structure induces correlation in C_{ij} both across jurisdictions for households of a given type and across types within a given jurisdiction, although the latter arises solely through dependence on $\Delta \log G_j$.

This specification incorporates two salient features of referendum participation. First, it allows turnout to respond to the size of the proposed spending change, reflecting the idea that larger capital projects are more likely to mobilize nonmarginal voters. Second, it allows participation costs to vary across household types, accounting for the fact that some groups—such as elderly individuals without children—may be more inclined or able to participate in initiatives that influence the provision of local public services.

Given this assumption, the probability of turnout among type-k households in location a is

$$T_a^k(\Delta G_j) = \Phi\left(\frac{\log\left|v_a^k(\Delta G_j) - v_a^k(0)\right| - \left(\mu_0^k + \mu_1 \Delta \log G_j\right)}{\sigma_0}\right) \tag{33}$$

where Φ denotes the cumulative distribution function of a standard normal random variable.

To identify the parameters governing the economic model of turnout, I proceed under the assumption that T_j^k is observed. Although publicly available data report only aggregate turnout, I have access to the Labels & Lists (L2) Voter Data, which compiles voter registration records from all fifty states and Washington, D.C., and supplements them with proprietary commercial data containing demographic and basic financial characteristics. I rely on this dataset to estimate participation rates for each household group in our sample of Wisconsin school district referenda.

Since the structural parameters of the model are known, the benefit from participation, given by $|v_a^k(\Delta G_j) - v_a^k(0)|$, is also known. In the remainder of this section, I exploit the parametric assumption on C_{ij} to estimate the parameters that maximize the likelihood of observing the turnout rates implied by the model. Accordingly, I specify a measurement model for $T_a^k(\Delta G_j)$. Letting $\breve{T}_a^k$ and $\breve{N}_a^k$ denote, respectively, the observed turnout and population count of type-k households in jurisdiction j, I assume

$$\breve{T}_a^k \sim \text{Binomial}\left(\breve{N}_a^k, T_a^k\right) \tag{34}$$

That is, observed turnout is modeled as a binomial random variable, with the number of trials given by the observed population count and the probability of success equal to the model-implied turnout rate T_a^k.

Given this specification, the parameter set of interest is $\mathcal{P} = \left\{\left\{\mu_0^k\right\}_{k\in\mathcal{K}}, \mu_1, \sigma_0\right\}$ and I let

ϑ denote the vector stacking all elements of $\mathcal{P}$. I index jurisdiction-referendum pairs by j.[18] The resulting likelihood function is then

$$L(\vartheta) = \prod_{j=1}^{n} \prod_{a \in \mathcal{A}_j} \prod_{k \in \mathcal{K}} \begin{pmatrix} \breve{N}_a^k \\ \breve{T}_a^k \end{pmatrix} T_a^k(\vartheta)^{\breve{T}_a^k} \left(1 - T_a^k(\vartheta)\right)^{\breve{N}_a^k - \breve{T}_a^k} \tag{35}$$

I estimate the parameters in $\mathcal{P}$ by maximizing the likelihood in (35) with respect to ϑ.

A distinctive feature of this setting is that the preference and housing supply parameters $\zeta \equiv [\alpha^1/\gamma^1, \alpha^2/\gamma^2, \alpha^3/\gamma^3, \alpha^4/\gamma^4, \eta]$ enter the likelihood function directly, as they influence both the decision to participate in the referendum and the choice to approve or reject the proposed expenditure change. Letting $\widehat{\zeta}$ denote the estimate of ζ, the log-likelihood function conditional on $\widehat{\zeta}$ is given by the following expression, up to an additive constant:

$$\log L\left(\vartheta; \widehat{\zeta}\right) = \sum_{j=1}^{n} \sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} \left[\breve{T}_a^k \log T_a^k\left(\vartheta; \widehat{\zeta}\right) + \left(\breve{N}_a^k - \breve{T}_a^k\right) \log\left(1 - T_a^k\left(\vartheta; \widehat{\zeta}\right)\right)\right] \tag{36}$$

Although $\widehat{\zeta}$ enters the likelihood function as a fixed constant, it is in fact the realized value of an estimator and thus subject to sampling variability. As a result, standard errors based solely on the curvature of the likelihood understate the true statistical uncertainty associated with $\widehat{\vartheta}$.

To address this issue, I implement a parametric bootstrap procedure that incorporates the stochastic nature of $\widehat{\zeta}$ into inference for ϑ. Specifically, I rely on the asymptotic normality of the estimator of ζ, which is distributed approximately as $\mathcal{N}\left(\widehat{\zeta}, \widehat{\Sigma}_\zeta\right)$ in finite samples. For each replication $m \in \{1, \ldots, \overline{m}\}$, I draw $\widehat{\zeta}^{(m)}$ from this distribution, re-estimate ϑ by maximizing the likelihood conditional on $\widehat{\zeta}^{(m)}$, and obtain $\widehat{\vartheta}^{(m)}$ and its corresponding variance-covariance matrix $\widehat{\Sigma}_\vartheta^{(m)}$. I subsequently compute the within-replication variance-covariance matrix as the average of the estimated variance-covariance matrices:

$$\overline{\widehat{\Sigma}}_\vartheta \equiv \frac{1}{\overline{m}} \sum_{m=1}^{\overline{m}} \widehat{\Sigma}_\vartheta^{(m)} \tag{37}$$

To capture simulation-induced dispersion in point estimates, I compute the between-

[18] That is, j indexes distinct referenda, allowing for multiple ballot measures within the same jurisdiction over time.

replication variance-covariance matrix:

$$\widetilde{\widehat{\Sigma}}_\vartheta \equiv \frac{1}{\overline{m}-1}\sum_{m=1}^{\overline{m}}\left(\widehat{\vartheta}^{(m)} - \overline{\widehat{\vartheta}}\right)\left(\widehat{\vartheta}^{(m)} - \overline{\widehat{\vartheta}}\right)' \quad \text{with} \quad \overline{\widehat{\vartheta}} \equiv \frac{1}{\overline{m}}\sum_{m=1}^{\overline{m}}\widehat{\vartheta}^{(m)} \tag{38}$$

To conclude, following Rubin (1987, pp. 76–77), I obtain the total variance-covariance matrix as

$$\widehat{\Sigma}_\vartheta = \overline{\widehat{\Sigma}}_\vartheta + \left(1+\frac{1}{\overline{m}}\right)\widetilde{\widehat{\Sigma}}_\vartheta \tag{39}$$

This total variance accounts for both the uncertainty conditional on $\widehat{\zeta}$ and the additional variability introduced by treating $\widehat{\zeta}$ as an estimate rather than a known quantity.

7 Parameter Estimates

Having laid out the identification strategy for the parameters governing household preferences, the housing market, and turnout behavior, I now present the estimates. I begin by documenting residential sorting responses to changes in school district spending and then turn to evidence on selective turnout. These results anchor the structural parameters used in the counterfactual analyses that follow.

7.1 Sorting Responses to Change in School District Spending

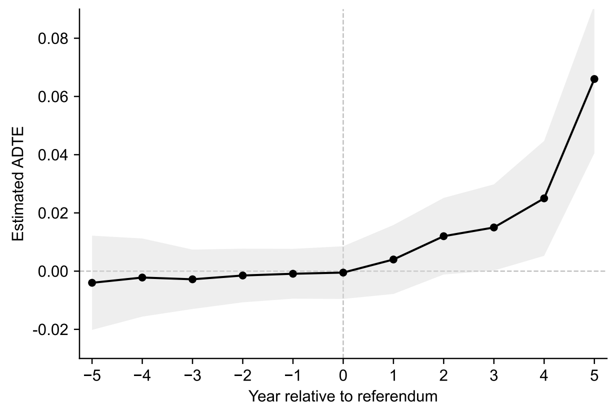
Equation (29) shows that, in the spatial equilibrium model, households move in response to spending changes according to their valuations of local public services. I use the observed sorting responses to recover preference heterogeneity.

For tractability, I partition the unit mass of households into four groups based on (i) the presence of children under age 18 and (ii) income relative to the Core-Based Statistical Area (CBSA) median family income. Thus, $|\mathcal{K}| = 4$: high-income with children, low-income with children, high-income without children, and low-income without children.

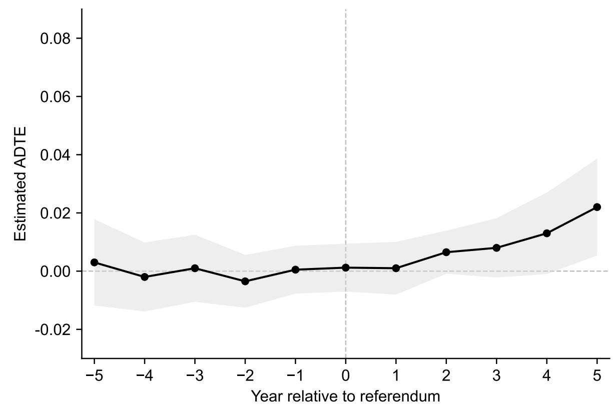
I then estimate ADTEs of referendum approval on the population composition of each location. Figure 9 reports the results. Five years after approval, the number of high-income households with children is about 7 percent higher, while the number of low-income households with children is about 6 percent lower. Effects for childless households are smaller but of the same sign: high-income without children rise by roughly 2 percent and low-income without children fall by about 3 percent. In aggregate, population increases by just over 2 percent, and the estimate is statistically significant at conventional levels.

These composition changes align with Biasi, Lafortune and Schönholzer (2025), who document that approved school expenditure referenda reduce the share of students below

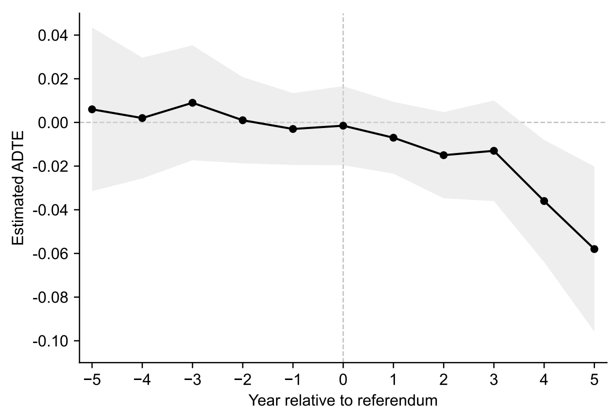
Figure 9: ADTEs of Referendum Approval on Population Composition



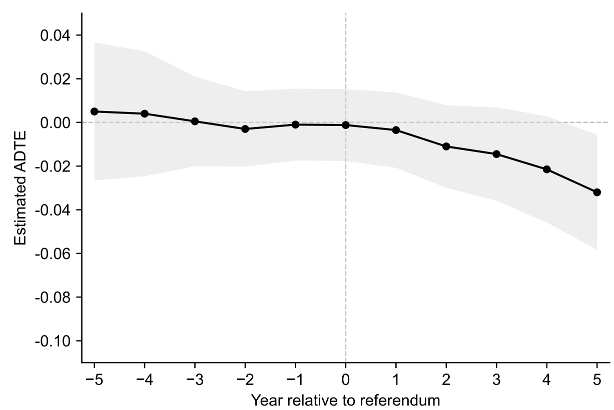
(a) With Children, Above Median Income



(b) Without Children, Above Median Income



(c) With Children, Below Median Income



(d) Without Children, Below Median Income

Notes: This figure displays estimates of average direct treatment effects (ADTEs) of approving school district expenditure referenda on the outcomes indicated beneath each panel. Estimates for relative years 1 through 5 correspond to the estimand reported in equation (30) in Ruggieri (2025). Estimates for relative years –5 through 0 are based on standard (i.e., static) local linear regression discontinuity estimators; those for years –5 to –1 serve as placebo tests. In both panels, estimates are from a pooled specification in which a single parameter is estimated for each relative year, using data from all referendum cohorts combined. Shaded gray areas denote 95 percent confidence intervals. Standard errors are computed using the nearest-neighbor method described in Calonico, Cattaneo and Titiunik (2014), with tuning parameter $j^* = 3$.

the poverty line and the proportion eligible for free or reduced-price lunch; in their analysis, nearly 30 percent of the subsequent test score gains are predicted by shifts in observed student characteristics. Taken together, the evidence indicates that household sorting across school districts is a salient margin of adjustment to changes in local public spending.

7.2 Structural Parameter Estimates

Given the reduced-form estimates in Sections 4.3 and 7.1, I recover the structural parameters η and $\left\{\alpha_j^k/\gamma^k\right\}_{j,k}$ by leveraging, respectively, the housing supply relation in (27) and the system implied by the choice probabilities in (29).

Table 1 reports the estimates. Across the four household groups, the marginal willingness to pay for K–12 education services (the α/γ ratio for the school sector) is substantially larger than the corresponding measure for municipal services. The education parameters display meaningful heterogeneity by group: consistent with Figure 9, α/γ is highest for high-income households with children and lowest for low-income households with children; values for

Table 1: Estimates of Household Preference Parameters and Elasticity of Housing Supply

		Estimates	
Parameter	Group	School	Municipal
α^1/γ^1	With Children, Above Median Income	1.076 (0.295)	0.079 (0.034)
α^2/γ^2	With Children, Below Median Income	0.508 (0.261)	0.050 (0.016)
α^3/γ^3	Without Children, Above Median Income	0.829 (0.267)	0.092 (0.043)
α^4/γ^4	Without Children, Below Median Income	0.481 (0.239)	0.044 (0.017)
η		0.334 (0.072)	

NOTES: This table presents estimates of $\left\{\alpha_j^k/\gamma^k\right\}_{j,k}$, which measure each household group's marginal willingness to pay for public education and municipal services in units of income, and η, the elasticity of housing supply. Point estimates are obtained by solving the systems of equations implied by household choice probabilities (25) and the housing supply equation (26), using dynamic regression discontinuity (RDD) estimates as inputs. Standard errors are computed via the delta method.

childless households are smaller in magnitude but follow the same ordering. Note that these ratios scale the utility weight on education, α, by the marginal utility of income, γ. Because γ is lower at higher income, part of the observed gap in α/γ across income groups reflects differences in marginal utility of income rather than differences in the underlying taste parameter.

The estimated elasticity of housing supply is 0.33, which is in line with recent estimates for urban areas in the United States (Baum-Snow and Han 2024).

Finally, I estimate the parameter vector ϑ, which governs the unobserved log cost of participation in local referenda, using the procedure described in Section 6.3. Table 2 presents the results. As expected, the estimated value of μ_1 is negative, consistent with the notion that participation costs decline in higher-stakes referenda, potentially due to lower informational or attentional barriers when the proposed policy is more salient (e.g., the construction or renovation of a school). The household-group-specific intercepts exhibit a notable pattern:

Table 2: Estimates of Turnout Parameters

Parameter	Group	Estimate
μ_0^1	With Children, Above Median Income	-1.32 (0.45)
μ_0^2	With Children, Below Median Income	1.67 (0.58)
μ_0^3	Without Children, Above Median Income	-5.26 (1.69)
μ_0^4	Without Children, Below Median Income	-4.80 (1.51)
μ_1		-1.73 (0.81)
σ_0		2.93 (0.41)

NOTES: This table reports estimates of the following parameters: $\{\mu_0^k\}_{k=1}^4$, the set of household-group-specific intercepts in the average log cost of participation in local referenda; μ_1, the common slope with respect to the proposed spending change $\Delta \log G_j$; and σ_0, the common standard deviation of the unobserved log cost. Point estimates are obtained via the maximum likelihood procedure outlined in Section 6.3, conditioning on the estimated parameter vector $\widehat{\zeta}$ reported in Table 1. Standard errors are computed using a two-step parametric bootstrap procedure with 100 outer replications and 20 inner replications per outer draw.

participation costs are highest among households with children and income below the median, and lowest among those without children—a group that likely includes most retirees. These findings align with patterns of voter selection in U.S. local elections documented by Berry (2024).

8 Counterfactual Exercises

With the estimated parameters in hand, I use the model to quantify the fiscal spillovers defined in Section 5.7 for school districts and municipal governments that either did not hold referenda during the sample period or experienced decisive (nonmarginal) outcomes. I then evaluate a counterfactual voting regime that internalizes these spillovers: ballots disclose the anticipated cross-jurisdiction effects and a symmetric intergovernmental transfer (a tax or a subsidy) equal to the estimated spillover is triggered upon approval, leaving overlapping jurisdictions fiscally neutral.

8.1 Quantification of Fiscal Spillovers

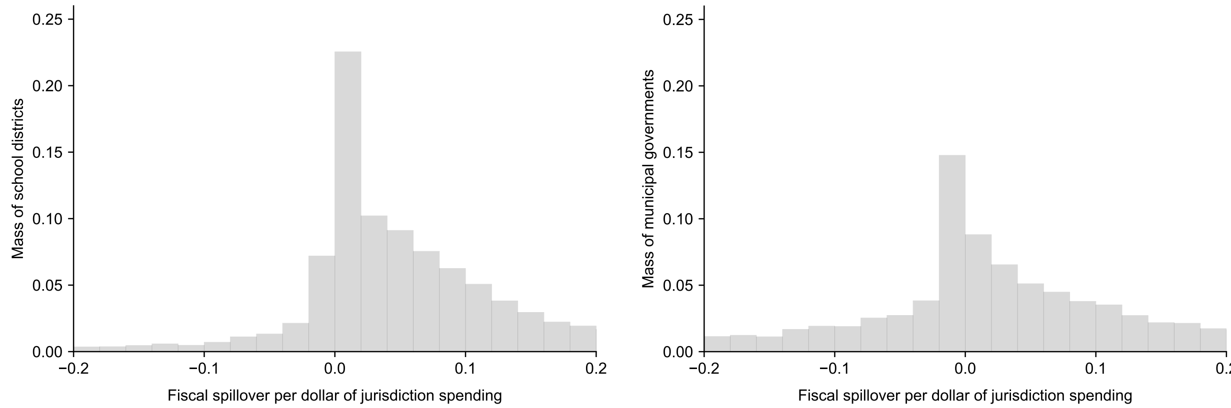
I fix jurisdictional boundaries at their 2020 configuration and compute fiscal spillovers from a marginal change in spending using equation (22).

Figure 10 reports the resulting distributions separately for school districts and municipal governments. Most cross-jurisdiction effects fall between -0.1 and 0.1 dollars per dollar of spending. For school districts, in line with the reduced-form results, the estimated spillover is statistically significantly positive in 55 percent of cases and negative in 12 percent. For municipalities and special purpose districts, the corresponding shares are 42 percent and 43 percent, respectively.

8.2 Internalization of Fiscal Spillovers in Local Referenda

I now evaluate a counterfactual voting regime in which fiscal spillovers are internalized in the propositions put before voters. I simulate, for every school district and municipality, a referendum that proposes a 5 percent increase in own spending (the median proposal size

Figure 10: Distribution of Cross-Jurisdictional Fiscal Spillovers



(a) School Districts (b) Municipal Governments

NOTES: The figure displays histograms of fiscal spillovers across jurisdictions for (a) school districts and (b) municipal governments in the United States. Each spillover is expressed as a share of the jurisdiction's baseline revenue. The measure follows the definition in Section 5.7.

in the data). For each jurisdiction, I compute turnout and the approval share under two regimes:

(i) Status quo: the 5 percent spending increase is considered on its own.

(ii) Internalization: the same 5 percent increase is paired with a symmetric intergovernmental transfer to (or from) overlapping jurisdictions equal to the estimated spillover implied by the proposal. Thus, if the marginal spillover is negative, the proposing jurisdiction faces an offsetting charge; if positive, it receives a compensating subsidy.[19]

Both regimes are consistent with the myopic voting model in Section 5.4. In each case, residents do not anticipate housing market or migration responses; they vote solely on the perceived trade-off between the proposed spending increase (net of any transfer) and the additional property tax burden required to finance it.

I compare passage rates across the two regimes and compute the implied change in welfare, aggregating over jurisdictions and household types.

For statistical inference on each counterfactual referendum outcome, I follow an approach analogous to that described in Section 6.3. Additional details appear in Appendix D.

[19]The transfer is scaled to the 5 percent proposal using the model's local approximation.

8.2.1 Results

Incorporating intergovernmental transfers into ballot measures has sizable effects on passage outcomes. For school districts, the internalization policy overturns 6.5 (1.2) percent of referenda that would otherwise pass and 22.9 (4.4) percent that would otherwise fail. For municipal governments, the corresponding figures are 11.8 (2.2) and 5.6 (1.1) percent.

To assess welfare, I compute the equivalent variation implied by the policy for each household type and scale it by the baseline level of welfare, then aggregate across groups. For each location $a \in \mathcal{A}$, let $v_a^k(1)$ and $v_a^k(0)$ denote the indirect utility of household type k under regimes with and without transfers, respectively. For each referendum-holding jurisdiction j and type k, define the proportional welfare change as

$$\Delta U_j^k \equiv \frac{\log\left(1+\sum_{\ell\in\mathcal{A}}\exp v_\ell^k(1)\right)-\log\left(1+\sum_{\ell\in\mathcal{A}}\exp v_\ell^k(0)\right)}{\log\left(1+\sum_{\ell\in\mathcal{A}}\exp v_\ell^k(0)\right)} \tag{40}$$

To summarize welfare at the group level, I take a weighted average of ΔU_j^k across jurisdictions j, using weights proportional to the population of households of type k.

Table 3 shows that welfare changes are positive for all household groups. In the school

Table 3: Estimates of Proportional Changes in Welfare

	ΔU^k (%)	
Group	School	Municipal
With Children, Above Median Income	0.42 (0.12)	0.06 (0.04)
With Children, Below Median Income	0.16 (0.05)	0.11 (0.05)
Without Children, Above Median Income	0.27 (0.10)	0.09 (0.05)
Without Children, Below Median Income	0.09 (0.04)	0.12 (0.07)

Notes: The table reports the estimated proportional change in welfare for each household group in the counterfactual exercise introduced in Section 8.2. Welfare changes are calculated from equation (40) and expressed in percentage points. Standard errors are computed using a two-step parametric bootstrap procedure with 100 outer replications and 20 inner replications per outer draw.

district counterfactual, high-income households experience the largest gains, reflecting both their higher willingness to pay for education services and the fact that a larger share of school district proposals generate positive spillovers and are therefore subsidized under the internalization regime. In the municipal counterfactual, taxes and subsidies are more evenly distributed across jurisdictions; welfare gains are correspondingly smaller and more similar across groups, consistent with the lower willingness to pay for municipal services.

In aggregate, household welfare rises by 0.25 (0.08) percent in the school district counterfactual and by 0.09 (0.04) percent in the municipal counterfactual. By raising the effective cost of proposals with negative spillovers and lowering it for those with positive spillovers, the transfer rule shifts marginal referendum outcomes accordingly, producing net welfare gains.

9 Conclusion

Local governments in the United States are vertically differentiated: in any given location, multiple overlapping jurisdictions provide distinct local public services and draw revenue from shared portions of the property tax base.

In this paper, I estimated the fiscal spillovers generated by that structure and proposed a mechanism to internalize them in local fiscal policy choice. On the data side, I assembled a new georeferenced dataset covering the universe of local government boundaries and nominal property tax rates nationwide over the past two decades. I then used a dynamic regression discontinuity design to estimate spillovers from narrowly approved property tax referenda. To extrapolate beyond effects identified at the approval threshold, I developed a spatial equilibrium model with overlapping jurisdictions and majority voting over the provision of local public goods.

Using the model, I quantified spillovers for all school districts and municipal governments in the United States and found sizable effects. I then evaluated a policy that (i) informs voters about spillovers across jurisdictions and (ii) applies symmetric intergovernmental transfers (taxes or subsidies) upon approval of a spending change. The counterfactual regime delivers aggregate welfare gains.

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Online Appendix

A Property Tax Rate Data

This section lists the sources I used to collect and compile data on property tax rates for each state or territory.

A.1 Alabama

The Alabama Department of Revenue prepares annual reports on the property tax "millage" rates set by counties, municipalities, and school districts throughout the state. Reports for the most recent five years are publicly available at https://www.revenue.alabama.gov/property-tax/property-tax-assessment/. For previous years, similar reports were obtained via a Public Records Request.

A.2 Alaska

The Alaska Department of Community and Regional Affairs annually compiles *Alaska Taxable* reports, detailing property tax rates set by boroughs and cities. These reports are accessible to the public at https://www.commerce.alaska.gov/dcra/admin/Taxable. Between 1998 and 2015, detailed property tax rate data are included in the main *Alaska Taxable* reports. For the years 2016 to 2019, similar data are exclusively available in the statistical supplement accompanying the *Alaska Taxable* reports. Starting from 2020, statutory property tax rates are no longer included in the *Alaska Taxable* reports. However, for specific boroughs and cities, this information can be found at https://dcra-cdo-dcced.opendata.arcgis.com/datasets/taxes-all-locations/. Any missing or incorrect values were rectified by cross-referencing individual municipality websites.

A.3 Arizona

The Arizona Department of Revenue does not release reports containing data on property tax rates set by counties, municipalities, school districts, and special purpose districts. Consequently, these data were collected on a county-by-county basis. For each of the fifteen counties in Arizona, publicly available reports from the "Assessor" or "Treasurer" sections of county websites were downloaded and digitized. Additionally, for several counties, these reports were supplemented with data obtained via Public Records Requests.

A.4 Arkansas

The Arkansas Assessment Coordination Division prepares annual *Millage Report* publications that contain data on the property tax rates set by counties, municipalities, school districts, and a limited number of special purpose districts. Reports for the most recent years are available at https://www.arkansasassessment.com/county-officials/millage-book/. For previous years, similar reports were obtained via Public Records Requests.

A.5 California

The California Board of Equalization does not release reports containing data on property tax rates set by counties, municipalities, school districts, and special purpose districts. Consequently, these data were collected on a county-by-county basis. Publicly available reports from the "Auditor-Controller" sections of county websites were downloaded and digitized for each of the fifty-eight counties in California. Additionally, data for several counties were supplemented through Public Records Requests.

A.6 Colorado

The Colorado Department of Local Affairs, Division of Property Taxation compiles annual reports detailing property tax rates set by counties, municipalities, school districts, and an extensive list of special purpose districts. The most recent report is publicly available at https://dpt.colorado.gov/annual-reports. For previous years, analogous reports were obtained via a Public Records Request.

A.7 Connecticut

The Connecticut Office of Policy and Management compiles annual data on property tax rates set by municipalities and a limited number of special purpose districts. These data are accessible to the public at https://portal.ct.gov/OPM/IGPP/Publications/Mill-Rates.

A.8 Delaware

The Delaware Division of Revenue does not publish reports containing data on property tax rates set by counties, municipalities, and school districts. Consequently, these data were collected on a county-by-county basis. Specifically, property tax rates for each of Delaware's three counties were digitized from tables found in the "Statistical Section" of the Annual Comprehensive Financial Reports.

A.9 District of Columbia

The historical property tax rates in the District of Columbia are documented in Section 47-812: "Establishment of Rates" of the Code of the District of Columbia. This section is accessible at https://code.dccouncil.gov/us/dc/council/code/sections/47-812.

A.10 Florida

Annually, each county in Florida discloses its property tax rates to the Florida Department of Revenue through the submission of two forms. The first, DR-403CC, includes details on property tax rates set by the county government, the county school board, and special purpose jurisdictions. The second, DR-403BM, is used to report property tax rates determined by municipalities. While these forms are not publicly available, the Florida Department of Revenue compiles and digitizes their contents. The resulting dataset was obtained through the submission of a Public Records Request.

A.11 Georgia

The Division of Local Government Services within the Georgia Department of Revenue releases annual reports titled *County Ad Valorem Tax Digest Millage Rates*. These reports provide comprehensive data on property tax "millage" rates determined by counties, municipalities, school districts, and special purpose districts. Recent reports are accessible to the public at https://dor.georgia.gov/local-government-services/digest-compliance-section/property-tax-millage-rates. Reports from prior years were acquired through Public Records Requests.

A.12 Hawaii

The Real Property Assessment Division within the Department of Budget and Fiscal Services of the City and County of Honolulu publishes annual reports that provide information on property tax rates set by each of the five counties in Hawaii. These reports are publicly available at https://www.realpropertyhonolulu.com/state-reports/2023/.

A.13 Idaho

The Idaho State Tax Commission does not provide consolidated reports summarizing property tax rates set by counties, municipalities, school districts, and special purpose districts. However, the pertinent data can be accessed by interactively selecting years and counties on the official website at https://apps2-tax.idaho.gov/i-1073.cfm.

A.14 Illinois

The Illinois Department of Revenue provides researchers with a collection of datasets on property taxes within the state, including details on tax rates set by counties, municipalities, townships, school districts, and special purpose districts. These annual datasets, titled *District EAV, CTE, and Total Rate by Property Class*, can be accessed on the official website at https://tax.illinois.gov/research/taxstats/propertytaxstatistics.html.

A.15 Indiana

The Indiana Department of Local Government Finance compiles annual reports detailing property tax rates set by counties, municipalities, townships, school districts, and special purpose districts. Reports for the most recent four years are publicly available at https://www.in.gov/dlgf/reports-and-data/reports/. For previous years, analogous reports were obtained via a Public Records Request.

A.16 Iowa

The Iowa Department of Management annually aggregates data pertaining to property tax rates imposed by counties, municipalities, townships, school districts, and special purpose districts. Detailed reports for each class of jurisdictions can be accessed at https://dom.iowa.gov/property-tax-rates. Additionally, a consolidated dataset containing the information from these reports is available at https://data.iowa.gov/Property-Assessment-Levy/Levy-Authority-Rates-in-Iowa-by-Fiscal-Year/xmkr-kpjb.

A.17 Kansas

The Kansas Department of Administration compiles and annually publishes county tax levy sheets that provide detailed data on property tax rates set by counties, municipalities, townships, school districts, and special purpose districts across the state. The reports can be accessed at https://admin.ks.gov/offices/accounts-reports/local-government/municipal-services/county-tax-levy-sheets. These county tax levy sheets are exclusively available in scanned PDF format, necessitating a substantial digitization effort.

A.18 Kentucky

The Kentucky Department of Revenue prepares comprehensive annual reports detailing property tax rates established by counties, municipalities, school districts, and special purpose districts. Both recent and historical reports can be retrieved from https://revenue.ky.gov/News/Publications/Pages/default.aspx.

A.19 Louisiana

The Louisiana Legislative Auditor annually releases *Maximum Millage Reports*, providing data on the property tax rates set by parishes, municipalities, school districts, and a large number of special purpose districts throughout the state. Parish-year-specific reports are available for download at https://lla.la.gov/resources/assessors-and-millages/maximum-millage-reports. Additionally, the Louisiana Tax Commission compiles analogous data into annual reports, offering coverage for earlier years and maintaining a harmonized format across time. These resources can be accessed at https://www.latax.state.la.us/Menu_AnnualReports/AnnualReports.aspx.

A.20 Maine

The Department of Administrative and Financial Services within Maine Revenue Services annually compiles the *Municipal Valuation Return Statistical Summary* reports. These publications provide comprehensive data on Maine municipalities, including details on the property tax rates they levy. Reports from the year 2009 onward are readily accessible at https://www.maine.gov/revenue/taxes/property-tax/municipal-services/valuation-return-statistical-summary. For earlier years, the corresponding data were acquired through a Public Records Request. Furthermore, historical data on property tax rates in Maine's unorganized territory were retrieved from https://www.maine.gov/revenue/taxes/property-tax/unorganized-territory.

A.21 Maryland

Until 2019, the Office of Policy Analysis within the Maryland Department of Legislative Services published annual reports titled *Overview of Maryland Local Governments: Finances and Demographic Information*. Within the appendices of these publications were tables summarizing the property tax rates levied by counties, municipalities, and a limited number of special service districts throughout the state. Starting from 2020, this information has been made available through individual documents on the website of the Maryland Department of Legislative Services. Additionally, the Maryland Department of Assessments and Taxation releases property tax reports for more recent years, accessible at https://dat.maryland.gov/Pages/Tax-Rates.aspx.

A.22 Massachusetts

The Massachusetts Division of Local Services provides researchers with a collection of datasets on property taxes within the state, including details on tax rates set by municipalities and special purpose districts. These datasets can be accessed at https://www.mass.gov/lists/property-tax-data-and-statistics#city,-town-and-special-purpose-district-tax-rates-.

A.23 Michigan

The Property Services Division within the Michigan Department of Treasury annually releases reports titled *Total Property Tax Rates in Michigan*. These reports encompass data on the property tax rate applicable to each geographical area defined by the intersection of a county with a school district and a city or township. Both current and historical reports can be downloaded from https://www.michigan.gov/taxes/property/estimator/related/millage-rates.

A.24 Minnesota

The Minnesota Department of Revenue makes available for researchers a comprehensive dataset on the history of property tax rates levied by counties, municipalities, and school districts in the state. To access this extensive dataset, researchers can utilize the “Download All Data” link available at https://www.revenue.state.mn.us/property-tax-history-data. Additionally, a similar dataset pertaining to special purpose districts was acquired through a Public Records Request.

A.25 Mississippi

The Mississippi Department of Revenue annually compiles two reports, namely *County Millage* and *City Millage*, providing a comprehensive overview of property tax rates imposed by various jurisdictions across the state. The *City Millage* reports encompass data on rates set by school districts. These publications are available for download at https://www.dor.ms.gov/property. The datasets from earlier years were obtained by filing a Public Records Request. However, it is essential to note that the Department of Revenue staff cannot ensure the completeness and/or accuracy of these historical data.

A.26 Missouri

The Missouri State Auditor annually publishes reports under the title *Missouri Property Tax Rates*. These reports provide comprehensive data on assessed values and property tax rates established by counties, municipalities, townships, school districts, and special purpose districts. Both current and historical reports can be accessed for reference at https://auditor.mo.gov/AuditReport/Reports?SearchLocalState=31.

A.27 Montana

The Montana Department of Revenue does not produce consolidated reports summarizing property tax rates set by counties, municipalities, school districts, and special purpose districts. The pertinent data were acquired through the submission of a Public Records Request.

A.28 Nebraska

The Property Assessment Division within the Nebraska Department of Revenue publishes annual reports that provide data on property tax valuations, taxes levied, and property tax rates throughout the state, including information by political subdivision within each county. These publications can be retrieved from https://revenue.nebraska.gov/PAD/research-statistical-reports/annual-reports.

A.29 Nevada

The Division of Local Government Services within the Nevada Department of Taxation annually compiles reports titled *Local Government Finance Redbook*. These publications contain detailed data on the property tax rates set by counties, municipalities, school districts, and special purpose districts. Current and digitized historical reports can be accessed at https://tax.nv.gov/LocalGovt/PolicyPub/ArchiveFiles/Redbook/.

A.30 New Hampshire

The New Hampshire Department of Revenue Administration offers researchers access to a range of datasets related to property taxation in the state over the last five years. These datasets can be downloaded from https://www.revenue.nh.gov/mun-prop/municipal/property-tax-rates.htm. For earlier years, comprehensive data on property tax rates set by municipalities statewide are available in the annual reports published by the Department, which can be found at https://www.revenue.nh.gov/publications/reports/index.htm. For a unified dataset encompassing both current and historical property tax rates, one can consult the website of the New Hampshire Public Finance Consortium at https://nhpfc.org/Data.

A.31 New Jersey

The Division of Taxation within the New Jersey Treasury offers a consistently updated dataset featuring current and historical property tax rates established by boroughs and townships in the state. This dataset is accessible in the "General Tax Rates by County and Municipality" section at https://www.nj.gov/treasury/taxation/lpt/statdata.shtml.

A.32 New Mexico

The New Mexico Department of Finance and Administration prepares annual reports on the property tax rates set by counties, municipalities, school districts, and special purpose districts. County-level reports for the most recent five years are publicly available at https://www.nmdfa.state.nm.us/local-government/budget-finance-bureau/property-taxes/certificates-of-property-tax-rates/. For previous years, similar reports or data in spreadsheet format were obtained via a Public Records Request.

A.33 New York

The Office of the New York State Comptroller provides researchers access to various current and historical datasets and reports on property tax rates set by counties, municipalities, and school districts throughout the state. While these datasets encompass information on special purpose districts, it is important to note that the data for these districts are grouped and not available on an individual entity basis. The primary directory for local government data in New York can be found at https://www.osc.ny.gov/local-government/data/real-property-tax-levies-taxable-full-value-and-full-value-tax-rates.

A.34 North Carolina

The North Carolina Department of Revenue prepares annual datasets on the property tax rates set by counties, municipalities, school districts, and special purpose districts across the state. Datasets for the most recent five years are publicly available at https://www.ncdor.gov/taxes-forms/property-tax/property-tax-rates. For previous years, similar data were obtained via a Public Records Request.

A.35 North Dakota

The Office of the North Dakota State Tax Commissioner offers researchers convenient access to property tax rate data through a user-friendly *Tax Levy Lookup* tool, accessible at https://www.tax.nd.gov/data. This interactive application provides data exclusively for years from 2015 onwards. Data for previous years were obtained via a Public Records Request.

A.36 Ohio

The Ohio Department of Taxation compiles annual datasets that contain information regarding the property tax rates levied by county governments, municipalities, townships, school districts, and special purpose districts. These comprehensive datasets can be retrieved from https://tax.ohio.gov/researcher/tax-analysis/tax-data-series/tds1.

A.37 Oklahoma

The Oklahoma Tax Commission does not publish consolidated reports detailing property tax rates set by counties, municipalities, school districts, and special purpose districts. Comprehensive data were acquired via a Public Records Request.

A.38 Oregon

The Research Section within the Oregon Department of Revenue annually compiles reports titled *Oregon Property Tax Statistics*. These publications contain data on the property tax rates set by counties, municipalities, school districts, and special purpose districts across the state. Current and historical reports, as well as detailed supplemental data, can be accessed at https://www.oregon.gov/dor/gov-research/Pages/Research-Reports-and-Statistics.aspx.

A.39 Pennsylvania

The Pennsylvania Department of Community and Economic Development provides researchers with access to two databases: the *Municipal Tax Database* and the *County Tax Database*. The former facilitates the retrieval of data on property tax rates set by boroughs, townships, and school districts across the state, and is accessible at https://munstats.pa.gov/Reports/ReportInformation2.aspx?report=taxes_Dyn_Excel. The latter stores information on property tax rates established by county governments and is accessible at https://munstats.pa.gov/Reports/ReportInformation2.aspx?report=CountyTaxSummary_Dyn_Excel. Unfortunately, the *Municipal Tax Database* contains several missing values and erroneous entries, thereby making it necessary to perform an extensive manual consistency check. For an alternative source of data on school district rates, the Department of Education produces annual reports available for download at https://www.education.pa.gov/Teachers%20-%20Administrators/School%20Finances/Finances/FinancialDataElements/Pages/default.aspx. Finally, because individual counties are responsible for carrying out real estate property assessments, the tax base on which rates are computed differs significantly across the state. To harmonize these values, the Department of Revenue calculates annual Common Level Ratio Real Estate Valuation Factors. Current and historical data on these harmonization factors can be accessed at https://www.revenue.pa.gov/TaxTypes/RTT/Pages/Common%20Level%20Ratios.aspx.

A.40 Rhode Island

The Division of Municipal Finance within the Rhode Island Department of Revenue compiles data on property tax rates established by municipalities and fire protection districts throughout the state. The corresponding reports can be accessed at https://municipalfinance.ri.gov/financial-tax-data/tax-rates.

A.41 South Carolina

The South Carolina Department of Revenue does not release consolidated reports providing an overview of property tax rates set by counties, municipalities, school districts, and special purpose districts. Instead, these reports are compiled and published by the South Carolina Association of Counties. Publications dating back to 2009 can be found at https://www.sccounties.org/research-information/property-tax-rates. For earlier reports, access was secured by contacting the Association directly.

A.42 South Dakota

The South Dakota Department of Revenue collects and compiles county-level data on property tax rates established by all political units in the state. Access to statewide datasets for the most recent five years is available at https://sdproptax.info/DataLink/Data. For datasets and reports from earlier years, the requisite information was acquired through the submission of several Public Records Requests.

A.43 Tennessee

The Division of Property Assessments within the Tennessee Comptroller of the Treasury annually releases reports that encompass data on the property tax rate applicable to each geographical area defined by the intersection of a county with a school district, a city, and a special purpose district. Both current and historical reports can be downloaded from https://comptroller.tn.gov/office-functions/pa/tax-resources/assessment-information-for-each-county/property-tax-rates.html.

A.44 Texas

The Texas Comptroller's Office compiles annual datasets on the property tax rates set by counties, municipalities, school districts, and special purpose districts across the state. Datasets for the most recent five years are publicly available at https://comptroller.texas.gov/taxes/property-tax/rates/. For previous years, similar reports were obtained via a Public Records Request.

A.45 Utah

The Utah State Tax Commission prepares annual reports on the property tax rates levied by counties, municipalities, school districts, and special purpose districts across the state. These reports can be downloaded from https://propertytax.utah.gov/rates/.

A.46 Vermont

The Division of Property Valuation and Review within the Vermont Department of Taxes issues an annual *Property Valuation and Review Annual Report*. This comprehensive report offers extensive insights into Vermont's property tax system. Accompanying the report are supplemental datasets, including one specifically detailing property tax rates imposed by municipalities and special purpose districts. The primary directory for accessing these annual reports is located at https://tax.vermont.gov/pvr-annual-report.

A.47 Virginia

The Virginia Department of Taxation annually compiles data on the property tax rates established by county governments, municipalities, and special purpose districts across the state.

These *Local Tax Rates Survey* reports can be accessed at https://www.tax.virginia.gov/local-tax-rates.

A.48 Washington

The Washington Department of Revenue provides researchers with comprehensive data on property taxes levied in the state. Detailed datasets outlining property tax rates set by counties, municipalities, school districts, and various special purpose districts are accessible at https://dor.wa.gov/about/statistics-reports/local-taxing-district-levy-detail. To complement these datasets, a county-by-county data collection process was undertaken to obtain data on rates applicable to each tax area.

A.49 West Virginia

The Office of the West Virginia State Auditor collects and compiles annual county-level data on property tax rates set by county governments, municipalities, and school districts throughout the state. Reports for the most recent ten years are publicly available at https://www.wvsao.gov/LocalGovernment/Reports. For previous years, similar reports were obtained via a Public Records Request.

A.50 Wisconsin

The Wisconsin Department of Revenue does not publish consolidated reports detailing property tax rates individually levied by counties, municipalities, school districts, and special purpose districts. These data were obtained by filing several Public Records Requests.

A.51 Wyoming

The Wyoming Department of Revenue annually issues *Property Tax Mill Levy by Tax District Summary* reports that provide data on the property tax rates specific to distinct geographical areas determined by the intersection of multiple local governments. Access to these reports is available at https://wyo-prop-div.wyo.gov/tax-districts/general-information.

Supplementary data on rates imposed by individual taxing jurisdictions were obtained through a Public Records Request.

A.52 Data Availability

The following table reports time periods for which data on property tax rates have been collected and are included in the main analysis.

Table A1: Time Periods of Property Tax Data Availability

State or Territory	**Years**	**State or Territory**	**Years**
Alabama	2000-2022	Montana	2009-2022
Alaska	1998-2022	Nebraska	2001-2022
Arizona	2009-2022	Nevada	2000-2022
Arkansas	1999-2022	New Hampshire	2003-2022
California	2000-2022	New Jersey	1997-2022
Colorado	2003-2022	New Mexico	2000-2022
Connecticut	1992-2022	New York	2002-2022
Delaware	1997-2022	North Carolina	2000-2022
District of Columbia	2006-2022	North Dakota	2000-2022
Florida	2001-2022	Ohio	1996-2022
Georgia	1999-2022	Oklahoma	2000-2022
Hawaii	1983-2022	Oregon	2007-2022
Idaho	2001-2022	Pennsylvania	1988-2022
Illinois	2008-2021	Rhode Island	2000-2022
Indiana	2006-2022	South Carolina	2005-2022
Iowa	2001-2022	South Dakota	2010-2022
Kansas	2011-2022	Tennessee	1997-2022
Kentucky	1999-2022	Texas	2000-2022
Louisiana	2005-2022	Utah	1997-2022
Maine	1998-2021	Vermont	2006-2022
Maryland	2005-2022	Virginia	1999-2021
Massachusetts	2002-2022	Washington	2002-2022
Michigan	2005-2022	West Virginia	2007-2022
Minnesota	2005-2022	Wisconsin	1989-2022
Mississippi	2012-2022	Wyoming	2010-2022
Missouri	2000-2022		

NOTES: For each state or territory, this table reports years for which data on property tax rates have been collected and are available for use.

Table A2: Within-County Share of Variance in Property Tax Rates by State or Territory

State or Territory	**Within Share**	**State or Territory**	**Within Share**
Alabama	0.419	Montana	0.546
Alaska	0.177	Nebraska	0.317
Arizona	0.813	Nevada	0.555
Arkansas	0.528	New Hampshire	0.640
California	0.726	New Jersey	0.724
Colorado	0.602	New Mexico	0.709
Connecticut	0.807	New York	0.547
Delaware	0.303	North Carolina	0.672
District of Columbia	0.000	North Dakota	0.532
Florida	0.425	Ohio	0.373
Georgia	0.421	Oklahoma	0.516
Hawaii	0.000	Oregon	0.684
Idaho	0.489	Pennsylvania	0.364
Illinois	0.766	Rhode Island	0.541
Indiana	0.707	South Carolina	0.489
Iowa	0.744	South Dakota	0.775
Kansas	0.436	Tennessee	0.505
Kentucky	0.404	Texas	0.693
Louisiana	0.012	Utah	0.355
Maine	0.896	Vermont	0.811
Maryland	0.440	Virginia	0.390
Massachusetts	0.565	Washington	0.549
Michigan	0.574	West Virginia	0.263
Minnesota	0.769	Wisconsin	0.639
Mississippi	0.588	Wyoming	0.442
Missouri	0.289		

NOTES: For each state, the table reports the share of variance in property tax rates attributable to within-county heterogeneity. This share is computed by estimating, separately within each state, a regression of tax area rates on county indicators and taking one minus the adjusted coefficient of determination from that regression. Observations are unweighted tax areas.

B Model Derivations

B.1 Household Utility Maximization

Household i faces the following utility maximization problem in location $a \in \mathcal{A}$:

$$\max_{H,X} \left\{ A_{ia} + \sum_{j \in \mathcal{J}_a} \alpha_{ij} \log \frac{G_j}{N_j^{\chi_j}} + \beta_i \log H + \gamma_i \log X \right\}$$
$$\text{s.t.} \quad X + P_a H \left(1 + \tau_a\right) \leq Y_i \quad \text{and} \quad H = 1 \tag{B.1}$$

The Lagrangian associated with this maximization problem is

$$\begin{aligned} \mathcal{L}\left(H, X; \lambda\right) = A_{ia} + \sum_{j \in \mathcal{J}_a} \alpha_{ij} \log \frac{G_j}{N_j^{\chi_j}} + \beta_i \log H + \gamma_i \log X \\ - \lambda \left(X + P_a H \left(1 + \tau_a\right) - Y_i\right) - \mu \left(H - 1\right) \end{aligned} \tag{B.2}$$

The first-order necessary conditions are

$$\left. \frac{\partial \mathcal{L}\left(H, X; \lambda\right)}{\partial H} \right|_{H = H_{ia}} = \frac{\beta_i}{H_{ia}} - \lambda_{ia} P_a \left(1 + \tau_a\right) - \mu_{ia} = 0 \tag{B.3}$$

$$\left. \frac{\partial \mathcal{L}\left(H, X; \lambda\right)}{\partial X} \right|_{X = X_{ia}} = \frac{\gamma_i}{X_{ia}} - \lambda_{ia} = 0 \tag{B.4}$$

$$\left. \frac{\partial \mathcal{L}\left(H, X; \lambda\right)}{\partial \lambda} \right|_{\lambda = \lambda_{ia}} = -X_{ia} - P_a H_{ia} \left(1 + \tau_a\right) + Y_i = 0 \tag{B.5}$$

$$\left. \frac{\partial \mathcal{L}\left(H, X; \lambda\right)}{\partial \mu} \right|_{\mu = \mu_{ia}} = -H_{ia} + 1 = 0 \tag{B.6}$$

The fourth first-order condition ensures that $H_{ia} = 1$. Then the budget constraint is

$$X_{ia} + P_a \left(1 + \tau_a\right) = Y_i \iff X_{ia} = Y_i - P_a \left(1 + \tau_a\right) \tag{B.7}$$

The second first-order condition implies that the first Lagrange multiplier is

$$\lambda_{ia} = \frac{\gamma_i}{Y_i - P_a \left(1 + \tau_a\right)} \tag{B.8}$$

which is positive since $\gamma_i > 0$ and households retain positive disposable income. Finally, the first first-order condition entails that

$$\mu_{ia} = \beta_i - \frac{\gamma_i P_a (1 + \tau_a)}{Y_i - P_a (1 + \tau_a)} \tag{B.9}$$

The second Lagrange multiplier is positive provided that

$$\frac{\beta_i}{\gamma_i} > \frac{P_a (1 + \tau_a)}{Y_i - P_a (1 + \tau_a)} \tag{B.10}$$

Plugging the Marshallian demands back into the utility function yields household i's indirect utility function:

$$\begin{aligned} V_{ia} &= A_{ia} + \sum_{j \in \mathcal{J}_a} \alpha_{ij} \log \frac{G_j}{N_j^{\chi_j}} + \beta_i \log 1 + \gamma_i \log [Y_i - P_a (1 + \tau_a)] \\ &= A_{ia} + \sum_{j \in \mathcal{J}_a} \alpha_{ij} \log \frac{G_j}{N_j^{\chi_j}} + \gamma_i \log [Y_i - P_a (1 + \tau_a)] \end{aligned} \tag{B.11}$$

Furthermore, household i's valuation of exogenous amenities is $A_{ia} \equiv \overline{A}_a + U_{ia}$, with $U_{ia} \sim \text{Gumbel}(0, \theta)$. The indirect utility function can thus be re-expressed as follows:

$$V_{ij} = \underbrace{\overline{A}_a + \sum_{j \in \mathcal{J}_a} \alpha_{ij} \log \frac{G_j}{N_j^{\chi_j}} + \gamma_i \log [Y_i - P_a (1 + \tau_a)]}_{\equiv v_{ia}} + U_{ia} \tag{B.12}$$

where v_{ia} indicates the non-idiosyncratic component of utility. Each household chooses the location that maximizes their indirect utility. Given the parametric assumption on the random component of amenity shocks, the probability that household i chooses location a is

$$N_{ia} = \frac{\exp (v_{ia}/\theta)}{1 + \sum_{\ell \in \mathcal{A}} \exp (v_{i\ell}/\theta)} \tag{B.13}$$

Letting $\mathcal{J}_a = \left\{ j_1 (a), \ldots, j_{|\mathcal{J}_a|} (a) \right\}$, define $\boldsymbol{\alpha}_{ia} \equiv \left[\alpha_{j_1}, \ldots, \alpha_{j_{|\mathcal{J}_a|}} \right]'$. Let $\boldsymbol{\delta}_{ia} \equiv [\boldsymbol{\alpha}'_{ia}, \gamma_i, Y_i]'$ be a random vector whose joint probability distribution and support are denoted with F and $\mathcal{D}$, respectively. Integrating choice probabilities over F yields the expected mass of households who choose location a:

$$N_a = \int_{\mathcal{D}} N_{ia}\left(\boldsymbol{\delta}_{ia}\right) dF\left(\boldsymbol{\delta}_{ia}\right) \tag{B.14}$$

B.2 Equilibrium in the Housing Market

The housing supply equation is

$$\log H_a^{\mathrm{S}} = \lambda + \eta \log P_a + B_a \tag{B.15}$$

Since each household consumes exactly one unit of housing, the aggregate demand for housing in location a is

$$\begin{aligned} H_a^{\mathrm{D}} &= \int_{\mathcal{D}} N_{ia}\left(\boldsymbol{\delta}_{ia}\right) H_{ia}\left(\boldsymbol{\delta}_{ia}\right) dF\left(\boldsymbol{\delta}_{ia}\right) && \text{(B.16)} \\ &= \int_{\mathcal{D}} N_{ia}\left(\boldsymbol{\delta}_{ia}\right) dF\left(\boldsymbol{\delta}_{ia}\right) && \text{(B.17)} \\ &= N_a && \text{(B.18)} \end{aligned}$$

Taking logarithms yields

$$\log H_a^{\mathrm{D}} = \log N_a \tag{B.19}$$

The equilibrium rental rate of housing equates log-demand and log-supply of housing:

$$\begin{aligned} \log H_a^{\mathrm{S}} = \log H_a^{\mathrm{D}} &\iff \lambda + \eta \log P_a + B_a = \log N_a && \text{(B.20)} \\ &\iff \log P_a = \frac{1}{\eta} \log N_a - \widetilde{\lambda} - \widetilde{B_a} && \text{(B.21)} \end{aligned}$$

where $\widetilde{\lambda} \equiv \frac{\lambda}{\eta}$ and $\widetilde{B}_a \equiv \frac{B_a}{\eta}$. Plugging the equilibrium rental rate of housing into the equation for the log-supply of housing yields the equilibrium level of housing space:

$$\log H_a = \lambda + \eta \log P_a + B_a = \lambda + \log N_a - \lambda - B_a + B_a = \log N_a \tag{B.22}$$

Finally, the equilibrium level of housing expenditure in location a is

$$\log P_a + \log H_a = \frac{1}{\eta}\log N_a - \widetilde{\lambda} - \widetilde{B_a} + \log N_a \tag{B.23}$$

$$= \frac{1+\eta}{\eta}\log N_a - \widetilde{\lambda} - \widetilde{B_a} \tag{B.24}$$

B.3 Sophisticated Voting over Local Public Services

In the main text, I set out a model with myopic voters: residents do not internalize how a change in local public spending affects migration into and out of the community and, through that channel, housing prices. In this section, I analyze a model of sophisticated voting in which residents anticipate and account for the induced sorting and housing market responses to local spending changes.

Consider a voter who resides in area $a \in \mathcal{A}_j$ and chooses their preferred level of government spending in jurisdiction $j \in \mathcal{J}_a$. The derivative of household i's indirect utility function with respect to government spending is

$$\begin{aligned}\frac{dV_{ia}}{d\log G_j} &= \alpha_{ij} - \sum_{m\in\mathcal{J}_a}\alpha_{im}\chi_m\frac{d\log N_m}{d\log G_j} \\ &\quad - \gamma_i\rho_{ia}\frac{d\log P_a}{d\log G_j} - \gamma_i\rho_{ia}\sum_{m\in\mathcal{J}_a}\frac{1+\tau_m}{1+\tau_a}\frac{d\log(1+\tau_m)}{d\log G_j}\end{aligned} \tag{B.25}$$

As in equation (11), the first-order condition associated with the implied maximization problem is

$$\begin{aligned}\alpha_{ij} &= \sum_{m\in\mathcal{J}_a}\alpha_{im}\chi_m\left.\frac{d\log N_m}{d\log G_j}\right|_{G_j=G_{jia}} \\ &\quad + \gamma_i\rho_{ia}\left.\frac{d\log P_a}{d\log G_j}\right|_{G_j=G_{jia}} + \gamma_i\rho_{ia}\sum_{m\in\mathcal{J}_a}\frac{1+\tau_m}{1+\tau_a}\left.\frac{d\log(1+\tau_m)}{d\log G_j}\right|_{G_j=G_{jia}}\end{aligned} \tag{B.26}$$

When a voter decides whether to approve or reject a proposed spending change, several endogenous variables are jointly determined. In particular, the housing stock, the housing price, and the property tax rate are pinned down by housing market clearing and the government budget constraint. Following Epple and Romer (1991), these two conditions define a Government Possibility Frontier (GPF): the locus of pairs of government spending and the gross of tax housing price that satisfy market clearing and budget balance. In what follows, I characterize the slope of the GPF under sophisticated voting.

The system of equations implied by the housing market clearing and government balanced budget conditions is

$$J_a\left(G_j, P_a, 1+\tau_j\right) = \log H_a^{\mathrm{S}} - \log H_a^{\mathrm{D}} = 0 \tag{B.27}$$

$$K_j\left(G_j, P_a, 1+\tau_j\right) = \log\left(\tau_j \sum_{\ell\in\mathcal{A}_j} P_\ell H_\ell^D + I_j\right) - \log G_j = 0 \tag{B.28}$$

where equation (B.28) must hold for every $j \in \mathcal{J}_a$. The goal of this section is to compute the partial derivatives required to solve this system in its general form. Recall that

$$J_a \equiv \lambda + \eta \log P_a + B_a - \log N_a \tag{B.29}$$

$$K_j \equiv \log\left(\tau_j \sum_{\ell\in\mathcal{A}_j} P_\ell N_\ell + I_j\right) - \log G_j \tag{B.30}$$

B.3.1 Household Utility

Recall that the non-idiosyncratic component of utility is

$$v_{ia} \equiv \overline{A}_a + \sum_{j\in\mathcal{J}_a} \alpha_{ij}\left[\log G_j - \chi_j \log N_j\right] + \gamma_i \log\left[Y_i - P_a\left(1+\tau_a\right)\right] \tag{B.31}$$

The probability of household i choosing location a is

$$N_{ia} = \frac{\exp\left(v_{ia}/\theta\right)}{1+\sum_{\ell\in\mathcal{A}}\exp\left(v_{i\ell}/\theta\right)} \tag{B.32}$$

and the expected mass of households choosing location a is

$$N_a = \int_{\mathcal{D}} N_{ia}\left(\boldsymbol{\delta}_{ia}\right) dF\left(\boldsymbol{\delta}_{ia}\right) \tag{B.33}$$

For convenience, define

$$\phi_i \equiv \frac{1}{1+\sum_{\ell\in\mathcal{A}}\exp\left(v_{i\ell}/\theta\right)} \tag{B.34}$$

As a preliminary step, compute the partial derivative of N_{ia} with respect to $v_{i\ell}$, with $a, \ell \in \mathcal{A}$. First, if $a = \ell$,

$$\frac{\partial N_{ia}}{\partial v_{i\ell}} = \frac{\phi_i}{\theta}\exp\left(v_{ia}/\theta\right) - \frac{\phi_i^2}{\theta}\exp\left(v_{i\ell}/\theta\right)\exp\left(v_{ia}/\theta\right) = \frac{N_{ia}}{\theta} - \frac{N_{ia}N_{i\ell}}{\theta} = \frac{N_{ia}}{\theta}\left(1-N_{i\ell}\right) \tag{B.35}$$

Second, if $a \neq \ell$,

$$\frac{\partial N_{ia}}{\partial v_{i\ell}} = -\frac{\phi_i^2}{\theta}\exp\left(v_{i\ell}/\theta\right)\exp\left(v_{ia}/\theta\right) = -\frac{N_{ia}N_{i\ell}}{\theta} \tag{B.36}$$

To summarize,

$$\frac{\partial N_{ia}}{\partial v_{i\ell}} = \frac{N_{ia}}{\theta}\left(\mathbb{I}\left[a=\ell\right] - N_{i\ell}\right) \tag{B.37}$$

We now compute the partial derivatives of $v_{i\ell}$ with respect to its endogenous variables:

$$\frac{\partial v_{i\ell}}{\partial \log G_j} = \alpha_{ij}\mathbb{I}\left[j\in\mathcal{J}_\ell\right] \tag{B.38}$$

$$\frac{\partial v_{i\ell}}{\partial \log P_a} = -\gamma_i\frac{P_a\left(1+\tau_a\right)}{Y_i - P_a\left(1+\tau_a\right)}\mathbb{I}\left[a=\ell\right] \tag{B.39}$$

$$\frac{\partial v_{i\ell}}{\partial \log\left(1+\tau_j\right)} = -\gamma_i\frac{P_\ell\left(1+\tau_j\right)}{Y_i - P_\ell\left(1+\tau_\ell\right)}\mathbb{I}\left[j\in\mathcal{J}_\ell\right] \tag{B.40}$$

$$\frac{\partial v_{i\ell}}{\partial \log N_j} = -\alpha_{ij}\chi_j\mathbb{I}\left[j\in\mathcal{J}_\ell\right] \tag{B.41}$$

For compactness, define $\rho_{ia} \equiv \frac{P_a(1+\tau_a)}{Y_i - P_a(1+\tau_a)}$.

B.3.2 Household Location Choice Probability

By an application of the chain rule, the partial derivative of N_{ia} with respect $\log G_j$ is

$$\frac{\partial N_{ia}}{\partial \log G_j} \tag{B.42}$$

$$= \sum_{\ell \in \mathcal{A}} \frac{\partial N_{ia}}{\partial v_{i\ell}} \frac{\partial v_{i\ell}}{\partial \log G_j} + \sum_{\ell \in \mathcal{A}} \frac{\partial N_{ia}}{\partial v_{i\ell}} \sum_{m \in \mathcal{J}} \frac{\partial v_{i\ell}}{\partial \log N_m} \frac{\partial \log N_m}{\partial N_m} \frac{\partial N_m}{\partial \log G_j} \tag{B.43}$$

$$= \sum_{\ell \in \mathcal{A}} \frac{N_{ia}}{\theta} \left(\mathbb{I}\left[a = \ell\right] - N_{i\ell} \right) \alpha_{ij} \mathbb{I}\left[j \in \mathcal{J}_\ell\right]$$

$$- \sum_{\ell \in \mathcal{A}} \frac{N_{ia}}{\theta} \left(\mathbb{I}\left[a = \ell\right] - N_{i\ell} \right) \sum_{m \in \mathcal{J}} \alpha_{im} \chi_m \mathbb{I}\left[m \in \mathcal{J}_\ell\right] \frac{1}{N_m} \frac{\partial N_m}{\partial \log G_j} \tag{B.44}$$

$$= \frac{N_{ia}}{\theta} \alpha_{ij} \left(\mathbb{I}\left[a \in \mathcal{A}_j\right] - N_{ij} \right)$$

$$- \frac{N_{ia}}{\theta} \sum_{m \in \mathcal{J}} \alpha_{im} \chi_m \left(\mathbb{I}\left[a \in \mathcal{A}_m\right] - N_{im} \right) \frac{1}{N_m} \frac{\partial N_m}{\partial \log G_j} \tag{B.45}$$

$$= \frac{N_{ia}}{\theta} \left(\alpha_{ij} \left(\mathbb{I}\left[a \in \mathcal{A}_j\right] - N_{ij} \right) - \sum_{m \in \mathcal{J}} \alpha_{im} \chi_m \left(\mathbb{I}\left[a \in \mathcal{A}_m\right] - N_{im} \right) \frac{1}{N_m} \frac{\partial N_m}{\partial \log G_j} \right) \tag{B.46}$$

The partial derivative of N_{ia} with respect $\log P_{a'}$ is

$$\frac{\partial N_{ia}}{\partial \log P_{a'}} \tag{B.47}$$

$$= \sum_{\ell \in \mathcal{A}} \frac{\partial N_{ia}}{\partial v_{i\ell}} \frac{\partial v_{i\ell}}{\partial \log P_{a'}} + \sum_{\ell \in \mathcal{A}} \frac{\partial N_{ia}}{\partial v_{i\ell}} \sum_{m \in \mathcal{J}} \frac{\partial v_{i\ell}}{\partial \log N_m} \frac{\partial \log N_m}{\partial N_m} \frac{\partial N_m}{\partial \log P_{a'}} \tag{B.48}$$

$$= - \sum_{\ell \in \mathcal{A}} \frac{N_{ia}}{\theta} \left(\mathbb{I}\left[a = \ell\right] - N_{i\ell} \right) \gamma_i \rho_{ia'} \mathbb{I}\left[a' = \ell\right]$$

$$- \sum_{\ell \in \mathcal{A}} \frac{N_{ia}}{\theta} \left(\mathbb{I}\left[a = \ell\right] - N_{i\ell} \right) \sum_{m \in \mathcal{J}} \alpha_{im} \chi_m \mathbb{I}\left[m \in \mathcal{J}_\ell\right] \frac{1}{N_m} \frac{\partial N_m}{\partial \log P_{a'}} \tag{B.49}$$

$$= - \frac{N_{ia}}{\theta} \left(\mathbb{I}\left[a = a'\right] - N_{ia'} \right) \gamma_i \rho_{ia'}$$

$$- \frac{N_{ia}}{\theta} \sum_{m \in \mathcal{J}} \alpha_{im} \chi_m \left(\mathbb{I}\left[a \in \mathcal{A}_m\right] - N_{im} \right) \frac{1}{N_m} \frac{\partial N_m}{\partial \log P_{a'}} \tag{B.50}$$

$$= \frac{N_{ia}}{\theta} \left(-\gamma_i \rho_{ia'} \left(\mathbb{I}\left[a = a'\right] - N_{ia'} \right) - \sum_{m \in \mathcal{J}} \alpha_{im} \chi_m \left(\mathbb{I}\left[a \in \mathcal{A}_m\right] - N_{im} \right) \frac{1}{N_m} \frac{\partial N_m}{\partial \log P_{a'}} \right) \tag{B.51}$$

The partial derivative of N_{ia} with respect $\log\left(1 + \tau_j\right)$ is

$$\frac{\partial N_{ia}}{\partial \log\left(1 + \tau_j\right)} \tag{B.52}$$

$$= \sum_{\ell \in \mathcal{A}} \frac{\partial N_{ia}}{\partial v_{i\ell}} \frac{\partial v_{i\ell}}{\partial \log\left(1 + \tau_j\right)} + \sum_{\ell \in \mathcal{A}} \frac{\partial N_{ia}}{\partial v_{i\ell}} \sum_{m \in \mathcal{J}} \frac{\partial v_{i\ell}}{\partial \log N_m} \frac{\partial \log N_m}{\partial N_m} \frac{\partial N_m}{\partial \log\left(1 + \tau_j\right)} \tag{B.53}$$

$$= - \sum_{\ell \in \mathcal{A}} \frac{N_{ia}}{\theta} \left(\mathbb{I}\left[a = \ell\right] - N_{i\ell} \right) \gamma_i \rho_{i\ell} \frac{1 + \tau_j}{1 + \tau_\ell} \mathbb{I}\left[j \in \mathcal{J}_\ell\right]$$

$$-\sum_{\ell\in\mathcal{A}}\frac{N_{ia}}{\theta}\left(\mathbb{I}\left[a=\ell\right]-N_{i\ell}\right)\sum_{m\in\mathcal{J}}\alpha_{im}\chi_m\mathbb{I}\left[m\in\mathcal{J}_\ell\right]\frac{1}{N_m}\frac{\partial N_m}{\partial\log\left(1+\tau_j\right)} \tag{B.54}$$

$$=-\frac{N_{ia}}{\theta}\left(\gamma_i\rho_{ia}\frac{1+\tau_j}{1+\tau_a}\mathbb{I}\left[a\in\mathcal{A}_j\right]-\sum_{\ell\in\mathcal{A}_j}N_{i\ell}\gamma_i\rho_{i\ell}\frac{1+\tau_j}{1+\tau_\ell}\right)$$

$$-\frac{N_{ia}}{\theta}\sum_{m\in\mathcal{J}}\alpha_{im}\chi_m\left(\mathbb{I}\left[a\in\mathcal{A}_m\right]-N_{im}\right)\frac{1}{N_m}\frac{\partial N_m}{\partial\log\left(1+\tau_j\right)} \tag{B.55}$$

$$=\frac{N_{ia}}{\theta}\Bigg(-\gamma_i\rho_{ia}\frac{1+\tau_j}{1+\tau_a}\mathbb{I}\left[a\in\mathcal{A}_j\right]+\sum_{\ell\in\mathcal{A}_j}N_{i\ell}\gamma_i\rho_{i\ell}\frac{1+\tau_j}{1+\tau_\ell}$$

$$-\sum_{m\in\mathcal{J}}\alpha_{im}\chi_m\left(\mathbb{I}\left[a\in\mathcal{A}_m\right]-N_{im}\right)\frac{1}{N_m}\frac{\partial N_m}{\partial\log\left(1+\tau_j\right)}\Bigg) \tag{B.56}$$

B.3.3 Expected Mass of Households in a Location

Let $\mathcal{A}=\{1,2,\ldots,\overline{a}\}$ and $\mathcal{J}=\left\{1,2,\ldots,\overline{j}\right\}$ be the sets of, respectively, areas and jurisdictions in a metropolitan area. Let $\boldsymbol{N}\equiv[N_1,N_2,\ldots,N_{\overline{a}}]'\in\mathbb{R}^{|\mathcal{A}|}$ be the vector that stacks location choice masses, with $N_a=\int_{\mathcal{D}}N_{ia}\left(\delta_{ij}\right)dF\left(\delta_{ij}\right)$ for any $a\in\mathcal{A}$. Let $\boldsymbol{W}\equiv\left[N_1,N_2,\ldots,N_{\overline{j}}\right]'\in\mathbb{R}^{|\mathcal{J}|}$ be the vector that stacks jurisdiction masses, with $N_j=\sum_{a\in\mathcal{J}_a}N_a$.

Let $\boldsymbol{J}_i\in\mathbb{R}^{|\mathcal{A}|\times|\mathcal{A}|}$ be the Jacobian matrix that stores the partial derivatives of household i's choice probabilities with respect to their individual utilities across locations. That is, each element of $\boldsymbol{J}_i$ is

$$\boldsymbol{J}_{ia\ell}\equiv\frac{\partial N_{ia}}{\partial v_{i\ell}}=\frac{N_{ia}}{\theta}\left(\mathbb{I}\left[a=\ell\right]-N_{i\ell}\right) \tag{B.57}$$

Let $\boldsymbol{C}_i\in\mathbb{R}^{|\mathcal{A}|\times|\mathcal{J}|}$ be the matrix that stores the negative partial derivatives of household i's utility in a location with respect to the mass of households across jurisdictions. That is, each element of $\boldsymbol{C}_i$ is

$$\boldsymbol{C}_{i\ell m}\equiv-\frac{\partial v_{i\ell}}{\partial\log N_m}=\alpha_{im}\chi_m\mathbb{I}\left[m\in\mathcal{J}_\ell\right] \tag{B.58}$$

Let $\boldsymbol{B}_i^{(X)}\in\mathbb{R}^{|\mathcal{A}|}$ be the matrix that stores the partial derivatives of household i's utility in a location with respect to the logarithm of an endogenous variable across locations. That is, for $X \in \{G_j, P_a, 1+\tau_j\}$, each element of $\boldsymbol{B}_i$ is

$$\boldsymbol{B}_{i\ell}^{(X)} \equiv \frac{\partial v_{i\ell}}{\partial \log X} \tag{B.59}$$

Specifically,

$$\boldsymbol{B}_{i\ell}^{(G_j)} \equiv \frac{\partial v_{i\ell}}{\partial \log G_j} = \alpha_{ij}\mathbb{I}\left[j \in \mathcal{J}_\ell\right] \tag{B.60}$$

$$\boldsymbol{B}_{i\ell}^{(P_a)} \equiv \frac{\partial v_{i\ell}}{\partial \log P_a} = -\gamma_i \rho_{ia}\mathbb{I}\left[a = \ell\right] \tag{B.61}$$

$$\boldsymbol{B}_{i\ell}^{(1+\tau_j)} \equiv \frac{\partial v_{i\ell}}{\partial \log\left(1+\tau_j\right)} = -\gamma_i \rho_{i\ell}\frac{1+\tau_j}{1+\tau_\ell}\mathbb{I}\left[j \in \mathcal{J}_\ell\right] \tag{B.62}$$

Given these vectors and matrices, the partial derivatives of household i's choice probabilities with respect to jurisdiction masses can be compactly expressed as $\boldsymbol{M}_i \equiv \boldsymbol{J}_i \boldsymbol{C}_i \in \mathbb{R}^{|\mathcal{A}|\times|\mathcal{J}|}$. That is, each element of $\boldsymbol{M}_i$ is

$$\boldsymbol{M}_{iam} \equiv -\sum_{\ell \in \mathcal{A}} \frac{\partial N_{ia}}{\partial v_{i\ell}} \frac{\partial v_{i\ell}}{\partial \log N_m} \tag{B.63}$$

Analogously, the partial derivatives of household i's choice probabilities with respect to the endogenous variables, net of congestion effects, can be compactly expressed as $\boldsymbol{L}_i^{(X)} \equiv \boldsymbol{J}_i \boldsymbol{B}_i^{(X)} \in \mathbb{R}^{|\mathcal{A}|}$. That is, each element of $\boldsymbol{L}_i^{(X)}$ is

$$\boldsymbol{L}_{ia}^{(X)} \equiv \sum_{\ell \in \mathcal{A}} \frac{\partial N_{ia}}{\partial v_{i\ell}} \frac{\partial v_{i\ell}}{\partial \log X} \tag{B.64}$$

Integrating over the distribution of the unobserved parameters yields

$$\boldsymbol{M} \equiv \int_{\mathcal{D}} \boldsymbol{M}_i\left(\delta_i\right) dF\left(\delta_i\right) \in \mathbb{R}^{|\mathcal{A}|\times|\mathcal{J}|} \qquad \boldsymbol{L}^{(X)} \equiv \int_{\mathcal{D}} \boldsymbol{L}_i^{(X)}\left(\delta_i\right) dF\left(\delta_i\right) \in \mathbb{R}^{|\mathcal{A}|} \tag{B.65}$$

Define a matrix $\boldsymbol{P} \in \{0,1\}^{|\mathcal{J}|\times|\mathcal{A}|}$ in which the (m,ℓ) element is equal to one if $\ell \in \mathcal{A}_m$. Formally,

$$\boldsymbol{P}_{m\ell} \equiv \mathbb{I}\left[\ell \in \mathcal{A}_m\right] \tag{B.66}$$

Clearly, $\boldsymbol{W} = \boldsymbol{P}\boldsymbol{N}$. Further define a matrix $\boldsymbol{Q} \equiv \operatorname{diag}\left(\boldsymbol{W}_1^{-1}, \boldsymbol{W}_2^{-1}, \ldots, \boldsymbol{W}_{\bar{j}}^{-1}\right)\boldsymbol{P} \in \mathbb{R}^{|\mathcal{J}|\times|\mathcal{A}|}$. Let $\boldsymbol{D}^{(X)} \in \mathbb{R}^{|\mathcal{A}|}$ be a vector that stacks the partial derivatives of jurisdiction masses with respect to the endogenous variables. That is, each element of $\boldsymbol{D}^{(X)}$ is

$$\boldsymbol{D}_\ell^{(X)} \equiv \frac{\partial N_\ell}{\partial \log X} \tag{B.67}$$

Pre-multiplying $\boldsymbol{D}^{(X)}$ by $\boldsymbol{Q}$ yields a $|\mathcal{J}|$-dimensional vector that stores the partial derivatives of logged jurisdiction masses with respect to the endogenous variables of the model. Specifically, the mth element of $\boldsymbol{Q}\boldsymbol{D}^{(X)} \in \mathbb{R}^{|\mathcal{J}|}$ is

$$\left(\boldsymbol{Q}\boldsymbol{D}^{(X)}\right)_m \equiv \frac{1}{N_m}\frac{\partial N_m}{\partial \log X} \tag{B.68}$$

The equilibrium system of equations is the following:

$$\begin{aligned}\boldsymbol{D}^{(X)} = \boldsymbol{L}^{(X)} - \boldsymbol{M}\boldsymbol{Q}\boldsymbol{D}^{(X)} &\iff \left(\boldsymbol{I}_{|\mathcal{A}|} + \boldsymbol{M}\boldsymbol{Q}\right)\boldsymbol{D}^{(X)} = \boldsymbol{L}^{(X)} \\ &\iff \boldsymbol{D}^{(X)} = \left(\boldsymbol{I}_{|\mathcal{A}|} + \boldsymbol{M}\boldsymbol{Q}\right)^{-1}\boldsymbol{L}^{(X)}\end{aligned} \tag{B.69}$$

B.3.4 Partial Derivatives for the Slope of the Government Possibility Frontier

Recall that

$$J_a \equiv \lambda + \eta \log P_a + B_a - \log N_a \tag{B.70}$$

$$K_j \equiv \log\left(\tau_j \sum_{\ell\in\mathcal{A}_j} P_\ell N_\ell + I_j\right) - \log G_j \tag{B.71}$$

As a consequence, the partial derivatives associated with the original system of equations can be rewritten as follows:

$$\frac{\partial J_a}{\partial \log G_j} = -\frac{\boldsymbol{D}_a^{(G_j)}}{N_a} \quad \text{for any } j \in \mathcal{J}_a \tag{B.72}$$

$$\frac{\partial J_a}{\partial \log P_a} = \eta - \boldsymbol{D}_a^{(P_a)} \tag{B.73}$$

$$\frac{\partial J_a}{\partial \log\left(1+\tau_j\right)} = -\frac{\boldsymbol{D}_a^{(1+\tau_j)}}{N_a} \quad \text{for any } j \in \mathcal{J}_a \tag{B.74}$$

In addition,

$$\frac{\partial K_j}{\partial \log G_m} = \frac{\tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell \boldsymbol{D}_\ell^{(G_j)}}{\tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + I_j} - \mathbb{I}\left[m = j\right] \quad \text{for } m \in \mathcal{J}_a \tag{B.75}$$

$$\frac{\partial K_j}{\partial \log P_a} = \frac{\tau_j P_a N_a + \tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell \boldsymbol{D}_\ell^{(P_a)}}{\tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + I_j} \quad \text{for } a \in \mathcal{A}_j \tag{B.76}$$

$$\frac{\partial K_j}{\partial \log\left(1+\tau_m\right)} = \frac{\left(1+\tau_j\right) \sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + \tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell \boldsymbol{D}_\ell^{(1+\tau_m)}}{\tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + I_j} \mathbb{I}\left[m = j\right] \quad \text{for } m \in \mathcal{J}_a \tag{B.77}$$

B.3.5 Partial Derivatives for the Slope of the GPF with Myopic Voting

The assumption of myopic voting entails that voters perceive jurisdiction boundaries as fixed and do not account for the mobility implications of a change in local expenditures and taxes. As a consequence, all of the terms involving a partial derivative of N_a are set to zero. The resulting partial derivatives from the previous section change as follows. For any location a,

$$\frac{\partial J_a}{\partial \log G_j} = 0 \quad \text{for any } j \in \mathcal{J}_a \tag{B.78}$$

$$\frac{\partial J_a}{\partial \log P_a} = \eta \tag{B.79}$$

$$\frac{\partial J_a}{\partial \log\left(1+\tau_j\right)} = 0 \quad \text{for any } j \in \mathcal{J}_a \tag{B.80}$$

In addition,

$$\frac{\partial K_j}{\partial \log G_m} = -\mathbb{I}\left[m = j\right] \quad \text{for } m \in \mathcal{J}_a \tag{B.81}$$

$$\frac{\partial K_j}{\partial \log P_a} = \frac{\tau_j P_a N_a}{\tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + I_j} \quad \text{for } a \in \mathcal{A}_j \tag{B.82}$$

$$\frac{\partial K_j}{\partial \log\left(1+\tau_m\right)} = \frac{\left(1+\tau_j\right) \sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell}{\tau_j \sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + I_j} \mathbb{I}\left[m = j\right] \quad \text{for } m \in \mathcal{J}_a \tag{B.83}$$

B.3.6 The Slope of the Government Possibility Frontier

Consider a voter who resides in area a and chooses their preferred level of government spending in jurisdiction $j \in \mathcal{J}_a$. Let $\mathcal{J}_a = \left\{1, \ldots, j, \ldots, \bar{j}\right\}$. In matrix form, the system of equations implied by the budget balance and housing market clearing conditions is

$$\begin{bmatrix} J_{ap} & J_{a\tau_1} & \dots & J_{a\tau_j} & \dots & J_{a\tau_{\bar{j}}} \\ K_{1p} & K_{1\tau_1} & \dots & K_{1\tau_j} & \dots & K_{1\tau_{\bar{j}}} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ K_{jp} & K_{j\tau_1} & \dots & K_{j\tau_j} & \dots & K_{j\tau_{\bar{j}}} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ K_{\bar{j}p} & K_{\bar{j}\tau_1} & \dots & K_{\bar{j}\tau_j} & \dots & K_{\bar{j}\tau_{\bar{j}}} \end{bmatrix} \begin{bmatrix} dp_a/dg_j \\ d\tau_1/dg_j \\ \vdots \\ d\tau_j/dg_j \\ \vdots \\ d\tau_{\bar{j}}/dg_j \end{bmatrix} = \begin{bmatrix} -J_{ag_j} \\ -K_{1g_j} \\ \vdots \\ -K_{jg_j} \\ \vdots \\ -K_{\bar{j}g_j} \end{bmatrix} \tag{B.84}$$

where the matrix of known coefficients is the Jacobian associated with the housing market clearing and balanced budget conditions. In addition, the unknowns are defined as $dg_j \equiv d\log G_j$, $dp_a \equiv d\log P_a$, and $d\tau_j \equiv d\log(1+\tau_j)$.

B.3.7 The Slope of the GPF with Myopic Voting

Under the assumption of myopic voting, the system of equations in (B.84) becomes

$$\begin{bmatrix} J_{ap} & 0 & \dots & 0 & \dots & 0 \\ K_{1p} & K_{1\tau_1} & \dots & 0 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ K_{jp} & 0 & \dots & K_{j\tau_j} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ K_{\bar{j}p} & 0 & \dots & 0 & \dots & K_{\bar{j}\tau_{\bar{j}}} \end{bmatrix} \begin{bmatrix} dp_a/dg_j \\ d\tau_1/dg_j \\ \vdots \\ d\tau_j/dg_j \\ \vdots \\ d\tau_{\bar{j}}/dg_j \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ -K_{jg_j} \\ \vdots \\ 0 \end{bmatrix} \tag{B.85}$$

To derive a closed-form expression for the solution to this system, consider the housing market clearing condition in location a:

$$J_{ap}\frac{dp_a}{dg_j} = 0 \iff \eta\frac{dp_a}{dg_j} = 0 \iff \frac{dp_a}{dg_j} = 0 \tag{B.86}$$

For any jurisdiction $m \in \mathcal{J}_a$, the balanced budget equation is the following:

$$K_{mp}\frac{dp_a}{dg_j} + K_{m\tau_m}\frac{d\tau_m}{dg_j} = -K_{mg_j} \iff \frac{d\tau_m}{dg_j} = -\frac{K_{mg_j}}{K_{m\tau_m}} \tag{B.87}$$

The previously computed partial derivatives can now be used to determine the total derivative of the rental rate of housing with respect to government spending:

$$\frac{d\log P_a}{d\log G_j} = 0 \tag{B.88}$$

Similarly, the total derivative of the property tax rate with respect to government spending is

$$\frac{d\log\left(1+\tau_m\right)}{d\log G_j} = \frac{\tau_j \sum_{\ell\in\mathcal{A}_j} P_\ell N_\ell + I_j}{\left(1+\tau_j\right)\sum_{\ell\in\mathcal{A}_j} P_\ell N_\ell}\mathbb{I}\left[m=j\right] \tag{B.89}$$

B.4 Preferred Property Tax Rates

The goal of this section is to derive the property tax rate preferred by household i residing in area a for jurisdiction j.

B.4.1 First-Order Conditions

Consider a myopic voter in area a choosing their preferred level of government spending on the public good provided by jurisdiction $j \in \mathcal{J}_a$. The derivative of household i's indirect utility function with respect to government spending is

$$\frac{dV_{ia}}{d\log G_j} = \alpha_{ij} - \gamma_i\rho_{ia}\frac{1+\tau_j}{1+\tau_a}\frac{d\log\left(1+\tau_j\right)}{d\log G_j} \tag{B.90}$$

As in equation (11), the first-order condition associated with the implied maximization problem is

$$\alpha_{ij} = \gamma_i\rho_{ia}\frac{1+\tau_j}{1+\tau_a}\frac{d\log\left(1+\tau_j\right)}{d\log G_j}\bigg|_{G_j=G_{jia}} \tag{B.91}$$

The property tax component of the marginal cost of increasing government spending is

$$\gamma_i\rho_{ia}\frac{1+\tau_j}{1+\tau_a}\frac{d\log\left(1+\tau_j\right)}{d\log G_j} = \gamma_i\rho_{ia}\frac{1+\tau_j}{1+\tau_a}\frac{\tau_j \sum_{\ell\in\mathcal{A}_j} P_\ell N_\ell + I_j}{\left(1+\tau_j\right)\sum_{\ell\in\mathcal{A}_j} P_\ell N_\ell} \tag{B.92}$$

$$= \gamma_i \rho_{ia} \frac{\tau_j}{1+\tau_a} \frac{\sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + I_j}{\sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell} \tag{B.93}$$

Replacing the two derivatives with the expressions derived in the previous section yields

$$\alpha_{ij} = \gamma_i \rho_{ia} \frac{\tau_j}{1+\tau_a} \frac{\sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + I_j}{\sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell} \tag{B.94}$$

This first-order condition is evaluated at $\tau_j = \tau_{jia}$, jurisdiction j's property tax rate preferred by household i residing in area $a \in \mathcal{A}_j$. For compactness, define

$$\Psi_{aj} \equiv \frac{\sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell}{\sum_{\ell \in \mathcal{A}_j} P_\ell N_\ell + I_j} \tag{B.95}$$

Then the first-order condition becomes

$$\alpha_{ij} = \frac{\gamma_i \rho_{ia}}{\Psi_{aj}} \frac{\tau_j}{1+\tau_a} \tag{B.96}$$

B.4.2 Preferred Property Tax Rates

The set of preferred property tax rates for household i in area a is the solution to the system of $|\mathcal{J}_a|$ equations implied by the first-order conditions in (B.96):

$$\alpha_{ij} = \frac{\gamma_i \rho_{ia}}{\Psi_{aj}} \frac{\tau_j}{1+\tau_a} \tag{B.97}$$

$$\iff \alpha_{ij} \Psi_{aj} (1+\tau_a) = \gamma_i \rho_{ia} \tau_j \tag{B.98}$$

$$\iff \alpha_{ij} \Psi_{aj} \left(1 + \sum_{m \neq j} \tau_m \right) = (\gamma_i \rho_{ia} - \alpha_{ij} \Psi_{aj}) \tau_j \tag{B.99}$$

$$\iff \alpha_{ij} \Psi_{aj} = -\alpha_{ij} \Psi_{aj} \sum_{m \neq j} \tau_m + (\gamma_i \rho_{ia} - \alpha_{ij} \Psi_{aj}) \tau_j \tag{B.100}$$

The solution is, for any j,

$$\tau_j = \frac{\alpha_{ij} \Psi_{aj}}{\gamma_i \rho_{ia} - \sum_{m \in \mathcal{J}_a} \alpha_{im} \Psi_{am}} \tag{B.101}$$

B.4.3 Second-Order Conditions

The goal of this section is to determine whether τ_{jia} is indeed a maximizer of V_{ia}. Replacing equation (B.96) into equation (B.102) yields a compact expression for the first derivative of the indirect utility:

$$\frac{dV_{ia}}{d\log G_j} = \alpha_{ij} - \frac{\gamma_i \rho_{ia}}{\Psi_{aj}} \frac{\tau_j}{1+\tau_a} \tag{B.102}$$

By two applications of the chain rule, the second derivative of the indirect utility is

$$\begin{aligned}
\frac{d^2 V_{ia}}{d\left(\log G_j\right)^2} &= \frac{\partial \frac{dV_{ia}}{d\log G_j}}{\partial \tau_j} \frac{d\tau_j}{d\log G_j} + \frac{\partial \frac{dV_{ia}}{d\log G_j}}{\partial \log G_j} && \text{(B.103)}\\
&= \gamma_i \rho_{ia} \frac{1+\tau_a-\tau_j}{\left(1+\tau_a\right)^2} \frac{\sum_{\ell\in\mathcal{A}_j} P_\ell N_\ell + I_j}{\sum_{\ell\in\mathcal{A}_j} P_\ell N_\ell} && \text{(B.104)}\\
&= \frac{\partial \frac{dV_{ia}}{d\log G_j}}{\partial \tau_j} \left(1+\tau_j\right) \frac{d\log\left(1+\tau_j\right)}{d\log G_j} && \text{(B.105)}
\end{aligned}$$

First,

$$\frac{\partial \frac{dV_{ia}}{d\log G_j}}{\partial \tau_j} = -\frac{\gamma_i \rho_{ia}}{\Psi_{aj}} \frac{1+\tau_a-\tau_j}{1+\tau_a} < 0 \tag{B.106}$$

Also recall that

$$\frac{d\log\left(1+\tau_j\right)}{d\log G_j} = \frac{1}{\left(1+\tau_j\right)\Psi_{aj}} > 0 \tag{B.107}$$

Combining these expressions, the second derivative of V_{ia} with respect to $\log G_j$ is

$$\frac{\partial \frac{dV_{ia}}{d\log G_j}}{\partial \tau_j} \left(1+\tau_j\right) \frac{d\log\left(1+\tau_j\right)}{d\log G_j} = -\frac{\gamma_i \rho_{ia}}{\Psi_{aj}} \frac{1+\tau_a-\tau_j}{1+\tau_a} \frac{1}{\left(1+\tau_j\right)\Psi_{aj}} < 0 \tag{B.108}$$

which is negative. Thus, the indirect utility V_{ia} is a strictly concave function of $\log G_j$ and τ_{jia} attains the unique global maximum of V_{ia}.

B.4.4 Comparative Statics

In this section, I check how the preferred tax rate varies as a function of parameter values. I focus on the preference for government spending $\{\alpha_{ij}\}_{j\in\mathcal{J}_a}$ and the preference for nonhousing consumption goods γ_i. As shown in equation (B.101), the property tax rate preferred by household i residing in area a for jurisdiction j is

$$\tau_{jia} = \frac{\alpha_{ij}\Psi_{aj}}{\gamma_i\rho_{ia} - \sum_{m\in\mathcal{J}_a}\alpha_{im}\Psi_{am}} \tag{B.109}$$

First, consider the derivative of τ_{jia} with respect to α_{ij}:

$$\frac{d\tau_{jia}}{d\alpha_{ij}} = \Psi_{aj}\frac{\gamma_i\rho_{ia} - \sum_{m\neq j}\alpha_{im}\Psi_{am}}{\left(\gamma_i\rho_{ia} - \sum_{m\in\mathcal{J}_a}\alpha_{im}\Psi_{am}\right)^2} > 0 \tag{B.110}$$

Second, the derivative of τ_{jia} with respect to the preference for government spending in a different jurisdiction α_{ik}, with $k \neq j$, is

$$\frac{d\tau_{jia}}{d\alpha_{ik}} = \frac{\alpha_{ij}\Psi_{aj}\Psi_{ak}}{\left(\gamma_i\rho_{ia} - \sum_{m\in\mathcal{J}_a}\alpha_{im}\Psi_{am}\right)^2} > 0 \tag{B.111}$$

Third, consider the derivative of τ_{jia} with respect to the preference for consumption of nonhousing goods:

$$\frac{d\tau_{jia}}{d\gamma_i} = -\frac{\alpha_{ij}\Psi_{aj}\rho_{ia}}{\left(\gamma_i\rho_{ia} - \sum_{m\in\mathcal{J}_a}\alpha_{im}\Psi_{am}\right)^2} < 0 \tag{B.112}$$

C Identification of Model Parameters

This section outlines how I identify the structural parameters of the spatial equilibrium model using regression discontinuity designs.

C.1 Outcome Elasticities with respect to Expenditure Changes

First, I compute the elasticity of any equilibrium variable at location $\ell \in \mathcal{J}$ with respect to school district j's expenditure change G_j. Unlike derivations pertaining to the Government

Possibility Frontier, I consider the response of all equilibrium variables to a discrete change in government spending.

C.1.1 Mass of Households

The expected mass of households who choose location a is

$$N_a^k = \sigma^k \frac{\exp\left(v_a^k/\theta^k\right)}{1 + \sum_{\ell \in \mathcal{A}} \exp\left(v_\ell^k/\theta^k\right)} \tag{C.113}$$

where σ^k denotes the mass of type-k households in the economy and

$$v_\ell^k \equiv \overline{A}_\ell + \sum_{j \in \mathcal{J}_\ell} \alpha_j^k \left[\log G_j - \chi_j \log N_j\right] + \gamma^k \log\left[y^k - P_\ell\left(1 + \sum_{j \in \mathcal{J}_\ell} \tau_j\right)\right] \tag{C.114}$$

I wish to derive an expression for the difference between logged population mass in location $a \in \mathcal{A}$ with and without referendum approval in jurisdiction $j \in \mathcal{J}_a$:

$$\Delta \log N_a^k \equiv \log N_a^k \left(\Delta G_j\right) - \log N_a^k \left(0\right) \tag{C.115}$$

where ΔG_j is the proposed expenditure hike on which residents vote. To keep notation compact, I express potential outcomes as functions of a binary treatment state indicating referendum approval, so that $\Delta \log N_a^k \equiv \log N_a^k (1) - \log N_a^k (0)$. Then

$$\begin{aligned}
\Delta \log N_a^k &= \log \sigma^k + \frac{v_a^k(1)}{\theta^k} - \log\left(1 + \sum_{\ell \in \mathcal{A}} \exp\left(\frac{v_\ell^k(1)}{\theta^k}\right)\right) \\
&\quad - \log \sigma^k - \frac{v_a^k(0)}{\theta^k} + \log\left(1 + \sum_{\ell \in \mathcal{A}} \exp\left(\frac{v_\ell^k(0)}{\theta^k}\right)\right) && \text{(C.116)} \\
&= \frac{\Delta v_a^k}{\theta^k} \\
&\quad - \left(\log\left(1 + \sum_{\ell \in \mathcal{A}} \exp\left(\frac{v_\ell^k(1)}{\theta^k}\right)\right) - \log\left(1 + \sum_{\ell \in \mathcal{A}} \exp\left(\frac{v_\ell^k(0)}{\theta^k}\right)\right)\right) && \text{(C.117)} \\
&= \frac{\Delta v_a^k}{\theta^k} - \left(\log Z^k(1) - \log Z^k(0)\right) && \text{(C.118)}
\end{aligned}$$

Next, I derive a second-order-accurate approximation to the utility difference Δv_a^k. For any $t \in [0,1]$,

$$\log P_a(t) = \log P_a(0) + t\left[\log P_a(1) - \log P_a(0)\right] \tag{C.119}$$

$$\log(1+\tau_j(t)) = \log(1+\tau_j(0)) + t\left[\log(1+\tau_j(1)) - \log(1+\tau_j(0))\right] \tag{C.120}$$

Define $\rho_a^k \equiv \frac{P_a(1+\tau_a)}{y^k - P_a(1+\tau_a)}$. Also define

$$\rho_a^k(t) \equiv \frac{P_a(t)(1+\tau_a(t))}{y^k - P_a(t)(1+\tau_a(t))} \qquad r_{aj}(t) \equiv \frac{1+\tau_j(t)}{1+\tau_a(t)} \tag{C.121}$$

Clearly, $\rho_a^k(t) = \rho_a^k(0)$ if $t=0$ and $\rho_a^k(t) = \rho_a^k(1)$ if $t=1$, and analogously for $r_{aj}(t)$. Then

$$\begin{aligned}
&\Delta\left\{\gamma^k \log\left[y^k - P_a\left(1 + \sum_{j\in\mathcal{J}_a}\tau_j\right)\right]\right\} \\
&= -\gamma^k \int_0^1 \rho_a^k(t)\,\Delta\log P_a dt - \gamma^k \int_0^1 \rho_a^k(t) \sum_{j\in\mathcal{J}_a} r_{aj}(t)\,\Delta\log(1+\tau_j)\,dt && \text{(C.122)}\\
&= -\gamma^k\left(\int_0^1 \rho_a^k(t)\,dt\right)\Delta\log P_a - \gamma^k \sum_{j\in\mathcal{J}_a}\left(\int_0^1 \rho_a^k(t)\,r_{aj}(t)\,dt\right)\Delta\log(1+\tau_j) && \text{(C.123)}
\end{aligned}$$

The first equality exploits the Fundamental Theorem of Calculus. In addition, define the mean-value budget share and tax rate ratio as, respectively,

$$\overline{\rho}_a^k \equiv \int_0^1 \rho_a^k(t)\,dt \qquad (\overline{\rho r})_{aj}^k \equiv \int_0^1 \rho_a^k(t)\,r_{aj}(t)\,dt \tag{C.124}$$

To summarize,

$$\begin{aligned}
&\Delta\left\{\gamma^k \log\left[y^k - P_a\left(1 + \sum_{j\in\mathcal{J}_a}\tau_j\right)\right]\right\} \\
&= -\gamma^k \overline{\rho}_a^k \Delta\log P_a - \gamma^k \sum_{j\in\mathcal{J}_a} (\overline{\rho r})_{aj}^k\,\Delta\log(1+\tau_j) && \text{(C.125)}
\end{aligned}$$

Because $\rho_a^k(t)$ is continuous on $[0,1]$, the mean-value theorem for integrals states that there exists a point $t_a^* \in (0,1)$ such that $\rho_a^k(t_a^*) = \overline{\rho}_a^k$. The same is true for $r_{aj}(t)$. A solution that is both second-order-accurate and pragmatic is the mid-point value, i.e., $t = 0.5$. Thus, define

$$\widetilde{\rho}_a^k \equiv \frac{\widetilde{P}_a (1+\widetilde{\tau}_a)}{y^k - \widetilde{P}_a (1+\widetilde{\tau}_a)} \approx \overline{\rho}_a^k \qquad \widetilde{\rho}_a^k \widetilde{r}_{aj} \equiv \widetilde{\rho}_a^k \frac{1+\widetilde{\tau}_j}{1+\widetilde{\tau}_a} \approx (\overline{\rho r})_{aj}^k \tag{C.126}$$

with

$$\widetilde{P}_a \equiv \sqrt{P_a(0)\, P_a(1)} \tag{C.127}$$

$$\widetilde{\tau}_j \equiv \sqrt{(1+\tau_j(0))\,(1+\tau_j(1))} - 1 \tag{C.128}$$

$$\widetilde{\tau}_a \equiv \sum_{j \in \mathcal{J}_a} \widetilde{\tau}_j \tag{C.129}$$

Combining previous derivations,

$$\begin{aligned} \frac{\Delta v_a^k}{\theta^k} \approx & \sum_{j \in \mathcal{J}_a} \frac{\alpha_j^k}{\theta^k} \left(\Delta \log G_j - \chi_j \Delta \log N_j\right) \\ & - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \Delta \log P_a - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \sum_{j \in \mathcal{J}_a} \widetilde{r}_{aj} \Delta \log (1+\tau_j) \end{aligned} \tag{C.130}$$

Next, I derive a second-order-accurate approximation to the difference between population mass denominators ΔZ^k. For any $t \in [0, 1]$,

$$v_\ell^k(t) = v_\ell^k(0) + t\left[v_\ell^k(1) - v_\ell^k(0)\right] \tag{C.131}$$

and define

$$Z^k(t) \equiv 1 + \sum_{\ell \in \mathcal{A}} \exp\left(\frac{v_\ell^k(t)}{\theta^k}\right) \tag{C.132}$$

Clearly, $Z^k(t) = Z^k(0)$ if $t = 0$ and $Z^k(t) = Z^k(1)$ if $t = 1$. Then

$$\begin{aligned} & \log Z^k(1) - \log Z^k(0) \\ & = \int_0^1 \frac{d}{dt} \log Z^k(t)\, dt \qquad \text{(C.133)} \\ & = \int_0^1 \frac{1}{Z^k(t)} \sum_{\ell \in \mathcal{A}} \exp\left(\frac{v_\ell^k(t)}{\theta^k}\right) \frac{v_\ell^k(1) - v_\ell^k(0)}{\theta^k} dt \qquad \text{(C.134)} \end{aligned}$$

$$= \int_0^1 \sum_{\ell \in \mathcal{A}} \frac{N_\ell^k(t)}{\sigma^k} \frac{v_\ell^k(1) - v_\ell^k(0)}{\theta^k} dt \tag{C.135}$$

$$= \sum_{\ell \in \mathcal{A}} \frac{v_\ell^k(1) - v_\ell^k(0)}{\theta^k} \int_0^1 \frac{N_\ell^k(t)}{\sigma^k} dt \tag{C.136}$$

$$= \sum_{\ell \in \mathcal{A}} \frac{\Delta v_\ell^k}{\theta^k} \int_0^1 \frac{N_\ell^k(t)}{\sigma^k} dt \tag{C.137}$$

The first equality exploits the Fundamental Theorem of Calculus. The second equality follows from an application of the chain rule. The third equality defines $N_\ell^k(t) \equiv \sigma^k \frac{\exp\left(\frac{v_\ell^k(t)}{\theta^k}\right)}{1+\sum_{m\in\mathcal{A}} \exp\left(\frac{v_m^k(t)}{\theta^k}\right)}$. In addition, define the mean-value population mass in location ℓ as

$$\overline{N}_\ell^k \equiv \int_0^1 N_\ell^k(t)\, dt \tag{C.138}$$

To summarize,

$$\log Z^k(1) - \log Z^k(0) = \sum_{\ell \in \mathcal{A}} \frac{\overline{N}_\ell^k}{\sigma^k} \frac{\Delta v_\ell^k}{\theta^k} \tag{C.139}$$

Because $N_\ell^k(t)$ is continuous on $[0,1]$, the mean-value theorem for integrals states that there exists a point $t_\ell^* \in (0,1)$ such that $N_\ell^k(t_\ell^*) = \overline{N}_\ell^k$. A solution that is both second-order-accurate and pragmatic is the mid-point value:

$$\overline{N}_\ell^k \approx \frac{N_\ell^k(0) + N_\ell^k(1)}{2} \equiv \widetilde{N}_\ell^k \tag{C.140}$$

Combining previous derivations,

$$\begin{aligned}
&\log Z^k(1) - \log Z^k(0) \\
&\approx \sum_{\ell \in \mathcal{A}} \frac{N_\ell^k(0) + N_\ell^k(1)}{2\sigma^k} \frac{\Delta v_\ell^k}{\theta^k} && \text{(C.141)} \\
&\approx \sum_{\ell \in \mathcal{A}} \frac{\widetilde{N}_\ell^k}{\sigma^k} \left(\sum_{m \in \mathcal{J}_\ell} \frac{\alpha_m^k}{\theta^k} (\Delta \log G_m - \chi_m \Delta \log N_m) \right. \\
&\left. - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \Delta \log P_\ell - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \sum_{m \in \mathcal{J}_\ell} \widetilde{r}_{\ell m} \Delta \log (1 + \tau_m) \right) && \text{(C.142)}
\end{aligned}$$

The difference between log household supply in the two treatment states is

$$
\begin{aligned}
&\Delta \log N_a^k \\
&\approx \sum_{j \in \mathcal{J}_a} \frac{\alpha_j^k}{\theta^k} \left(\Delta \log G_j - \chi_j \Delta \log N_j\right) - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \Delta \log P_a - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \sum_{j \in \mathcal{J}_a} \widetilde{r}_{aj} \Delta \log \left(1 + \tau_j\right) \\
&- \sum_{\ell \in \mathcal{A}} \frac{\widetilde{N}_\ell^k}{\sigma^k} \left(\sum_{m \in \mathcal{J}_\ell} \frac{\alpha_m^k}{\theta^k} \left(\Delta \log G_m - \chi_m \Delta \log N_m\right) \right. \\
&\left. - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \Delta \log P_\ell - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \sum_{m \in \mathcal{J}_\ell} \widetilde{r}_{\ell m} \Delta \log \left(1 + \tau_m\right) \right)
\end{aligned} \tag{C.143}
$$

Finally, we divide both sides by the proposed change in log school district spending:

$$
\begin{aligned}
&\frac{\Delta \log N_a^k}{\Delta \log G_j} \\
&\approx \sum_{m \in \mathcal{J}_a} \frac{\alpha_m^k}{\theta^k} \left(\frac{\Delta \log G_m}{\Delta \log G_j} - \chi_m \frac{\Delta \log N_m}{\Delta \log G_j} \right) - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \frac{\Delta \log P_a}{\Delta \log G_j} - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \sum_{m \in \mathcal{J}_a} \widetilde{r}_{am} \frac{\Delta \log \left(1 + \tau_m\right)}{\Delta \log G_j} \\
&- \sum_{\ell \in \mathcal{A}} \frac{\widetilde{N}_\ell^k}{\sigma^k} \left(\sum_{q \in \mathcal{J}_\ell} \frac{\alpha_q^k}{\theta^k} \left(\frac{\Delta \log G_q}{\Delta \log G_j} - \chi_q \frac{\Delta \log N_q}{\Delta \log G_j} \right) \right. \\
&\left. - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \frac{\Delta \log P_\ell}{\Delta \log G_j} - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \sum_{q \in \mathcal{J}_\ell} \widetilde{r}_{\ell q} \frac{\Delta \log \left(1 + \tau_q\right)}{\Delta \log G_j} \right)
\end{aligned} \tag{C.144}
$$

$$
\begin{aligned}
&= \left(1 - \frac{\widetilde{N}_a^k}{\sigma^k}\right) \left(\sum_{m \in \mathcal{J}_a} \frac{\alpha_m^k}{\theta^k} \frac{\Delta \log G_m}{\Delta \log G_j} - \sum_{m \in \mathcal{J}_a} \frac{\alpha_m^k \chi_m}{\theta^k} \frac{\Delta \log N_m}{\Delta \log G_j} \right. \\
&\left. - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \frac{\Delta \log P_a}{\Delta \log G_j} - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \sum_{m \in \mathcal{J}_a} \widetilde{r}_{am} \frac{\Delta \log \left(1 + \tau_m\right)}{\Delta \log G_j} \right) \\
&- \sum_{\ell \neq a} \frac{\widetilde{N}_\ell^k}{\sigma^k} \left(\sum_{q \in \mathcal{J}_\ell} \frac{\alpha_q^k}{\theta^k} \frac{\Delta \log G_q}{\Delta \log G_j} - \sum_{q \in \mathcal{J}_\ell} \frac{\alpha_q^k \chi_q}{\theta^k} \frac{\Delta \log N_q}{\Delta \log G_j} \right. \\
&\left. - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \frac{\Delta \log P_\ell}{\Delta \log G_j} - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \sum_{q \in \mathcal{J}_\ell} \widetilde{r}_{\ell q} \frac{\Delta \log \left(1 + \tau_q\right)}{\Delta \log G_j} \right)
\end{aligned} \tag{C.145}
$$

C.1.2 Price of a Housing Unit

In any location a, the equilibrium price of one unit of housing is

$$\log P_a = \frac{1}{\eta}\log\sum_{k\in\mathcal{K}} N_a^k - \frac{\lambda}{\eta} - \frac{B_a}{\eta} \tag{C.146}$$

I wish to compute $\Delta \log P_a \equiv \log P_a(1) - \log P_a(0)$. To begin with,

$$\Delta \log P_a = \frac{1}{\eta}\left(\log\sum_{k\in\mathcal{K}} N_a^k(1) - \log\sum_{k\in\mathcal{K}} N_a^k(0)\right) \tag{C.147}$$

Now define

$$M_a(0) \equiv \sum_{k\in\mathcal{K}} N_a^k(0) \qquad M_a(1) \equiv \sum_{k\in\mathcal{K}} N_a^k(1) \tag{C.148}$$

For any $t \in [0,1]$,

$$N_a^k(t) = N_a^k(0) + t\left[N_a^k(1) - N_a^k(0)\right] \tag{C.149}$$

and define

$$M_a(t) \equiv \sum_{k\in\mathcal{K}} N_a^k(t) \tag{C.150}$$

Clearly, $M_a(t) = M_a(0)$ if $t = 0$ and $M_a(t) = M_a(1)$ if $t = 1$. Then

$$\log M_a(1) - \log M_a(0)$$

$$= \int_0^1 \frac{d\log M_a(t)}{dt} dt \tag{C.151}$$

$$= \int_0^1 \frac{1}{M_a(t)} \sum_{k\in\mathcal{K}} \left[N_a^k(1) - N_a^k(0)\right] dt \tag{C.152}$$

$$= \int_0^1 \sum_{k\in\mathcal{K}} \frac{N_a^k(t)}{M_a(t)} \frac{N_a^k(1) - N_a^k(0)}{N_a^k(t)} dt \tag{C.153}$$

$$= \int_0^1 \sum_{k\in\mathcal{K}} \frac{N_a^k(t)}{M_a(t)} \frac{d\log N_a^k(t)}{dt} dt \tag{C.154}$$

$$= \sum_{k\in\mathcal{K}} \int_0^1 \frac{N_a^k(t)}{M_a(t)} \frac{d\log N_a^k(t)}{dt} dt \tag{C.155}$$

$$= \sum_{k\in\mathcal{K}} \Delta\log N_a^k \int_0^1 \frac{N_a^k(t)}{M_a(t)} \frac{d\log N_a^k(t)}{dt} \frac{1}{\Delta\log N_a^k} dt \tag{C.156}$$

The first equality uses the Fundamental Theorem of Calculus. The second and fourth equalities apply the chain rule. The third equality multiplies and divides by $N_a^k(t)$. Now define the mean-value weight as

$$\overline{L}_a^k \equiv \int_0^1 \frac{N_a^k(t)}{M_a(t)} \frac{d\log N_a^k(t)}{dt} \frac{1}{\Delta \log N_a^k} dt \tag{C.157}$$

$$= \int_0^1 \frac{N_a^k(t)}{M_a(t)} \frac{\Delta N_a^k}{N_a^k(t)} \frac{1}{\Delta \log N_a^k} dt \tag{C.158}$$

$$= \int_0^1 \frac{1}{M_a(t)} \frac{\Delta N_a^k}{\Delta \log N_a^k} dt \tag{C.159}$$

$$= \frac{\Delta N_a^k}{\Delta \log N_a^k} \int_0^1 \frac{1}{M_a(t)} dt \tag{C.160}$$

$$= \frac{\Delta N_a^k}{\Delta \log N_a^k} \frac{\Delta \log M_a}{\Delta M_a} \tag{C.161}$$

Thus,

$$\overline{L}_a^k = \frac{\Delta N_a^k}{\Delta M_a} \frac{\Delta \log M_a}{\Delta \log N_a^k} \tag{C.162}$$

To summarize,

$$\log M_a(1) - \log M_a(0) = \sum_{k \in \mathcal{K}} \overline{L}_a^k \Delta \log N_a^k \tag{C.163}$$

Because $N_a^k(t)$ is continuous on $[0,1]$, the mean-value theorem for integrals states that there exists a point $t_a^* \in (0,1)$ such that $\frac{N_a^k(t_a^*)}{M_a(t_a^*)} = \overline{L}_a^k$. A solution that is both second-order-accurate and pragmatic is the mid-point value:

$$\overline{L}_a^k \approx \frac{N_a^k(0) + N_a^k(1)}{\sum_{m \in \mathcal{K}} \left[N_a^m(0) + N_a^m(1)\right]} \equiv \widetilde{L}_a^k \tag{C.164}$$

Combining previous derivations,

$$\log M_a(1) - \log M_a(0) \approx \sum_{k \in \mathcal{K}} \widetilde{L}_a^k \Delta \log N_a^k \tag{C.165}$$

The difference between log inverse housing demand in the two treatment states is

$$\Delta \log P_a \approx \frac{1}{\eta} \sum_{k \in \mathcal{K}} \widetilde{L}_a^k \Delta \log N_a^k \tag{C.166}$$

Finally, I divide both sides by the proposed change in log school district spending:

$$\frac{\Delta \log P_a}{\Delta \log G_j} \approx \frac{1}{\eta} \sum_{k \in \mathcal{K}} \widetilde{L}_a^k \frac{\Delta \log N_a^k}{\Delta \log G_j} \tag{C.167}$$

C.1.3 Number of Housing Units

In any location a, the equilibrium number of housing units is

$$\log H_a = \lambda + \eta \log P_a + B_a \tag{C.168}$$

I wish to compute $\Delta \log H_a \equiv \log H_a(1) - \log H_a(0)$. Trivially,

$$\Delta \log H_a = \eta \Delta \log P_a \tag{C.169}$$

Finally, I divide both sides by the proposed change in log school district spending:

$$\frac{\Delta \log H_a}{\Delta \log G_j} = \eta \frac{\Delta \log P_a}{\Delta \log G_j} \tag{C.170}$$

C.1.4 Jurisdictional Balanced-Budget Condition

In any jurisdiction m, the balanced budget condition is

$$\log \tau_m = \log(G_m + I_m) - \log \sum_{\ell \in \mathcal{A}_m} P_\ell H_\ell \tag{C.171}$$

I wish to compute $\Delta \log \tau_m \equiv \log \tau_m(1) - \log \tau_m(0)$. For any $t \in [0, 1]$, define

$$\log G_m(t) \equiv \log G_m(0) + t(\log G_m(1) - \log G_m(0)) \tag{C.172}$$

$$\log I_m(t) \equiv \log I_m(0) + t(\log I_m(1) - \log I_m(0)) \tag{C.173}$$

$$\log P_\ell(t) \equiv \log P_\ell(0) + t(\log P_\ell(1) - \log P_\ell(0)) \quad \text{for any } \ell \in \mathcal{A}_m \tag{C.174}$$

$$\log H_\ell(t) \equiv \log H_\ell(0) + t(\log H_\ell(1) - \log H_\ell(0)) \quad \text{for any } \ell \in \mathcal{A}_m \tag{C.175}$$

Also define

$$E_m(t) \equiv G_m(t) + I_m(t) \qquad\qquad R_m(t) \equiv \sum_{\ell \in \mathcal{A}_m} P_\ell(t) H_\ell(t) \tag{C.176}$$

Then

$$\begin{aligned}
&\log E_m(1) - \log E_m(0) \\
&= \int_0^1 \frac{d \log E_m(t)}{dt} dt && \text{(C.177)}\\
&= \int_0^1 \frac{1}{E_m(t)} \frac{dE_m(t)}{dt} dt && \text{(C.178)}\\
&= \int_0^1 \frac{1}{E_m(t)} \left(\frac{dG_m(t)}{dt} + \frac{dI_m(t)}{dt} \right) dt && \text{(C.179)}\\
&= \int_0^1 \frac{1}{E_m(t)} \left(G_m(t) \frac{d \log G_m(t)}{dt} + I_m(t) \frac{d \log I_m(t)}{dt} \right) dt && \text{(C.180)}\\
&= \int_0^1 \frac{1}{E_m(t)} \left(G_m(t)\, d \log G_m(t) + I_m(t)\, d \log I_m(t) \right) && \text{(C.181)}\\
&= \int_0^1 \frac{1}{E_m(t)} \left(G_m(t)\, \Delta \log G_m dt + I_m(t)\, \Delta \log I_m dt \right) && \text{(C.182)}\\
&= \Delta \log G_m \int_0^1 \frac{G_m(t)}{E_m(t)} dt + \Delta \log I_m \int_0^1 \frac{I_m(t)}{E_m(t)} dt && \text{(C.183)}
\end{aligned}$$

The first equality exploits the Fundamental Theorem of Calculus. The second and fourth equalities apply the chain rule. The sixth equality follows from the definitions of $G_m(t)$ and $I_m(t)$. In addition, define $S_m^G(t) \equiv G_m(t)/E_m(t)$ and $S_m^I(t) \equiv I_m(t)/E_m(t)$. The mean-value expenditure shares in jurisdiction m are

$$\overline{S}_m^G \equiv \int_0^1 S_m^G(t)\, dt \qquad\qquad \overline{S}_m^I \equiv \int_0^1 S_m^I(t)\, dt \tag{C.184}$$

To summarize,

$$\Delta \log E_m \equiv \log E_m(1) - \log E_m(0) = \overline{S}_m^G \Delta \log G_m + \overline{S}_m^I \Delta \log I_m \tag{C.185}$$

Because $S_m^G(t)$ is continuous on $[0,1]$, the mean-value theorem for integrals states that there exists a point $t_m^* \in (0,1)$ such that $S_m^G(t_m^*) = \overline{S}_m^G$. The same is true for $S_m^I(t)$. A solution that is both second-order-accurate and pragmatic is the mid-point value, i.e., $t = 0.5$. Thus, define

$$\widetilde{S}_m^G \equiv \frac{\widetilde{G}_m}{\widetilde{G}_m + \widetilde{I}_m} \approx \overline{S}_m^G \qquad \widetilde{S}_m^I \equiv \frac{\widetilde{I}_m}{\widetilde{G}_m + \widetilde{I}_m} \approx \overline{S}_m^I \tag{C.186}$$

with

$$\widetilde{G}_m \equiv \sqrt{G_m(0)\, G_m(1)} \qquad \widetilde{I}_m \equiv \sqrt{I_m(0)\, I_m(1)} \tag{C.187}$$

Combining previous derivations,

$$\Delta \log E_m \approx \widetilde{S}_m^G \Delta \log G_m + \widetilde{S}_m^I \Delta \log I_m \tag{C.188}$$

Following similar steps:

$$\log R_m(1) - \log R_m(0)$$

$$= \int_0^1 \frac{d \log R_m(t)}{dt} dt \tag{C.189}$$

$$= \int_0^1 \frac{1}{R_m(t)} \frac{dR_m(t)}{dt} dt \tag{C.190}$$

$$= \int_0^1 \frac{1}{R_m(t)} \frac{d \sum_{\ell \in \mathcal{A}_m} P_\ell(t)\, H_\ell(t)}{dt} dt \tag{C.191}$$

$$= \int_0^1 \frac{1}{R_m(t)} \left(\sum_{\ell \in \mathcal{A}_m} P_\ell(t)\, H_\ell(t) \frac{d \log P_\ell(t)}{dt} + \sum_{\ell \in \mathcal{A}_m} P_\ell(t)\, H_\ell(t) \frac{d \log H_\ell(t)}{dt} \right) dt \tag{C.192}$$

$$= \int_0^1 \frac{1}{R_m(t)} \left(\sum_{\ell \in \mathcal{A}_m} P_\ell(t)\, H_\ell(t)\, d \log P_\ell(t) + \sum_{\ell \in \mathcal{A}_m} P_\ell(t)\, H_\ell(t)\, d \log H_\ell(t) \right) \tag{C.193}$$

$$= \int_0^1 \frac{1}{R_m(t)} \left(\sum_{\ell \in \mathcal{A}_m} P_\ell(t)\, H_\ell(t)\, \Delta \log P_\ell dt + \sum_{\ell \in \mathcal{A}_m} P_\ell(t)\, H_\ell(t)\, \Delta \log H_\ell dt \right) \tag{C.194}$$

$$= \sum_{\ell \in \mathcal{A}_m} \Delta \log P_\ell \int_0^1 \frac{P_\ell(t)\, H_\ell(t)}{R_m(t)} dt + \sum_{\ell \in \mathcal{A}_m} \Delta \log H_\ell \int_0^1 \frac{P_\ell(t)\, H_\ell(t)}{R_m(t)} dt \tag{C.195}$$

$$= \sum_{\ell \in \mathcal{A}_m} (\Delta \log P_\ell + \Delta \log H_\ell) \int_0^1 \frac{P_\ell(t)\, H_\ell(t)}{R_m(t)} dt \tag{C.196}$$

The first equality exploits the Fundamental Theorem of Calculus. The second and fourth equalities apply the chain rule. The sixth equality follows from the definitions of $P_\ell(t)$ and $H_\ell(t)$. In addition, define $S_\ell^R(t) \equiv P_\ell(t) H_\ell(t) / R_m(t)$. The mean-value revenue share in location $\ell \in \mathcal{A}_m$ is

$$\overline{S}_\ell^R \equiv \int_0^1 S_\ell^R(t)\, dt \tag{C.197}$$

To summarize,

$$\Delta \log R_m \equiv \log R_m(1) - \log R_m(0) = \sum_{\ell \in \mathcal{A}_m} \overline{S}_\ell^R \left(\Delta \log P_\ell + \Delta \log H_\ell\right) \tag{C.198}$$

Because $S_\ell^R(t)$ is continuous on $[0,1]$, the mean-value theorem for integrals states that there exists a point $t_\ell^* \in (0,1)$ such that $S_\ell^R(t_\ell^*) = \overline{S}_\ell^R$. A solution that is both second-order-accurate and pragmatic is the mid-point value, i.e., $t = 0.5$. Thus, define

$$\widetilde{S}_\ell^R \equiv \frac{\widetilde{P}_\ell \widetilde{H}_\ell}{\widetilde{R}_m} \approx \overline{S}_\ell^R \tag{C.199}$$

with

$$\widetilde{P}_\ell \equiv \sqrt{P_\ell(0) P_\ell(1)} \qquad \widetilde{H}_\ell \equiv \sqrt{H_\ell(0) H_\ell(1)} \qquad \widetilde{R}_m \equiv \sum_{\ell \in \mathcal{A}_m} \widetilde{P}_\ell \widetilde{H}_\ell \tag{C.200}$$

Combining previous derivations,

$$\Delta \log R_m \approx \sum_{\ell \in \mathcal{A}_m} \widetilde{S}_\ell^R \left(\Delta \log P_\ell + \Delta \log H_\ell\right) \tag{C.201}$$

Then,

$$\Delta \log \tau_m \approx \widetilde{S}_m^G \Delta \log G_m + \widetilde{S}_m^I \Delta \log I_m - \sum_{\ell \in \mathcal{A}_m} \widetilde{S}_\ell^R \left(\Delta \log P_\ell + \Delta \log H_\ell\right) \tag{C.202}$$

Finally, I divide both sides by the proposed change in log school district spending:

$$\frac{\Delta \log \tau_m}{\Delta \log G_j} \approx \widetilde{S}_m^G \frac{\Delta \log G_m}{\Delta \log G_j} + \widetilde{S}_m^I \frac{\Delta \log I_m}{\Delta \log G_j} - \sum_{\ell \in \mathcal{A}_m} \widetilde{S}_\ell^R \frac{\Delta \log P_\ell}{\Delta \log G_j} - \sum_{\ell \in \mathcal{A}_m} \widetilde{S}_\ell^R \frac{\Delta \log H_\ell}{\Delta \log G_j} \tag{C.203}$$

C.2 Identification with Regression Discontinuity Estimands

We now translate the elasticities obtained above into a system of linear equations, where the unknowns are structural parameters and the known terms correspond to regression discontinuity estimands. This mapping is obtained by taking expectations with respect to the joint distribution of the model's unobservables and conditioning on $S_j = 0$, under which regression discontinuity estimands identify weighted averages of elasticities.

C.2.1 Mass of Households

The elasticity of household supply in location $a \in \mathcal{A}$ with respect to a change in school district expenditures in jurisdiction $j \in \mathcal{J}$ (equation C.145) is

$$
\begin{aligned}
&\frac{\Delta \log N_a^k}{\Delta \log G_j} \\
&\approx \left(1 - \frac{\widetilde{N}_a^k}{\sigma^k}\right) \left(\sum_{m \in \mathcal{J}_a} \frac{\alpha_m^k}{\theta^k} \frac{\Delta \log G_m}{\Delta \log G_j} - \sum_{m \in \mathcal{J}_a} \frac{\alpha_m^k \chi_m}{\theta^k} \frac{\Delta \log N_m}{\Delta \log G_j} \right. \\
&\left. - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \frac{\Delta \log P_a}{\Delta \log G_j} - \frac{\gamma^k \widetilde{\rho}_a^k}{\theta^k} \sum_{m \in \mathcal{J}_a} \widetilde{r}_{am} \frac{\Delta \log (1 + \tau_m)}{\Delta \log G_j} \right) \\
&- \sum_{\ell \neq a} \frac{\widetilde{N}_\ell^k}{\sigma^k} \left(\sum_{q \in \mathcal{J}_\ell} \frac{\alpha_q^k}{\theta^k} \frac{\Delta \log G_q}{\Delta \log G_j} - \sum_{q \in \mathcal{J}_\ell} \frac{\alpha_q^k \chi_q}{\theta^k} \frac{\Delta \log N_q}{\Delta \log G_j} \right. \\
&\left. - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \frac{\Delta \log P_\ell}{\Delta \log G_j} - \frac{\gamma^k \widetilde{\rho}_\ell^k}{\theta^k} \sum_{q \in \mathcal{J}_\ell} \widetilde{r}_{\ell q} \frac{\Delta \log (1 + \tau_q)}{\Delta \log G_j} \right) \qquad \text{(C.204)}
\end{aligned}
$$

Taking expectations of both sides with respect to the joint probability distribution of the unobservables and conditioning on the running variable being equal to the cutoff yields the following equation:

$$
\begin{aligned}
\mathbb{E}\left[\frac{\Delta \log N_a^k}{\Delta \log G_j} \middle| S_j = 0 \right] \approx& \sum_{m \in \mathcal{J}_a} \frac{\alpha_m^k}{\theta^k} \times \mathbb{E}\left[\left(1 - \frac{\widetilde{N}_a^k}{\sigma^k}\right) \frac{\Delta \log G_m}{\Delta \log G_j} \middle| S_j = 0 \right] \\
&- \sum_{m \in \mathcal{J}_a} \frac{\alpha_m^k \chi_m}{\theta^k} \times \mathbb{E}\left[\left(1 - \frac{\widetilde{N}_a^k}{\sigma^k}\right) \frac{\Delta \log N_m}{\Delta \log G_j} \middle| S_j = 0 \right] \\
&- \frac{\gamma^k}{\theta^k} \times \mathbb{E}\left[\widetilde{\rho}_a^k \left(1 - \frac{\widetilde{N}_a^k}{\sigma^k}\right) \frac{\Delta \log P_a}{\Delta \log G_j} \middle| S_j = 0 \right]
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{\gamma^k}{\theta^k} \times \sum_{m \in \mathcal{J}_a} \mathbb{E}\left[\widetilde{\rho}_a^k \widetilde{r}_{am} \left(1 - \frac{\widetilde{N}_a^k}{\sigma^k}\right) \frac{\Delta \log (1 + \tau_m)}{\Delta \log G_j} \middle| S_j = 0 \right] \\
&- \sum_{\ell \neq a} \sum_{q \in \mathcal{J}_\ell} \frac{\alpha_q^k}{\theta^k} \times \mathbb{E}\left[\frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log G_q}{\Delta \log G_j} \middle| S_j = 0 \right] \\
&+ \sum_{\ell \neq a} \sum_{q \in \mathcal{J}_\ell} \frac{\alpha_q^k \chi_q}{\theta^k} \times \mathbb{E}\left[\frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log N_q}{\Delta \log G_j} \middle| S_j = 0 \right] \\
&+ \frac{\gamma^k}{\theta^k} \times \sum_{\ell \neq a} \mathbb{E}\left[\widetilde{\rho}_\ell^k \frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log P_\ell}{\Delta \log G_j} \middle| S_j = 0 \right] \\
&+ \frac{\gamma^k}{\theta^k} \times \sum_{\ell \neq a} \sum_{q \in \mathcal{J}_\ell} \mathbb{E}\left[\widetilde{\rho}_\ell^k \widetilde{r}_{aq} \frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log (1 + \tau_q)}{\Delta \log G_j} \middle| S_j = 0 \right] \qquad \text{(C.205)}
\end{aligned}
$$

C.2.2 Price of a Housing Unit

The elasticity of housing demand in location $a \in \mathcal{A}$ with respect to a change in school district expenditures in jurisdiction $j \in \mathcal{J}$ (equation C.167) is

$$
\frac{\Delta \log P_a}{\Delta \log G_j} \approx \frac{1}{\eta} \sum_{k \in \mathcal{K}} \widetilde{L}_a^k \frac{\Delta \log N_a^k}{\Delta \log G_j} \qquad \text{(C.206)}
$$

Taking expectations of both sides with respect to the joint probability distribution of the unobservables and conditioning on the running variable being equal to the cutoff yields the following equation:

$$
\mathbb{E}\left[\frac{\Delta \log P_a}{\Delta \log G_j} \middle| S_j = 0 \right] \approx \frac{1}{\eta} \times \sum_{k \in \mathcal{K}} \mathbb{E}\left[\widetilde{L}_a^k \frac{\Delta \log N_a^k}{\Delta \log G_j} \middle| S_j = 0 \right] \qquad \text{(C.207)}
$$

C.2.3 Number of Housing Units

The elasticity of housing supply in location $a \in \mathcal{A}$ with respect to a change in school district expenditures in location $j \in \mathcal{J}$ (equation C.170) is

$$
\frac{\Delta \log H_a}{\Delta \log G_j} = \eta \frac{\Delta \log P_a}{\Delta \log G_j} \qquad \text{(C.208)}
$$

Taking expectations of both sides with respect to the joint probability distribution of the unobservables and conditioning on the running variable being equal to the cutoff yields the following equation:

$$\mathbb{E}\left[\frac{\Delta\log H_a}{\Delta\log G_j}\middle| S_j=0\right]=\eta\times\mathbb{E}\left[\frac{\Delta\log P_a}{\Delta\log G_j}\middle| S_j=0\right] \tag{C.209}$$

C.2.4 Jurisdictional Balanced-Budget Condition

The elasticity of the property tax rate in jurisdiction $m \in \mathcal{J}$ with respect to a change in school district expenditures in jurisdiction $j \in \mathcal{J}$ (equation C.203) is

$$\frac{\Delta\log\tau_m}{\Delta\log G_j}\approx\widetilde{S}_m^G\frac{\Delta\log G_m}{\Delta\log G_j}+\widetilde{S}_m^I\frac{\Delta\log I_m}{\Delta\log G_j}+\sum_{\ell\in\mathcal{A}_m}\widetilde{S}_\ell^R\frac{\Delta\log P_\ell}{\Delta\log G_j}+\sum_{\ell\in\mathcal{A}_m}\widetilde{S}_\ell^R\frac{\Delta\log H_\ell}{\Delta\log G_j} \tag{C.210}$$

Taking expectations of both sides with respect to the joint probability distribution of the unobservables and conditioning on the running variable being equal to the cutoff yields the following equation:

$$\begin{aligned}\mathbb{E}\left[\frac{\Delta\log\tau_m}{\Delta\log G_j}\middle| S_j=0\right]&\approx\mathbb{E}\left[\widetilde{S}_m^G\frac{\Delta\log G_m}{\Delta\log G_j}\middle| S_j=0\right]+\mathbb{E}\left[\widetilde{S}_m^I\frac{\Delta\log I_m}{\Delta\log G_j}\middle| S_j=0\right]\\&-\sum_{\ell\in\mathcal{A}_m}\mathbb{E}\left[\widetilde{S}_\ell^R\frac{\Delta\log P_\ell}{\Delta\log G_j}\middle| S_j=0\right]-\sum_{\ell\in\mathcal{A}_m}\mathbb{E}\left[\widetilde{S}_\ell^R\frac{\Delta\log H_\ell}{\Delta\log G_j}\middle| S_j=0\right]\end{aligned} \tag{C.211}$$

D Statistical Inference

In this section, I detail the procedures for statistical inference on the counterfactual outcomes and welfare discussed in Section 8.

Let W_j be a generic outcome of interest, such as welfare or an indicator for whether the counterfactual referendum is approved. Each estimator $\widehat{W}_j$ is a function of the estimated parameter vectors $\widehat{\zeta}$ and $\widehat{\vartheta}$, and therefore inherits sampling variability from both. I account for this uncertainty by drawing from the known approximate distribution of the estimator of ζ, namely $\mathcal{N}\left(\widehat{\zeta},\widehat{\Sigma}_\zeta\right)$. For each replication $m\in\{1,\ldots,\overline{m}\}$, I sample a realization $\widehat{\zeta}^{(m)}$, re-estimate ϑ with maximum likelihood conditional on $\widehat{\zeta}^{(m)}$, and compute the corresponding outcome $\widehat{W}_j^{(m)}$ using the parameter pair $\left(\widehat{\zeta}^{(m)},\widehat{\vartheta}^{(m)}\right)$.

This procedure captures the sampling uncertainty in $\widehat{\zeta}$ but treats $\widehat{\vartheta}$ as fixed within each draw. To propagate the uncertainty in $\widehat{\vartheta}$ given $\widehat{\zeta}^{(m)}$, I implement an additional parametric bootstrap. Specifically, within each replication m, I draw $\overline{r}$ times from the known approximate distribution of the maximum likelihood estimator of ϑ, given by $\mathcal{N}\left(\widehat{\vartheta}^{(m)}, \widehat{\Sigma}_{\vartheta}^{(m)}\right)$. For each resulting pair (m, r), I recompute the outcome, yielding $\widehat{W}_j^{(m,r)}$.

To construct confidence intervals around each counterfactual statistic, I compute the total variance of $\widehat{W}_j$ by combining within- and between-replication components. I begin by calculating the within-replication variance associated with the mth draw:

$$\widehat{\sigma}^{2(m)} \equiv \frac{1}{\overline{r}-1} \sum_{r=1}^{\overline{r}} \left(\widehat{W}_j^{(m,r)} - \overline{\widehat{W}}_j^{(m)} \right)^2 \tag{D.212}$$

where the mean across inner replications is given by $\overline{\widehat{W}}_j^{(m)} \equiv \frac{1}{\overline{r}} \sum_{r=1}^{\overline{r}} \widehat{W}_j^{(m,r)}$. I then average the resulting values across outer replications to obtain the within-replication component of the total variance:

$$\overline{\widehat{\sigma}}^2 \equiv \frac{1}{\overline{m}} \sum_{m=1}^{\overline{m}} \widehat{\sigma}^{2(m)} \tag{D.213}$$

Next, I compute the between-replication variance, which captures the uncertainty due to sampling variation in the first-stage parameter vector $\widehat{\zeta}$:

$$\widetilde{\widehat{\sigma}}^2 \equiv \frac{1}{\overline{m}-1} \sum_{m=1}^{\overline{m}} \left(\widehat{W}_j^{(m)} - \overline{\widehat{W}}_j \right)^2 \tag{D.214}$$

with $\overline{\widehat{W}}_j \equiv \frac{1}{\overline{m}} \sum_{m=1}^{\overline{m}} \widehat{W}_j$. Finally, following Rubin (1987, pp. 76–77), I obtain the total variance of $\widehat{\mathrm{AVE}}_{Z_\ell}(b)$ as

$$\widehat{\sigma}^2(b) = \overline{\widehat{\sigma}}^2(b) + \left(1 + \frac{1}{\overline{m}}\right) \widetilde{\widehat{\sigma}}^2(b) \tag{D.215}$$