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. A typical location is served by multiple overlapping jurisdictions that share property tax base and specialize in the provision of one or more local public goods. This paper evaluates the implications of such vertical differentiation for the equilibrium levels of government spending, property tax rates, and household welfare. I propose a spatial theory of overlapping jurisdictions in which residents collectively determine the local mix of expenditures and taxes. Because fiscal policy capitalizes into housing prices and all jurisdictions draw revenue from housing, the cost of raising expenditures in a location is implicitly shared with other coexisting jurisdictions. This fiscal externality leads to inefficiently high government spending and property tax rates, and to lower household welfare, relative to institutional regimes with coterminous or only horizontally differentiated jurisdictions. To identify the model's structural parameters, I exploit a dynamic regression discontinuity design based on referenda in which local governments seek voter approval to raise property taxes and increase spending. I use this variation to estimate the effects of fiscal policy changes on household mobility, housing prices, and public expenditures. Combining these estimates with a quantitative version of the model and novel georeferenced data covering all U.S. local governments, I conduct counterfactuals comparing the current institutional structure to one with general-purpose, horizontally differentiated jurisdictions. Preliminary results suggest that such a reform would raise household welfare by approximately 0.8 percent.

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1 Introduction

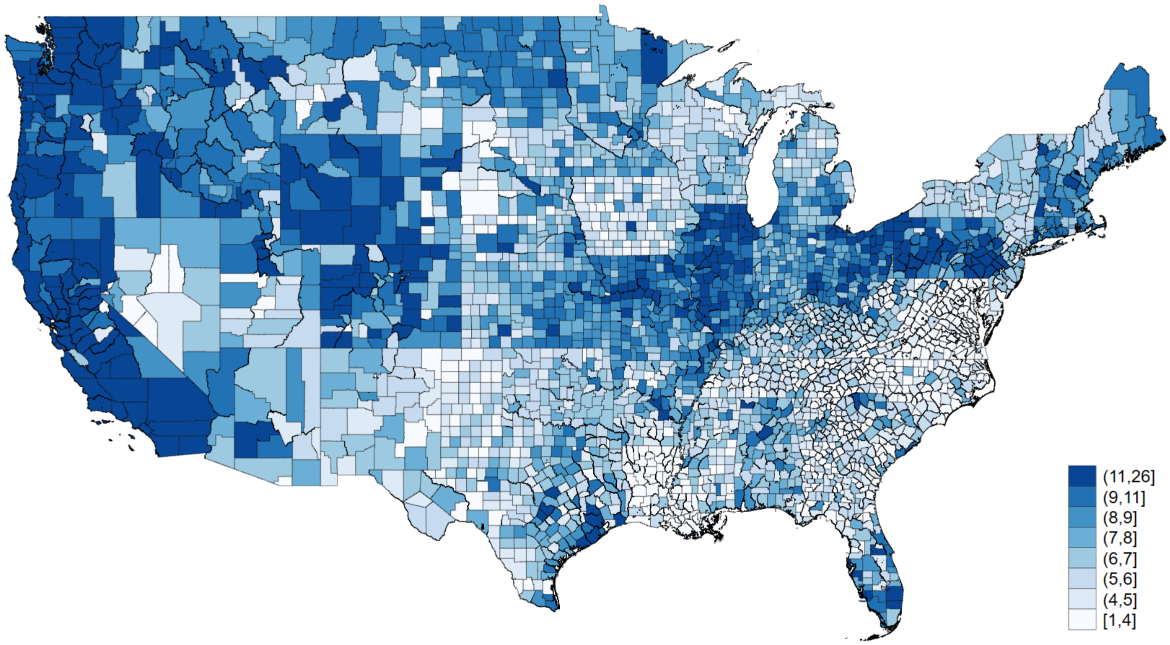
Local governments provide essential public services in the United States. Their scope ranges from K-12 education to fire protection, emergency medical services, utilities, parks and recreation, water conservation, and police protection. Because local governments primarily fund these services through residential property taxes[1], economists and policymakers have long been interested in the implications of local financing for household sorting (Tiebout 1956), housing values (Oates 1969, Hamilton 1976), and inequality in access to public goods (Bucovetsky 1982).

Standard spatial equilibrium models of local jurisdictions consider single-layer, general purpose governments that finance a bundle of public goods with a uniform tax rate on housing expenditures (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). In the United States, however, local governments are both horizontally and vertically differentiated. They are horizontally differentiated because a public good, such as K-12 education, is typically provided by multiple competing jurisdictions, such as school districts. Local governments are also vertically differentiated because any location is generally served by multiple jurisdictions, each of which delivers one or more services and sets a property tax rate to finance them. Figure 1 shows that the vertical differentiation of local governments is quantitatively important, especially in the Midwest and Pacific regions.

The goal of this paper is to study how such vertical differentiation affects the provision of local public goods and the taxation of residential property. To do so, I develop a spatial equilibrium model of a metropolitan area in which local jurisdictions overlap and thus share tax base. Within each jurisdiction, residents with heterogeneous preferences for public goods vote on their preferred mix of expenditures and taxes. In the model, any change in local fiscal policy is capitalized into housing values. Because jurisdictions share part of their territory and tax the same asset, a change in government spending in a district affects the

[1] In 2022, property taxes made up approximately 69 percent of total local government tax receipts (U.S. Bureau of Economic Analysis 2023*a*).

Figure 1: 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 2017. 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 2017 Census of Governments (U.S. Census Bureau 2017).

tax base of all overlapping districts, thereby indirectly impacting their fiscal policies. This externality is such that a jurisdiction's cost of a marginal increase in spending is borne, in part, by voters who reside outside its boundaries. In equilibrium, this induces a higher level of government spending and higher tax rates relative to a setting in which jurisdictions are perfectly coterminous or do not overlap at all.

The predictions of this model are consistent with the arguments put forward by Berry (2009) and empirically tested by Berry (2008). Both highlight that the vertical structure of local governments induces a fiscal common pool, from which independent overlapping jurisdictions draw more resources than they would if local public goods were provided by single-layer, general purpose governments.

To quantify the model, I exploit a regression discontinuity design based on referenda in which local governments seek voter approval to raise property tax rates and increase expenditures. These referenda generate plausibly exogenous variation in fiscal policy near the approval threshold, which I use to estimate the average effects of fiscal changes on key endogenous outcomes: population size, housing prices, tax rates, and government spending. I then map these reduced-form estimates to the model's structure, allowing me to recover the values of structural parameters that rationalize the observed effects at the cutoff.

Using the fully quantified spatial equilibrium model, I conduct a counterfactual analysis that alters the institutional organization of local governments in U.S. metropolitan areas. In particular, I evaluate the welfare implications of replacing vertically overlapping, single-purpose jurisdictions with horizontally differentiated, general-purpose governments that provide a broad set of local public goods. Preliminary results from this exercise indicate that such a reorganization would raise household welfare by approximately 0.8 percent on average.

This paper contributes to three literatures. First, it embeds an important feature of the structure of local governments in the United States into a spatial equilibrium model of residential choice in a metropolitan area. As previously discussed, models of equilibria across jurisdictions have a long tradition in public finance, but previous papers abstract from the vertical differentiation of local governments and instead estimate parameters using data from towns in Massachusetts, one of the very few states in which local public goods are provided by general purpose, non-overlapping jurisdictions (Epple and Sieg 1999, Epple, Romer and Sieg 2001, Calabrese et al. 2006, Calabrese, Epple and Romano 2012). Second, this paper adds to the broad literature that studies concurrent taxation by governments sharing tax base. This literature has mostly focused on the interplay between federal and state governments (Johnson 1988, Boadway and Keen 1996, Besley and Rosen 1998, Albouy 2009), whereas local governments have received more limited attention (Greer 2015, Jimenez 2015, Agrawal 2016, Brien and Yan 2020). Finally, this paper leverages tools from modern quantitative spatial modeling (Redding and Rossi-Hansberg 2017 for a review) to analyze equilibria of local jurisdictions.

The remainder of the paper is organized as follows. In Section 2, I provide an overview of local governments in the United States. In Section 3, I illustrate the spatial equilibrium model and its properties. In Section 4, I describe the model solution and perform a number of simulation exercises that offer insights into the welfare implications of alternative local government structures. Section 9 concludes.

2 Local Governments in the United States

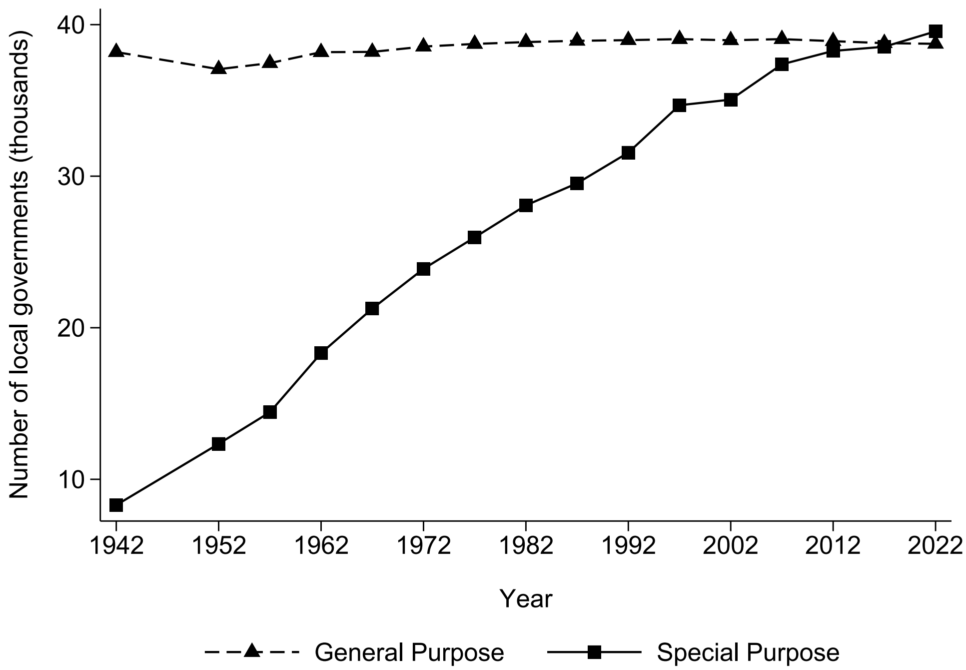
In 2022, around 91 thousand local governments spent 1.86 trillion dollars (U.S. Bureau of Economic Analysis 2023*a*) and employed 12.2 million full-time equivalent units (U.S. Census Bureau 2022). The local government sector, as a whole, employs a workforce that is approximately 40 percent larger than that of federal and state governments combined (U.S. Bureau of Economic Analysis 2023*b*).

Local governments vary greatly in terms of scope. General purpose jurisdictions, namely counties and municipalities, provide bundles of services, including law enforcement, election organization, urban planning, the court system, and housing assistance. Instead, special purpose jurisdictions, such as fire protection districts, library districts, and water conservation districts, specialize in the provision of a single local public good. As shown in Figure 2, the number of general purpose governments has remained approximately constant over the last eighty years, while special purpose jurisdictions have grown more than fourfold. This growth is attributable to the fact that several State constitutions make it easy for its residents to create local governments (Berry 2008). Local governments vary greatly in terms of size too. Special purpose districts can be as large as groups of counties and as small as a few blocks in an urban area. Jurisdiction boundaries are determined at the time of creation, but annexations and secessions are not infrequent.

Local governments primarily fund their services by levying property taxes, sales taxes, and charging residents with fees linked to specific services, such as utilities (U.S. Bureau of Economic Analysis 2023*a*). Each jurisdiction maintains its own independent budget and determines its intended level of expenditures on an annual basis. County governments are then responsible for regularly assessing property values[2] and computing each jurisdiction's tax rate, i.e., the ratio of its projected expenditures and the aggregate assessed value of residential property within its boundaries. A typical property tax bill lists all of the jurisdictions to which a land parcel is subject to, and the unique combination of local governments overlapping in a given location is referred to as "Tax Code Area" or "Tax Rate Area".

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

Figure 2: Number of General and Special Purpose Governments in 1942-2022



Notes: This figure displays the number of general and special purpose governments active in the United States from 1942 to 2022. General purpose jurisdictions include counties, municipalities, and townships. Special purpose districts comprise every other jurisdiction except for school districts. Source: author's own calculations based on data from the 2022 Census of Governments (U.S. Census Bureau 2022).

Finally, local governments are administered by democratically elected representatives or – in a small number of cases – State-appointed officials. In addition to local elections for selecting representatives, residents frequently participate in referenda, which allow local governments to seek approval for tax increases that administrators alone cannot enact. These referenda have garnered significant attention in the empirical public finance literature that estimates the effect of increased government expenditure on various outcomes, such as student test scores (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).

3 A Spatial Equilibrium Model with Overlapping Jurisdictions

In line with prior literature, this model describes a metropolitan area in which households choose where to live, housing prices are determined locally, and the provision of public goods occurs via majority voting. The model is static and is meant to capture long-term allocations of households, government spending, tax rates, and housing prices.

Consider a unit mass of households indexed by i. Households can be partitioned into a finite set of observable types indexed by $k \in \mathcal{K}$, each with mass $\sigma^k \in (0, 1)$. Households choose one among a finite set of localities indexed by $a \in \mathcal{A}$. Public goods are provided by jurisdictions indexed by $j \in \mathcal{J}$ that do not necessarily coincide with localities because jurisdictions of different types overlap arbitrarily. The set of jurisdictions overlapping in community a is denoted with $\mathcal{J}_a$. Symmetrically, the set of areas spanned by jurisdiction j is denoted with $\mathcal{A}_j$. The boundaries of jurisdictions are fixed and the model abstracts from commuting and the labor market. As a matter of fact, income is a type-specific endowment. This choice is consistent with the assumption that firm location choice is not affected by residential property taxation and the structure of local governments. As a consequence, amenities in households' utility function will incorporate the value of location-specific features that can be attributed to the geographic distance between residents and firms.

3.1 Households

The household residential choice problem is similar to Epple and Platt (1998), with one important distinction. In this model, I do not characterize heterogeneity in preferences for local public goods by parameterizing the joint probability distribution of household income and taste for public spending. Instead, I leverage a finite set of observable household types that differ in their preference strength for public goods. Moreover, I augment households' utility function with an additive idiosyncratic preference shock for locations. These choices are in line with workhorse models of neighborhood choice in urban economics (Bayer, Ferreira and McMillan 2007, Ahlfeldt et al. 2015, Almagro and Domínguez-Iino 2024) as well as worker and firm location choice 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, Diamond and Gaubert 2017). In area a, households' utility is log-additive in exogenous location amenities A_a, housing floor space H, a composite numeraire consumption good X, and government spending per capita in all of the jurisdictions that overlap in that area $\{G_j/N_j\}_{j \in \mathcal{J}_a}$. In addition, the price of the numeraire good is normalized to one and households rent housing space at rate R_a. They also pay property taxes to finance the provision of local public goods. Importantly, the property tax rate in location a is the sum of the rates levied by the jurisdictions that overlap there,

$$\tau_a \equiv \sum_{j \in \mathcal{J}_a} \tau_j \tag{1}$$

Households are endowed with income y^k that is allowed to vary only across types. In any location a, type-k households demand housing space and the numeraire to maximize their utility subject to a budget constraint:

$$\max_{H,X} \left\{ A_a + \sum_{j \in \mathcal{J}_a} \alpha_j^k \log \frac{G_j}{N_j} + \beta^k \log H + \gamma^k \log X \right\} \quad \text{s.t.} \quad X + R_a H \left(1 + \tau_a\right) \leq y^k \tag{2}$$

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

$$V_{ia} = \rho^k + \sum_{j \in \mathcal{J}_a} \alpha_j^k \log \frac{G_j}{N_j} - \beta^k \log R_a - \beta^k \log \left(1 + \tau_a\right) + A_{ia} \tag{3}$$

where ρ^k is a deterministic constant. I model the amenity component of utility as the sum of a location-type-specific mean and a random variable that follows a Type-I Extreme Value distribution with type-specific scale parameter θ^k,

$$A_{ia} = \overline{a}_a^k + U_{ia} \quad \text{with} \quad U_{ia} \sim \text{T1EV}\left(0, \theta^k\right) \tag{4}$$

Households sort into the area that yields the highest indirect utility. As in McFadden (1974), the parametric assumption on the idiosyncratic component of utility implies a closed-form expression for the mass of type-k households who choose location a,

$$N_a^k = \sigma^k \frac{\exp\left(v_a^k / \theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k / \theta^k\right)} \tag{5}$$

where the nonstochastic component of utility is

$$v_a^k \equiv \rho^k + \overline{a}_a^k + \sum_{j \in \mathcal{J}_a} \alpha_j^k \log \frac{G_j}{N_j} - \beta^k \log R_a - \beta^k \log \left(1 + \tau_a\right) \tag{6}$$

Jurisdictions primarily differ by their function. As a matter of fact, counties, municipalities, school districts, and special purpose districts deliver mutually exclusive services. Thus, jurisdictions that perform the same function do not overlap. Given a jurisdiction j, such as "Chicago Public Schools", let F be a categorical variable that returns a jurisdiction's function. In this example, $\text{F}(j) = \text{SCHOOL}$. To restrict the cardinality of the set of parameters measuring preferences for local government spending, I assume that the marginal value of any class of public goods (e.g., K-12 education, fire protection, etc.) does not exhibit variation across jurisdictions for a given household type. Formally, for any k,

$$\alpha_j^k = \alpha_{j'}^k \text{ for all } (j, j') \text{ s.t. } \text{F}(j) = \text{F}(j') \tag{7}$$

This restriction implies that α_j^k can be interpreted as the additional utility enjoyed by type-k households due to a marginal change in logged government spending per capita on good j.

3.2 Housing Market

In each area, housing space is supplied competitively. Firms in the construction sector produce with homogeneous technology that exhibits decreasing returns to scale. Thus, the marginal cost of housing space is strictly increasing in the output. For rental rates of housing above the average cost, the housing supply function is

$$\log H_a^{\text{S}} = \lambda + \eta \log R_a + B_a \tag{8}$$

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,

$$\log H_a^{\text{D}} = \log \sum_{k'} \pi^{k'} N_a^{k'} - \log R_a - \log(1 + \tau_a) \tag{9}$$

with $\pi^k \equiv \frac{\beta^k}{\beta^k + \gamma^k} y^k$. The market-clearing rental rate of housing is such that aggregate housing expenditures in equilibrium are

$$\log R_a H_a = \log \sum_{k'} \pi^{k'} N_a^{k'} - \log(1 + \tau_a) \tag{10}$$

3.3 Provision of Local Public Goods

Local fiscal policy is determined by jurisdictions, not areas. Jurisdictions choose a level of government spending per capita G and set a property tax rate τ to fund it. Each jurisdiction runs a balanced budget,

$$G_j = \tau_j R_j H_j \iff G_j = \tau_j \sum_{a \in \mathcal{A}_j} R_a H_a \tag{11}$$

Clearly, for any level of G_j, τ_j is pinned down by population and housing expenditures. The remainder of this section will delve into the collective action process that aggregates preferences to determine a jurisdiction's expenditure-tax mix. First, I will derive household type k's preferred tax rate to fund the provision of public good j in area a. I will then apply a similar argument to compute the tax rate preferred by every other type in all areas spanned by jurisdiction j. Subsequently, I will illustrate that majority-rule voting is sufficient for a unique voting equilibrium to exist in every jurisdiction.

The level of government spending per capita on public good j preferred by type-k households who live in area a is the one that maximizes their indirect utility,

$$G^k_{ja} = \arg\max_{G_j} v^k_a = \arg\max_{G_j} \left\{ \sum_{j \in \mathcal{J}_a} \alpha^k_j \log \frac{G_j}{N_j} - \beta^k \log R_a - \beta^k \log (1 + \tau_a) \right\} \tag{12}$$

Assuming that the objective function is strictly concave in $\log G_j$ (this is proved in Appendix A.5.3), the first-order condition associated with this maximization problem is

$$\underbrace{\alpha^k_j}_{\text{marginal benefit}} = \underbrace{\alpha^k_j \frac{d \log N_j}{d \log G_j}\bigg|_{G_j = G^k_{ja}} + \beta^k \frac{d \log R_a}{d \log G_j}\bigg|_{G_j = G^k_{ja}} + \beta^k \sum_{j' \in \mathcal{J}_a} \frac{1 + \tau_{j'}}{1 + \tau_a} \frac{d \log (1 + \tau_{j'})}{d \log G_j}\bigg|_{G_j = G^k_{ja}}}_{\text{marginal cost}} \tag{13}$$

Intuitively, the marginal benefit of an increase in government spending is its marginal utility. On the other hand, the marginal cost of an increase in government spending is the marginal disutility that stems from an increase in the local gross-of-tax rental rate of housing required to finance it. Clearly, R_a and $\{\tau_{j'}\}_{j' \in \mathcal{J}_a}$ are endogenous variables and their values are constrained by two restrictions, namely housing market clearing and balanced budget. Following Epple and Romer (1991), these equations define a Government Possibility Frontier (GPF), a relationship between government spending and the gross-of-tax rental rate of housing along which any spending change is such that the two constraints hold. Because a voter in location a belongs to $|\mathcal{J}_a|$ jurisdictions, each public good is associated with a distinct Government Possibility Frontier. Moreover, each GPF takes into account several constraints jointly. Consider a resident of area a choosing their preferred level of government spending per capita in jurisdiction j. In the remainder of this section, the maintained assumption is that voters internalize the effect of a change in a jurisdiction's expenditure on both area a's housing market and the budget of all jurisdictions that belong to $\mathcal{J}_a$. However, they take as given the housing market in other communities and the fiscal policy chosen by other local governments. As a consequence, the implicit choice variables for a resident of area a voting in jurisdiction j are $\left\{G_j, R_a, \{\tau_{j'}\}_{j' \in \mathcal{J}_a}\right\}$. By assumption, $\left\{\{G_{j'}\}_{j' \neq j}, \{R_a\}_{a' \neq a}, \{\tau_{j'}\}_{j' \notin \mathcal{J}_a}\right\}$ are held constant in the derivations that follow. The $\mathcal{J}_a + 1$ equations characterizing the feasible allocations of $\left\{G_j, R_a, \{\tau_{j'}\}_{j' \in \mathcal{J}_a}\right\}$ are area a's housing market clearing and the balanced budget for each jurisdiction in $\mathcal{J}_a$:

$$J_a\left(G_j, R_a, \{\tau_{j'}\}_{j' \in \mathcal{J}_a}\right) \equiv H_a^{\mathrm{S}} - H_a^{\mathrm{D}} = 0 \tag{14}$$

$$K_j\left(G_j, R_a, \{\tau_{j'}\}_{j' \in \mathcal{J}_a}\right) \equiv \tau_j R_j H_j - G_j = 0 \quad \text{for all } j \in \mathcal{J}_a \tag{15}$$

To derive the slope of the GPF, I proceed analogously to Epple and Romer (1991) and totally differentiate the system of equations around its $\mathcal{J}_a + 2$ arguments:

$$\frac{\partial J_a}{\partial \log G_j} d\log G_j + \frac{\partial J_a}{\partial \log R_a} d\log R_a + \sum_{j' \in \mathcal{J}_a} \frac{\partial J_a}{\partial \log\left(1 + \tau_{j'}\right)} d\log\left(1 + \tau_{j'}\right) = 0 \tag{16}$$

$$\frac{\partial K_{j'}}{\partial \log G_j} d\log G_j + \frac{\partial K_{j'}}{\partial \log R_a} d\log R_a + \sum_{j' \in \mathcal{J}_a} \frac{\partial K_{j'}}{\partial \log\left(1 + \tau_{j'}\right)} d\log\left(1 + \tau_{j'}\right) = 0 \tag{17}$$

where equation (17) must hold for every $j' \in \mathcal{J}_a$. To develop intuition on this system, it is useful to specialize the metropolitan area into a partition of four areas implied by two school districts and two cities.

3.3.1 The GPF in a 2×2 Metropolitan Area

Consider a stylized metropolitan area with two cities and two school districts that partition the territory into four areas. Using the notation from the model, this metropolitan area comprises four jurisdictions indexed by $j \in \{\mathrm{s}_1, \mathrm{s}_2, \mathrm{c}_1, \mathrm{c}_2\}$ and four areas indexed by $a \in \{1, 2, 3, 4\}$.

Figure 3: A Metropolitan Area with two School Districts and two Cities

$a = 1$ S_1 and C_1	$a = 2$ S_2 and C_1
$a = 3$ S_1 and C_2	$a = 4$ S_2 and C_2

NOTES: This figure displays a stylized metropolitan area served by two school districts (S_1 and S_2) and two cities (C_1 and C_2) that overlap into four areas indexed by $a \in \{1, 2, 3, 4\}$.

In the remainder of this section, I will derive the Government Possibility Frontier faced by a voter in area $a = 1$, who must determine their preferred level of government spending for jurisdictions S_1 and C_1. To keep notation compact, I will refer to these jurisdictions as S and C, respectively. The school district spans areas 1 and 3, while the city spans areas and 1 and 2. As a consequence, the system of equations that restricts the set of feasible allocations for G_{S} and G_{C} is the following:

$$J_1 \equiv \lambda_1 + (1+\eta)\log R_1 + B_1 + \log\left(1 + \tau_{\text{S}} + \tau_{\text{C}}\right) - \log \sum_{k'} \pi^{k'} N_1^{k'} = 0 \tag{18}$$

$$K_{\text{S}} \equiv \log \tau_{\text{S}} + \log\left(R_1 H_1 + R_3 H_3\right) - \log G_{\text{S}} = 0 \tag{19}$$

$$K_{\text{C}} \equiv \log \tau_{\text{C}} + \log\left(R_1 H_1 + R_2 H_2\right) - \log G_{\text{C}} = 0 \tag{20}$$

Consider the goal of deriving the Government Possibility Frontier associated with the preferred choice of G_{S}. Derivations for G_{C} are symmetric. Total differentiation of the system of equations in (18) and (19) around its four arguments yields another system of equations, here presented in matrix form:

$$\begin{bmatrix} J_{1g_{\text{S}}} & J_{1r_1} & J_{1\tau_{\text{S}}} & J_{1\tau_{\text{C}}} \\ K_{\text{S}g_{\text{S}}} & K_{\text{S}r_1} & K_{\text{S}\tau_{\text{S}}} & K_{\text{S}\tau_{\text{C}}} \\ K_{\text{C}g_{\text{S}}} & K_{\text{S}r_1} & K_{\text{S}\tau_{\text{S}}} & K_{\text{C}\tau_{\text{C}}} \end{bmatrix} \begin{bmatrix} dg_{\text{S}} \\ dr_1 \\ d\tau_{\text{S}} \\ d\tau_{\text{C}} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \tag{21}$$

where the unknowns are defined as $dg_{\text{S}} \equiv d\log G_{\text{S}}$, $dr_1 \equiv d\log R_1$, $d\tau_{\text{S}} \equiv d\log\left(1 + \tau_{\text{S}}\right)$, and $d\tau_{\text{C}} \equiv d\log\left(1 + \tau_{\text{C}}\right)$. The matrix of known coefficients is the Jacobian associated with the housing market clearing and balanced budget equations. The system in (21) has three equations and four unknowns. Since the focus of this analysis is on a marginal change in school district spending, one can divide every equation by dg_{S}, thus reducing the number of unknowns by one. The system of equations can then be rewritten as

$$\begin{bmatrix} J_{1r_1} & J_{1\tau_{\text{S}}} & J_{1\tau_{\text{C}}} \\ K_{\text{S}r_1} & K_{\text{S}\tau_{\text{S}}} & K_{\text{S}\tau_{\text{C}}} \\ K_{\text{S}r_1} & K_{\text{S}\tau_{\text{S}}} & K_{\text{C}\tau_{\text{C}}} \end{bmatrix} \begin{bmatrix} dr_1/dg_{\text{S}} \\ d\tau_{\text{S}}/dg_{\text{S}} \\ d\tau_{\text{C}}/dg_{\text{S}} \end{bmatrix} = \begin{bmatrix} -J_{1g_{\text{S}}} \\ -K_{\text{S}g_{\text{S}}} \\ -K_{\text{C}g_{\text{S}}} \end{bmatrix} \tag{22}$$

If the coefficient matrix is nonsingular, the solution to this system yields the desired slopes of the Government Possibility Frontier. For a voter residing in community $a = 1$ choosing their preferred level of school spending, the relevant derivatives are those appearing in the first-order condition (13), namely dr_1/dg_{S}, $d\tau_{\text{S}}/dg_{\text{S}}$, and $d\tau_{\text{C}}/dg_{\text{S}}$. Symmetric derivations for city government spending yield dr_1/dg_{C}, $d\tau_{\text{S}}/dg_{\text{C}}$, and $d\tau_{\text{C}}/dg_{\text{C}}$. The resulting system of first-order conditions for a type-k household in area 1 is

$$\alpha_{\text{S}}^k = \beta^k \left(\frac{dr_1}{dg_{\text{S}}} + \frac{1+\tau_{\text{S}}}{1+\tau_{\text{S}}+\tau_{\text{C}}} \frac{d\tau_{\text{S}}}{dg_{\text{S}}} + \frac{1+\tau_{\text{C}}}{1+\tau_{\text{S}}+\tau_{\text{C}}} \frac{d\tau_{\text{C}}}{dg_{\text{S}}} \right) \tag{23}$$

$$\alpha_{\text{C}}^k = \beta^k \left(\frac{dr_1}{dg_{\text{C}}} + \frac{1+\tau_{\text{S}}}{1+\tau_{\text{S}}+\tau_{\text{C}}} \frac{d\tau_{\text{S}}}{dg_{\text{C}}} + \frac{1+\tau_{\text{C}}}{1+\tau_{\text{S}}+\tau_{\text{C}}} \frac{d\tau_{\text{C}}}{dg_{\text{C}}} \right) \tag{24}$$

where, by definition, $\tau_1 \equiv \tau_{\text{S}} + \tau_{\text{C}}$. Equations (23) and (24) are optimality conditions that jointly characterize a household's preferred levels of government spending on school and city services. This system of two equations in two unknowns, τ_{S} and τ_{C}, can be solved to compute the unique school and city property tax rates preferred by type-k households in area 1. Similar arguments are employed to determine the optimal tax rates for all other groups and locations.

3.3.2 Majority-Rule Voting

The comparison of individual utilities by residents is only the first step in modeling the process that aggregated individual process into a collectively chosen expenditure-tax mix. A natural addition involves the consideration of participation in local referenda. As thoroughly described by Berry (2009), turnout in local elections in the United States is typically low[3],

[3]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) finds 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.

especially when referenda are scheduled not to coincide with general elections in November (Kogan, Lavertu and Peskowitz 2018). Perhaps unsurprisingly, the few participants are extremely selected, with turnout disproportionately driven by white, affluent, and elderly voters (Berry 2024). In addition, special interest groups play a sizable role in driving the outcome of local consultations (Anzia 2014). Motivated by this evidence, I propose an economic model of the choice to participate in the referendum. Specifically, I posit that an individual of type k votes in the referendum held by jurisdiction j if the cost associated with participating does not exceed a type-specific constant ζ^k. This cost is modeled as an unobserved random variable C_a^k with support over the positive real line. This random variable is meant to capture the cost of acquiring information about the referendum as well as the pecuniary and opportunity costs of voting. Thus, the probability of turnout for households of type k in location a is $T_a^k \equiv F_C\left(\zeta^k\right)$, with F_C denoting the cumulative distribution function of C_a^k. Moreover, a jurisdiction's expected turnout is the ratio of the expected mass of voters and the expected mass of residents in that jurisdiction:

$$T_j \equiv \frac{\overbrace{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k}^{\text{expected mass of resident voters in } j}}{\underbrace{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k}_{\text{expected mass of residents in } j}} \tag{25}$$

Clearly, the support of T_j lies in the unit interval. Finally, I define a Bernoulli random variable W_a^k that takes the value one if type-k households' preferred tax rate is smaller than or equal to a hypothetical tax rate τ_j:

$$W_a^k\left(\tau_j\right) = \mathbb{I}\left[\tau_{ja}^k \leq \tau_j\right] \tag{26}$$

Then, a jurisdiction's expected mass of households who prefer a lower property tax rate than τ_j is

$$S_j^- \equiv \frac{\overbrace{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k W_a^k}^{\text{expected mass of resident voters preferring a lower } \tau_j}}{\underbrace{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k}_{\text{expected mass of resident voters in } j}} \tag{27}$$

The definition for S_j^+ is symmetric. Evidently, the support of both lies in the unit interval.

To determine the property tax rate collectively chosen in each jurisdiction, I assume residents vote with majority rule. An appealing feature of this model is that, despite the overlapping structure of local governments, voters implicitly participate to multiple one-dimensional elections. As a matter of fact, each jurisdiction independently sets its fiscal policy. Moreover, every household type has an area-jurisdiction-specific preferred tax rate, τ_{ja}^k, and this policy variable can be ordered within any jurisdiction. The global strict concavity of the objective function ensures that tax rates further away from a group's bliss point are less preferred. Formally, preferences are single-peaked. Single-peaked preferences and voting on a unidimensional policy variable are the two assumptions required for the median voter theorem to hold (Black 1948). Thus, the equilibrium tax rate in jurisdiction j is the median rate among those preferred by its resident voters. Formally, the collectively chosen rate τ_j is such that

$$\frac{\sum_{a\in\mathcal{A}_j}\sum_{k\in\mathcal{K}} N_a^k T_a^k W_a^k(\tau_j)}{\sum_{a\in\mathcal{A}_j}\sum_{k\in\mathcal{K}} N_a^k T_a^k} \geq 0.5 \quad \text{and} \quad \frac{\sum_{a\in\mathcal{A}_j}\sum_{k\in\mathcal{K}} N_a^k T_a^k \left(1 - W_a^k(\tau_j)\right)}{\sum_{a\in\mathcal{A}_j}\sum_{k\in\mathcal{K}} N_a^k T_a^k} \geq 0.5 \qquad (28)$$

An analogous argument can be applied to every other jurisdiction in area a to obtain τ_a. Since both the set of locations $\mathcal{A}_j$ and the set of household types $\mathcal{K}$ are finite, the median property tax rate τ_j need not be unique. As a matter of fact, both inequalities on line (28) may hold as equalities, implying that two equilibrium rates exist. In this scenario, τ_j is assumed to be the simple average of the two median rates.

3.3.3 The Equilibrium Tax Rate under Myopic Voting

Without further restrictions, it is hard to provide an economic interpretation to the slope of the Government Possibility Frontier. To develop some intuition on the implications of overlapping jurisdictions for the expenditure-tax mix and ultimately welfare, it is convenient to assume that voters are myopic. Myopic voting is a common restriction in models of voting behavior applied to local jurisdictions (Westhoff 1977, Epple, Filimon and Romer 1984, Calabrese, Epple and Romano 2012). In this context, as clarified by Epple and Romer (1991), this assumption entails that voters take community boundaries as fixed and ignore any effect of spending changes on household mobility. This restriction can be viewed as weakening the rationality requirements that the model attributes to voters, since it reduces the set of model variables voters based their choice on. The main practical implication of this assumption is that, for the purpose of deriving the slope of the Government Possibility Frontier, any partial derivative of N_a^k is set to zero. As a result, in the example of a 2×2 metropolitan area, the system in equation (22) simplifies as follows:

$$\begin{bmatrix} 1+\eta & \frac{1+\tau_{\mathrm{S}}}{1+\tau_1} & \frac{1+\tau_{\mathrm{C}}}{1+\tau_1} \\ (1+\eta)\,\Psi_{1\mathrm{S}} & \frac{1+\tau_{\mathrm{S}}}{\tau_{\mathrm{S}}} & 0 \\ (1+\eta)\,\Psi_{1\mathrm{C}} & 0 & \frac{1+\tau_{\mathrm{C}}}{\tau_{\mathrm{C}}} \end{bmatrix} \begin{bmatrix} dr_1/dg_{\mathrm{S}} \\ d\tau_{\mathrm{S}}/dg_{\mathrm{S}} \\ d\tau_{\mathrm{C}}/dg_{\mathrm{S}} \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} \tag{29}$$

where $\Psi_{aj} \equiv \frac{R_a H_a}{\sum_{a' \in \mathcal{A}_j} R_{a'} H_{a'}}$ denotes location a's housing expenditure share in jurisdiction j. The resulting components of the Government Possibility Frontier are easily interpretable. To begin with, the total derivative of the rental rate of housing with respect to school spending per capita is

$$\frac{dr_1}{dg_{\mathrm{S}}} = -\frac{1}{1+\eta}\left(\frac{\tau_{\mathrm{S}}}{1+\tau_1-\Psi_{1\mathrm{S}}\tau_{\mathrm{S}}-\Psi_{1\mathrm{C}}\tau_{\mathrm{C}}}\right) < 0 \tag{30}$$

Under myopic voting, a marginal increase in school spending has an unambiguous negative effect on the net-of-tax rental rate of housing because the higher tax rate required to finance it depresses housing demand. Importantly, the magnitude of this effect increases monotonically with $\Psi_{1\mathrm{C}}$, the housing expenditure share of area $a = 1$ within the city. This is a core result. Ceteris paribus, the more a jurisdiction shares tax base with one or more other overlapping jurisdictions, the larger is the implicit negative effect of a local expenditure change on the net-of-tax rental rate of housing. In other words, the vertical differentiation of local governments *amplifies* the effects of a local spending change. Why is this the case? Because the school district shares tax base with the city and, for the city budget to remain balanced, a higher city rate must offset the tax base erosion induced by a fall in r_1. As a matter of fact, the total derivative of the city property tax rate with respect to school spending per capita is

$$\frac{d\tau_{\mathrm{C}}}{dg_{\mathrm{S}}} = \frac{\Psi_{1\mathrm{C}}\tau_{\mathrm{S}}}{1+\tau_1-\Psi_{1\mathrm{S}}\tau_{\mathrm{S}}-\Psi_{1\mathrm{C}}\tau_{\mathrm{C}}} > 0 \tag{31}$$

In addition,

$$\frac{d\tau_{\mathrm{S}}}{dg_{\mathrm{S}}} = \frac{\tau_{\mathrm{S}}}{1+\tau_{\mathrm{S}}} + \frac{\Psi_{1\mathrm{S}}\tau_{\mathrm{S}}}{1+\tau_{\mathrm{S}}}\left(\frac{\tau_{\mathrm{S}}}{1+\tau_1-\Psi_{1\mathrm{S}}\tau_{\mathrm{S}}-\Psi_{1\mathrm{C}}\tau_{\mathrm{C}}}\right) > 0 \tag{32}$$

As expected, a marginal increase in school spending induces a higher school property tax rate. Once again, the steepness of this slope increases with $\Psi_{1\mathrm{C}}$, area $a = 1$'s share of housing expenditures in the city. To summarize, an increase in school district expenditures results in a higher property tax rate, not only within the school district itself, but also in the city that overlaps with it. Such propagation occurs as a result of the net-of-tax housing price reduction caused by the local school tax hike. In any area within the school district, the magnitude of this spillover increases with the contribution of that area to the tax revenue received by overlapping cities. Ultimately, since a change in one jurisdiction's fiscal policy affects the tax base shared with other jurisdictions, local residents bear only a fraction of the cost of funding that policy change. More formally, it is useful to revisit the marginal cost on the right side of equation (23). The rate at which this marginal cost increases as a function of τ_{S} is increasing in the share of housing expenditures that the school district shares with the city, i.e.,

$$\frac{\partial^2}{\partial \tau_{\text{S}} \partial \Psi_{1\text{C}}} \left(\frac{dr_1}{dg_{\text{S}}} + \frac{1+\tau_{\text{S}}}{1+\tau_{\text{S}}+\tau_{\text{C}}} \frac{d\tau_{\text{S}}}{dg_{\text{S}}} + \frac{1+\tau_{\text{C}}}{1+\tau_{\text{S}}+\tau_{\text{C}}} \frac{d\tau_{\text{C}}}{dg_{\text{S}}} \right) > 0 \tag{33}$$

In economic terms, a larger $\Psi_{1\text{C}}$ implies that a larger fraction of the marginal cost of increasing school spending is borne by school district residents. In other words, the fiscal externality that this policy change imposes on households who live within city borders, but outside the school district, is smaller. As a consequence, for any $\Psi_{1\text{C}}$ in the interior of the unit interval, and ceteris paribus, school district residents prefer a higher tax rate than they would if the two jurisdictions were vertically coterminous, i.e., $\Psi_{1\text{C}} = 1$. A symmetric argument applies to city residents and the first-order condition in equation (24). In equilibrium, this induces all household types to prefer higher property tax rates.

Replacing the slopes of the Government Possibility Frontier in (30), (31), and (32) into the first-order condition in (24) yields the following implicit expression for the school property tax rate preferred by households of type k residing in area $a = 1$:

$$\alpha_{\text{S}}^k = \beta^k \left(\frac{\tau_{\text{S}}}{1+\tau_1 - \Psi_{1\text{S}}\tau_{\text{S}} - \Psi_{1\text{C}}\tau_{\text{C}}} \right) \left(\frac{\Psi_{1\text{S}}\tau_{\text{S}} + \Psi_{1\text{C}}\tau_{\text{C}}}{1+\tau_1} - \frac{1}{1+\eta} \right) + \beta^k \frac{\tau_{\text{S}}}{1+\tau_1} \tag{34}$$

This first-order condition characterizes the best response for type-k households who reside in area $a = 1$ and choose their preferred level of school spending. As a matter of fact, for any city property tax rate τ_{C}, equation (34) returns the utility-maximizing school property tax rate τ_{S}. This best response and its symmetric city counterpart jointly determine the unique pair of preferred tax rates $\left(\tau^k_{\text{s}1}, \tau^k_{\text{c}1}\right)$. Specifically, for $j \in \{\text{s}, \text{c}\}$,

$$\tau^k_{j1} = \frac{\alpha^k_j \left(1+\eta\right)}{\beta^k \eta - \left(1+\eta\right) \sum_{\ell \in \{\text{s},\text{c}\}} \alpha^k_\ell \left(1 - \Psi_{1\ell}\right)} \tag{35}$$

Appendix A.5.4 shows that each of these tax rates increases with the strength of the preference for government spending α^k_j, diminishes with the strength of the preference for housing space β^k, and declines with the elasticity of housing supply η. While the first two findings are intuitive, the third is explained by the observation that a more elastic housing supply mitigates the responsiveness of the equilibrium rental rate of housing to changes in property tax rates. As a consequence, a jurisdiction requires a lower rate to increase its expenditure while still maintaining a balanced budget.

3.4 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 areas indexed by $a \in \mathcal{A}$; a unit mass of households indexed by i; a partition of households into observable types indexed by $k \in \mathcal{K}$, each with positive mass σ^k and endowed with positive income y^k; a partition of households across areas such that each area has positive population N_a; a set of stochastic location amenities $\{A_a\}_a$; a set of stochastic productivity shocks in the residential construction sector $\{B_a\}_a$; a vector of rental rates of housing $\{R_a\}_a$ and property tax rates $\{\tau_j\}_j$; an allocation of government spending per capita $\{G_j\}_j$; an allocation of housing space $\{H_i\}_i$ and numeraire consumption good $\{X_i\}_i$ such that

(1) Households in every area choose housing space and the numeraire consumption good to maximize their utility subject to a budget constraint. For any $a \in \mathcal{A}$,

$$\max_{H,X} \left\{ A_a + \sum_{j \in \mathcal{J}_a} \alpha^k_j \log \frac{G_j}{N_j} + \beta^k \log H + \gamma^k \log X \right\} \quad \text{s.t.} \quad X + R_a H \left(1 + \tau_a\right) \leq y^k$$

where the aggregate property tax rate is

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

(2) Each household resides in the area that yields the highest indirect utility,

$$V_{ia} = \rho^k + \sum_{j \in \mathcal{J}_a} \alpha^k_j \log \frac{G_j}{N_j} - \beta^k \log R_a - \beta^k \log \left(1 + \tau_a\right) + A_{ia}$$

where ρ^k is a deterministic constant and the stochastic valuation of amenities is parameterized as

$$A_{ia} = \overline{a}_a^k + U_{ia} \quad \text{with} \quad U_{ia} \sim \text{T1EV}\left(0, \theta^k\right)$$

(3) Firms in the construction sector supply housing with a technology that exhibits decreasing returns to scale, so that the supply of housing space is, for any a,

$$\log H_a^{\text{S}} \equiv \lambda + \eta \log R_a + B_a$$

(4) The housing market clears in every area. For any a,

$$\log H_a = \log H_a^{\text{S}} = \log H_a^{\text{D}} \equiv \log \sum_{k'} \pi^{k'} N_a^{k'} - \log R_a - \log\left(1 + \tau_a\right)$$

(5) Each jurisdiction operates with a balanced budget. For any j,

$$G_j = \tau_j \sum_{a \in \mathcal{A}_j} R_a H_a$$

(6) Each jurisdiction's level of government spending per capita is determined according to majority-rule voting among its residents. For any j, the collectively chosen property tax rate τ_j is such that

$$\frac{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k W_a^k\left(\tau_j\right)}{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k} \geq 0.5 \quad \text{and} \quad \frac{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k \left(1 - W_a^k\left(\tau_j\right)\right)}{\sum_{a \in \mathcal{A}_j} \sum_{k \in \mathcal{K}} N_a^k T_a^k} \geq 0.5$$

where τ_{ja}^k denotes the tax rate preferred by type-k households in area a to finance government spending by jurisdiction $j \in \mathcal{J}_a$.

3.5 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), household type k's welfare is

$$W^k \equiv \mathbb{E}\left[\max_{a \in \mathcal{A}} \left\{v_a^k + A_{ia}\right\}\right] = c + \ln \sum_{a \in \mathcal{A}} \exp\left(\frac{v_a^k}{\theta^k}\right) \tag{36}$$

where v_a^k is the deterministic component of household type k's utility in area a, the expectation is taken with respect to the probability distribution of A_{ia}, and c denotes the Euler-Mascheroni constant. To determine aggregate welfare, I integrate type-specific welfare over its probability mass function,

$$W \equiv \sum_k \sigma^k W^k \tag{37}$$

4 Model Solution and Simulation

Let $\mathcal{P}$ denote the set of model parameters:

$$\mathcal{P} = \left\{ \left\{\alpha_j^k\right\}_{j,k}, \left\{\beta^k\right\}_k, \left\{\gamma^k\right\}_k, \left\{\theta^k\right\}_k, \left\{\sigma^k\right\}_k, \left\{y^k\right\}_k, \left\{\overline{a}_a^k\right\}_{a,k}, \lambda, \eta, \left\{b_a\right\}_a \right\} \tag{38}$$

where b_a indicates a realization of B_a. Furthermore, let $\mathcal{Y}$ denote the set of endogenous variables:

$$\mathcal{Y} = \left\{ \left\{N_a^k\right\}_{a,k}, \left\{G_j\right\}_j, \left\{\tau_j\right\}_j \right\} \tag{39}$$

Other endogenous variables, such as $\left\{R_a\right\}_a$, can be recovered once $\mathcal{Y}$ is known. Notice that the cardinality of $\mathcal{Y}$ is $|\mathcal{A}| \times |\mathcal{K}| + |\mathcal{J}| + |\mathcal{J}|$. For a given set of parameter values $\mathcal{P}$, I solve the system implied by the following non-redundant equations:

(1) $|\mathcal{A}| \times |\mathcal{K}|$ location-type choice probabilities in (5);

(2) $|\mathcal{J}|$ jurisdiction balanced budgets in (11);

(3) $|\mathcal{J}|$ jurisdiction property tax rates chosen with majority voting in (28).

Future drafts of this paper will include a proof of existence and uniqueness of the solution to this system. In the meantime, I experimented with a large number of possible parameter vectors and initial guesses, always achieving convergence to the same solution.

4.1 Simulation Exercises

In this section, I perform a number of simulation exercises using non-calibrated parameter values. The primary goal of these simulations is to explore the implications of imperfectly overlapping governments for the level of public spending, property tax rates, and household

Table 1: Parameter Values for Model Simulations

Parameter	**Value**
$\alpha_{\mathrm{s}}^{\mathrm{a}}$, $\alpha_{\mathrm{s}}^{\mathrm{b}}$	.12
$\alpha_{\mathrm{c}}^{\mathrm{a}}$, $\alpha_{\mathrm{c}}^{\mathrm{b}}$	.06
β^{a}, β^{b}	.5
γ^{a}, γ^{b}	.32
θ^{a},θ^{b}	1
y^{a},y^{b}	5
σ^{a}	.51
σ^{b}	.49
$\overline{a}_1^{\mathrm{a}}$, $\overline{a}_2^{\mathrm{a}}$, $\overline{a}_3^{\mathrm{a}}$, $\overline{a}_4^{\mathrm{a}}$	.1
$\overline{a}_1^{\mathrm{b}}$, $\overline{a}_2^{\mathrm{b}}$, $\overline{a}_3^{\mathrm{b}}$, $\overline{a}_4^{\mathrm{b}}$	.1
λ	1
η	1
b_1, b_2, b_3, b_4	1

Notes: This table reports model parameter values for the simulation exercises described in this section.

welfare. In doing so, I abstract from all other sources of heterogeneity. First, I assume that household types are endowed with the same level of income and have identical preferences for public goods. Second, I assume that the valuation of local amenities is homogeneous both across types and areas. Third, I restrict housing supply parameters to be constant in space. For simplicity, I leverage the stylized metropolitan area depicted in Figure 3 and assume that there are only two household types, $\mathcal{K} = \{\mathrm{a}, \mathrm{b}\}$. To break election ties, one household type has a marginally larger mass. However, this choice is irrelevant for the conclusions of the simulation because preferences and income are homogeneous. Table 1 reports the full list of parameter values.

The goal of the first set of simulations is to compute and compare equilibrium government spending, property tax rates, and welfare in the model with imperfectly overlapping jurisdictions with a similar model in which each city-school district pair has the same tax base. This can be achieved in numerous ways, and I focus on three possible scenarios.

First, I consider a setting in which each area is served by a distinct city-school district pair, implying that eight jurisdictions exist in the metropolitan area as a whole. Second, I focus on the case in which cities and school districts are coterminous and their coverage

Table 2: Comparison of Model Output across Jurisdiction Structures

Variable	Imperfect	Area	City	Metro
G_{S}	1.08	.85	.85	.85
G_{C}	.54	.43	.43	.43
τ_{S}	.75	.48	.48	.48
τ_{C}	.38	.24	.24	.24
τ_a	1.13	.72	.72	.72
R_a	.21	.24	.24	.24
$R_a\,(1+\tau_a)$	.45	.41	.41	.41
$R_a H_a$	.33	.41	.41	.41
$\tau_a R_a H_a$	.38	.30	.30	.30
W	3.27	3.28	3.28	3.28

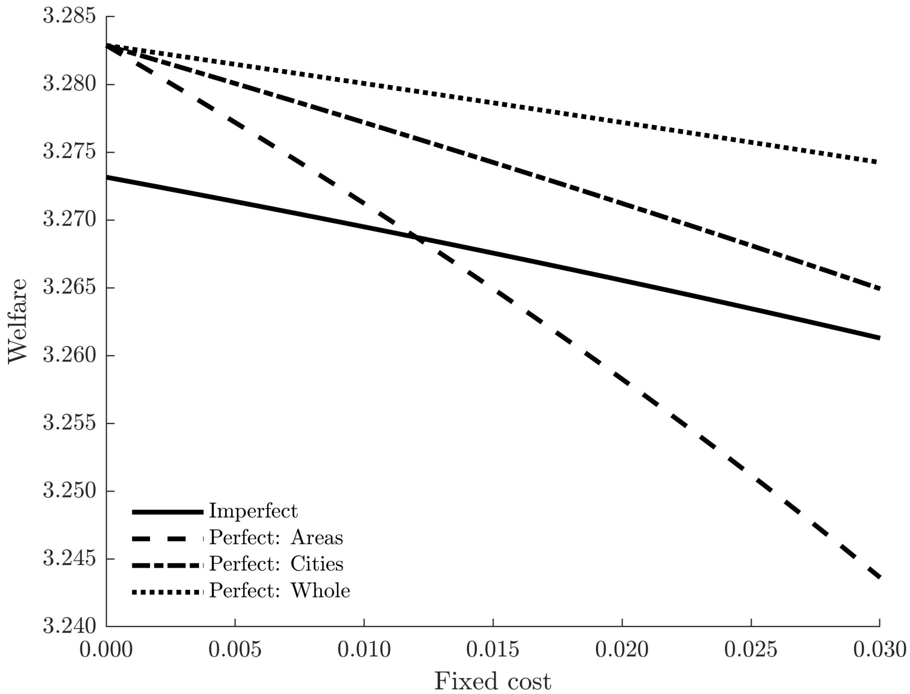
NOTES: This table reports the value of selected equilibrium variables from alternative versions of the model. The "Imperfect" column shows the output of the baseline model with imperfectly overlapping jurisdictions. The "Area" column reports the output of a model in which each of the four areas is served by a distinct city-school district pair. The "City" column displays equilibrium variables in a model with perfectly overlapping cities and school districts that follow city boundaries. The "Metro" column shows the output of a model in which public good provision is fully centralized.

areas follow city boundaries. Finally, I consider a version of the model in which public good provision is centralized and the metropolitan area is served by one city and one school district that span its entire territory. Table 2 reports the output of these simulations.

As predicted by the theory, both government spending per capita and tax rates are higher in the model with imperfectly overlapping jurisdictions. Moreover, the net-of-tax rental rate of housing is lower, but accounting for property taxation yields a higher full price of housing. Analogously, the value of the tax base is lower than it would be with perfectly overlapping jurisdictions, but tax revenues are higher. Overall, the effect on aggregate household welfare is negative. Noticeably, the output of the model with perfectly overlapping governments is independent of jurisdiction size. This is explained by the fact that the marginal cost of producing government services is constant – in fact, equal to 1 – and thus the technology in the government sector exhibits constant returns to scale.

The role of economies of scale for the purpose of determining the optimal size of jurisdictions has a long tradition in this literature (Oates 1972 for a comprehensive discussion). Moreover, school district consolidations and municipal annexations occur frequently in present times and are relevant for policy. In the second set of simulations, I introduce

Figure 4: Fixed Costs and Aggregate Welfare



Notes: This figure displays aggregate welfare against the fixed cost f_j, which is assumed to be homogeneous across jurisdictions. Each of the four lines corresponds to a structure of local governments. "Imperfect" refers to a model with imperfectly overlapping jurisdictions. The other three lines correspond to versions of the model in which jurisdictions overlap perfectly and coincide with areas, cities, or the entire metropolitan area.

increasing returns to scale in the government sector. Specifically, I model the average cost of delivering public goods as

$$c\left(f_j, G_j, N_j\right) = \frac{f_j}{N_j} + \frac{G_j}{N_j} \tag{40}$$

where f_j is a deterministic constant that measures fixed costs. If $f_j = 0$, then $c\left(f_j, G_j, N_j\right)$ reduces to G_j and the baseline version of the model is restored. In the presence of fixed costs, a jurisdiction's balanced budget equation becomes

$$c\left(f_j, G_j, N_j\right) N_j = \tau_j R_j H_j \tag{41}$$

I solve the model for each element of a grid of values of f ranging from 0 to 0.03 and for each local government structure described earlier in this section. Figure 4 plots aggregate welfare against the fixed cost. As expected, jurisdiction size matters for aggregate welfare when local governments' production function exhibits increasing returns to scale. Specifically, if $f = 0$, welfare in the model with imperfectly overlapping jurisdictions is lower.

However, as fixed costs increase, the gains from centralization become larger and eventually the imperfectly overlapping structure produces higher welfare than both the fully decentralized equilibrium and the equilibrium with jurisdictions that coincide with cities. Ultimately, which structure maximizes household welfare is an empirical question.

5 Identification of Structural Parameters

In this section, I illustrate how to quantify the spatial equilibrium model leveraging a regression discontinuity designs based on referenda in which local governments seek to raise property tax rates and increase expenditure.

5.1 Background

School districts and special purpose jurisdictions fund a significant portion of their operations with revenue from property taxes. For school districts, property taxes account for more than 80 percent of their receipts from local sources (U.S. Department of Education, National Center for Education Statistics 2023). However, state constitutions typically impose caps on tax rates, annual growth in tax revenue, or annual growth in assessed property values, thereby constraining the extent to which school districts and other local governments can tax their base (Lincoln Institute of Land Policy and George Washington Institute of Public Policy 2025). In several states, local jurisdictions can bypass these constraints if a majority of voters approves a spending initiative in a local referendum. These ballot initiatives are often intended to fund large capital expenditures, such as school construction or renovation projects (Fischer, Duncombe and Syverson 2023). If a referendum is approved, a local government will typically issue general obligation bonds and repay the principal and interest over a predetermined number of years using extra property tax revenue.

Starting from the seminal contribution of Cellini, Ferreira and Rothstein (2010), empirical public finance and education economists have leveraged school bond referenda to estimate the effects of increased school expenditures on housing prices, student test scores, and other educational outcomes. In general, establishing a causal relationship between local government expenditures and educational and real estate outcomes is challenging. As a matter of fact, whether a jurisdiction sets a higher or lower tax rate is likely systematically related to the unobserved determinants of educational outcomes, for example because households who value educational investments are more likely to both sort into a well-funded school district (Poterba 1997) and assist their children academically (Guryan, Hurst and Kearney 2008). Analogously, heterogeneity in property tax rates is likely systematically related to unobserved heterogeneity in features of the housing market, for instance because better natural amenities both drive housing prices upwards and make it easier for local governments to levy higher tax rates via fiscal extraction (Brueckner and Neumark 2014, Diamond 2017). The fact that property tax rates are a (collective) choice variable and this choice may be affected by unobserved determinants of the outcomes invalidates the causal interpretation of simple comparisons of conditional means. Regression discontinuity designs that exploit expenditure referenda overcome these identification challenges by comparing conditional outcome means in jurisdictions that narrowly approved or rejected a local ballot initiative.

In this paper, I focus on the effect of referendum approval on the model's endogenous variables: household counts, housing prices, housing units, and aggregate government expenditures. Given the complex vertically differentiated structure of local governments that characterizes most U.S. metropolitan areas, I aggregate jurisdictions into two main groups, namely school districts and all other special-purpose jurisdictions combined. With regard to school districts, the setting is the state of Wisconsin, where referenda are routinely held to authorize both operational and capital expenditures (Baron 2022). With regard to all other local jurisdictions, I exploit referenda held in the state of Washington.

5.2 Identification of Average Effects at the Cutoff

Hereafter, I provide a formal identification argument for the average effects of referendum approval on model outcomes. For simplicity, I focus on housing prices R_j, but identical arguments apply to household masses, property tax rates, housing units, and government expenditure.

Let R_j and S_j denote, respectively, the housing price and the approval vote share margin in school district j. Each referendum proposes a deterministic and binding expenditure increase $\Delta G_j > 0$, which is known to residents prior to voting. Define the approval indicator as $D_j \equiv \mathbb{I}\left[S_j > 0\right]$, where $D_j = 1$ if the referendum is approved. Initially, I adopt a potential outcomes model in which $R_j\left(d\right)$ denotes the potential housing price in district j under treatment status $d \in \{0,1\}$.

The primary target parameter is the average treatment effect of referendum approval on log housing prices at the threshold:

$$\text{ATE}(0) \equiv \mathbb{E}\left[\log R_j(1) - \log R_j(0) \,|\, S_j = 0\right] \tag{42}$$

This parameter is nonparametrically point identified under a standard continuity assumption (Hahn, Todd and Van der Klaauw 2001).

Assumption 1 (Continuity at the Cutoff) *For each $d \in \{0,1\}$, the function $s \mapsto \mathbb{E}\left[\log R_j(d) \,|\, S_j = s\right]$ is continuous at $s = 0$.*

Under Assumption 1, ATE(0) is identified via the sharp regression discontinuity estimand

$$\theta(0) \equiv \lim_{s \downarrow 0} \mathbb{E}\left[\log R_j | S_j = s\right] - \lim_{s \uparrow 0} \mathbb{E}\left[\log R_j | S_j = s\right] \tag{43}$$

However, $\theta(0)$ is difficult to interpret when proposed expenditure changes ΔG_j vary across referenda. A binary treatment may obscure meaningful variation in the intensity of the underlying policy intervention. To recover a more interpretable, elasticity-like parameter, I normalize the sharp RD estimand by the average realized change in expenditures at the cutoff. Specifically, I consider the variable $D_j \times \Delta \log G_j$, which equals the proposed change in log spending for approved referenda and is zero otherwise. Since ΔG_j is known to voters prior to the election and is binding upon approval, the resulting first stage is deterministic. The corresponding estimand takes the form of a fuzzy regression discontinuity estimand with a known first-stage shift:

$$\theta^{\text{G}}(0) \equiv \frac{\lim_{s \downarrow 0} \mathbb{E}\left[\log R_j | S_j = s\right] - \lim_{s \uparrow 0} \mathbb{E}\left[\log R_j | S_j = s\right]}{\lim_{s \downarrow 0} \mathbb{E}\left[D_j \times \Delta \log G_j | S_j = s\right]} \tag{44}$$

where the lower-limit expectation in the denominator is omitted, as it equals zero by construction. To interpret this parameter, I redefine potential outcomes as functions of the realized change in spending, writing $R_j(d \times \Delta G_j)$ for $d \in \{0,1\}$. I now adapt the continuity assumption to this setting.

Assumption 2 (Continuity at the Cutoff) *For each $d \in \{0,1\}$, the functions $s \mapsto \mathbb{E}\left[\log R_j(d \times \Delta G_j) \,|\, S_j = s\right]$ and $s \mapsto \mathbb{E}\left[\Delta \log G_j | S_j = s\right]$ are continuous at $s = 0$.*

Under Assumption 2, the estimand $\theta^{\mathrm{G}}(0)$ identifies a weighted average of housing price arc elasticities with respect to proposed changes in school expenditures among jurisdictions at the approval threshold:

$$\mathrm{WAVE}(0) \equiv \mathbb{E}\left[\omega_j \times \frac{\log R_j(\Delta G_j) - \log R_j(0)}{\Delta \log G_j} \middle| S_j = 0\right] \tag{45}$$

where weights are defined as

$$\omega_j \equiv \frac{\Delta \log G_j}{\mathbb{E}[\Delta \log G_j | S_j = 0]} \tag{46}$$

ensuring they integrate to one at the cutoff. This result is proved in Appendix **??**.

For estimation, I implement local polynomial regression. Given a random sample $\left\{[S_j, R_j, \Delta G_j]'\right\}_{j=1}^{n}$ and a bandwidth $h_n > 0$, let $\mathcal{S}(h_n) = [-h_n, h_n]$ be a discontinuity window implied by realizations of the running variable around the zero cutoff. Moreover, let $\mathcal{S}^{-}(h_n) = [-h_n, 0)$ and $\mathcal{S}^{+}(h_n) = [0, h_n]$ indicate, respectively, the left and right discontinuity half-windows. For any outcome A, I estimate intercepts via local linear regression:

$$\left[\widehat{\mu}_{A+,1}^{(0)}(h_n), \widehat{\mu}_{A+,1}^{(1)}(h_n)\right]' \equiv \arg\min_{b_0, b_1 \in \mathbb{R}} \sum_{j=1}^{n} \mathbb{I}\left[S_j \in \mathcal{S}^{+}(h_n)\right] (\log A_j - b_0 - b_1 S_j)^2 k_{h_n}(S_j)$$

$$\left[\widehat{\mu}_{A-,1}^{(0)}(h_n), \widehat{\mu}_{A-,1}^{(1)}(h_n)\right]' \equiv \arg\min_{b_0, b_1 \in \mathbb{R}} \sum_{j=1}^{n} \mathbb{I}\left[S_j \in \mathcal{S}^{-}(h_n)\right] (\log A_j - b_0 - b_1 S_j)^2 k_{h_n}(S_j)$$

where $k_{h_n}(S_j) = (1 - |S_j|/h_n)/h_n$ is the triangular kernel. Assuming standard regularity conditions hold (see Assumptions 1 and 2 in Calonico, Cattaneo and Titiunik 2014), I estimate $\mathrm{WAVE}(0)$ with

$$\widehat{\theta}^{\mathrm{G}}(0) \equiv \frac{\widehat{\mu}_{R+,1}^{(1)}(h_n) - \widehat{\mu}_{R-,1}^{(1)}(h_n)}{\widehat{\mu}_{\Delta G+,1}^{(1)}(h_n)} \tag{47}$$

I compute $\widehat{\theta}^{\mathrm{G}}(0)$ in the window whose width minimizes the estimator's mean squared error (Imbens and Kalyanaraman 2012). In addition, I construct nonparametric confidence intervals around the bias-corrected point estimates using the method developed by Calonico, Cattaneo and Titiunik (2014). Finally, I compute standard errors using the nearest-neighbor variance estimator developed in that paper, with the default tuning parameter $j^* = 3$.

5.3 Microfoundation of the RDD Approval Vote Share Margin

In this section, I link the reduced-form average partial effects at the cutoff using the model structure. By doing so, I derive a system of equations that allows me to infer the structural parameters of the model.

As described in the previous section, referenda held by local governments seek to authorize an extra spending amount ΔG_j. I now embed this quantity in the model to derive a microfoundation for the running variable in the regression discontinuity design.

I maintain the assumption that the unobserved cost of participating in the referendum varies across households and locations. However, I characterize the choice to vote or not in terms of both cost and benefit. Specifically, I model the benefit as the magnitude of the potential anticipated effect of the change in government spending on household utility. Intuitively, if ΔG_j is a "high-stakes event" for a household, then ceteris paribus that household is more likely to turn out. Formally, the benefit is defined as $\left|v_j^k\left(\Delta G_j\right)-v_j^k\left(0\right)\right|$. Thus, the probability of voting among type-k households in jurisdiction j becomes

$$T_j^k\left(\Delta G_j\right)\equiv F_C\left(\left|v_j^k\left(\Delta G_j\right)-v_j^k\left(0\right)\right|\right) \tag{48}$$

where F_C denotes the cumulative distribution function of the unobserved cost. As in the general case, a jurisdiction's expected turnout is defined as the ratio of the expected mass of voters and the expected mass of residents in that jurisdiction:

$$T_j\left(\Delta G_j\right)\equiv\frac{\overbrace{\sum_{k\in\mathcal{K}}N_j^kT_j^k\left(\Delta G_j\right)}^{\text{expected mass of resident voters in } j}}{\underbrace{\sum_{k\in\mathcal{K}}N_j^k}_{\text{expected mass of residents in } j}} \tag{49}$$

Clearly, the support of T_j lies in the unit interval. Finally, the Bernoulli random variable taking the value one if type-k households approve the proposed government spending change in jurisdiction j is $W_j^k\left(\Delta G_j\right)=\mathbb{I}\left[v_j^k\left(\Delta G_j\right)\geq v_j^k\left(0\right)\right]$. As in the general case, a jurisdiction's expected approval vote share is defined as the ratio of the expected mass of voters who approve the referendum and the expected mass of voters in that jurisdiction:

$$S_j\left(\Delta G_j\right) \equiv \frac{\overbrace{\sum_{k\in\mathcal{K}} N_j^k T_j^k\left(\Delta G_j\right) W_j^k\left(\Delta G_j\right)}^{\text{expected mass of resident voters approving in } j}}{\underbrace{\sum_{k\in\mathcal{K}} N_j^k T_j^k\left(\Delta G_j\right)}_{\text{expected mass of resident voters in } j}} \tag{50}$$

Evidently, the support of S_j lies in the unit interval too.

5.4 Household Preferences and Elasticity of Housing Supply

The spatial equilibrium model features the following endogenous variables:

(a) $|\mathcal{A}| \times |\mathcal{K}|$ population masses $\left\{N_a^k\right\}_{a,k}$

(b) $|\mathcal{A}|$ rental rates of housing $\left\{R_a\right\}_j$

(c) $|\mathcal{A}|$ quantities of housing space $\left\{H_a\right\}_j$

(d) $|\mathcal{J}|$ levels of education spending $\left\{G_j\right\}_j$ and $|\mathcal{J}|$ property tax rates $\left\{\tau_j\right\}_j$

The approval of a referendum induces a change in local public spending by a known amount ΔG_j. I seek to characterize the equilibrium response of each endogenous variable in the model to this policy shock. To this end, I compute arc elasticities that summarize the proportional response of outcomes to proportional changes in expenditures. For any endogenous variable Z_ℓ in location $\ell \in \mathcal{A}$, let $Z_\ell(0)$ denote the potential outcome under the status quo (i.e., absent referendum approval), and let $Z_\ell\left(\Delta G_j\right)$ denote the potential outcome under the approved expenditure change. The arc elasticity of Z_ℓ with respect to education spending is defined as

$$E_{Z_\ell}\left(\Delta G_j\right) \equiv \frac{\log Z_\ell\left(\Delta G_j\right) - \log Z_\ell(0)}{\Delta \log G_j} \tag{51}$$

While this elasticity captures the causal response of an individual 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 provides a formal basis for linking elasticities across outcomes. Specifically, consider the following nonredundant equations that govern the behavior of the endogenous variables in equilibrium.

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

$$N_\ell^k = \sigma^k \frac{\exp\left(v_\ell^k/\theta^k\right)}{\sum_{j' \in \mathcal{J}} \exp\left(v_{j'}^k/\theta^k\right)} \tag{52}$$

with $v_\ell^k \equiv \rho^k + \overline{A}_\ell^k + \sum_{j \in \mathcal{J}_\ell} \alpha_j^k \log \frac{G_j}{N_j} - \beta^k \log R_\ell - \beta^k \log(1+\tau_\ell)$.

(b) The equilibrium rental rate of housing in area $\ell \in \mathcal{J}$:

$$\log R_\ell = \frac{1}{\eta} \log \sum_{k \in \mathcal{K}} N_\ell^k - \frac{\lambda}{\eta} - \frac{B_\ell}{\eta} \tag{53}$$

Equivalently, the equilibrium quantity of housing space in location $\ell \in \mathcal{J}$:

$$\log H_\ell = \lambda + \eta \log R_\ell + B_\ell \tag{54}$$

(c) The balanced budget run by jurisdiction $j \in \mathcal{J}$:

$$G_j = \tau_\ell R_j H_j \tag{55}$$

For each of these equilibrium conditions, I compute arc elasticities and use them to derive a system of equations characterizing the response of the spatial equilibrium to the expenditure change $\Delta \log G_j$. For example, the housing supply equation (54) implies

$$\frac{\Delta \log H_\ell}{\Delta \log G_j} = \eta \frac{\Delta \log R_\ell}{\Delta \log G_j} \tag{56}$$

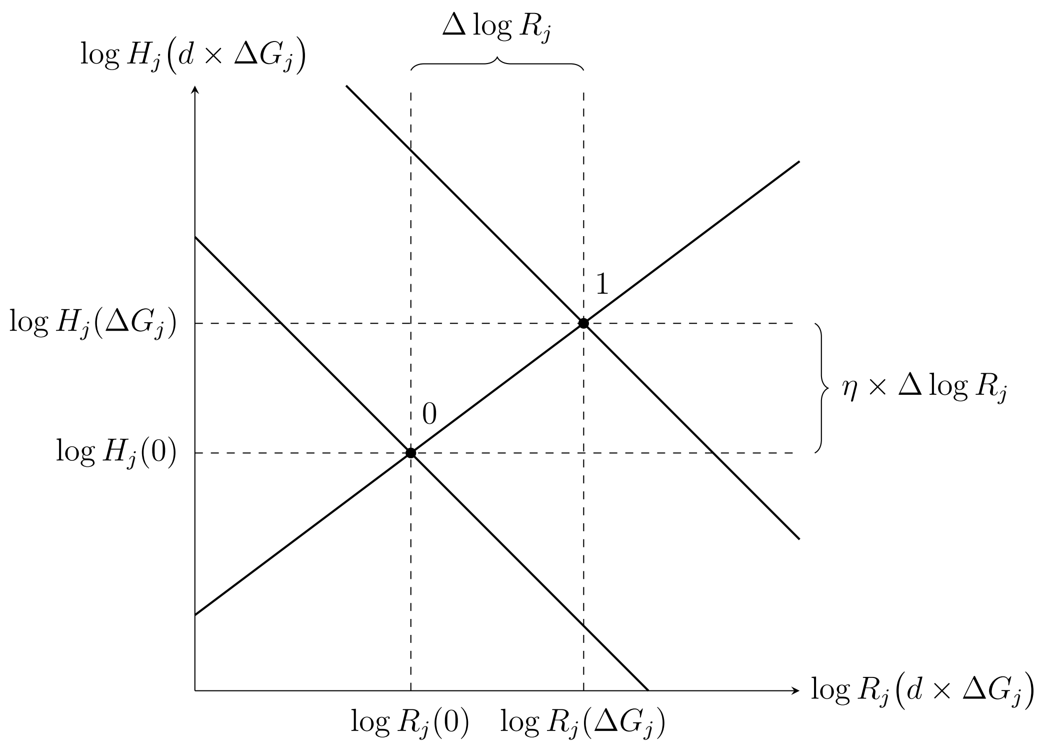
This relationship reflects the fact that a change in education spending affects housing demand through household mobility, while the supply of housing remains directly unaffected. The resulting shift in demand leads to price adjustments that can be used to infer the supply elasticity η. Figure 5 illustrates the equilibrium in location j's housing market under both referendum rejection and approval, showing how differences in potential outcomes map into the structural parameter of interest.

Although the arc elasticities in equation (56) are not observable, Section 5.2 establishes that they are point identified in expectation using a regression discontinuity design centered at the approval threshold. Specifically, taking expectations of both sides of equation (56) conditional on $S_j = 0$[4] and integrating over the joint probability distribution of unobservables (i.e., $\overline{A}_j$ and B_j), I obtain

$$\mathbb{E}\left[\frac{\Delta \log H_\ell}{\Delta \log G_j}\middle| S_j = 0\right] = \eta \times \mathbb{E}\left[\frac{\Delta \log R_\ell}{\Delta \log G_j}\middle| S_j = 0\right] \tag{57}$$

Since both conditional expectations are identified, equation (57) can be used to recover the structural parameter η. Analogous expressions derived from the remaining equilibrium conditions are provided in Appendix B.

Figure 5: Equilibria in the Local Housing Market



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

Applying this strategy across all equilibrium relationships yields a system of equations that enables identification of the full set of structural parameters:

(a) $2|\mathcal{K}|$ preference parameters for education and other local governments' spending $\left\{\alpha_j^k/\theta^k\right\}_k$

[4]With a slight abuse of notation, I redefine S_j to denote the approval vote share margin, i.e., $S_j - 0.5$.

(b) $|\mathcal{K}|$ preference parameters for the numeraire consumption good $\left\{\gamma^k/\theta^k\right\}_k$

(c) One elasticity of housing supply η.

These parameters are identified as long as their number does not exceed the number of equations, i.e. $|\mathcal{A}|\left(|\mathcal{K}|+2\right) \geq 3|\mathcal{K}|+1$. In practice, the number of locations will typically be large relative to the assumed number of household types, thus leading to overidentification.

6 Data

In this section, I describe the data sources that I use to estimate the model's parameters.

6.1 Spatial Partitioning and Household Heterogeneity

Wisconsin and Washington comprise 57 Core-Based Statistical Areas (CBSAs), of which 28 are Metropolitan Statistical Areas (MSAs) and 23 are Micropolitan Statistical Areas (μSAs). I consider each of these CBSAs as a region in my spatial equilibrium model, meaning that each CBSA is partitioned into several overlapping jurisdictions and households choose where to live within said CBSA or opt for the outside option, which I model as the combined areas of each state located outside CBSAs[5]. Since CBSAs vary significantly in terms of population, I do not normalize their population to a unit mass and instead, for any household type k, interpret σ^k and N_a^k as population counts, rather than expected masses. CBSAs naturally vary in their number of local governments $\mathcal{J}^6$, while I set $\mathcal{K}=4$ across the board. Specifically, I consider households whose income is above or below the Wisconsin median, further distinguished based on whether they have zero or a positive number of children aged less than 18 years old. Since I focus on location choice based on expenditures by school districts and other local governments, I wish to differentiate families by their willingness to pay for local public services (α_j^k/γ^k in the model), and presence of children jointly with income are two likely salient factors for this parameter.

[5]According to the 2019-2023 American Community Survey, 13.4 percent of families live outside Core-Based Statistical Areas.

[6]For the purpose of estimating the effect of referendum approval in jurisdictions other than the one holding the referendum, I aggregate those local governments into an "outer" jurisdiction. Clearly, the definition of this outside area varies depending on the jurisdiction holding the referendum.

6.2 Property Tax Rates

I construct a comprehensive, nationwide georeferenced dataset encompassing all local government entities – counties, municipalities, school districts, and special purpose districts – and their property tax rates from the early 2000s to 2022. To my knowledge, this is the most geographically granular dataset on U.S. local governments and property tax rates available to date.

The determination of property tax rates is a highly decentralized process. Indeed, each local government maintains its own independent budget and sets its desired level of expenditures on an annual basis. County governments are then responsible for regularly assessing property values[7] and formally computing each jurisdiction's tax rate, i.e., the ratio of its projected expenditures and the aggregate assessed value of residential property within its boundaries. A standard property tax bill lists all of the jurisdictions to which a land parcel is subject to, and the unique combination of local governments overlapping in a given location is referred to as "Tax Code Area" or "Tax Rate Area".

States' departments of revenue, finance, or local affairs typically gather county-level data on property assessed values and jurisdiction tax rates. In addition, these departments often compile annual reports containing varying degrees of information on local finances. Whenever possible, I collected or requested state-level data on jurisdiction- and or area-level property tax rates. If a state did not make granular data available for the public, I gathered similar data county by county[8]. Appendix D reports the complete list of data sources for each state.

6.3 Local Government Boundaries

The U.S. Census Bureau TIGER/Line dataset includes annual shapefiles for the most important legal boundaries in the country, including those of counties, municipalities, townships, and school districts. For each state and year between 2008 and 2022, the TIGER/Line shapefiles corresponding to local taxing jurisdictions were downloaded and intersected in order to produce "tax code areas" implied by unique combinations of general purpose governments and school districts. Because the TIGER/Line dataset does not encompass special purpose districts, additional shapefiles were retrieved from a broad range of state GIS repositories,

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

[8] I collected data county by county in Arizona, California, Kansas, and Washington.

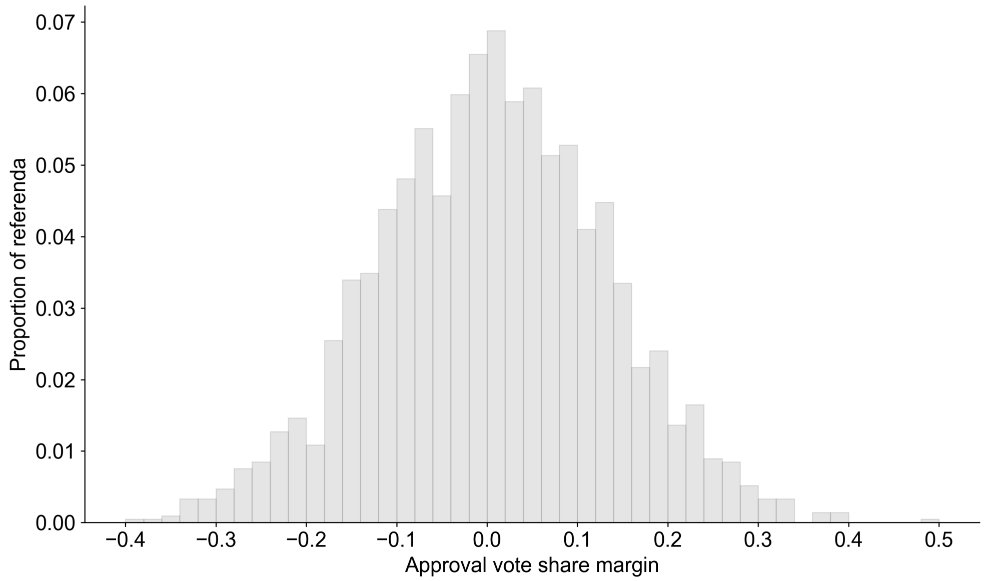
maps, county-level descriptions, and even municipal codes containing detailed descriptions of the boundaries of special purpose jurisdictions. Finally, in the states of Florida and Texas, boundaries were constructed with a bottom-up approach. Specifically, county assessors (in Florida) and county appraisal districts (in Texas) make parcel-level shapefiles available for download on their websites. Parcels are uniquely identified by a code that can be linked to annual appraisal rolls. By so doing, each parcel in a county is linked to the set of jurisdictions that overlap in that area. Special purpose district boundaries can then be obtained by dissolving parcels spanned by common sets of jurisdictions. Overall, the final shapefiles cover fifty states and the District of Columbia and consist of approximately 187 thousand tax areas with nonzero population.

6.4 Referenda

The Wisconsin Department of Public Instruction collects and publishes comprehensive data on all school district referenda held in the state since 1990 (Wisconsin Department of Public Instruction 2025). This dataset includes, among other variables, information on the approval vote share, which I use as the running variable in the RDD. As for referenda held by special purpose jurisdictions in the state of Washington, the Municipal Research and Services Center (Municipal Research and Services Center 2025) collects data on all local ballot initiatives since 2011. Whenever possible, I supplement this dataset with county-level data on similar referenda that took place prior to 2011.

The combined sample includes 3,528 referenda, of which 58.8 percent were approved. The average approval vote share margin is 2.22 percentage points, with an average of 10.5 percentage points among approved referenda and –9.59 percentage points among those that were rejected. Figure 6 displays a histogram of the approval vote share margin. To assess the validity of the design, I test for discontinuities in the density of the running variable at the cutoff using the local polynomial density estimators developed by Cattaneo, Jansson and Ma (2020). The null hypothesis of equal densities on either side of the cutoff is not rejected (p-value = 0.82), suggesting that manipulation of the running variable around the threshold is unlikely to be a concern in this setting.

Figure 6: Density of the Approval Vote Share Margin



NOTES: This figure 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 50 percent approval threshold.

6.5 Housing Prices

To construct the housing price outcome, I follow an approach similar to that of Biasi, Lafortune and Schönholzer (2025) and Ruggieri (2025). Specifically, I rely on a repeat-sales house price index developed by Contat and Larson (2024), which covers all Census tracts located within Core-Based Statistical Areas[9] in the United States from 1989 to 2021. The index is normalized to 100 in 1989 for all tracts, allowing for within-tract temporal comparisons but not cross-sectional ones. To allow for level comparisons across school districts, I incorporate data on the average value of owner-occupied single-family homes at the Census tract level, as reported in the U.S. Census Bureau's 2000 Decennial Census[10]. For each tract, I compute a calibration factor as the ratio of the 2000 Census home value to the 2000 value of the house price index from Contat and Larson (2024), and apply this factor to the full time series of the index. The resulting measure of housing prices allows for both cross-sectional and intertemporal comparisons. Next, I compute the centroid of each Census tract and assign it to the corresponding elementary, secondary, or unified school district based on the 2010

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

[10]The collection of this variable was discontinued beginning with the 2010 Decennial Census.

TIGER/Line shapefiles provided by the U.S. Census Bureau[11] (U.S. Census Bureau 2025*b*). Finally, for each district, I calculate a population-weighted average of housing prices across its constituent Census tracts[12]. This yields the outcome variable used in the RDD.

6.6 Population Counts

I complement housing price data with household-type-specific population counts from the 2000 Decennial Census and the five-year American Community Surveys (ACSs) ranging from 2005-2009 to 2019-2023. Because family counts based on presence of dependent children and income are not available prior to the 2000 Decennial Census, these outcomes cannot be measured exactly five years after each referendum, as I instead can do for housing prices. I then adopt the following solution. For referenda that occurred between 1990 and 1995, population count outcomes are measured in the 2000 Decennial Census. For referenda that occurred between 1996 and 2000, population count outcomes are measured in the 2005-2009 ACS. Starting from 2001, referenda are linked to the five-year American Community Survey that begins exactly five years later. That is, I use the 2006-2010 ACS for referenda in 2001, the 2007-2011 ACS for referenda in 2002, and so on until referenda that took place in 2014, for which I use the last currently available, 2019-2023 ACS.

6.7 Other Local Government Finances

I also collect data on school district finances provided by the Wisconsin Department of Public Instruction. Specifically, I draw each district's revenue from all sources and property tax revenue. I use the revenue from all sources, including grants from the federal and state governments, to measure G_j in the model, effectively imposing that jurisdictions balance their budget. In doing so, I assume that intergovernmental transfers are fixed for each jurisdiction and are not adjusted in response to changes in property tax rates[13]. This choice does not

[11] I use 2010 tract and school district boundaries because the house price index constructed by Contat and Larson (2024) is based on 2010 Census tracts.

[12] Although I compute population-weighted averages, this choice is not consequential, as Census tracts are designed to contain approximately 4,000 inhabitants (U.S. Census Bureau 2025*a*).

[13] In Wisconsin, the primary source of state aid to school districts is the State Equalization Aid program. This program allocates funds through a three-tier formula under which the share of a district's costs covered by state aid declines as the district's property tax base per pupil increases. As a result, when a school district approves a referendum to raise expenditures, its state aid is mechanically reduced, though by less than one dollar for each additional dollar of authorized spending. In addition, this offset does not apply to referenda authorizing the issuance of general obligation bonds to finance capital expenditures, which often involve the

invalidate my identification strategy because changes in school expenditure authorized by referenda are repaid entirely with revenue from property taxes. Thus, school district j's balanced budget condition can be re-expressed as

$$G_j = \tau_j R_j H_j + I_j \tag{58}$$

where I_j denotes grants issues by the federal and state governments. Finally, I use the property tax rate to infer the average aggregate consumption of housing H_j by dividing each district's property tax revenue by the average property tax liability, namely the product of the average housing price R_j by τ_j. For all other special purpose jurisdictions, I follow analogous steps using quinquennial data from the 1992-2017 editions of the Census of Governments.

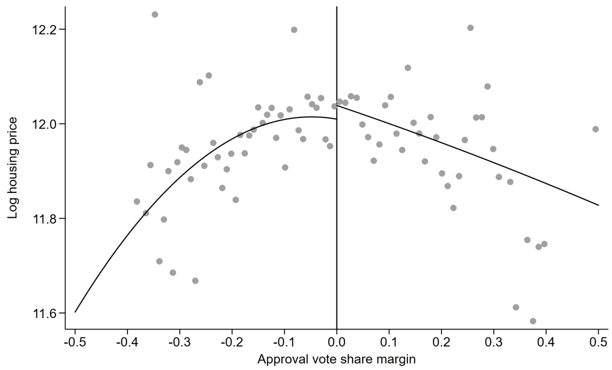
7 Results

7.1 Reduced-Form Estimates

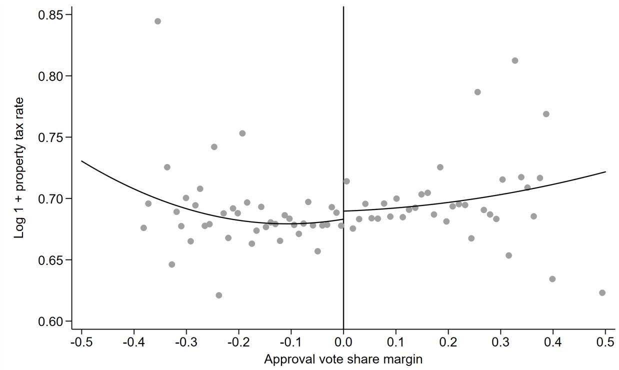
I estimate the effect of local government expenditure authorization on housing prices, household counts, property tax rates, and aggregate government expenditures, all measured five years after each referendum. Because of the temporal lag between treatment assignment and outcome measurement, additional referenda may occur during the intervening period. The difficulty of identifying interpretable causal parameters in settings where jurisdictions are subject to repeated treatment assignments over time was first highlighted by Cellini, Ferreira and Rothstein (2010) and has since become an important concern in empirical local public finance. A growing body of research in applied econometrics has developed identification strategies tailored to such environments, commonly referred to as dynamic regression discontinuity designs (Cellini, Ferreira and Rothstein 2010, Hsu and Shen 2024, Ruggieri 2025). In the current version of this paper, I do not adopt these dynamic RD approaches. Consequently, I interpret the estimand as an intent-to-treat effect generated by the discontinuity in the referendum approval margin.

largest proposed increases in spending. Approximately 75 percent of capital outlays are financed by school districts using local revenue (Filardo 2016), and the distribution of these expenditures varies substantially within the state (Biasi 2023; Biasi, Lafortune and Schönholzer 2025).

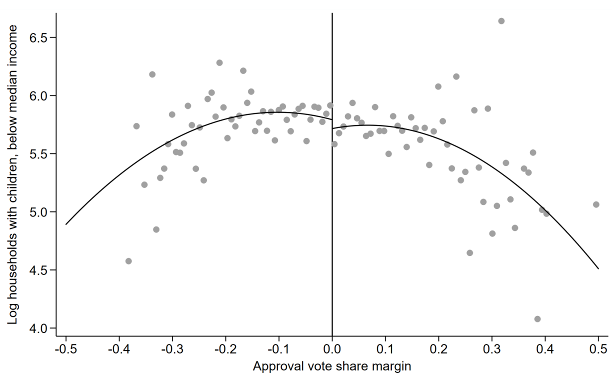
Figure 7: Binned Outcome Means by Approval Vote Share Margin



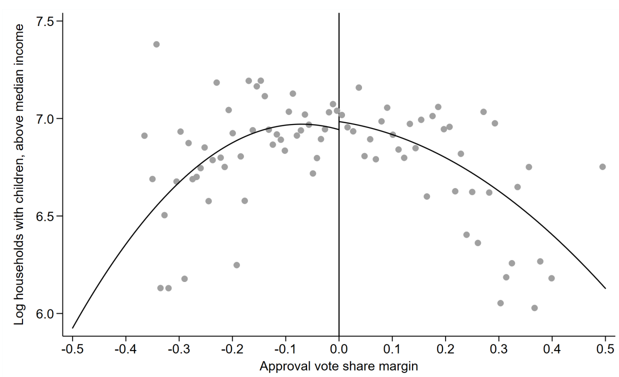
(a) Log Housing Prices R_j



(b) Log Property Tax Rate $1 + \tau_j$



(c) Log Families with Children, Low Income N_j^1



(d) Log Families with Children, High Income N_j^2

NOTES: This figure displays nonparametric estimates of several outcomes at the local jurisdiction level, binned by the approval vote share margin. Fitted values are obtained from global quadratic regressions estimated separately on each side of the cutoff. The number and spacing of bins are selected using spacing estimators, following the data-driven procedure proposed by Calonico, Cattaneo and Titiunik (2015). The approval vote share margin is defined as the difference between the share of votes in favor of the proposed expenditure measure and the 50 percent approval threshold. Outcomes are measured five years after each referendum.

I begin by describing the empirical distribution of four main outcome variables at the school district level, conditional on the approval vote margin. Figure 7 displays nonparametric estimates of housing prices, property tax rates, and two household counts within bins implied by the running variable. For housing prices and family counts, the figure reveals a concave relationship: districts with referenda that are either overwhelmingly approved or rejected tend to exhibit lower average housing prices and a smaller number of households relative to those near the cutoff. To the right of the threshold, average housing prices are modestly higher, consistent with the positive capitalization of marginally approved expenditure authorizations into property values. Similarly, the number of families with children and income above the median slightly increases, while the number of families with children and income below the median follows a symmetric pattern. Finally, as expected, the property tax rate is higher as a consequence of referendum approval.

Table 3: Estimated Effects of Referendum Approval

Outcome	Group	Estimate
N_j^1	With Children, Below Median Income	-0.090
		(0.019)
N_j^2	With Children, Above Median Income	0.027
		(0.013)
N_j^3	Without Children, Below Median Income	0.000
		(0.143)
N_j^4	Without Children, Above Median Income	0.014
		(0.016)
R_j		0.013
		(0.006)
$1 + \tau_j$		0.007
		(0.004)

NOTES: This table reports local linear estimates of the average effect of approving local government expenditure referenda on several outcomes. Each row presents the bias-corrected estimate of ATE(0), the average treatment effect at the cutoff, with the estimand given in equation (43). Estimation adjusts for jurisdiction and year indicators, and relies on a triangular kernel, with bandwidths selected to minimize the mean squared error of the estimator (Imbens and Kalyanaraman 2012), following the procedure developed by Calonico, Cattaneo and Titiunik (2014). Standard errors are computed using the nearest-neighbor variance estimator proposed by Calonico, Cattaneo and Titiunik (2014), with the default tuning parameter $j^* = 3$.

I then turn to formally estimating the effect of referendum approval on the model's endogenous variables. Table 3 reports local linear estimates of the average treatment effect at the cutoff. Consistent with the analysis in the previous paragraph, marginal approval increases housing prices by an estimated 1.3 percent over a five-year horizon and the property tax rate by approximately 0.7 percent. In addition, these changes in government spending affect household sorting across jurisdictions. The number of families with children and income below the median decreases significantly, while the number of families with children and income above the median increases. The mobility patterns of households without children appear less affected, with the estimated effects being small and not precisely estimated.

Overall, the results indicate that marginally approved referenda lead to a positive capitalization of school expenditure authorizations into local housing prices, consistent with prior evidence from Cellini, Ferreira and Rothstein (2010) and Biasi, Lafortune and Schönholzer (2025). This effect appears to be driven by the mobility of higher-income households with children into jurisdictions that authorized extra government expenditures.

7.2 Structural Parameters

In this section, I use the reduced-form estimates from the previous section to estimate the structural parameters entering the household choice probabilities and housing supply.

I begin by revisiting the indirect utility function V_{ij} and applying two standard 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 parameter 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 district j as

$$V_{ij} = \frac{\overline{A}_j}{\gamma^k} + \sum_{j \in \mathcal{J}_a} \frac{\alpha_j^k}{\gamma^k} \log G_j + \log \left[y^k - R_j \left(1 + \tau_j\right) \right] + U_{ij} \tag{59}$$

where the idiosyncratic component U_{ij} follows a Type-I Extreme Value 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 welfare measures expressed in utils, this normalization is without loss of generality.

I am now ready to estimate the structural parameters $\left\{\alpha_j^k/\gamma^k\right\}_{k=1}^4$ by leveraging the system of equations implied by household choice probabilities. As detailed in equations (B.248) and (B.249), this step involves, for each household type, the estimation of 18 regression discontinuity coefficients, each of which identifies the WAVE (0) of a distinct outcome variable with respect to school expenditures, i.e., a weighted average of arc elasticities with respect to the underlying policy variable. I adopt a similar approach to estimate the elasticity of housing supply η, which, as discussed in Section 5.4, can be recovered from just two RDD estimates.

For statistical inference, I compute analytical standard errors using the delta method, which requires estimates of the pairwise covariances among the RDD coefficients (see Appendix C). To obtain these covariances, I extract each outcome's sample based on its own MSE-optimal bandwidth and stack them in pairs. For each pair, I estimate a model in which the local linear instrumental variables specifications are fully interacted with sample indicators, and I cluster heteroskedasticity-robust standard errors by referendum identifier. This procedure yields estimates of the covariance between the two coefficients associated with $D_j \times \Delta \log G_j$. Once the full variance-covariance matrix of RDD parameters is constructed, I apply Ledoit-Wolf shrinkage to its correlation matrix (Ledoit and Wolf 2004) in order to regularize the estimates ($\lambda^* \approx 0.027$) and improve the stability of subsequent inference.

Table 4: Estimates of $\left\{\alpha_j^k/\gamma^k\right\}_{k=1}^4$ and η

		Estimate	
Parameter	Group	School	Other
α^1/γ^1	With Children, Below Median Income	0.693	0.217
		(0.183)	(0.083)
α^2/γ^2	With Children, Above Median Income	0.868	0.245
		(0.214)	(0.094)
α^3/γ^3	Without Children, Below Median Income	0.709	0.302
		(0.218)	(0.097)
α^4/γ^4	Without Children, Above Median Income	0.830	0.322
		(0.204)	(0.106)
η		0.439	
		(0.096)	

Notes: This table presents estimates of $\left\{\alpha_j^k/\gamma^k\right\}_{k=1}^4$, which measure each household group's marginal willingness to pay for public education expenditure and other local government 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 (52) and the housing supply equation (54), using regression discontinuity (RDD) estimates as inputs. Standard errors are computed via the delta method.

Table 4 reports the estimated structural parameters. Across the four household groups, the marginal willingness to pay for K–12 education expenditures—captured by α/γ—is below one. Although the standard errors of pairwise differences are not small enough to support formal statistical comparisons, the point estimates display meaningful heterogeneity. In particular, α/γ is highest among households with children under the age of 18 and income above the median, and lowest among households with children and income below the median. This pattern is consistent with the findings of Biasi, Lafortune and Schönholzer (2025), which shows that the approval of school expenditure referenda affects the composition of the student body, reducing the share of Hispanic students, increasing the share of Asian students, and decreasing the proportion of pupils eligible for free or reduced-price lunch (FRPL). Taken together, this evidence suggests that household sorting across school districts is a salient margin of adjustment in response to changes in local public spending.

With regard to local government services other than education, the marginal willingness to pay is significantly lower. As for education-related parameters, standard errors do not allow for formal statistical comparisons. However, the estimates suggest that families without children value these local public goods more than families with children. Since the former group includes elderly residents, the evidence reported in Table 4 is consistent with the notion that this household type has a higher valuation for local public goods including hospital and emergency medical services, as well as parks and recreation and fire protection.

Finally, my estimate of the elasticity of housing supply is 0.44, a value I consider plausible given my focus on relatively urbanized areas.

Having completed the estimation of the parameters identified solely through RDD coefficients, I proceed to estimate the location-type-specific intercepts $\left\{\overline{A}_a/\gamma^k\right\}_{a,k}$ for all school districts located within CBSAs in Wisconsin. For each CBSA, I solve the system of equations that set the model-implied conditional population shares N_a^k/σ^k equal to their observed counterparts in the year prior to each referendum. I follow an analogous procedure to estimate the location-specific productivity terms $\{B_a\}_a$ in the construction sector, along with the common intercept λ. To achieve point identification, I impose the normalization that the mean of B_a across locations is zero.

8 Counterfactual Exercise

Having estimated the parameters governing the spatial equilibrium model, I conduct a counterfactual exercise that alters the institutional structure of local governments in the United

States. For each Micropolitan and Metropolitan Statistical Area (μSA and MSA), I eliminate vertical overlap by replacing the existing multi-layered system with a single layer of jurisdictions. These new jurisdictions are defined by current municipal boundaries and are assumed to provide a bundle of local public goods, including those currently delivered by special-purpose districts.

Using the estimated parameters and model structure, I solve for the new spatial equilibrium under this institutional configuration. Specifically, I compute the allocations of household masses $\left\{N_a^k\right\}_a$, housing prices $\{R_a\}_a$, property tax rates $\{\tau_a\}_a$, and government expenditures $\{G_a\}_a$ that jointly satisfy the housing market clearing condition, the balanced budget constraint, and the system of household location choices. In each jurisdiction, the property tax rate continues to be determined by majority voting: the chosen rate is one that at least half of local residents prefer to any alternative.

I then compute ex-ante welfare for each household type using equation (36) and aggregate across types to obtain a measure of average welfare in each statistical area. Preliminary results indicate that, on average, this institutional reform would increase household welfare by approximately 0.8 percent nationwide. This gain is primarily driven by reductions in local government spending and lower gross-of-tax housing prices.

Future drafts of the paper will explore the heterogeneity in welfare effects across different regions, identifying which areas are most likely to benefit—or potentially lose—from a shift to horizontally differentiated, general-purpose local governments.

9 Conclusion

In the United States, local governments are both horizontally and vertically differentiated. As a matter of fact, every location is typically served by multiple overlapping jurisdictions that specialize in the provision of one or more local public goods. This paper has proposed a spatial theory of local governments that overlap and thus share tax base. In the model, each jurisdiction's fiscal policy is collectively determined by voters who differ in their preferences for public goods. Because changes in government spending and property tax rates capitalize into housing values and all jurisdictions draw revenue from housing, a district's fiscal policy affects the tax base of all other overlapping jurisdictions. Voters internalize that they bear only a fraction of the full cost of increasing expenditures in their own jurisdiction, thus facing an incentive to prefer more. In equilibrium, jurisdictions choose a higher level of expenditures and set higher property tax rates than they would if jurisdictions were vertically coterminous or did not overlap at all. In a quantified version of the model, an alternative local government structure that replaces overlapping jurisdictions with horizontally differentiated, general-purpose governments yields higher household welfare on average.

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Appendix

A Derivations

A.1 Household Utility Maximization

Type-k households face the following utility maximization problem in location a:

$$\max_{H,X}\left\{A_a+\sum_{j\in\mathcal{J}_a}\alpha^k\log G_j+\beta^k\log H+\gamma^k\log X\right\}\quad \text{s.t.}\quad X+R_aH\left(1+\tau_a\right)\leq y^k \tag{A.1}$$

The Lagrangian associated with this maximization problem is

$$\begin{aligned}\mathcal{L}\left(H,X;\lambda_a^k\right)=&\ A_a+\sum_{j\in\mathcal{J}_a}\alpha^k\log G_j+\beta^k\log H+\gamma^k\log X\\&-\lambda_a^k\left(X+R_aH\left(1+\tau_a\right)-y^k\right)\end{aligned} \tag{A.2}$$

The first-order necessary conditions are

$$\frac{\partial\mathcal{L}\left(H,X;\lambda_a^k\right)}{\partial H}=\frac{\beta^k}{H_a^k}-\lambda_a^kR_a\left(1+\tau_a\right)=0 \tag{A.3}$$

$$\frac{\partial \mathcal{L}\left(H, X; \lambda_a^k\right)}{\partial X} = \frac{\gamma^k}{X_a^k} - \lambda_a^k = 0 \tag{A.4}$$

$$\frac{\partial \mathcal{L}\left(H, X; \lambda_a^k\right)}{\partial \lambda_a^k} = -X_a^k - R_a H_a^k \left(1 + \tau_a\right) + y^k = 0 \tag{A.5}$$

Combining the first two first-order conditions yields

$$\frac{\gamma^k}{X_a^k} = \frac{\beta^k}{R_a \left(1 + \tau_a\right) H_a^k} \iff \frac{\beta^k}{\gamma^k} X_a^k = R_a \left(1 + \tau_a\right) H_a^k \tag{A.6}$$

Plugging back into the budget constraint,

$$X_a^k + \frac{\beta^k}{\gamma^k} X_a^k = y^k \iff \frac{\beta^k + \gamma^k}{\gamma^k} X_a^k = y^k \iff X_a^k = \frac{\gamma^k}{\beta^k + \gamma^k} y^k \tag{A.7}$$

Thus,

$$\frac{\beta^k}{\beta^k + \gamma^k} y^k = R_a \left(1 + \tau_a\right) H_a^k \iff H_a^k = \frac{\beta^k}{\beta^k + \gamma^k} \frac{1}{R_a \left(1 + \tau_a\right)} y^k \tag{A.8}$$

Taking the logarithm of the optimal demand for the numeraire good and housing space,

$$\log X_a^k = \log \left(\frac{\gamma^k}{\beta^k + \gamma^k} \right) + \log y^k \tag{A.9}$$

$$\log H_a^k = \log \left(\frac{\beta^k}{\beta^k + \gamma^k} \right) - \log R_a - \log \left(1 + \tau_a\right) + \log y^k \tag{A.10}$$

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

$$\begin{aligned} V_{ia} = & A_{ia} + \sum_{j \in \mathcal{J}_a} \alpha^k \log G_j \\ & + \beta^k \left(\log \left(\frac{\beta^k}{\beta^k + \gamma^k} \right) - \log R_a - \log \left(1 + \tau_a\right) + \log y^k \right) \\ & + \gamma^k \left(\log \left(\frac{\gamma^k}{\beta^k + \gamma^k} \right) + \log y^k \right) \end{aligned} \tag{A.11}$$

Define a type-specific deterministic constant:

$$\rho^k \equiv \beta^k \log \left(\frac{\beta^k}{\beta^k + \gamma^k} \right) + \gamma^k \log \left(\frac{\gamma^k}{\beta^k + \gamma^k} \right) + \left(\beta^k + \gamma^k \right) \log y^k \tag{A.12}$$

Furthermore, recall that household i's valuation of exogenous amenities is $A_{ia} \equiv \overline{a}_a^k + U_{ia}$, with $U_{ia} \sim \text{T1EV}\left(0, \theta^k\right)$. The indirect utility function can thus be re-expressed as follows:

$$V_{ia} = \underbrace{\rho^k + \overline{a}_a^k + \sum_{j \in \mathcal{J}_a} \alpha^k \log G_j - \beta^k \log R_a - \beta^k \log \left(1 + \tau_a\right)}_{\equiv v_a^k} + U_{ia} \tag{A.13}$$

where v_a^k indicates the type-location-specific component of utility. Each household chooses the location that maximizes their indirect utility. Because of the parametric assumption regarding the random component of amenity shocks, the probability of choosing location a among type-k households is

$$S_a^k = \frac{\exp\left(v_a^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \tag{A.14}$$

Recalling that the mass of type-k households is σ^k, the mass of households who are of type k and sort into location a is

$$N_a^k = \sigma^k S_a^k = \sigma^k \frac{\exp\left(v_a^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \tag{A.15}$$

A.2 Equilibrium in the Housing Market

The housing supply equation is

$$\log H_a^S = \lambda + \eta \log R_a + B_a \tag{A.16}$$

The aggregate demand for housing among type-k households in location a is

$$H_a^{\mathrm{D},k} = N_a^k H_a^k \tag{A.17}$$

The aggregate demand for housing in location a can thus be computed as

$$\begin{aligned}
H_a^{\mathrm{D}} &= \sum_{k'} H_a^{\mathrm{D},k'} && \text{(A.18)}\\
&= \sum_{k'} N_a^{k'} H_a^{k'} && \text{(A.19)}\\
&= \sum_{k'} N_a^{k'} \frac{\beta^{k'}}{\beta^{k'} + \gamma^{k'}} \frac{1}{R_a\left(1+\tau_a\right)} y^{k'} && \text{(A.20)}\\
&= \frac{1}{R_a\left(1+\tau_a\right)} \sum_{k'} N_a^{k'} \underbrace{\frac{\beta^{k'}}{\beta^{k'} + \gamma^{k'}} y^{k'}}_{\equiv \pi^{k'}} && \text{(A.21)}\\
&= \frac{\sum_{k'} \pi^{k'} N_a^{k'}}{R_a\left(1+\tau_a\right)} && \text{(A.22)}
\end{aligned}$$

Taking logarithms yields

$$\log H_a^{\mathrm{D}} = \log \sum_{k'} \pi^{k'} N_a^{k'} - \log R_a - \log\left(1+\tau_a\right) \tag{A.23}$$

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

$$\log H_a^{\mathrm{D}} = \log H_a^{\mathrm{S}} \iff \lambda + \eta \log R_a + B_a = \log \sum_{k'} \pi^{k'} N_a^{k'} - \log R_a - \log(1+\tau_a) \tag{A.24}$$

$$\iff (1+\eta)\log R_a = \log \sum_{k'} \pi^{k'} N_a^{k'} - \log(1+\tau_a) - \lambda - B_a \tag{A.25}$$

$$\iff \log R_a = \frac{1}{1+\eta} \log \sum_{k'} \pi^{k'} N_a^{k'} - \frac{1}{1+\eta} \log(1+\tau_a) - \widetilde{\lambda} - \widetilde{B_a} \tag{A.26}$$

with $\widetilde{\lambda} \equiv \frac{\lambda}{1+\eta}$ and $\widetilde{B}_a \equiv \frac{B_a}{1+\eta}$. Plugging the equilibrium rental rate of housing into the equation for the log-supply of housing yields the equilibrium level of housing space:

$$\log H_a = \lambda + \eta \log R_a + B_a \tag{A.27}$$

$$= \frac{\eta}{1+\eta} \log \sum_{k'} \pi^{k'} N_a^{k'} - \frac{\eta}{1+\eta} \log(1+\tau_a) - \eta\widetilde{\lambda} - \eta\widetilde{B_a} + \lambda + B_a \tag{A.28}$$

$$= \frac{\eta}{1+\eta} \log \sum_{k'} \pi^{k'} N_a^{k'} - \frac{\eta}{1+\eta} \log(1+\tau_a) + \widetilde{\lambda} + \widetilde{B}_a \tag{A.29}$$

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

$$\log R_a H_a = \log \sum_{k'} \pi^{k'} N_a^{k'} - \log(1+\tau_a) \tag{A.30}$$

A.3 Household Supply

As shown in equation (5), the mass of type-k households who choose to reside in area a is

$$N_a^k = \sigma^k \frac{\exp\left(v_a^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \tag{A.31}$$

where the nonstochastic component of utility is

$$v_a^k \equiv \rho^k + \overline{a}_a^k + \sum_{j \in \mathcal{J}_a} \alpha_j^k \log G_j - \beta^k \log R_a - \beta^k \log(1+\tau_a) \tag{A.32}$$

Taking logarithms yields

$$\log N_a^k = \log \sigma^k \frac{\exp\left(v_a^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \tag{A.33}$$

$$= \log \sigma^k \underbrace{- \log \sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)}_{\equiv \phi^k} + \frac{v_a^k}{\theta^k} \tag{A.34}$$

$$= \phi^k + \log \sigma^k + v_a^k \tag{A.35}$$

$$= \phi^k + \underbrace{\log \sigma^k + \rho^k/\theta^k}_{\equiv \zeta^k} + \frac{\overline{a}_a^k}{\theta^k} + \sum_{j \in \mathcal{J}_a} \frac{\alpha_j^k}{\theta^k} \log G_j - \frac{\beta^k}{\theta^k} \log R_a - \frac{\beta^k}{\theta^k} \log (1 + \tau_a) \quad \text{(A.36)}$$

$$= \phi^k + \zeta^k + \frac{\overline{a}_a^k}{\theta^k} + \sum_{j \in \mathcal{J}_a} \frac{\alpha_j^k}{\theta^k} \log G_j - \frac{\beta^k}{\theta^k} \log R_a - \frac{\beta^k}{\theta^k} \log (1 + \tau_a) \quad \text{(A.37)}$$

Computing the exponential again yields

$$N_a^k = \frac{\exp\left(\phi^k + \zeta^k + \frac{\overline{a}_a^k}{\theta^k} + \sum_{j \in \mathcal{J}_a} \frac{\alpha_j^k}{\theta^k} \log G_j\right)}{\exp\left(\frac{\beta^k}{\theta^k} \log R_a + \frac{\beta^k}{\theta^k} \log (1 + \tau_a)\right)} = e^{\phi^k} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j \in \mathcal{J}_a} G_j^{\alpha_j^k/\theta^k}}{R_a^{\beta^k/\theta^k} (1 + \tau_a)^{\beta^k/\theta^k}} \quad \text{(A.38)}$$

Further define

$$\widetilde{\phi}^k \equiv e^{\phi^k} = \exp\left(-\log \sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)\right) = \frac{1}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \quad \text{(A.39)}$$

Then the mass of type-k households choosing location a can be expressed as

$$N_a^k = \widetilde{\phi}^k e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j \in \mathcal{J}_a} G_j^{\alpha_j^k/\theta^k}}{R_a^{\beta^k/\theta^k} (1 + \tau_a)^{\beta^k/\theta^k}} \quad \text{(A.40)}$$

A.4 The Government Possibility Frontier

Consider a voter who resides in area $a \in \mathcal{A}_j$ and chooses their preferred level of government spending per capita G_j. The system of equations implied by the housing market clearing and government balanced budget conditions is

$$\frac{\partial J_a}{\partial \log G_j} d\log G_j + \frac{\partial J_a}{\partial \log R_a} d\log R_a + \frac{\partial J_a}{\partial \log (1 + \tau_j)} d\log (1 + \tau_j) = 0 \quad \text{(A.41)}$$

$$\frac{\partial K_j}{\partial \log G_j} d\log G_j + \frac{\partial K_j}{\partial \log R_a} d\log R_a + \frac{\partial K_j}{\partial \log (1 + \tau_j)} d\log (1 + \tau_j) = 0 \quad \text{(A.42)}$$

where equation (A.42) 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

$$J_a \equiv \lambda + (1 + \eta) \log R_a + B_a - \log \sum_{k'} \pi^{k'} N_a^{k'} + \log (1 + \tau_a) \quad \text{(A.43)}$$

$$K_j \equiv \log \tau_j + \log \sum_{a' \in \mathcal{A}_j} R_{a'} H_{a'} - \log G_j - \log \sum_{a' \in \mathcal{A}_j} N_{a'} \quad \text{(A.44)}$$

A.4.1 Sum of Exponentials

For any household type k, the partial derivatives of $\widetilde{\phi}^k$, i.e., the reciprocal of the sum of exponentials, are the following:

$$\frac{\partial \widetilde{\phi}^k}{\partial \log G_j} = -\left(\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)\right)^{-2} \left(\frac{\alpha_j^k}{\theta^k} \sum_{a' \in \mathcal{A}_j} \exp\left(v_{a'}^k/\theta^k\right)\right) \tag{A.45}$$

$$= -\frac{\alpha_j^k}{\theta^k} \widetilde{\phi}^k \frac{\sum_{a' \in \mathcal{A}_j} \exp\left(v_{a'}^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} = -\frac{\alpha_j^k}{\theta^k} \widetilde{\phi}^k S_j^k \tag{A.46}$$

$$\frac{\partial \widetilde{\phi}^k}{\partial \log R_a} = -\left(\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)\right)^{-2} \left(-\frac{\beta^k}{\theta^k} \exp\left(v_a^k/\theta^k\right)\right) \tag{A.47}$$

$$= \frac{\beta^k}{\theta^k} \widetilde{\phi}^k \frac{\exp\left(v_a^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} = \frac{\beta^k}{\theta^k} \widetilde{\phi}^k S_a^k \tag{A.48}$$

$$\frac{\partial \widetilde{\phi}^k}{\partial \log\left(1+\tau_j\right)} = -\left(\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)\right)^{-2} \left(-\frac{\beta^k}{\theta^k} \left(1+\tau_j\right) \sum_{a' \in \mathcal{A}_j} \frac{\exp\left(v_{a'}^k/\theta^k\right)}{1+\tau_{a'}}\right) \tag{A.49}$$

$$= \frac{\beta^k}{\theta^k} \left(1+\tau_j\right) \widetilde{\phi}^k \frac{\sum_{a' \in \mathcal{A}_j} \frac{\exp\left(v_{a'}^k/\theta^k\right)}{1+\tau_{a'}}}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \tag{A.50}$$

A.4.2 Population by Area and Type

To begin with, for any household type k, area a, and jurisdiction $j \in \mathcal{J}_a$,

$$\frac{\partial N_a^k}{\partial \log G_j} = \frac{\partial N_a^k/\partial G_j}{\partial \log G_j/\partial G_j} = G_j \frac{\partial N_a^k}{\partial G_j} \tag{A.51}$$

$$= G_j \left(\frac{\partial \widetilde{\phi}^k}{\partial G_j} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_{j'}^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1+\tau_a\right)^{\beta^k/\theta^k}} + \widetilde{\phi}^k e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_{j'}^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1+\tau_a\right)^{\beta^k/\theta^k}} \frac{\alpha_j^k}{\theta^k} G_j^{-1}\right) \tag{A.52}$$

$$= G_j \left(\frac{\partial \widetilde{\phi}^k}{\partial \log G_j} \frac{\partial \log G_j}{\partial G_j} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_j^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1+\tau_a\right)^{\beta^k/\theta^k}} + N_a^k \frac{\alpha_j^k}{\theta^k} \frac{1}{G_j}\right) \tag{A.53}$$

$$= G_j \left(-\frac{\alpha_j^k}{\theta^k} \widetilde{\phi}^k S_j^k \frac{1}{G_j} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_j^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1+\tau_a\right)^{\beta^k/\theta^k}} + N_a^k \frac{\alpha_j^k}{\theta^k} \frac{1}{G_j}\right) \tag{A.54}$$

$$= G_j \left(-\frac{\alpha_j^k}{\theta^k} S_j^k \frac{1}{G_j} N_a^k + N_a^k \frac{\alpha_j^k}{\theta^k} \frac{1}{G_j}\right) \tag{A.55}$$

$$= \left(-\frac{\alpha_j^k}{\theta^k} S_j^k N_a^k + N_a^k \frac{\alpha_j^k}{\theta^k}\right) \tag{A.56}$$

$$= \frac{\alpha_j^k}{\theta^k} N_a^k \left(1 - S_j^k\right) \tag{A.57}$$

Instead, for any household type k, area a, and jurisdiction $j \notin \mathcal{J}_a$,

$$\frac{\partial N_a^k}{\partial \log G_j} = -\frac{\alpha_j^k}{\theta^k} N_a^k S_j^k \tag{A.58}$$

In addition, for any household type k and area a,

$$\frac{\partial N_a^k}{\partial \log R_a} = \frac{\partial N_a^k / \partial R_a}{\partial \log R_a / \partial R_a} = R_a \frac{\partial N_a^k}{\partial R_a} \tag{A.59}$$

$$= R_a \left(\frac{\partial \widetilde{\phi}^k}{\partial R_a} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_{j'}^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1 + \tau_a\right)^{\beta^k/\theta^k}} - \widetilde{\phi}^k e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_{j'}^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1 + \tau_a\right)^{\beta^k/\theta^k}} \frac{\beta^k}{\theta^k} R_a^{-1} \right) \tag{A.60}$$

$$= R_a \left(\frac{\partial \widetilde{\phi}^k}{\partial \log R_a} \frac{\partial \log R_a}{\partial R_a} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_j^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1 + \tau_a\right)^{\beta^k/\theta^k}} - N_a^k \frac{\beta^k}{\theta^k} \frac{1}{R_a} \right) \tag{A.61}$$

$$= R_a \left(\frac{\beta^k}{\theta^k} \widetilde{\phi}^k S_a^k \frac{1}{R_a} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_j^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1 + \tau_a\right)^{\beta^k/\theta^k}} - N_a^k \frac{\beta^k}{\theta^k} \frac{1}{R_a} \right) \tag{A.62}$$

$$= R_a \left(\frac{\beta^k}{\theta^k} S_a^k \frac{1}{R_a} N_a^k - N_a^k \frac{\beta^k}{\theta^k} \frac{1}{R_a} \right) \tag{A.63}$$

$$= \left(\frac{\beta^k}{\theta^k} S_a^k N_a^k - N_a^k \frac{\beta^k}{\theta^k} \right) \tag{A.64}$$

$$= -\frac{\beta^k}{\theta^k} N_a^k \left(1 - S_a^k\right) \tag{A.65}$$

Instead, for any household type k and area $a' \neq a$,

$$\frac{\partial N_a^k}{\partial \log R_{a'}} = \frac{\beta^k}{\theta^k} N_{a'}^k S_{a'}^k \tag{A.66}$$

Finally, for any household type k, area a, and jurisdiction $j \in \mathcal{J}_a$,

$$\frac{\partial N_a^k}{\partial \log \left(1 + \tau_j\right)} = \frac{\partial N_a^k / \partial \left(1 + \tau_j\right)}{\partial \log \left(1 + \tau_j\right) / \partial \left(1 + \tau_j\right)} = \left(1 + \tau_j\right) \frac{\partial N_a^k}{\partial \left(1 + \tau_j\right)} \tag{A.67}$$

$$= \left(\frac{\partial \widetilde{\phi}^k}{\partial \left(1 + \tau_j\right)} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_{j'}^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1 + \tau_a\right)^{\beta^k/\theta^k}} \right. \tag{A.68}$$

$$\left. - \widetilde{\phi}^k e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_{j'}^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1 + \tau_a\right)^{\beta^k/\theta^k}} \frac{\beta^k}{\theta^k} \left(1 + \tau_a\right)^{-1} \right) \left(1 + \tau_j\right) \tag{A.69}$$

$$= \left(\frac{\partial \widetilde{\phi}^k}{\partial \log \left(1 + \tau_j\right)} \frac{\partial \log \left(1 + \tau_j\right)}{\partial \left(1 + \tau_j\right)} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_j^k/\theta^k}}{R_a^{\beta^k/\theta^k} \left(1 + \tau_a\right)^{\beta^k/\theta^k}} \right. \tag{A.70}$$

$$- N_a^k \frac{\beta^k}{\theta^k} \frac{1}{1+\tau_a} \Bigg) (1+\tau_j) \tag{A.71}$$

$$= \Bigg(\frac{\beta^k}{\theta^k} (1+\tau_j) \widetilde{\phi}^k \frac{\sum_{a' \in \mathcal{A}_j} \frac{\exp\left(v_{a'}^k/\theta^k\right)}{1+\tau_{a'}}}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \frac{1}{1+\tau_j} e^{\zeta^k} \frac{e^{\overline{a}_a^k/\theta^k} \Pi_{j' \in \mathcal{J}_a} G_{j'}^{\alpha_j^k/\theta^k}}{R_a^{\beta^k/\theta^k} (1+\tau_a)^{\beta^k/\theta^k}} \tag{A.72}$$

$$- N_a^k \frac{\beta^k}{\theta^k} \frac{1}{1+\tau_a} \Bigg) (1+\tau_j) \tag{A.73}$$

$$= (1+\tau_j) \left(\frac{\beta^k}{\theta^k} \frac{\sum_{a' \in \mathcal{A}_j} \frac{\exp\left(v_{a'}^k/\theta^k\right)}{1+\tau_{a'}}}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} N_a^k - N_a^k \frac{\beta^k}{\theta^k} \frac{1}{1+\tau_a} \right) \tag{A.74}$$

$$= \frac{\beta^k}{\theta^k} N_a^k \left(\frac{\sum_{a' \in \mathcal{A}_j} \frac{1+\tau_j}{1+\tau_{a'}} \exp\left(v_{a'}^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} - \frac{1+\tau_j}{1+\tau_a} \right) \tag{A.75}$$

$$= -\frac{\beta^k}{\theta^k} N_a^k \left(\frac{1+\tau_j}{1+\tau_a} - \frac{\sum_{a' \in \mathcal{A}_j} \frac{1+\tau_j}{1+\tau_{a'}} \exp\left(v_{a'}^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \right) \tag{A.76}$$

Instead, for any household type k, area a, and jurisdiction $j \notin \mathcal{J}_a$,

$$\frac{\partial N_a^k}{\partial \log(1+\tau_j)} = \frac{\beta^k}{\theta^k} N_a^k \frac{\sum_{a' \in \mathcal{A}_j} \frac{1+\tau_j}{1+\tau_{a'}} \exp\left(v_{a'}^k/\theta^k\right)}{\sum_{a'} \exp\left(v_{a'}^k/\theta^k\right)} \tag{A.77}$$

A.4.3 Logged Population by Area and Type

To begin with, for any household type k, area a, and jurisdiction $j \in \mathcal{J}_a$,

$$\frac{\partial \log N_a^k}{\partial \log G_j} = \frac{\partial \log N_a^k}{\partial N_a^k} \frac{\partial N_a^k}{\partial \log G_j} = \frac{1}{N_a^k} \frac{\alpha_j^k}{\theta^k} N_a^k \left(1 - S_j^k\right) = \frac{\alpha_j^k}{\theta^k} \left(1 - S_j^k\right) \tag{A.78}$$

Instead, for any household type k, area a, and jurisdiction $j \notin \mathcal{J}_a$,

$$\frac{\partial \log N_a^k}{\partial \log G_j} = -\frac{\alpha_j^k}{\theta^k} S_j^k \tag{A.79}$$

In addition, for any household type k and area a,

$$\frac{\partial \log N_a^k}{\partial \log R_a} = \frac{\partial \log N_a^k}{\partial N_a^k} \frac{\partial N_a^k}{\partial \log R_a} = -\frac{1}{N_a^k} \frac{\beta^k}{\theta^k} N_a^k \left(1 - S_a^k\right) = -\frac{\beta^k}{\theta^k} \left(1 - S_a^k\right) \tag{A.80}$$

Instead, for any household type k and area $a' \neq a$,

$$\frac{\partial \log N_a^k}{\partial \log R_{a'}} = \frac{\beta^k}{\theta^k} S_{a'}^k \tag{A.81}$$

Finally, for any $j \in \mathcal{J}_a$,

$$\frac{\partial \log N_a^k}{\partial \log(1+\tau_j)} = \frac{\partial \log N_a^k}{\partial N_a^k} \frac{\partial N_a^k}{\partial \log(1+\tau_j)} \tag{A.82}$$

$$= -\frac{1}{N_a^k}\frac{\beta^k}{\theta^k}N_a^k\left(\frac{1+\tau_j}{1+\tau_a} - \frac{\sum_{a'\in\mathcal{A}_j}\frac{1+\tau_j}{1+\tau_{a'}}\exp\left(v_{a'}^k/\theta^k\right)}{\sum_{a'}\exp\left(v_{a'}^k/\theta^k\right)}\right) \tag{A.83}$$

$$= -\frac{\beta^k}{\theta^k}\left(\frac{1+\tau_j}{1+\tau_a} - \frac{\sum_{a'\in\mathcal{A}_j}\frac{1+\tau_j}{1+\tau_{a'}}\exp\left(v_{a'}^k/\theta^k\right)}{\sum_{a'}\exp\left(v_{a'}^k/\theta^k\right)}\right) \quad \text{for any } j\in\mathcal{J}_a \tag{A.84}$$

Instead, for any household type k, area a, and jurisdiction $j \notin \mathcal{J}_a$,

$$\frac{\partial \log N_a^k}{\partial \log(1+\tau_j)} = \frac{\beta^k}{\theta^k}\frac{\sum_{a'\in\mathcal{A}_j}\frac{1+\tau_j}{1+\tau_{a'}}\exp\left(v_{a'}^k/\theta^k\right)}{\sum_{a'}\exp\left(v_{a'}^k/\theta^k\right)} \tag{A.85}$$

A.4.4 Logged Population by Area

To begin with, for any area a and jurisdiction $j \in \mathcal{J}_a$,

$$\frac{\partial \log N_a}{\partial \log G_j} = \frac{\partial \log N_a}{\partial N_a}\frac{\partial N_a}{\partial \log G_j} = \frac{1}{N_a}\frac{\partial \sum_{k'} N_a^{k'}}{\partial \log G_j} \tag{A.86}$$

$$= \frac{1}{N_a}\sum_{k'}\frac{\partial N_a^{k'}}{\partial \log G_j} = \frac{1}{N_a}\sum_{k'}\frac{\alpha_j^{k'}}{\theta^k}N_a^{k'}\left(1-S_j^{k'}\right) \tag{A.87}$$

Instead, for any area a and jurisdiction $j \notin \mathcal{J}_a$,

$$\frac{\partial \log N_a}{\partial \log G_j} = -\frac{1}{N_a}\sum_{k'}\frac{\alpha_j^{k'}}{\theta^k}N_a^{k'}S_j^{k'} \tag{A.88}$$

In addition, for any area a,

$$\frac{\partial \log N_a}{\partial \log R_a} = \frac{\partial \log N_a}{\partial N_a}\frac{\partial N_a}{\partial \log R_a} = \frac{1}{N_a}\frac{\partial \sum_{k'} N_a^{k'}}{\partial \log R_a} \tag{A.89}$$

$$= \frac{1}{N_a}\sum_{k'}\frac{\partial N_a^{k'}}{\partial \log R_a} = -\frac{1}{N_a}\sum_{k'}\frac{\beta^{k'}}{\theta^{k'}}N_a^{k'}\left(1-S_a^{k'}\right) \tag{A.90}$$

Instead, for any area $a' \neq a$,

$$\frac{\partial \log N_a}{\partial \log R_{a'}} = \frac{1}{N_a}\sum_{k'}\frac{\beta^{k'}}{\theta^{k'}}N_{a'}^{k'}S_{a'}^{k'} \tag{A.91}$$

Finally, for any area a and jurisdiction $j \in \mathcal{J}_a$,

$$\frac{\partial \log N_a}{\partial \log(1+\tau_j)} = \frac{\partial \log N_a}{\partial N_a}\frac{\partial N_a}{\partial \log(1+\tau_j)} = \frac{1}{N_a}\frac{\partial \sum_{k'} N_a^{k'}}{\partial \log(1+\tau_j)} \tag{A.92}$$

$$= \frac{1}{N_a}\sum_{k'}\frac{\partial N_a^{k'}}{\partial \log(1+\tau_j)} \tag{A.93}$$

$$= -\frac{1}{N_a}\sum_{k'}\frac{\beta^{k'}}{\theta^{k'}}N_{a'}^{k'}\left(\frac{1+\tau_j}{1+\tau_a} - \frac{\sum_{a'\in\mathcal{A}_j}\frac{1+\tau_j}{1+\tau_{a'}}\exp\left(v_{a'}^{k'}/\theta^{k'}\right)}{\sum_{a'}\exp\left(v_{a'}^{k'}/\theta^{k'}\right)}\right) \tag{A.94}$$

Instead, for any area a and jurisdiction $j \notin \mathcal{J}_a$,

$$\frac{\partial \log N_a}{\partial \log(1+\tau_j)} = \frac{1}{N_a} \sum_{k'} \frac{\beta^{k'}}{\theta^{k'}} N_{a'}^{k'} \frac{\sum_{a' \in \mathcal{A}_j} \frac{1+\tau_j}{1+\tau_{a'}} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)}{\sum_{a'} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)} \tag{A.95}$$

A.4.5 System of Equations for the Government Possibility Frontier

For any area a, the partial derivatives associated with the market clearing condition J_a are

$$\frac{\partial J_a}{\partial \log G_j} = -\left(\sum_{k'} \pi^{k'} N_a^{k'}\right)^{-1} \sum_{k'} \pi^{k'} \frac{\alpha_j^{k'}}{\theta^{k'}} N_a^{k'} \left(1 - S_j^{k'}\right) \quad \text{for any } j \in \mathcal{J}_a \tag{A.96}$$

$$\frac{\partial J_a}{\partial \log G_j} = \left(\sum_{k'} \pi^{k'} N_a^{k'}\right)^{-1} \sum_{k'} \pi^{k'} \frac{\alpha_j^{k'}}{\theta^{k'}} N_a^{k'} S_j^{k'} \quad \text{for any } j \notin \mathcal{J}_a \tag{A.97}$$

$$\frac{\partial J_a}{\partial \log R_a} = 1 + \eta + \left(\sum_{k'} \pi^{k'} N_a^{k'}\right)^{-1} \sum_{k'} \pi^{k'} \frac{\beta^{k'}}{\theta^{k'}} N_a^{k'} \left(1 - S_a^{k'}\right) \tag{A.98}$$

$$\frac{\partial J_a}{\partial \log R_{a'}} = -\left(\sum_{k'} \pi^{k'} N_a^{k'}\right)^{-1} \sum_{k'} \pi^{k'} \frac{\beta^{k'}}{\theta^{k'}} N_a^{k'} S_a^{k'} \quad \text{for any } a' \neq a \tag{A.99}$$

$$\frac{\partial J_a}{\partial \log(1+\tau_j)} = \frac{1+\tau_j}{1+\tau_a} + \left(\sum_{k'} \pi^{k'} N_a^{k'}\right)^{-1} \tag{A.100}$$

$$\sum_{k'} \pi^{k'} \frac{\beta^{k'}}{\theta^{k'}} N_a^{k'} \left(\frac{1+\tau_j}{1+\tau_a} - \frac{\sum_{a' \in \mathcal{A}_j} \frac{1+\tau_j}{1+\tau_{a'}} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)}{\sum_{a'} \exp\left(v_{a'}^{k'}/\theta^{k}\right)}\right) \quad \text{for any } j \in \mathcal{J}_a \tag{A.101}$$

$$\frac{\partial J_a}{\partial \log(1+\tau_j)} = -\left(\sum_{k'} \pi^{k'} N_a^{k'}\right)^{-1} \tag{A.102}$$

$$\sum_{k'} \pi^{k'} \frac{\beta^{k'}}{\theta^{k'}} N_a^{k'} \frac{\sum_{a' \in \mathcal{A}_j} \frac{1+\tau_j}{1+\tau_{a'}} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)}{\sum_{a'} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)} \quad \text{for any } j \notin \mathcal{J}_a \tag{A.103}$$

For any jurisdiction j, the partial derivatives associated with the balanced budget condition K_j are

$$\frac{\partial K_j}{\partial \log G_j} = -1 - \frac{1}{\sum_{a' \in \mathcal{A}_j} N_{a'}} \sum_{a' \in \mathcal{A}_j} \sum_{k'} \frac{\alpha_j^{k'}}{\theta^{k'}} N_{a'}^{k'} \left(1 - S_j^{k'}\right) \tag{A.104}$$

$$\frac{\partial K_j}{\partial \log G_{j'}} = \frac{1}{\sum_{a' \in \mathcal{A}_j} N_{a'}} \sum_{a' \in \mathcal{A}_j} \sum_{k'} \frac{\alpha_{j'}^{k'}}{\theta^{k'}} N_{a'}^{k'} S_{j'}^{k'} \quad \text{for any } j' \neq j \tag{A.105}$$

$$\frac{\partial K_j}{\partial \log R_a} = \frac{(1+\eta) R_a H_a}{\sum_{a' \in \mathcal{A}_j} R_{a'} H_{a'}} + \frac{1}{\sum_{a' \in \mathcal{A}_j} N_{a'}} \sum_{k'} \frac{\beta^{k'}}{\theta^{k'}} N_a^{k'} \left(1 - S_a^{k'}\right) \quad \text{for any } a \in \mathcal{A}_j \tag{A.106}$$

$$\frac{\partial K_j}{\partial \log R_a} = -\frac{1}{\sum_{a'\in\mathcal{A}_j} N_{a'}} \sum_{k'} \frac{\beta^{k'}}{\theta^{k'}} N_a^{k'} S_a^{k'} \quad \text{for any } a \notin \mathcal{A}_j \tag{A.107}$$

$$\frac{\partial K_j}{\partial \log (1+\tau_j)} = \frac{1+\tau_j}{\tau_j} \tag{A.108}$$

$$+ \frac{1}{\sum_{a'\in\mathcal{A}_j} N_{a'}} \sum_{a'\in\mathcal{A}_j} \sum_{k'} \frac{\beta^{k'}}{\theta^{k'}} N_{a'}^{k'} \left(\frac{1+\tau_j}{1+\tau_a} - \frac{\sum_{a'\in\mathcal{A}_j} \frac{1+\tau_j}{1+\tau_{a'}} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)}{\sum_{a'} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)} \right) \tag{A.109}$$

$$\frac{\partial K_j}{\partial \log (1+\tau_{j'})} = -\frac{1}{\sum_{a'\in\mathcal{A}_j} N_{a'}} \sum_{a'\in\mathcal{A}_j} \sum_{k'} \frac{\beta^{k'}}{\theta^{k'}} N_{a'}^{k'} \frac{\sum_{a'\in\mathcal{A}_j} \frac{1+\tau_{j'}}{1+\tau_{a'}} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)}{\sum_{a'} \exp\left(v_{a'}^{k'}/\theta^{k'}\right)} \quad \text{for any } j' \neq j \tag{A.110}$$

A.4.6 Partial Derivatives 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^k are set to zero. The resulting partial derivatives from the previous section change as follows. For any area a,

$$\frac{\partial J_a}{\partial \log G_j} = 0 \quad \text{for any } j \in \mathcal{J}_a \tag{A.111}$$

$$\frac{\partial J_a}{\partial \log G_j} = 0 \quad \text{for any } j \notin \mathcal{J}_a \tag{A.112}$$

$$\frac{\partial J_a}{\partial \log R_a} = 1+\eta \tag{A.113}$$

$$\frac{\partial J_a}{\partial \log R_{a'}} = 0 \quad \text{for any } a' \neq a \tag{A.114}$$

$$\frac{\partial J_a}{\partial \log (1+\tau_j)} = \frac{1+\tau_j}{1+\tau_a} \quad \text{for any } j \in \mathcal{J}_a \tag{A.115}$$

$$\frac{\partial J_a}{\partial \log (1+\tau_j)} = 0 \quad \text{for any } j \notin \mathcal{J}_a \tag{A.116}$$

In addition, for any jurisdiction j,

$$\frac{\partial K_j}{\partial \log G_j} = -1 \tag{A.117}$$

$$\frac{\partial K_j}{\partial \log G_{j'}} = 0 \quad \text{for any } j' \neq j \tag{A.118}$$

$$\frac{\partial K_j}{\partial \log R_a} = \frac{(1+\eta) R_a H_a}{\sum_{a'\in\mathcal{A}_j} R_{a'} H_{a'}} \equiv (1+\eta)\,\Psi_{aj} \quad \text{for any } a \in \mathcal{A}_j \tag{A.119}$$

$$\frac{\partial K_j}{\partial \log R_a} = 0 \quad \text{for any } a \notin \mathcal{A}_j \tag{A.120}$$

$$\frac{\partial K_j}{\partial \log(1+\tau_j)} = \frac{1+\tau_j}{\tau_j} \tag{A.121}$$

$$\frac{\partial K_j}{\partial \log(1+\tau_{j'})} = 0 \quad \text{for any } j' \neq j \tag{A.122}$$

A.4.7 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 $\mathcal{J}_a = \{1, \ldots, j, \ldots, \bar{j}\}$. In matrix form, the system of equations implied by the budget balance and housing market clearing conditions is

$$\begin{bmatrix} J_{ar} & J_{a\tau_1} & \ldots & J_{a\tau_j} & \ldots & J_{a\tau_{\bar{j}}} \\ K_{1r} & K_{1\tau_1} & \ldots & K_{1\tau_j} & \ldots & K_{1\tau_{\bar{j}}} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ K_{jr} & K_{j\tau_1} & \ldots & K_{j\tau_j} & \ldots & K_{j\tau_{\bar{j}}} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ K_{\bar{j}r} & K_{\bar{j}\tau_1} & \ldots & K_{\bar{j}\tau_j} & \ldots & K_{\bar{j}\tau_{\bar{j}}} \end{bmatrix} \begin{bmatrix} dr_a/dg_j \\ d\tau_1/dg_j \\ \vdots \\ d\tau_j/dg_j \\ \vdots \\ d\tau_{\bar{j}}/dg_j \end{bmatrix} = \begin{bmatrix} -J_{ag_j} \\ -K_{1g_j} \\ \vdots \\ -K_{jg_j} \\ \vdots \\ -K_{\bar{j}g_j} \end{bmatrix} \tag{A.123}$$

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 $dg_j \equiv d\log G_j$, $dr_a \equiv d\log R_a$, and $d\tau_j \equiv d\log(1+\tau_j)$.

A.4.8 The Slope of the GPF with Myopic Voting

Under the assumption of myopic voting, the system of equations in (A.123) becomes

$$\begin{bmatrix} J_{ar} & J_{a\tau_1} & \ldots & J_{a\tau_j} & \ldots & J_{a\tau_{\bar{j}}} \\ K_{1r} & K_{1\tau_1} & \ldots & 0 & \ldots & 0 \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ K_{jr} & 0 & \ldots & K_{j\tau_j} & \ldots & 0 \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ K_{\bar{j}r} & 0 & \ldots & 0 & \ldots & K_{\bar{j}\tau_{\bar{j}}} \end{bmatrix} \begin{bmatrix} dr_a/dg_j \\ d\tau_1/dg_j \\ \vdots \\ d\tau_j/dg_j \\ \vdots \\ d\tau_{\bar{j}}/dg_j \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ -K_{jg_j} \\ \vdots \\ 0 \end{bmatrix} \tag{A.124}$$

To derive a closed-form expression for the solution to this system, consider the balanced budget equation for any jurisdiction $j' \in \mathcal{J}_a$:

$$K_{j'r}\frac{dr_a}{dg_j} + K_{j'\tau_{j'}}\frac{d\tau_{j'}}{dg_j} = -K_{j'g_j} \iff \frac{d\tau_{j'}}{dg_j} = -\frac{K_{j'g_j}}{K_{j'\tau_{j'}}} - \frac{K_{j'r}}{K_{j'\tau_{j'}}}\frac{dr_a}{dg_j} \tag{A.125}$$

Plugging this expression into the housing market clearing condition yields

$$J_{ar}\frac{dr_a}{dg_j}+\sum_{j'\in\mathcal{J}_a}J_{a\tau_{j'}}\frac{d\tau_{j'}}{dg_j}=0 \iff J_{ar}\frac{dr_a}{dg_j}+\sum_{j'\in\mathcal{J}_a}J_{a\tau_{j'}}\left(-\frac{K_{j'g_j}}{K_{j'\tau_{j'}}}-\frac{K_{j'r}}{K_{j'\tau_{j'}}}\frac{dr_a}{dg_j}\right)=0 \quad (A.126)$$

$$\iff J_{ar}\frac{dr_a}{dg_j}-\sum_{j'\in\mathcal{J}_a}\frac{J_{a\tau_{j'}}K_{j'g_j}}{K_{j'\tau_{j'}}}-\sum_{j'\in\mathcal{J}_a}\frac{J_{a\tau_{j'}}K_{j'r}}{K_{j'\tau_{j'}}}\frac{dr_a}{dg_j}=0 \quad (A.127)$$

$$\iff \left(J_{ar}-\sum_{j'\in\mathcal{J}_a}\frac{J_{a\tau_{j'}}K_{j'r}}{K_{j'\tau_{j'}}}\right)\frac{dr_a}{dg_j}=\sum_{j'\in\mathcal{J}_a}\frac{J_{a\tau_{j'}}K_{j'g_j}}{K_{j'\tau_{j'}}} \quad (A.128)$$

$$\iff \frac{dr_a}{dg_j}=\left(J_{ar}-\sum_{j'\in\mathcal{J}_a}\frac{J_{a\tau_{j'}}K_{j'r}}{K_{j'\tau_{j'}}}\right)^{-1}\sum_{j'\in\mathcal{J}_a}\frac{J_{a\tau_{j'}}K_{j'g_j}}{K_{j'\tau_{j'}}} \quad (A.129)$$

Finally, the slope of the property tax rate levied by jurisdiction j' is

$$\frac{d\tau_{j'}}{dg_j}=-\frac{K_{j'g_j}}{K_{j'\tau_{j'}}}-\frac{K_{j'r}}{K_{j'\tau_{j'}}}\frac{dr_a}{dg_j} \quad (A.130)$$

$$=-\frac{K_{j'g_j}}{K_{j'\tau_{j'}}}-\frac{K_{j'r}}{K_{j'\tau_{j'}}}\left(J_{ar}-\sum_{\ell\in\mathcal{J}_a}\frac{J_{a\tau_\ell}K_{\ell r}}{K_{\ell\tau_\ell}}\right)^{-1}\sum_{\ell\in\mathcal{J}_a}\frac{J_{a\tau_\ell}K_{\ell g_j}}{K_{\ell\tau_\ell}} \quad (A.131)$$

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:

$$\frac{d\log R_a}{d\log G_j}=\left(J_{ar}-\sum_{j'\in\mathcal{J}_a}\frac{J_{a\tau_{j'}}K_{j'r}}{K_{j'\tau_{j'}}}\right)^{-1}\sum_{j'\in\mathcal{J}_a}\frac{J_{a\tau_{j'}}K_{j'g_j}}{K_{j'\tau_{j'}}} \quad (A.132)$$

$$=\left(1+\eta-\sum_{j'\in\mathcal{J}_a}\frac{\frac{1+\tau_{j'}}{1+\tau_a}(1+\eta)\Psi_{aj'}}{\frac{1+\tau_{j'}}{\tau_{j'}}}\right)^{-1}\sum_{j'\in\mathcal{J}_a}\frac{\frac{1+\tau_{j'}}{1+\tau_a}(-1)\mathbb{I}[j'=j]}{\frac{1+\tau_{j'}}{\tau_{j'}}} \quad (A.133)$$

$$=-\left(1+\eta-\sum_{j'\in\mathcal{J}_a}\frac{\tau_{j'}}{1+\tau_a}(1+\eta)\Psi_{aj'}\right)^{-1}\frac{\tau_j}{1+\tau_a} \quad (A.134)$$

$$=-\frac{1}{1+\eta}\left(1-\frac{\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}{1+\tau_a}\right)^{-1}\frac{\tau_j}{1+\tau_a} \quad (A.135)$$

$$=-\frac{1}{1+\eta}\left(\frac{1+\tau_a-\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}{1+\tau_a}\right)^{-1}\frac{\tau_j}{1+\tau_a} \quad (A.136)$$

$$=-\frac{1}{1+\eta}\left(\frac{\tau_j}{1+\tau_a-\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}\right) \quad (A.137)$$

Similarly, the total derivative of jurisdiction $j' \neq j$'s property tax rate with respect to government spending per capita is

$$\frac{d\log(1+\tau_{j'})}{d\log G_j} = -\frac{K_{j'g_j}}{K_{j'\tau_{j'}}} - \frac{K_{j'r}}{K_{j'\tau_{j'}}}\frac{d\log R_a}{d\log G_j} \tag{A.138}$$

$$= -\frac{(1+\eta)\,\Psi_{aj'}}{\frac{1+\tau_{j'}}{\tau_{j'}}}\left(-\frac{1}{1+\eta}\frac{\tau_j}{1+\tau_a-\sum_{\ell\in\mathcal{J}_a}\Psi_{a\ell}\tau_\ell}\right) \tag{A.139}$$

$$= \frac{\Psi_{aj'}\tau_{j'}}{1+\tau_{j'}}\left(\frac{\tau_j}{1+\tau_a-\sum_{\ell\in\mathcal{J}_a}\Psi_{a\ell}\tau_\ell}\right) \tag{A.140}$$

Instead, for jurisdiction j,

$$\frac{d\log(1+\tau_j)}{d\log G_j} = -\frac{K_{jg_j}}{K_{j\tau_j}} - \frac{K_{jr}}{K_{j\tau_j}}\frac{d\log R_a}{d\log G_j} \tag{A.141}$$

$$= \frac{1}{\frac{1+\tau_j}{\tau_j}} - \frac{(1+\eta)\,\Psi_{aj}}{\frac{1+\tau_j}{\tau_j}}\left(-\frac{1}{1+\eta}\frac{\tau_j}{1+\tau_a-\sum_{\ell\in\mathcal{J}_a}\Psi_{a\ell}\tau_\ell}\right) \tag{A.142}$$

$$= \frac{\tau_j}{1+\tau_j} + \frac{\Psi_{aj}\tau_j}{1+\tau_j}\left(\frac{\tau_j}{1+\tau_a-\sum_{\ell\in\mathcal{J}_a}\Psi_{a\ell}\tau_\ell}\right) \tag{A.143}$$

A.5 Preferred Property Tax Rates

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

A.5.1 First-Order Conditions

Consider a voter in area a choosing their preferred level of government spending per capita 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

$$\frac{dV_{ia}}{d\log G_j} = \alpha_j^k - \beta^k\frac{d\log R_a}{d\log G_j} - \beta^k\sum_{j'\in\mathcal{J}_a}\frac{1+\tau_{j'}}{1+\tau_a}\frac{d\log(1+\tau_{j'})}{d\log G_j} \tag{A.144}$$

As in equation (13), the first-order condition associated with the implied maximization problem is

$$\alpha_j^k = \beta^k\frac{d\log R_a}{d\log G_j}\bigg|_{G_j=G_{ja}^k} + \beta^k\sum_{j'\in\mathcal{J}_a}\frac{1+\tau_{j'}}{1+\tau_a}\frac{d\log(1+\tau_{j'})}{d\log G_j}\bigg|_{G_j=G_{ja}^k} \tag{A.145}$$

Let us maintain the assumption that voters are myopic. First, the property tax component of the marginal cost of increasing government spending is

$$\sum_{j'\in\mathcal{J}_a}\frac{1+\tau_{j'}}{1+\tau_a}\frac{d\log\left(1+\tau_{j'}\right)}{d\log G_j}=\sum_{j'\in\mathcal{J}_a}\frac{1+\tau_{j'}}{1+\tau_a}\frac{\Psi_{aj'}\tau_{j'}}{1+\tau_{j'}}\left(\frac{\tau_j}{1+\tau_a-\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}\right) \tag{A.146}$$

$$+\frac{1+\tau_j}{1+\tau_a}\frac{\tau_j}{1+\tau_j} \tag{A.147}$$

$$=\frac{\tau_j}{1+\tau_a}+\sum_{j'\in\mathcal{J}_a}\frac{\Psi_{aj'}\tau_{j'}}{1+\tau_a}\left(\frac{\tau_j}{1+\tau_a-\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}\right) \tag{A.148}$$

$$=\frac{\tau_j}{1+\tau_a}+\frac{\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}{1+\tau_a}\left(\frac{\tau_j}{1+\tau_a-\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}\right) \tag{A.149}$$

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

$$\alpha_j^k=-\beta^k\frac{1}{1+\eta}\left(\frac{\tau_j}{1+\tau_a-\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}\right) \tag{A.150}$$

$$+\beta^k\frac{\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}{1+\tau_a}\left(\frac{\tau_j}{1+\tau_a-\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}\right)+\beta^k\frac{\tau_j}{1+\tau_a} \tag{A.151}$$

$$=\beta^k\left(\frac{\tau_j}{1+\tau_a-\sum_{j'\in\mathcal{A}_j}\Psi_{aj'}\tau_{j'}}\right)\left(\frac{\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}{1+\tau_a}-\frac{1}{1+\eta}\right)+\beta^k\frac{\tau_j}{1+\tau_a} \tag{A.152}$$

This first-order condition is evaluated at $\tau_j=\tau_{ja}^k$, jurisdiction j's property tax rate preferred by type-k households residing in area $a\in\mathcal{A}_j$.

A.5.2 Preferred Property Tax Rates

The set of preferred property tax rates for type-k households in area a is the solution to the system of $|\mathcal{J}_a|$ equations implied by the first-order conditions in (A.152). The preferred property tax rate for jurisdiction $j\in\mathcal{J}_a$ is therefore

$$\tau_{ja}^k=\frac{\alpha_j^k\left(1+\eta\right)}{\beta^k\eta-\left(1+\eta\right)\sum_{j'\in\mathcal{J}_a}\alpha_{j'}^k\left(1-\Psi_{aj'}\right)} \tag{A.153}$$

The numerator of τ_{ja}^k is positive because, by assumption, all of the elements of $\left\{\alpha_j^k\right\}_{j,k}$ are positive and the elasticity of housing supply η is positive. However, without further restrictions, the denominator may be negative, possibly yielding illogically valued tax rates. In the worst-case scenario, $\Psi_{aj'}\to 0$ for all $j'\in\mathcal{J}_a$, which would imply that area a does not belong to any of the jurisdictions in $\mathcal{J}_a$. In this case,

$$\lim_{\Psi_{aj'}\to 0\ \forall j'\in\mathcal{J}_a}\left(\beta^k\eta-(1+\eta)\sum_{j'\in\mathcal{J}_a}\alpha^k_{j'}\left(1-\Psi_{aj'}\right)\right)=\beta^k\eta-(1+\eta)\sum_{j'\in\mathcal{J}_a}\alpha^k_{j'} \tag{A.154}$$

which is positive provided that

$$\beta^k\eta-(1+\eta)\sum_{j'\in\mathcal{J}_a}\alpha^k_{j'}>0 \iff \frac{\sum_{j'\in\mathcal{J}_a}\alpha^k_{j'}}{\beta^k}<\frac{\eta}{1+\eta} \tag{A.155}$$

To conclude, if the inequality in (A.155) is true, the optimal property tax rate τ^k_{ja} is positive for any set of housing expenditure shares $\{\Psi_{aj'}\}_{j'\in\mathcal{J}_a}$.

A.5.3 Second-Order Conditions

The goal of this section is to determine whether τ^k_{ja} is indeed a maximizer of V_{ia}. Replacing equation (A.152) into equation (A.156) yields a compact expression for the first derivative of the indirect utility:

$$\frac{dV_{ia}}{d\log G_j}=\alpha^k_j-\beta^k\left(\frac{\tau_j}{1+\tau_a-\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}\right)\left(\frac{\sum_{j'\in\mathcal{J}_a}\Psi_{aj'}\tau_{j'}}{1+\tau_a}-\frac{1}{1+\eta}\right)-\beta^k\frac{\tau_j}{1+\tau_a} \tag{A.156}$$

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

$$\frac{d^2V_{ia}}{d\left(\log G_j\right)^2}=\sum_{j'\in\mathcal{J}_a}\frac{d\frac{dV_{ia}}{d\log G_j}}{d\tau_{j'}}\frac{d\tau_{j'}}{d\log G_j} \tag{A.157}$$

$$=\sum_{j'\in\mathcal{J}_a}\frac{d\frac{dV_{ia}}{d\log G_j}}{d\tau_{j'}}\frac{d\tau_{j'}}{d\log(1+\tau_{j'})}\frac{d\log(1+\tau_{j'})}{d\log G_j} \tag{A.158}$$

$$=\sum_{j'\in\mathcal{J}_a}\frac{d\frac{dV_{ia}}{d\log G_j}}{d\tau_{j'}}\left(1+\tau_{j'}\right)\frac{d\log(1+\tau_{j'})}{d\log G_j} \tag{A.159}$$

As shown in (A.140), the derivative of the property tax rate in a different jurisdiction is

$$\left(1+\tau_{j'}\right)\frac{d\log\left(1+\tau_{j'}\right)}{d\log G_j}=\tau_j\left(\frac{\Psi_{aj'}\tau_{j'}}{1+\sum_{\ell\in\mathcal{J}_a}\left(1-\Psi_{a\ell}\right)\tau_\ell}\right)>0 \tag{A.160}$$

Instead, as shown in (A.143), the derivative of the property tax rate in the same jurisdiction is

$$\left(1+\tau_j\right)\frac{d\log\left(1+\tau_j\right)}{d\log G_j}=\tau_j+\Psi_{aj}\tau_j\left(\frac{\tau_j}{1+\sum_{\ell\in\mathcal{J}_a}\left(1-\Psi_{a\ell}\right)\tau_\ell}\right) \tag{A.161}$$

$$= \tau_j \left(1 + \frac{\Psi_{aj}\tau_j}{1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell} \right) \tag{A.162}$$

$$= \tau_j \left(\frac{1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell + \Psi_{aj}\tau_j}{1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell} \right) > 0 \tag{A.163}$$

Moreover, the derivative of $\frac{dV_{ia}}{d \log G_j}$ with respect to the tax rate in a different jurisdiction is

$$\frac{d \frac{dV_{ia}}{d \log G_j}}{d\tau_{j'}} = \left(\sum_{\ell \in \mathcal{J}_a} \sum_{m \in \mathcal{J}_a} (1 - \Psi_{a\ell})(1 - \Psi_{am}) \tau_\ell \tau_m + 2 \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell + 1 \right)^{-1} \tag{A.164}$$

$$\beta^k \eta (1 - \Psi_{aj'}) \tau_j \tag{A.165}$$

$$= \left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^{-2} \beta^k \eta (1 - \Psi_{aj'}) \tau_j > 0 \tag{A.166}$$

Finally, the derivative of $\frac{dV_{ia}}{d \log G_j}$ with respect to the tax rate in the same jurisdiction is

$$\frac{d \frac{dV_{ia}}{d \log G_j}}{d\tau_j} = - \left(\sum_{\ell \in \mathcal{J}_a} \sum_{m \in \mathcal{J}_a} (1 - \Psi_{a\ell})(1 - \Psi_{am}) \tau_\ell \tau_m + 2 \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell + 1 \right)^{-1} \tag{A.167}$$

$$\beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \tag{A.168}$$

$$= - \left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^{-2} \beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) < 0 \tag{A.169}$$

To keep notation compact, I define the following terms:

$$\triangle_{j'} \equiv \frac{d \frac{dV_{ia}}{d \log G_j}}{d\tau_{j'}} (1 + \tau_{j'}) \frac{d \log(1 + \tau_{j'})}{d \log G_j} \qquad \square_j \equiv \frac{d \frac{dV_{ia}}{d \log G_j}}{d\tau_j} (1 + \tau_j) \frac{d \log(1 + \tau_j)}{d \log G_j} \tag{A.170}$$

Combining previous expressions, the $j' \neq j$ term in the summation on line (A.159) is

$$\triangle_{j'} = \left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^{-2} \beta^k \eta (1 - \Psi_{aj'}) \tau_j \tau_j \left(\frac{\Psi_{aj'}\tau_{j'}}{1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell} \right) \tag{A.171}$$

$$= \frac{\beta^k \eta (1 - \Psi_{aj'}) \tau_j \tau_j \Psi_{aj'} \tau_{j'}}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell\right)^3} \tag{A.172}$$

$$= \frac{\beta^k \eta (1 - \Psi_{aj'}) \Psi_{aj'} \tau_{j'} \tau_j^2}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell\right)^3} > 0 \tag{A.173}$$

Similarly, the $j' = j$ term in the summation on line (A.159) is

$$\square_j = - \left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^{-2} \beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \tag{A.174}$$

$$\tau_j \left(\frac{1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell + \Psi_{aj} \tau_j}{1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell} \right) \tag{A.175}$$

$$= - \left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^{-3} \beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \tag{A.176}$$

$$\tau_j \left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell + \Psi_{aj} \tau_j \right) \tag{A.177}$$

$$= - \frac{\beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell + \Psi_{aj} \tau_j \right) \tau_j}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \tag{A.178}$$

$$= - \frac{\beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell + \tau_j \right) \tau_j}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \tag{A.179}$$

$$= - \frac{\beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right)^2 \tau_j}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \tag{A.180}$$

$$- \frac{\beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \tau_j^2}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} < 0 \tag{A.181}$$

Thus, the summation on line (A.159) reduces to

$$\sum_{j' \in \mathcal{J}_a \setminus \{j\}} \triangle_{j'} + \square_j = \frac{\sum_{\ell \in \mathcal{J}_a \setminus \{j\}} \beta^k \eta (1 - \Psi_{a\ell}) \Psi_{a\ell} \tau_\ell \tau_j^2}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \tag{A.182}$$

$$- \frac{\beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \tau_j^2}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \tag{A.183}$$

$$- \frac{\beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right)^2 \tau_j}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \tag{A.184}$$

Focusing on the terms on lines (A.182) and (A.183):

$$\frac{\sum_{\ell \in \mathcal{J}_a \setminus \{j\}} \beta^k \eta (1 - \Psi_{a\ell}) \Psi_{a\ell} \tau_\ell \tau_j^2}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} - \frac{\beta^k \eta \left(1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \tau_j^2}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \tag{A.185}$$

$$= \frac{\beta^k \eta \tau_j^2}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \left(\sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \Psi_{a\ell} \tau_\ell - 1 - \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) \tau_\ell \right) \tag{A.186}$$

$$= \frac{\beta^k \eta \tau_j^2}{\left(1 + \sum_{\ell \in \mathcal{J}_a} (1 - \Psi_{a\ell}) \tau_\ell \right)^3} \left(-1 + \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1 - \Psi_{a\ell}) (\Psi_{a\ell} - 1) \tau_\ell \right) \tag{A.187}$$

$$= \frac{\beta^k \eta \tau_j^2}{\left(1+\sum_{\ell \in \mathcal{J}_a} (1-\Psi_{a\ell}) \tau_\ell\right)^3} \left(-1 - \sum_{\ell \in \mathcal{J}_a \setminus \{j\}} (1-\Psi_{a\ell})^2 \tau_\ell \right) < 0 \tag{A.188}$$

Because the term on line (A.184) is negative, $\sum_{j' \in \mathcal{J}_a \setminus \{j\}} \triangle_{j'} + \square_j$ is negative too, implying that the indirect utility V_{ia} is a strictly concave function of $\log G_j$. Thus, τ_{ja}^k attains the unique global maximum of V_{ia}.

A.5.4 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 per capita α_j^k, the preference for housing space β^k, and the elasticity of housing supply η. As shown in equation (A.153), the property tax rate preferred by type-k households residing in area a for jurisdiction j is

$$\tau_{ja}^k = \frac{\alpha_j^k (1+\eta)}{\beta^k \eta - (1+\eta) \sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})} \tag{A.189}$$

First, consider the derivative of τ_{ja}^k with respect to α_j^k:

$$\frac{d\tau_{ja}^k}{d\alpha_j^k} = \frac{(1+\eta)\left(\beta^k \eta - (1+\eta)\sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})\right) + \alpha_j^k (1+\eta)^2 (1-\Psi_{aj})}{\left(\beta^k \eta - (1+\eta) \sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})\right)^2} \tag{A.190}$$

which is positive provided that the inequality in (A.155) is true. Second, the derivative of τ_{ja}^k with respect to β^k is

$$\frac{d\tau_{ja}^k}{d\beta^k} = -\frac{\alpha_j^k (1+\eta)\eta}{\left(\beta^k \eta - (1+\eta) \sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})\right)^2} \tag{A.191}$$

which is negative. Third, consider the derivative of τ_{ja}^k with respect to η:

$$\frac{d\tau_{ja}^k}{d\eta} = \frac{\alpha_j^k \left(\beta^k \eta - (1+\eta)\sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})\right) - \alpha_j^k (1+\eta)\left(\beta^k - \sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})\right)}{\left(\beta^k \eta - (1+\eta) \sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})\right)^2} \tag{A.192}$$

$$= \frac{\alpha_j^k \beta^k \eta - \alpha_j^k (1+\eta) \beta^k}{\left(\beta^k \eta - (1+\eta) \sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})\right)^2} \tag{A.193}$$

$$= -\frac{\alpha_j^k \beta^k}{\left(\beta^k \eta - (1+\eta) \sum_{j' \in \mathcal{J}_a} \alpha_{j'}^k (1-\Psi_{aj'})\right)^2} \tag{A.194}$$

which is negative too. Finally, the derivative of τ_{ja}^k with respect to the preference for government spending in a different jurisdiction $\alpha_{j'}^k$, with $j' \neq j$, is

$$\frac{d\tau_{ja}^k}{d\alpha_{j'}^k} = -\frac{\alpha_j^k (1+\eta)^2 (1-\Psi_{aj'})}{\left(\beta^k \eta - (1+\eta) \sum_{\ell \in \mathcal{J}_a} \alpha_\ell^k (1-\Psi_{a\ell})\right)^2} \tag{A.195}$$

which is again negative.

B Identification of Model Parameters

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

B.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.

B.1.1 Household Supply

The expected mass of households who choose location j is

$$N_j^k = \sigma^k \frac{\exp\left(v_j^k/\theta^k\right)}{\sum_\ell \exp\left(v_\ell^k/\theta^k\right)} \tag{B.196}$$

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

$$v_\ell^k \equiv \overline{A}_\ell + \alpha^k \log G_\ell - \chi \alpha^k \log N_\ell + \gamma^k \log\left[y^k - R_\ell (1+\tau_\ell)\right] \tag{B.197}$$

I wish to derive an expression for the difference between logged population mass with and without referendum approval:

$$\Delta \log N_j^k \equiv \log N_j^k (\Delta G_j) - \log N_j^k (0) \tag{B.198}$$

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 $\Delta \log N_j^k \equiv \log N_j^k (1) - \log N_j^k (0)$. Then

$$\Delta \log N_j^k = \log \sigma^k + \frac{v_j^k (1)}{\theta^k} - \log \sum_\ell \exp\left(\frac{v_\ell^k (1)}{\theta^k}\right)$$

$$- \log \sigma^k - \frac{v_j^k(0)}{\theta^k} + \log \sum_\ell \exp\left(\frac{v_\ell^k(0)}{\theta^k}\right) \tag{B.199}$$

$$= \frac{\Delta v_j^k}{\theta^k} - \left(\log \sum_\ell \exp\left(\frac{v_\ell^k(1)}{\theta^k}\right) - \log \sum_\ell \exp\left(\frac{v_\ell^k(0)}{\theta^k}\right)\right) \tag{B.200}$$

$$= \frac{\Delta v_j^k}{\theta^k} - \left(\log Z^k(1) - \log Z^k(0)\right) \tag{B.201}$$

First,

$$\frac{\Delta v_j^k}{\theta^k} = \frac{\alpha^k}{\theta^k}\Delta \log G_j - \frac{\chi \alpha^k}{\theta^k}\Delta \log N_j - \frac{\gamma^k \rho_j^k}{\theta^k}\Delta \log R_j - \frac{\gamma^k \rho_j^k}{\theta^k}\Delta \log(1+\tau_j) \tag{B.202}$$

where $\rho_j^k \equiv \frac{R_j(1+\tau_j)}{y^k - R_j(1+\tau_j)}$. Second, for any $t \in [0,1]$,

$$v_{\ell,t}^k = v_\ell^k(0) + t\left[v_\ell^k(1) - v_\ell^k(0)\right] \tag{B.203}$$

and define

$$Z_t^k \equiv \sum_\ell \exp\left(\frac{v_{\ell,t}^k}{\theta^k}\right) \tag{B.204}$$

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

$$\log Z^k(1) - \log Z^k(0)$$

$$= \int_0^1 \frac{d}{dt}\log Z_t^k dt \tag{B.205}$$

$$= \int_0^1 \frac{1}{Z_t^k}\sum_\ell \exp\left(\frac{v_{\ell,t}^k}{\theta^k}\right)\frac{v_\ell^k(1) - v_\ell^k(0)}{\theta^k}dt \tag{B.206}$$

$$= \int_0^1 \sum_\ell \frac{N_{\ell,t}^k}{\sigma^k}\frac{v_\ell^k(1) - v_\ell^k(0)}{\theta^k}dt \tag{B.207}$$

$$= \sum_\ell \frac{v_\ell^k(1) - v_\ell^k(0)}{\theta^k}\int_0^1 \frac{N_{\ell,t}^k}{\sigma^k}dt \tag{B.208}$$

$$= \sum_\ell \frac{\Delta v_\ell^k}{\theta^k}\int_0^1 \frac{N_{\ell,t}^k}{\sigma^k}dt \tag{B.209}$$

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

$$\overline{N}_\ell^k \equiv \int_0^1 N_{\ell,t}^k dt \tag{B.210}$$

To summarize,

$$\log Z^k(1) - \log Z^k(0) = \sum_\ell \frac{\overline{N}_\ell^k}{\sigma^k}\frac{\Delta v_\ell^k}{\theta^k} \tag{B.211}$$

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

$$\overline{N}_\ell^k \approx \frac{N_\ell^k(0) + N_\ell^k(1)}{2} \equiv \widetilde{N}_\ell^k \tag{B.212}$$

Combining previous derivations,

$$\begin{aligned}
&\log Z^k(1) - \log Z^k(0) \\
&\approx \sum_\ell \frac{N_\ell^k(0) + N_\ell^k(1)}{2\sigma^k}\frac{\Delta v_\ell^k}{\theta^k} && \text{(B.213)}\\
&= \sum_\ell \frac{\widetilde{N}_\ell^k}{\sigma^k}\left(\frac{\alpha^k}{\theta^k}\Delta\log G_\ell - \frac{\chi\alpha^k}{\theta^k}\Delta\log N_\ell - \frac{\gamma^k\rho_\ell^k}{\theta^k}\Delta\log R_\ell - \frac{\gamma^k\rho_\ell^k}{\theta^k}\Delta\log(1+\tau_\ell)\right) && \text{(B.214)}
\end{aligned}$$

Finally, the difference between log household supply in the two treatment states is

$$\begin{aligned}
&\Delta\log N_j^k \\
&\approx \frac{\alpha^k}{\theta^k}\Delta\log G_j - \frac{\chi\alpha^k}{\theta^k}\Delta\log N_j - \frac{\gamma^k\rho_j^k}{\theta^k}\Delta\log R_j - \frac{\gamma^k\rho_j^k}{\theta^k}\Delta\log(1+\tau_j) \\
&- \sum_\ell \frac{\widetilde{N}_\ell^k}{\sigma^k}\left(\frac{\alpha^k}{\theta^k}\Delta\log G_\ell - \frac{\chi\alpha^k}{\theta^k}\Delta\log N_\ell - \frac{\gamma^k\rho_\ell^k}{\theta^k}\Delta\log R_\ell - \frac{\gamma^k\rho_\ell^k}{\theta^k}\Delta\log(1+\tau_\ell)\right) && \text{(B.215)}
\end{aligned}$$

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

$$\begin{aligned}
&\frac{\Delta\log N_j^k}{\Delta\log G_j} \\
&\approx \frac{\alpha^k}{\theta^k} - \frac{\chi\alpha^k}{\theta^k}\frac{\Delta\log N_j}{\Delta\log G_j} - \frac{\gamma^k\rho_j^k}{\theta^k}\frac{\Delta\log R_j}{\Delta\log G_j} - \frac{\gamma^k\rho_j^k}{\theta^k}\frac{\Delta\log(1+\tau_j)}{\Delta\log G_j} \\
&- \sum_\ell \frac{\widetilde{N}_\ell^k}{\sigma^k}\left(\frac{\alpha^k}{\theta^k}\frac{\Delta\log G_\ell}{\Delta\log G_j} - \frac{\chi\alpha^k}{\theta^k}\frac{\Delta\log N_\ell}{\Delta\log G_j} - \frac{\gamma^k\rho_\ell^k}{\theta^k}\frac{\Delta\log R_\ell}{\Delta\log G_j} - \frac{\gamma^k\rho_\ell^k}{\theta^k}\frac{\Delta\log(1+\tau_\ell)}{\Delta\log G_j}\right) && \text{(B.216)}\\
&= \left(1 - \frac{\widetilde{N}_j^k}{\sigma^k}\right)\left(\frac{\alpha^k}{\theta^k} - \frac{\chi\alpha^k}{\theta^k}\frac{\Delta\log N_j}{\Delta\log G_j} - \frac{\gamma^k\rho_j^k}{\theta^k}\frac{\Delta\log R_j}{\Delta\log G_j} - \frac{\gamma^k\rho_j^k}{\theta^k}\frac{\Delta\log(1+\tau_j)}{\Delta\log G_j}\right) \\
&- \sum_{\ell\neq j} \frac{\widetilde{N}_\ell^k}{\sigma^k}\left(\frac{\alpha^k}{\theta^k}\frac{\Delta\log G_\ell}{\Delta\log G_j} - \frac{\chi\alpha^k}{\theta^k}\frac{\Delta\log N_\ell}{\Delta\log G_j} - \frac{\gamma^k\rho_\ell^k}{\theta^k}\frac{\Delta\log R_\ell}{\Delta\log G_j} - \frac{\gamma^k\rho_\ell^k}{\theta^k}\frac{\Delta\log(1+\tau_\ell)}{\Delta\log G_j}\right) && \text{(B.217)}
\end{aligned}$$

For any location $j' \neq j$, analogous derivations yield

$$\begin{aligned}
&\frac{\Delta \log N_{j'}^k}{\Delta \log G_j} \\
&\approx \left(1 - \frac{\widetilde{N}_{j'}^k}{\sigma^k}\right)\left(\frac{\alpha^k}{\theta^k}\frac{\Delta \log G_{j'}}{\Delta \log G_j} - \frac{\chi\alpha^k}{\theta^k}\frac{\Delta \log N_{j'}}{\Delta \log G_j} - \frac{\gamma^k\rho_{j'}^k}{\theta^k}\frac{\Delta \log R_{j'}}{\Delta \log G_j} - \frac{\gamma^k\rho_{j'}^k}{\theta^k}\frac{\Delta \log (1+\tau_{j'})}{\Delta \log G_j}\right) \\
&- \sum_{\ell \neq j'} \frac{\widetilde{N}_\ell^k}{\sigma^k}\left(\frac{\alpha^k}{\theta^k}\frac{\Delta \log G_\ell}{\Delta \log G_j} - \frac{\chi\alpha^k}{\theta^k}\frac{\Delta \log N_\ell}{\Delta \log G_j} - \frac{\gamma^k\rho_\ell^k}{\theta^k}\frac{\Delta \log R_\ell}{\Delta \log G_j} - \frac{\gamma^k\rho_\ell^k}{\theta^k}\frac{\Delta \log (1+\tau_\ell)}{\Delta \log G_j}\right) \quad \text{(B.218)}
\end{aligned}$$

B.1.2 Rental Rate of Housing

In any location ℓ, the equilibrium rental rate of housing is

$$\log R_\ell = \frac{1}{\eta}\log\sum_k N_\ell^k - \frac{\lambda}{\eta} - \frac{B_\ell}{\eta} \quad \text{(B.219)}$$

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

$$\Delta \log R_\ell = \frac{1}{\eta}\left(\log\sum_k N_\ell^k(1) - \log\sum_k N_\ell^k(0)\right) \quad \text{(B.220)}$$

Now define

$$M_\ell(0) \equiv \sum_k N_\ell^k(0) \qquad M_\ell(1) \equiv \sum_k N_\ell^k(1) \quad \text{(B.221)}$$

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

$$N_{\ell,t}^k = N_\ell^k(0) + t\left[N_\ell^k(1) - N_\ell^k(0)\right] \quad \text{(B.222)}$$

and define

$$M_{\ell,t} \equiv \sum_k N_{\ell,t}^k \quad \text{(B.223)}$$

Clearly, $M_{\ell,t} = M_\ell(0)$ if $t = 0$ and $M_{\ell,t} = M_\ell(1)$ if $t = 1$. Then

$$\begin{aligned}
&\log M_\ell(1) - \log M_\ell(0) \\
&= \int_0^1 \frac{d\log M_{\ell,t}}{dt}dt \quad \text{(B.224)} \\
&= \int_0^1 \frac{1}{M_{\ell,t}}\sum_k\left[N_\ell^k(1) - N_\ell^k(0)\right]dt \quad \text{(B.225)}
\end{aligned}$$

$$= \int_0^1 \sum_k \frac{N_{\ell,t}^k}{M_{\ell,t}} \frac{N_\ell^k(1) - N_\ell^k(0)}{N_{\ell,t}^k} dt \tag{B.226}$$

$$= \int_0^1 \sum_k \frac{N_{\ell,t}^k}{M_{\ell,t}} \frac{d \log N_{\ell,t}^k}{dt} dt \tag{B.227}$$

$$= \sum_k \int_0^1 \frac{N_{\ell,t}^k}{M_{\ell,t}} \frac{d \log N_{\ell,t}^k}{dt} dt \tag{B.228}$$

$$= \sum_k \Delta \log N_\ell^k \int_0^1 \frac{N_{\ell,t}^k}{M_{\ell,t}} \frac{d \log N_{\ell,t}^k}{dt} \frac{1}{\Delta \log N_\ell^k} dt \tag{B.229}$$

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 $N_{\ell,t}^k$. Now define the mean-value weight as

$$\overline{L}_\ell^k \equiv \int_0^1 \frac{N_{\ell,t}^k}{M_{\ell,t}} \frac{d \log N_{\ell,t}^k}{dt} \frac{1}{\Delta \log N_\ell^k} dt \tag{B.230}$$

$$= \int_0^1 \frac{N_{\ell,t}^k}{M_{\ell,t}} \frac{\Delta N_\ell^k}{N_{\ell,t}^k} \frac{1}{\Delta \log N_\ell^k} dt \tag{B.231}$$

$$= \int_0^1 \frac{1}{M_{\ell,t}} \frac{\Delta N_\ell^k}{\Delta \log N_\ell^k} dt \tag{B.232}$$

$$= \frac{\Delta N_\ell^k}{\Delta \log N_\ell^k} \int_0^1 \frac{1}{M_{\ell,t}} dt \tag{B.233}$$

$$= \frac{\Delta N_\ell^k}{\Delta \log N_\ell^k} \frac{\Delta \log M_\ell}{\Delta M_\ell} \tag{B.234}$$

Thus,

$$\overline{L}_\ell^k = \frac{\Delta N_\ell^k}{\Delta M_\ell} \frac{\Delta \log M_\ell}{\Delta \log N_\ell^k} \tag{B.235}$$

To summarize,

$$\log M_\ell(1) - \log M_\ell(0) = \sum_k \overline{L}_\ell^k \Delta \log N_\ell^k \tag{B.236}$$

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

$$\overline{L}_\ell^k \approx \frac{N_\ell^k(0) + N_\ell^k(1)}{\sum_m \left[N_\ell^m(0) + N_\ell^m(1)\right]} \equiv \widetilde{L}_\ell^k \tag{B.237}$$

Combining previous derivations,

$$\log M_\ell(1) - \log M_\ell(0) \approx \sum_k \widetilde{L}_\ell^k \Delta \log N_\ell^k \tag{B.238}$$

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

$$\Delta \log R_\ell \approx \frac{1}{\eta} \sum_k \widetilde{L}_\ell^k \Delta \log N_\ell^k \tag{B.239}$$

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

$$\frac{\Delta \log R_\ell}{\Delta \log G_j} \approx \frac{1}{\eta} \sum_k \widetilde{L}_\ell^k \frac{\Delta \log N_\ell^k}{\Delta \log G_j} \tag{B.240}$$

B.1.3 Housing Units

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

$$\log H_\ell = \lambda + \eta \log R_\ell + B_\ell \tag{B.241}$$

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

$$\Delta \log H_\ell = \eta \Delta \log R_\ell \tag{B.242}$$

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

$$\frac{\Delta \log H_\ell}{\Delta \log G_j} = \eta \frac{\Delta \log R_\ell}{\Delta \log G_j} \tag{B.243}$$

B.1.4 Balanced Budget

In any location ℓ, the balanced budget condition is

$$\log G_\ell = \log \tau_\ell + \log R_\ell + \log H_\ell \tag{B.244}$$

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

$$\Delta \log G_\ell = \Delta \log \tau_\ell + \Delta \log R_\ell + \Delta \log H_\ell \tag{B.245}$$

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

$$\frac{\Delta \log G_\ell}{\Delta \log G_j} = \frac{\Delta \log \tau_\ell}{\Delta \log G_j} + \frac{\Delta \log R_\ell}{\Delta \log G_j} + \frac{\Delta \log H_\ell}{\Delta \log G_j} \tag{B.246}$$

B.2 Identification with Regression Discontinuity Estimands

I 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 $S_j = 0.5$, under which regression discontinuity estimands identify weighted averages of elasticities.

B.2.1 Household Supply

The elasticity of household supply in location j with respect to a change in school district expenditures in location j (equation B.218) is

$$\begin{aligned}
&\frac{\Delta \log N_j^k}{\Delta \log G_j} \\
&\approx \left(1 - \frac{\widetilde{N}_j^k}{\sigma^k}\right)\left(\frac{\alpha^k}{\theta^k} - \frac{\chi\alpha^k}{\theta^k}\frac{\Delta \log N_j}{\Delta \log G_j} - \frac{\gamma^k\rho_j^k}{\theta^k}\frac{\Delta \log R_j}{\Delta \log G_j} - \frac{\gamma^k\rho_j^k}{\theta^k}\frac{\Delta \log(1+\tau_j)}{\Delta \log G_j}\right) \\
&- \sum_{\ell \neq j}\frac{\widetilde{N}_\ell^k}{\sigma^k}\left(\frac{\alpha^k}{\theta^k}\frac{\Delta \log G_\ell}{\Delta \log G_j} - \frac{\chi\alpha^k}{\theta^k}\frac{\Delta \log N_\ell}{\Delta \log G_j} - \frac{\gamma^k\rho_\ell^k}{\theta^k}\frac{\Delta \log R_\ell}{\Delta \log G_j} - \frac{\gamma^k\rho_\ell^k}{\theta^k}\frac{\Delta \log(1+\tau_\ell)}{\Delta \log G_j}\right) \quad \text{(B.247)}
\end{aligned}$$

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:

$$\begin{aligned}
\mathbb{E}\left[\frac{\Delta \log N_j^k}{\Delta \log G_j}\middle| S_j = 0.5\right] = &\frac{\alpha^k}{\theta^k} \times \mathbb{E}\left[\left(1 - \frac{\widetilde{N}_j^k}{\sigma^k}\right)\middle| S_j = 0.5\right] \\
&- \frac{\chi\alpha^k}{\theta^k} \times \mathbb{E}\left[\left(1 - \frac{\widetilde{N}_j^k}{\sigma^k}\right)\frac{\Delta \log N_j}{\Delta \log G_j}\middle| S_j = 0.5\right] \\
&- \frac{\gamma^k}{\theta^k} \times \mathbb{E}\left[\rho_j^k\left(1 - \frac{\widetilde{N}_j^k}{\sigma^k}\right)\frac{\Delta \log R_j}{\Delta \log G_j}\middle| S_j = 0.5\right] \\
&- \frac{\gamma^k}{\theta^k} \times \mathbb{E}\left[\rho_j^k\left(1 - \frac{\widetilde{N}_j^k}{\sigma^k}\right)\frac{\Delta \log(1+\tau_j)}{\Delta \log G_j}\middle| S_j = 0.5\right] \\
&- \frac{\alpha^k}{\theta^k} \times \sum_{\ell \neq j}\mathbb{E}\left[\frac{\widetilde{N}_\ell^k}{\sigma^k}\frac{\Delta \log G_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right] \\
&+ \frac{\chi\alpha^k}{\theta^k} \times \sum_{\ell \neq j}\mathbb{E}\left[\frac{\widetilde{N}_\ell^k}{\sigma^k}\frac{\Delta \log N_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right]
\end{aligned}$$

$$+\frac{\gamma^k}{\theta^k} \times \sum_{\ell \neq j} \mathbb{E}\left[\rho_\ell^k \frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log R_\ell}{\Delta \log G_j} \middle| S_j = 0.5\right]$$

$$+\frac{\gamma^k}{\theta^k} \times \sum_{\ell \neq j} \mathbb{E}\left[\rho_\ell^k \frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log (1+\tau_\ell)}{\Delta \log G_j} \middle| S_j = 0.5\right] \tag{B.248}$$

For any location $j' \neq j$, analogous derivations yield the following equation:

$$\begin{aligned}
\mathbb{E}\left[\frac{\Delta \log N_{j'}^k}{\Delta \log G_j} \middle| S_j = 0.5\right] = & \frac{\alpha^k}{\theta^k} \times \mathbb{E}\left[\left(1 - \frac{\widetilde{N}_{j'}^k}{\sigma^k}\right) \frac{\Delta \log G_{j'}}{\Delta \log G_j} \middle| S_j = 0.5\right] \\
& - \frac{\chi \alpha^k}{\theta^k} \times \mathbb{E}\left[\left(1 - \frac{\widetilde{N}_{j'}^k}{\sigma^k}\right) \frac{\Delta \log N_{j'}}{\Delta \log G_j} \middle| S_j = 0.5\right] \\
& - \frac{\gamma^k}{\theta^k} \times \mathbb{E}\left[\rho_{j'}^k \left(1 - \frac{\widetilde{N}_{j'}^k}{\sigma^k}\right) \frac{\Delta \log R_{j'}}{\Delta \log G_j} \middle| S_j = 0.5\right] \\
& - \frac{\gamma^k}{\theta^k} \times \mathbb{E}\left[\rho_{j'}^k \left(1 - \frac{\widetilde{N}_{j'}^k}{\sigma^k}\right) \frac{\Delta \log (1+\tau_{j'})}{\Delta \log G_j} \middle| S_j = 0.5\right] \\
& - \frac{\alpha^k}{\theta^k} \times \mathbb{E}\left[\frac{\widetilde{N}_j^k}{\sigma^k} \middle| S_j = 0.5\right] \\
& - \frac{\alpha^k}{\theta^k} \times \sum_{\ell \neq j, j'} \mathbb{E}\left[\frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log G_\ell}{\Delta \log G_j} \middle| S_j = 0.5\right] \\
& + \frac{\chi \alpha^k}{\theta^k} \times \sum_{\ell \neq j'} \mathbb{E}\left[\frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log N_\ell}{\Delta \log G_j} \middle| S_j = 0.5\right] \\
& + \frac{\gamma^k}{\theta^k} \times \sum_{\ell \neq j'} \mathbb{E}\left[\rho_\ell^k \frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log R_\ell}{\Delta \log G_j} \middle| S_j = 0.5\right] \\
& + \frac{\gamma^k}{\theta^k} \times \sum_{\ell \neq j'} \mathbb{E}\left[\rho_\ell^k \frac{\widetilde{N}_\ell^k}{\sigma^k} \frac{\Delta \log (1+\tau_\ell)}{\Delta \log G_j} \middle| S_j = 0.5\right]
\end{aligned} \tag{B.249}$$

B.2.2 Rental Rate of Housing

The elasticity of housing demand in location $\ell \in \mathcal{J}$ with respect to a change in school district expenditures in location j (equation B.240) is

$$\frac{\Delta \log R_\ell}{\Delta \log G_j} \approx \frac{1}{\eta} \sum_k \widetilde{L}_\ell^k \frac{\Delta \log N_\ell^k}{\Delta \log G_j} \tag{B.250}$$

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:

$$\mathbb{E}\left[\frac{\Delta \log R_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right] = \frac{1}{\eta} \times \sum_k \mathbb{E}\left[\widetilde{L}_\ell^k \frac{\Delta \log N_\ell^k}{\Delta \log G_j}\middle| S_j = 0.5\right] \tag{B.251}$$

B.2.3 Housing Units

The elasticity of housing supply in location $\ell \in \mathcal{J}$ with respect to a change in school district expenditures in location j (equation B.243) is

$$\frac{\Delta \log H_\ell}{\Delta \log G_j} = \eta \frac{\Delta \log R_\ell}{\Delta \log G_j} \tag{B.252}$$

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:

$$\mathbb{E}\left[\frac{\Delta \log H_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right] = \eta \times \mathbb{E}\left[\frac{\Delta \log R_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right] \tag{B.253}$$

B.2.4 Balanced Budget

The elasticity of school district expenditures in location $\ell \in \mathcal{J}$ with respect to a change in school district expenditures in location j (equation B.246) is

$$\frac{\Delta \log G_\ell}{\Delta \log G_j} = \frac{\Delta \log \tau_\ell}{\Delta \log G_j} + \frac{\Delta \log R_\ell}{\Delta \log G_j} + \frac{\Delta \log H_\ell}{\Delta \log G_j} \tag{B.254}$$

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:

$$\begin{aligned}\mathbb{E}\left[\frac{\Delta \log G_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right] &= \mathbb{E}\left[\frac{\Delta \log \tau_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right] \\ &\quad + \mathbb{E}\left[\frac{\Delta \log R_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right] + \mathbb{E}\left[\frac{\Delta \log H_\ell}{\Delta \log G_j}\middle| S_j = 0.5\right]\end{aligned} \tag{B.255}$$

C Statistical Inference on Structural Parameters

In this section, I provide details on statistical inference for the structural parameters that govern household preferences and the elasticity of housing supply.

C.1 Household Preferences

Assume there are two jurisdictions ($|\mathcal{J}| = 2$) and set $\chi = 1$. For compactness, let θ_n denote the nth regression discontinuity estimand, with the numbering following the order of appearance in equations (B.248)-(B.249). The system of equations can then be written as

$$\begin{cases} \theta_1 & = \alpha\left(\theta_2 - \theta_3 - \theta_6 + \theta_7\right) + \gamma\left(-\theta_4 - \theta_5 + \theta_8 + \theta_9\right) \\ \theta_{10} & = \alpha\left(\theta_{11} - \theta_{12} - \theta_{15} + \theta_{16}\right) + \gamma\left(-\theta_{13} - \theta_{14} + \theta_{17} + \theta_{18}\right) \end{cases} \tag{C.256}$$

Define the intermediate sums

$$\psi_1 \equiv \theta_2 - \theta_3 - \theta_6 + \theta_7 \qquad \xi_1 \equiv -\theta_4 - \theta_5 + \theta_8 + \theta_9, \tag{C.257}$$

$$\psi_2 \equiv \theta_{11} - \theta_{12} - \theta_{15} + \theta_{16} \qquad \xi_2 \equiv -\theta_{13} - \theta_{14} + \theta_{17} + \theta_{18} \tag{C.258}$$

With these definitions, the system can be expressed in matrix form as

$$\begin{bmatrix} \psi_1 & \xi_1 \\ \psi_2 & \xi_2 \end{bmatrix} \begin{bmatrix} \alpha \\ \gamma \end{bmatrix} = \begin{bmatrix} \theta_1 \\ \theta_{10} \end{bmatrix} \tag{C.259}$$

where the determinant of the coefficient matrix is given by $\Delta \equiv \psi_1\xi_2 - \psi_2\xi_1 \neq 0$. The solution to the system is then

$$\alpha = \frac{\theta_1\xi_2 - \theta_{10}\xi_1}{\Delta} \qquad \gamma = \frac{\psi_1\theta_{10} - \psi_2\theta_1}{\Delta} \tag{C.260}$$

Let $\widehat{\theta} = \left[\widehat{\theta}_1, \ldots, \widehat{\theta}_{18}\right]'$ denote the vector of estimated regression discontinuity parameters, with associated variance-covariance matrix $\widehat{\Sigma}_\theta$. I compute the Jacobian matrix of $[\alpha, \gamma]'$

with respect to the vector of underlying estimands, yielding

$$
\mathrm{J} = \frac{1}{\Delta}\begin{bmatrix} \xi_2 & -\psi_2 \\ -\alpha\xi_2 & \theta_{10} - \gamma\xi_2 \\ \alpha\xi_2 & -\theta_{10} + \gamma\xi_2 \\ \theta_{10} - \alpha\psi_2 & -\gamma\psi_2 \\ \theta_{10} - \alpha\psi_2 & -\gamma\psi_2 \\ \alpha\xi_2 & -\theta_{10} + \gamma\xi_2 \\ -\alpha\xi_2 & \theta_{10} - \gamma\xi_2 \\ -\theta_{10} + \alpha\psi_2 & \gamma\psi_2 \\ -\theta_{10} + \alpha\psi_2 & \gamma\psi_2 \\ -\xi_1 & \psi_1 \\ \alpha\xi_1 & -\theta_1 + \gamma\xi_1 \\ -\alpha\xi_1 & \theta_1 - \gamma\xi_1 \\ -\theta_1 + \alpha\psi_1 & \gamma\psi_1 \\ -\theta_1 + \alpha\psi_1 & \gamma\psi_1 \\ -\alpha\xi_1 & \theta_1 - \gamma\xi_1 \\ \alpha\xi_1 & -\theta_1 + \gamma\xi_1 \\ \theta_1 - \alpha\psi_1 & -\gamma\psi_1 \\ \theta_1 - \alpha\psi_1 & -\gamma\psi_1 \end{bmatrix}' \tag{C.261}
$$

where each row corresponds to a partial derivative with respect to θ_n for $n = 1, \ldots, 18$. Let $[\widehat{\alpha}, \widehat{\gamma}]'$ denote the estimate of $[\alpha, \gamma]'$. Substituting estimated parameters into the Jacobian yields the matrix $\widehat{\mathrm{J}}$. By an application of the Delta method, the estimated variance-covariance matrix of $[\widehat{\alpha}, \widehat{\gamma}]'$ is

$$
\begin{bmatrix} \mathbb{V}[\widehat{\alpha}] & \mathbb{C}[\widehat{\alpha}, \widehat{\gamma}] \\ \mathbb{C}[\widehat{\alpha}, \widehat{\gamma}] & \mathbb{V}[\widehat{\gamma}] \end{bmatrix} \approx \widehat{\mathrm{J}}\widehat{\Sigma}_\theta\widehat{\mathrm{J}}' \tag{C.262}
$$

Finally, applying the Delta method to the ratio α/γ, the variance of the estimator $\widehat{\alpha}/\widehat{\gamma}$ is approximated by

$$
\mathbb{V}[\widehat{\alpha}/\widehat{\gamma}] \approx \begin{bmatrix} 1/\widehat{\gamma} & -\widehat{\alpha}/\widehat{\gamma}^2 \end{bmatrix} \widehat{\mathrm{J}}\widehat{\Sigma}_\theta\widehat{\mathrm{J}}' \begin{bmatrix} 1/\widehat{\gamma} \\ -\widehat{\alpha}/\widehat{\gamma}^2 \end{bmatrix} \tag{C.263}
$$

C.2 Elasticity of Housing Supply

As described in equation (B.253), the housing supply elasticity η is point identified as the ratio of two regression discontinuity estimands, whose outcomes are housing quantity H and housing price R, respectively. Let θ_H and θ_R denote these estimands, with corresponding estimators $\widehat{\theta}_H$ and $\widehat{\theta}_R$. By the Delta method, the estimated variance of $\widehat{\eta}$ is

$$\mathbb{V}\left[\widehat{\eta}\right] \approx \begin{bmatrix} 1/\widehat{\theta}_R & -\widehat{\theta}_H/\widehat{\theta}_R^2 \end{bmatrix} \begin{bmatrix} \mathbb{V}\left[\widehat{\theta}_H\right] & \mathbb{C}\left[\widehat{\theta}_H, \widehat{\theta}_L\right] \\ \mathbb{C}\left[\widehat{\theta}_H, \widehat{\theta}_L\right] & \mathbb{V}\left[\widehat{\theta}_R\right] \end{bmatrix} \begin{bmatrix} 1/\widehat{\theta}_R \\ -\widehat{\theta}_H/\widehat{\theta}_R^2 \end{bmatrix} \tag{C.264}$$

D Data Sources

This section lists the sources I used to collect and compile data on property tax rates for each state or territory. The following table reports time periods for which data on property tax rates have been collected.

Table D1: 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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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/.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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: Fi-*

nances 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.

D.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-.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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/.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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.

D.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/.

D.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.

D.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.

D.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.

D.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.

D.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.

D.51 Wyoming

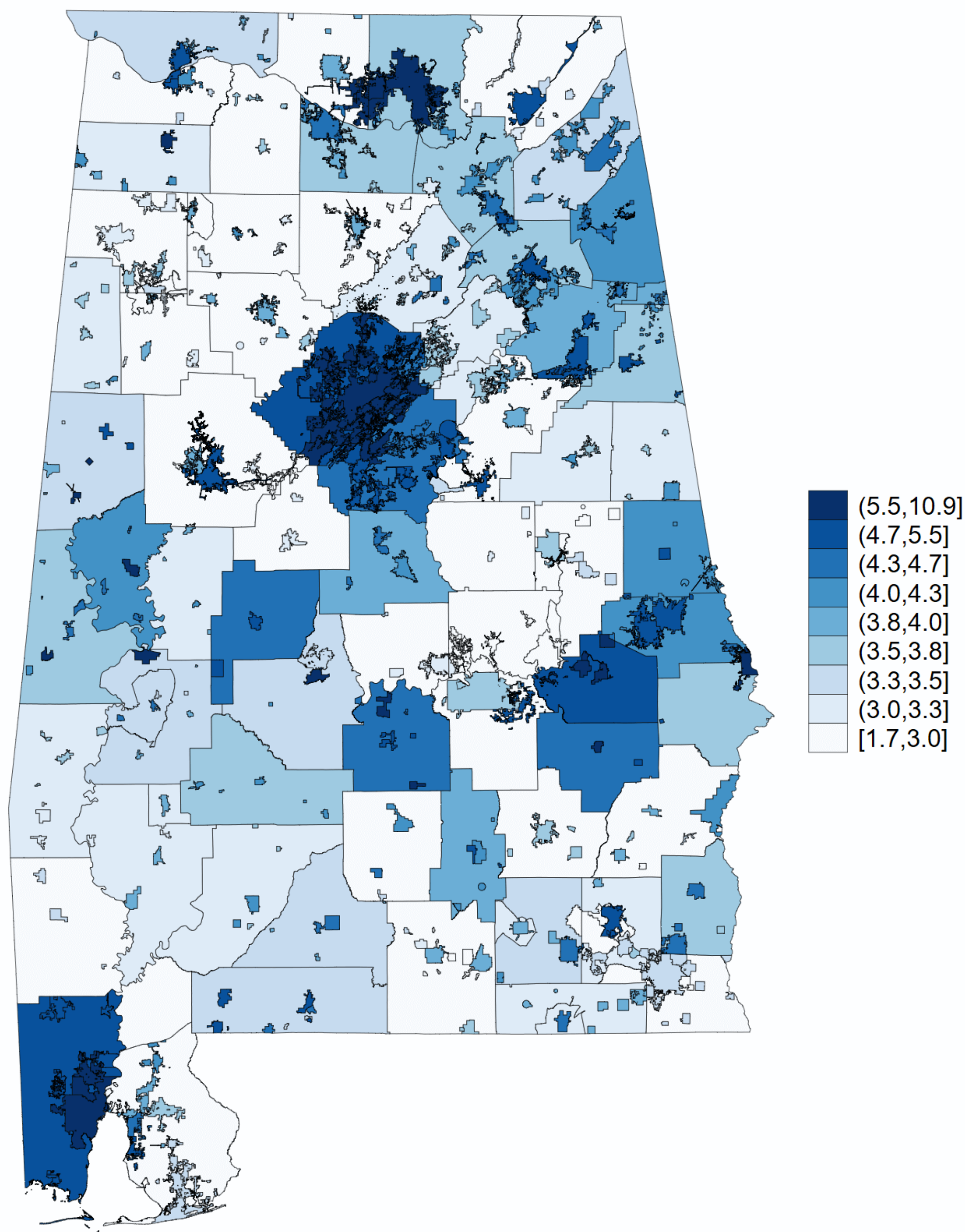
The Wyoming Department of Revenue annually issues *Property Tax Mill Levy by Tax District Summary* reports that provide data on the property tax rates specific to distinct geographical areas determined by the intersection of multiple local governments. Access to these reports is available at https://wyo-prop-div.wyo.gov/tax-districts/general-information.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

E State Maps

This section showcases state-level maps of property tax rates at the most granular geographic level. In general, these rates are not directly comparable across states due to variations in factors such as the ratio of property assessed value to market value, appraisal standards, and deductions applicable to specific categories, e.g. homeowners.

E.1 Alabama

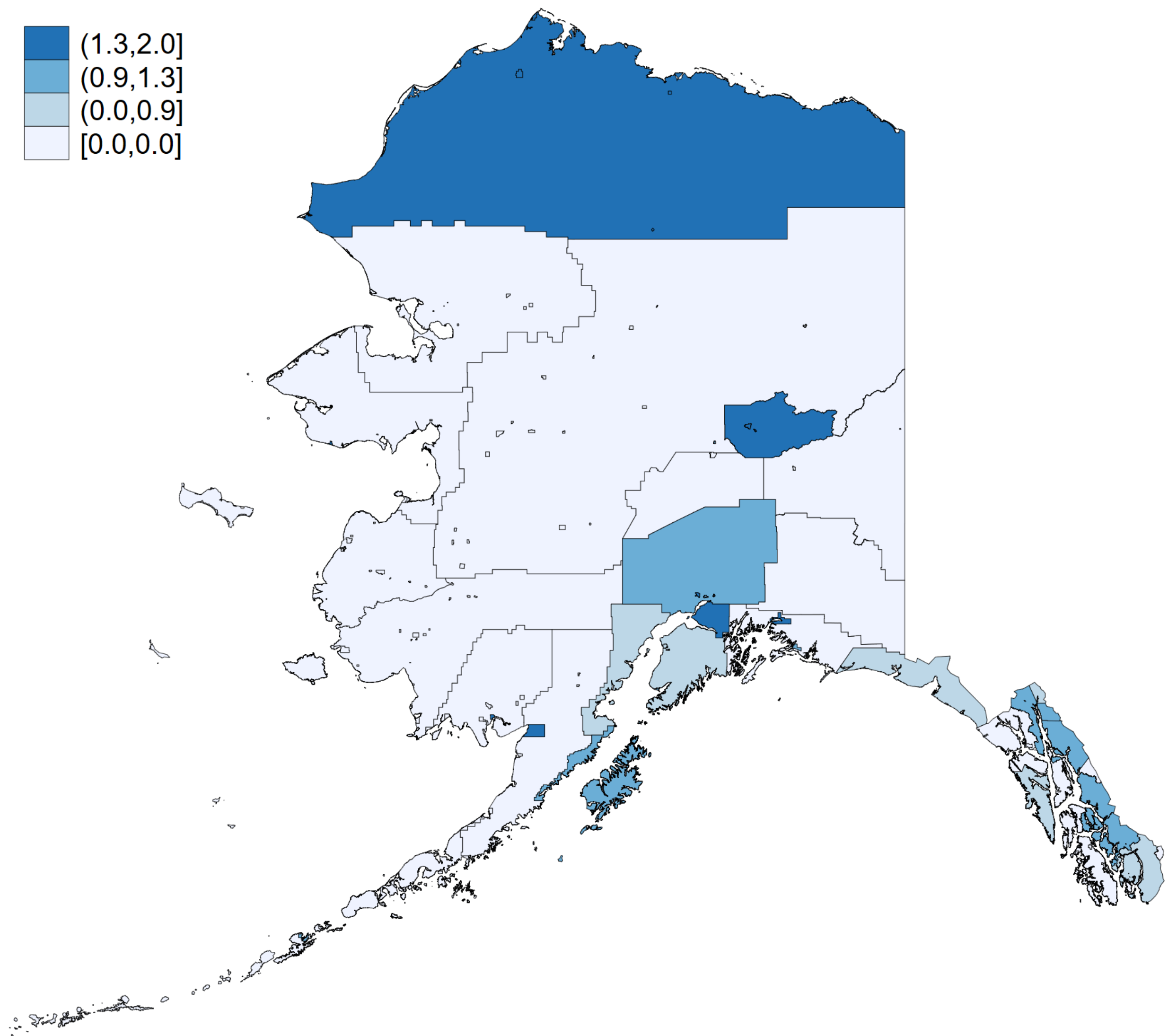
Figure E1: Property Tax Rates (pp) in Alabama in 2020



Notes: This map displays statutory property tax rates levied in Alabama in 2020. Tax areas are implied by unique intersections of counties, municipalities, and school districts.

E.2 Alaska

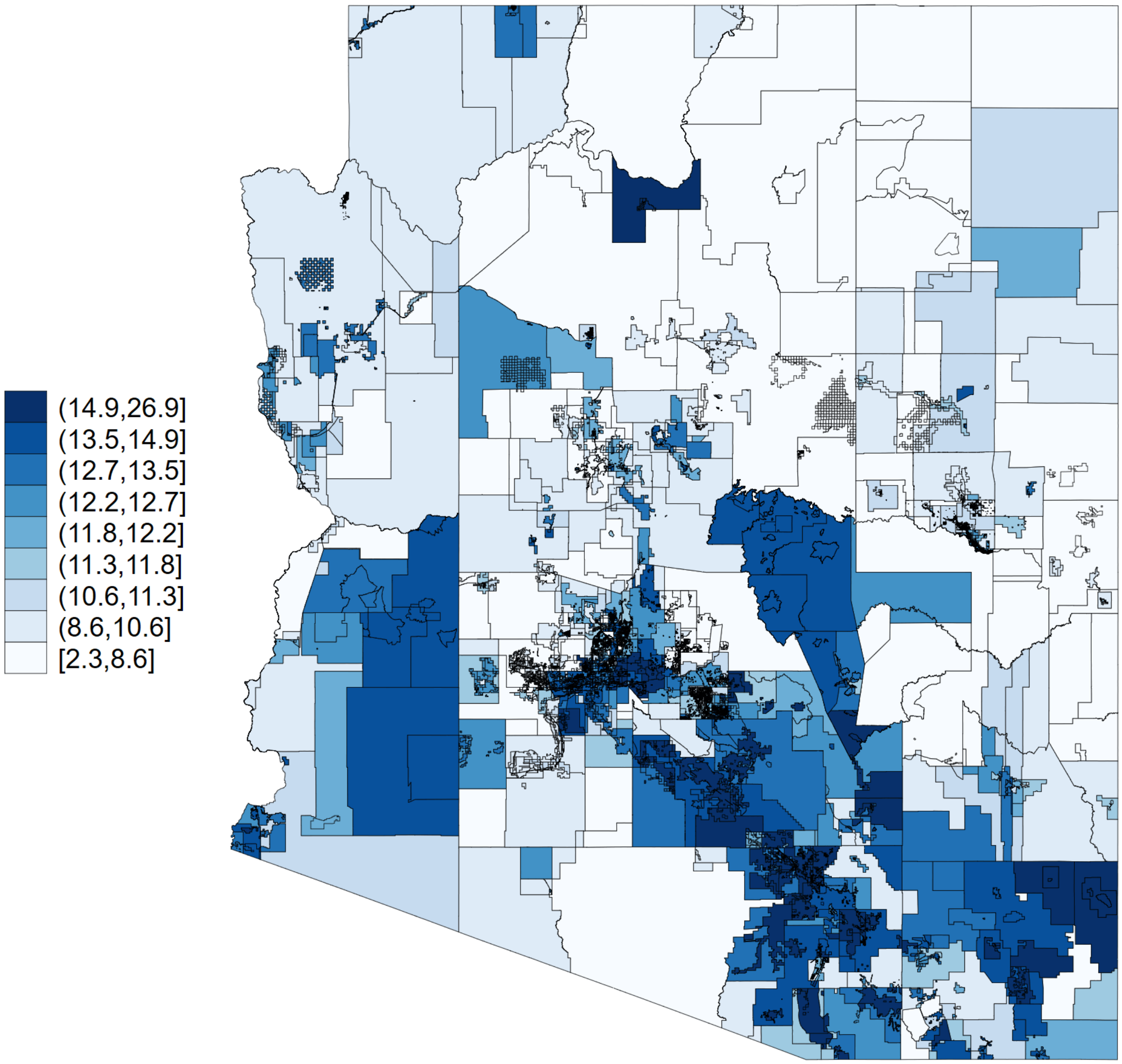
Figure E2: Property Tax Rates (pp) in Alaska in 2020



NOTES: This map displays statutory property tax rates levied in Alaska in 2020. Tax areas are implied by unique intersections of counties, municipalities, boroughs, and unorganized territories.

E.3 Arizona

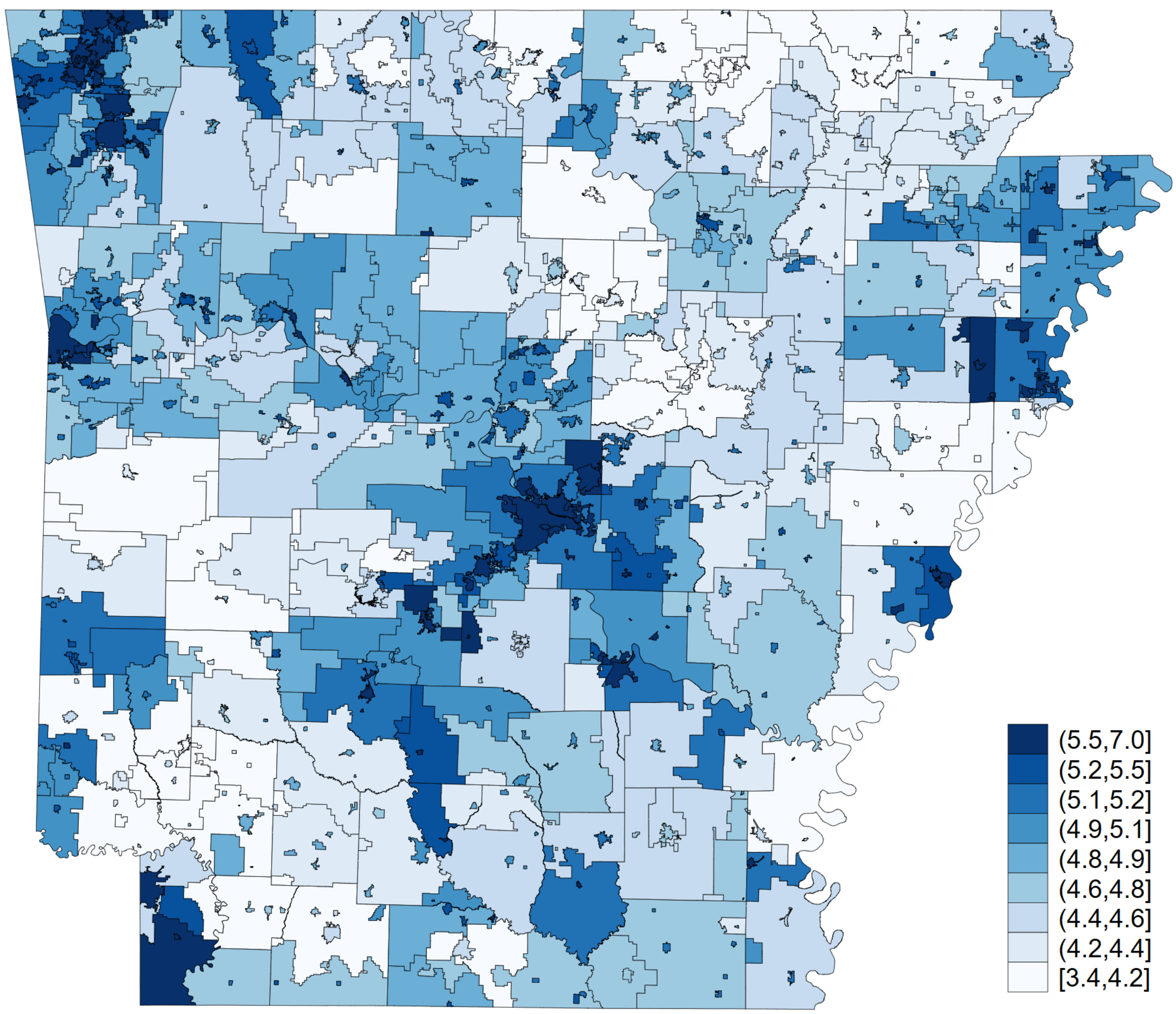
Figure E3: Property Tax Rates (pp) in Arizona in 2020



NOTES: This map displays statutory property tax rates levied in Arizona in 2020. Tax areas are implied by unique intersections of counties, municipalities, elementary school districts, high school districts, unified school districts, community college districts, community facilities districts, county improvement districts, county recreation improvement districts, domestic water improvement districts, downtown development districts, electrical districts, enhanced municipal services districts, fire protection districts, flood control districts, health service districts, hospital districts, joint technological education districts, library districts, maintenance improvement districts, pest abatement districts, redevelopment districts, road improvement districts, road improvement maintenance districts, sanitary districts, street lighting districts, water conservation districts, and water improvement districts.

E.4 Arkansas

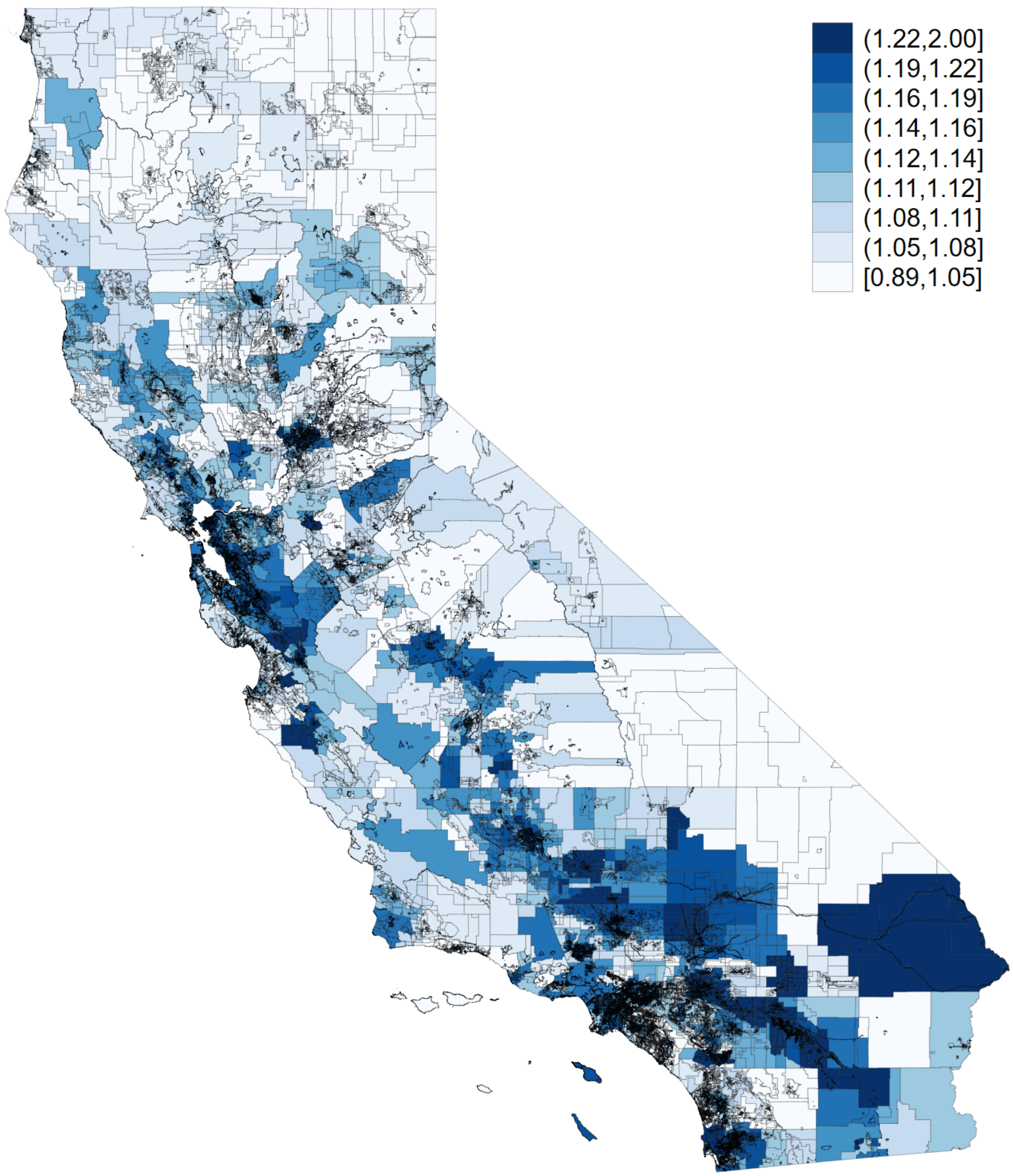
Figure E4: Property Tax Rates (pp) in Arkansas in 2020



NOTES: This map displays statutory property tax rates levied in Arkansas in 2020. Tax areas are implied by unique intersections of counties, municipalities, and school districts.

E.5 California

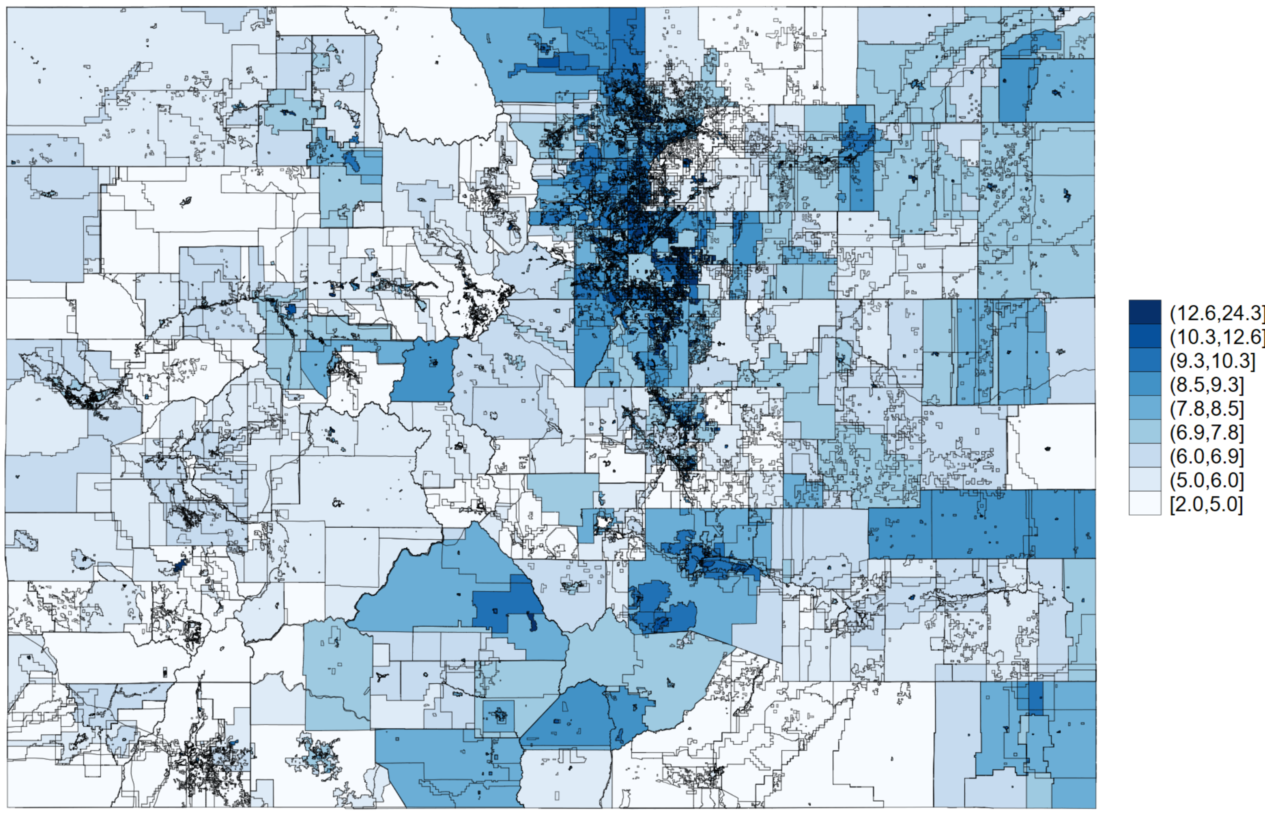
Figure E5: Property Tax Rates (pp) in California in 2020



NOTES: This map displays statutory property tax rates levied in California in 2020. Tax areas are implied by unique intersections of counties, municipalities, elementary school districts, high school districts, unified school districts, air quality management districts, airport districts, cemetery districts, community college districts, community facilities districts, county service districts, drainage districts, fire protection districts, flood control districts, garbage districts, health districts, highway districts, hospital districts, irrigation districts, levee districts, library districts, mosquito and vector control districts, municipal improvement districts, park and recreation districts, parking districts, pest control districts, police districts, port districts, public utility districts, resource conservation districts, road improvement districts, sanitary districts, sewer districts, water districts, water conservation districts, and water reclamation districts.

E.6 Colorado

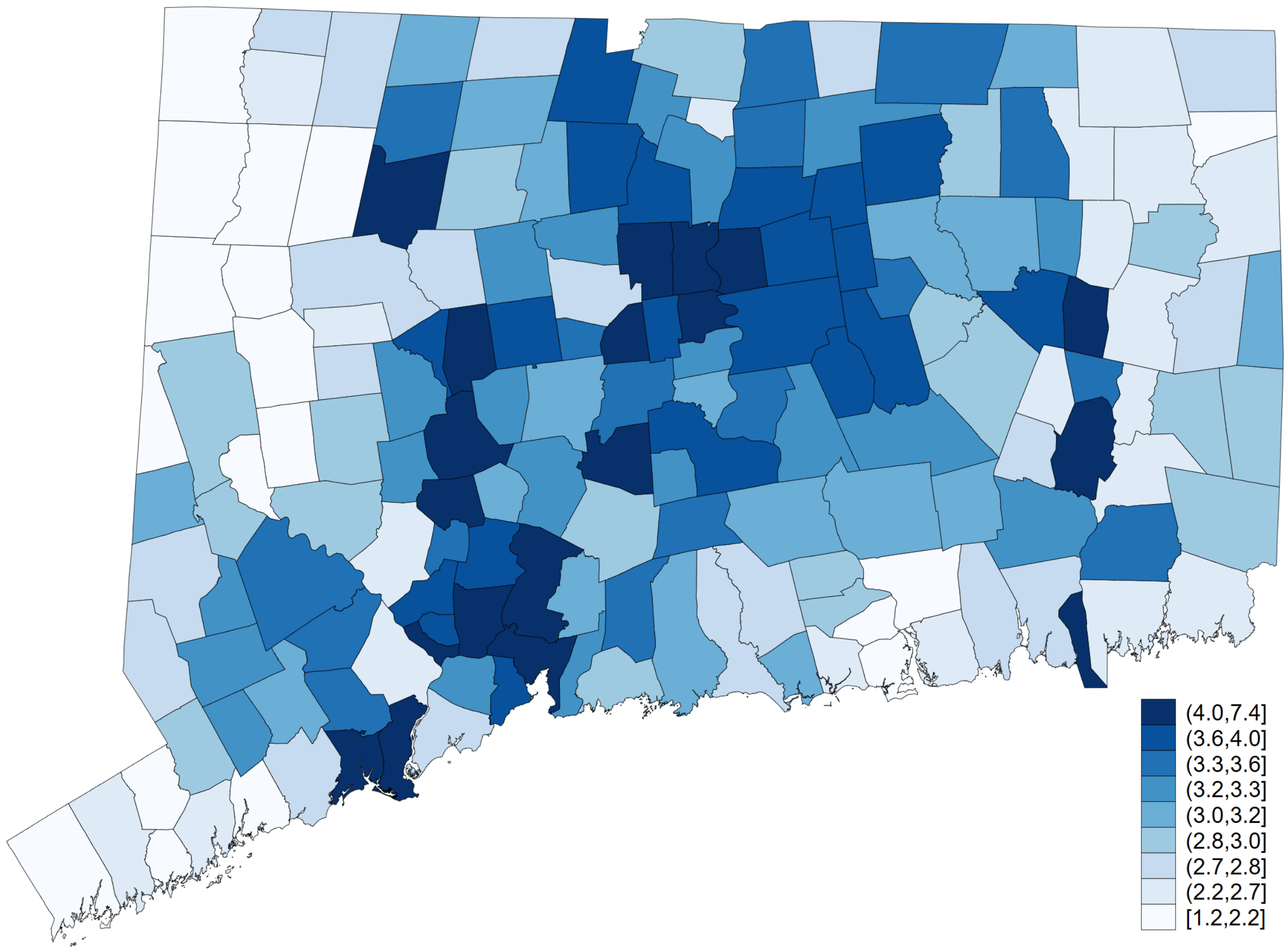
Figure E6: Property Tax Rates (pp) in Colorado in 2020



Notes: This map displays statutory property tax rates levied in Colorado in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, ambulance districts, business improvement districts, cemetery districts, community college districts, downtown development authorities, fire protection districts, general improvement districts, health service districts, hospital districts, irrigation districts, law enforcement authorities, library districts, metropolitan districts, mosquito control districts, park and recreation districts, pest control districts, public improvement districts, road improvement districts, sanitation districts, soil conservation districts, solid waste disposal districts, special improvement districts, transportation districts, urban drainage and flood control districts, water conservancy districts, water conservation districts, water districts, water and sanitation districts, weed control districts.

E.7 Connecticut

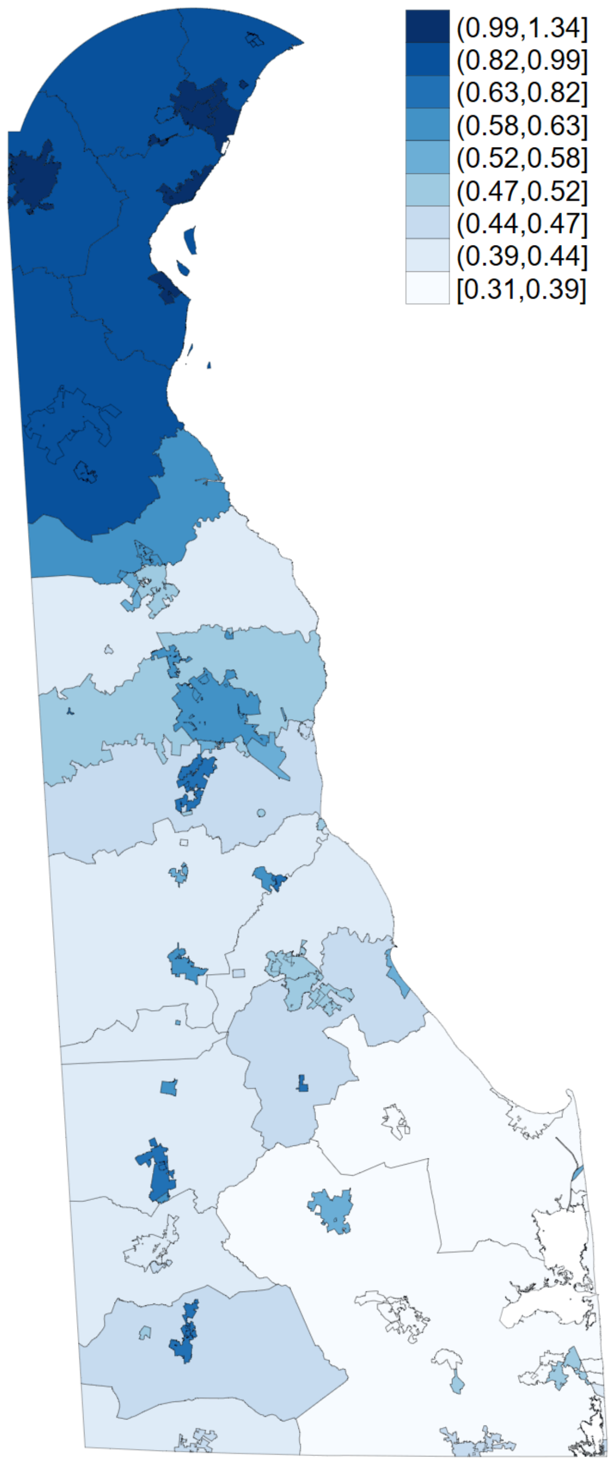
Figure E7: Property Tax Rates (pp) in Connecticut in 2020



NOTES: This map displays statutory property tax rates levied in Connecticut in 2020. Tax areas are implied by unique intersections of municipalities, fire protection districts, and special service districts.

E.8 Delaware

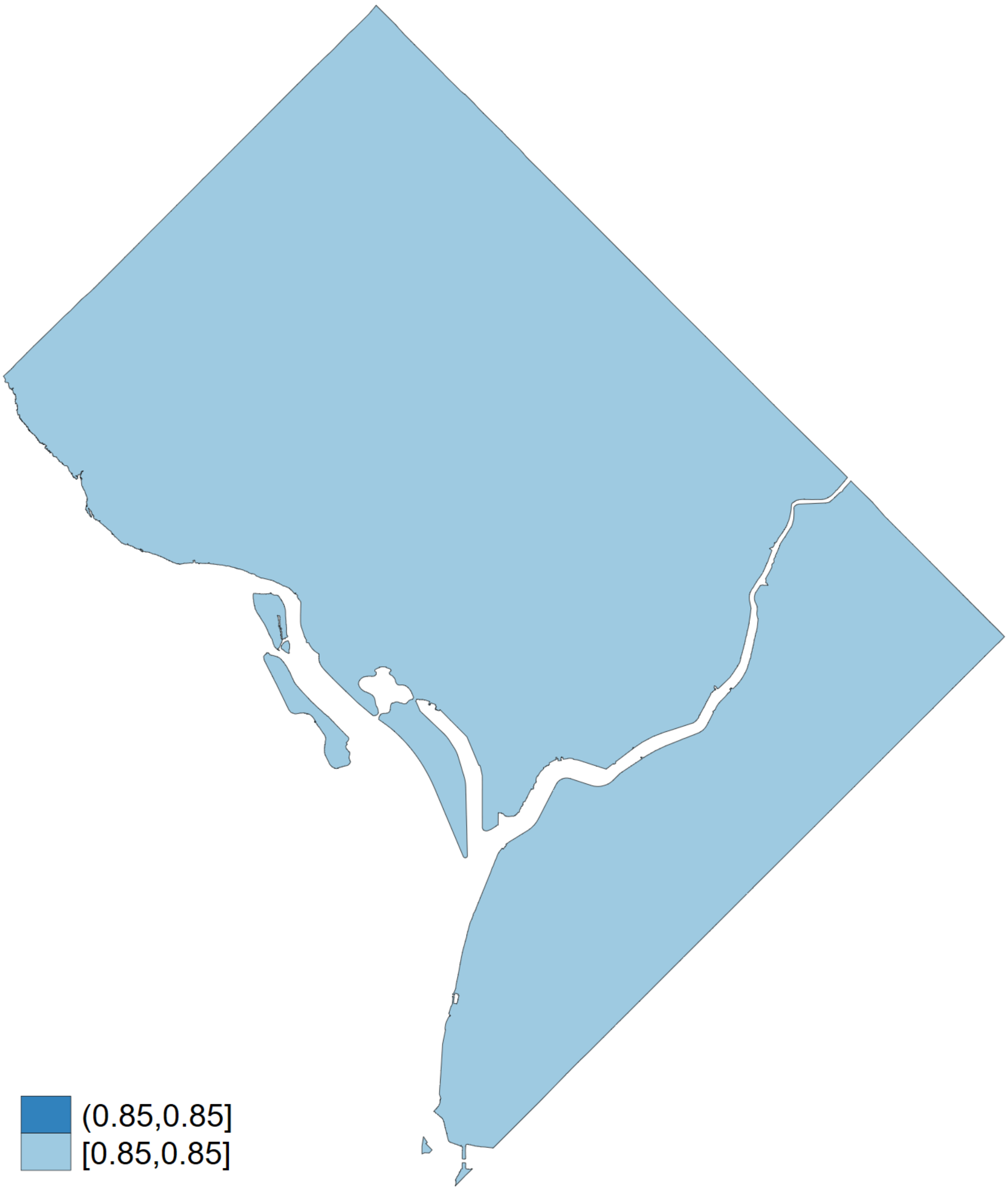
Figure E8: Property Tax Rates (pp) in Delaware in 2020



NOTES: This map displays statutory property tax rates levied in Delaware in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, and vocational-technical school districts.

E.9 District of Columbia

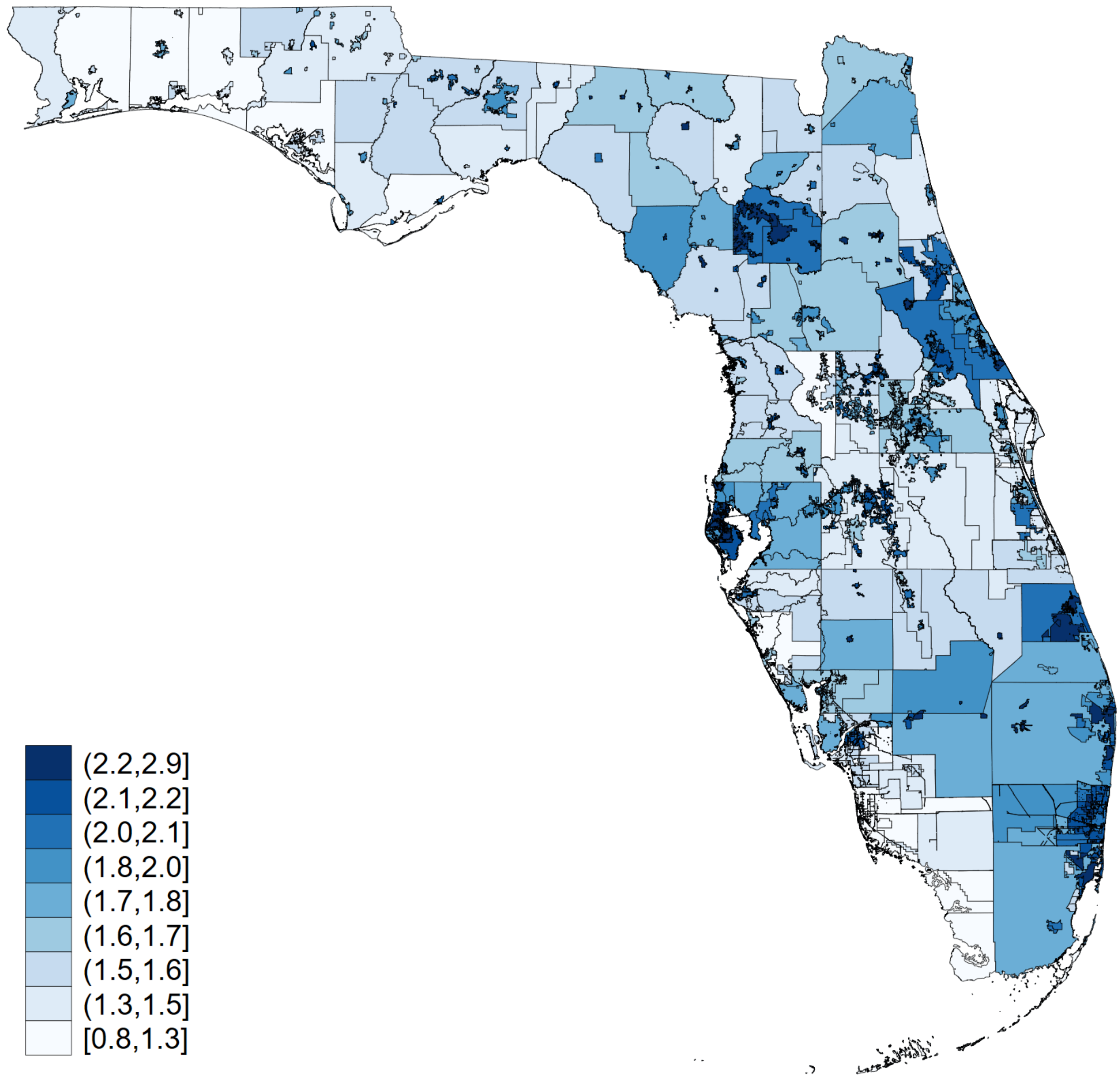
Figure E9: Property Tax Rates (pp) in the District of Columbia in 2020



Notes: This map displays the statutory property tax rate levied in the District of Columbia in 2020.

E.10 Florida

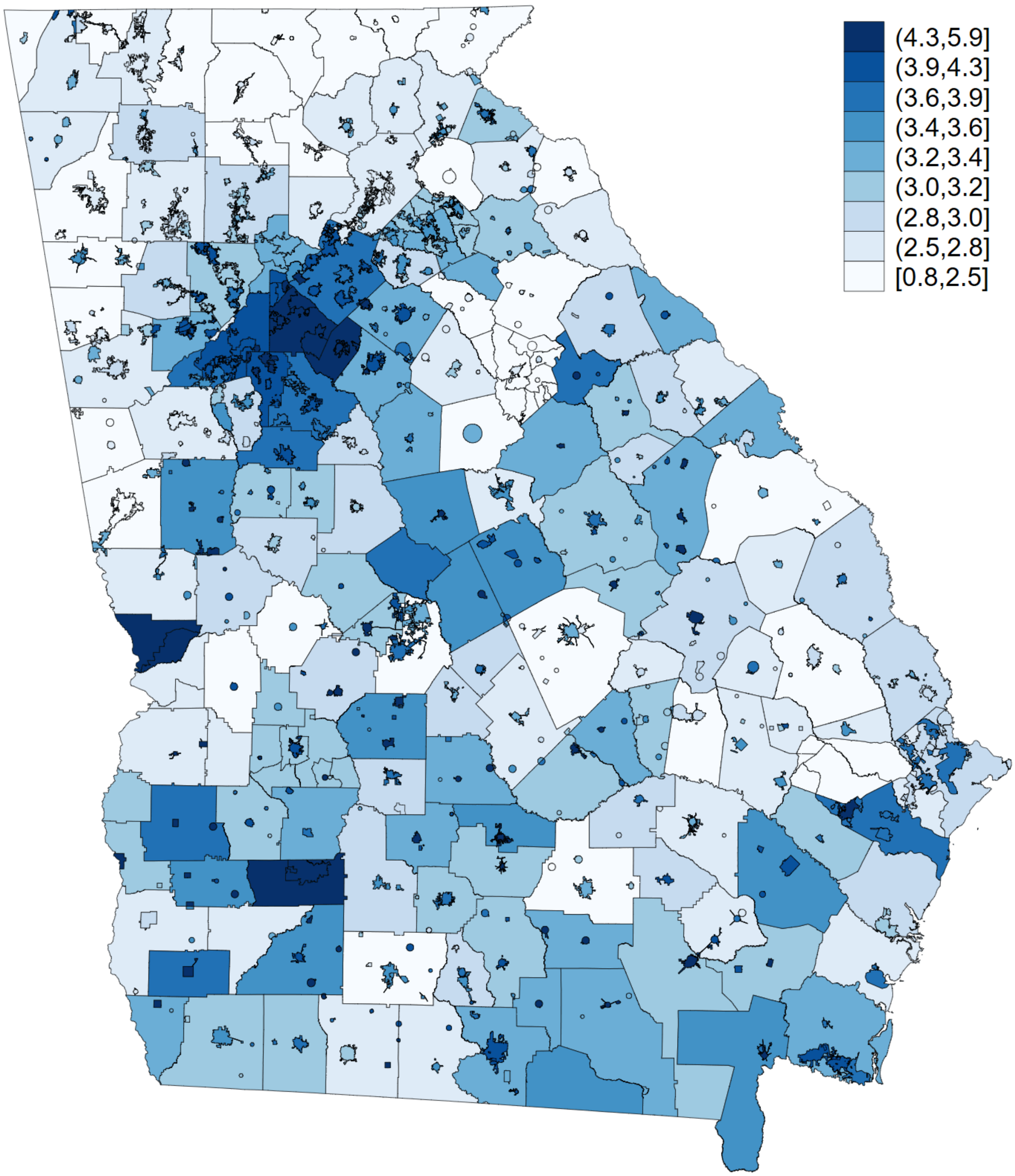
Figure E10: Property Tax Rates (pp) in Florida in 2020



NOTES: This map displays statutory property tax rates levied in Florida in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, airport districts, beach erosion districts, beach nourishment districts, conservation districts, downtown development authorities, drainage districts, emergency medical services districts, fire protection districts, healthcare districts, hospital districts, improvement districts, lake management districts, library districts, mosquito control districts, municipal services districts, navigation districts, park and recreation districts, road districts, safe neighborhood improvement districts, sewer districts, street lighting districts, transportation districts, water districts, water management districts, and water and sewer districts.

E.11 Georgia

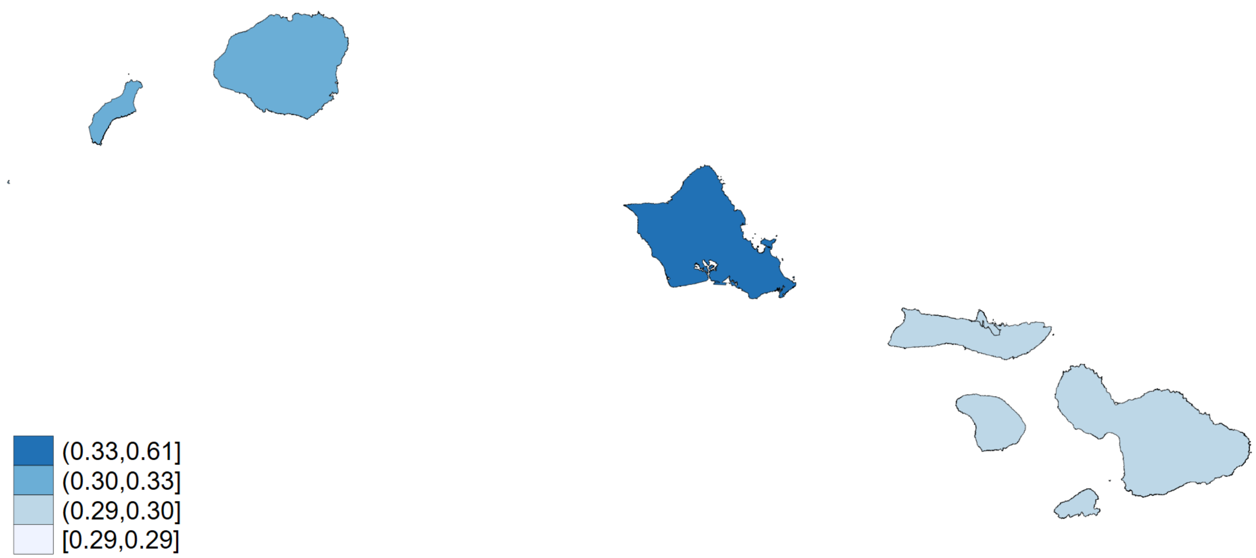
Figure E11: Property Tax Rates (pp) in Georgia in 2020



NOTES: This map displays statutory property tax rates levied in Georgia in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, business improvement districts, community improvement districts, development authorities, emergency medical services districts, fire protection districts, hospital districts, library districts, municipal services districts, recreation districts, road districts, sanitation districts, solid waste disposal districts, special service districts, and transit districts.

E.12 Hawaii

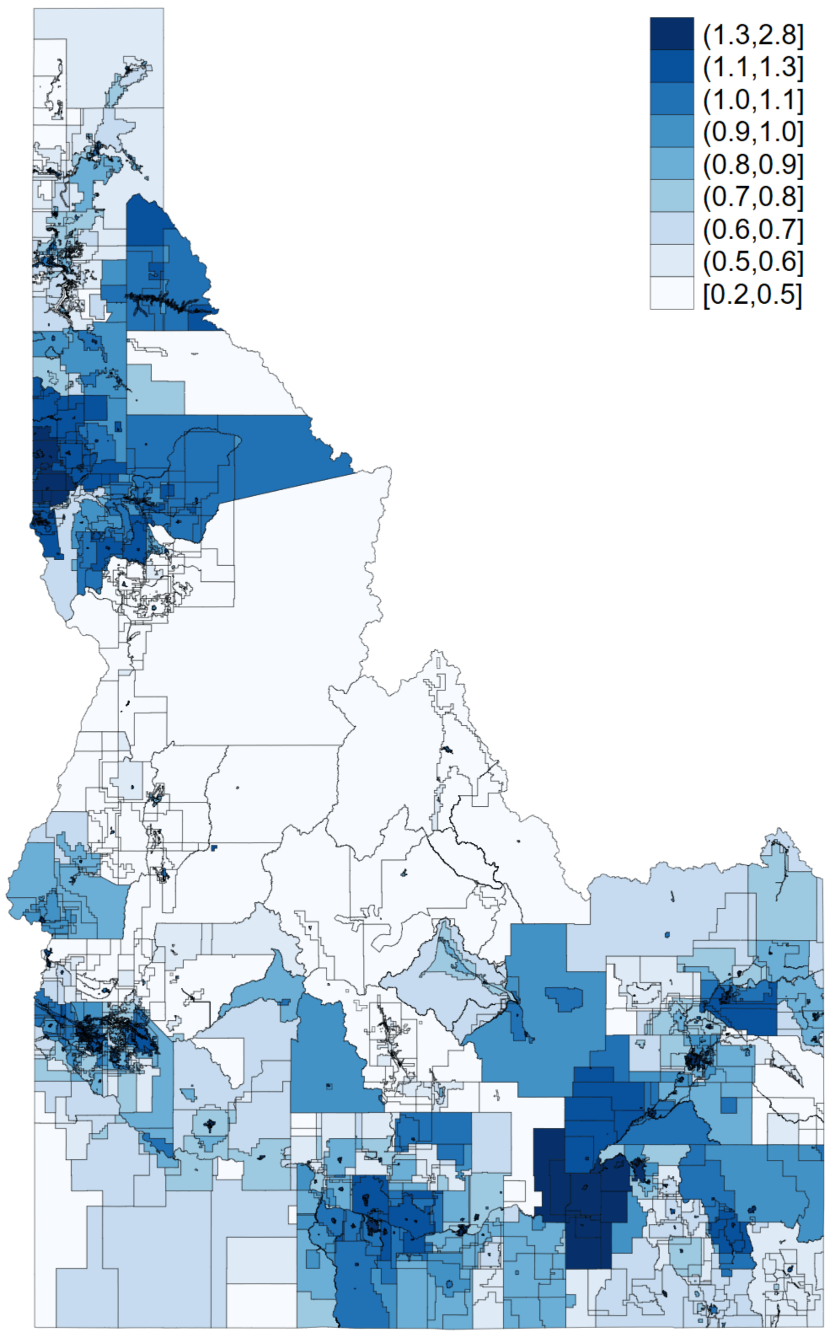
Figure E12: Property Tax Rates (pp) in Hawaii in 2020



NOTES: This map displays statutory homestead property tax rates levied in Hawaii in 2020. Tax areas are implied by counties.

E.13 Idaho

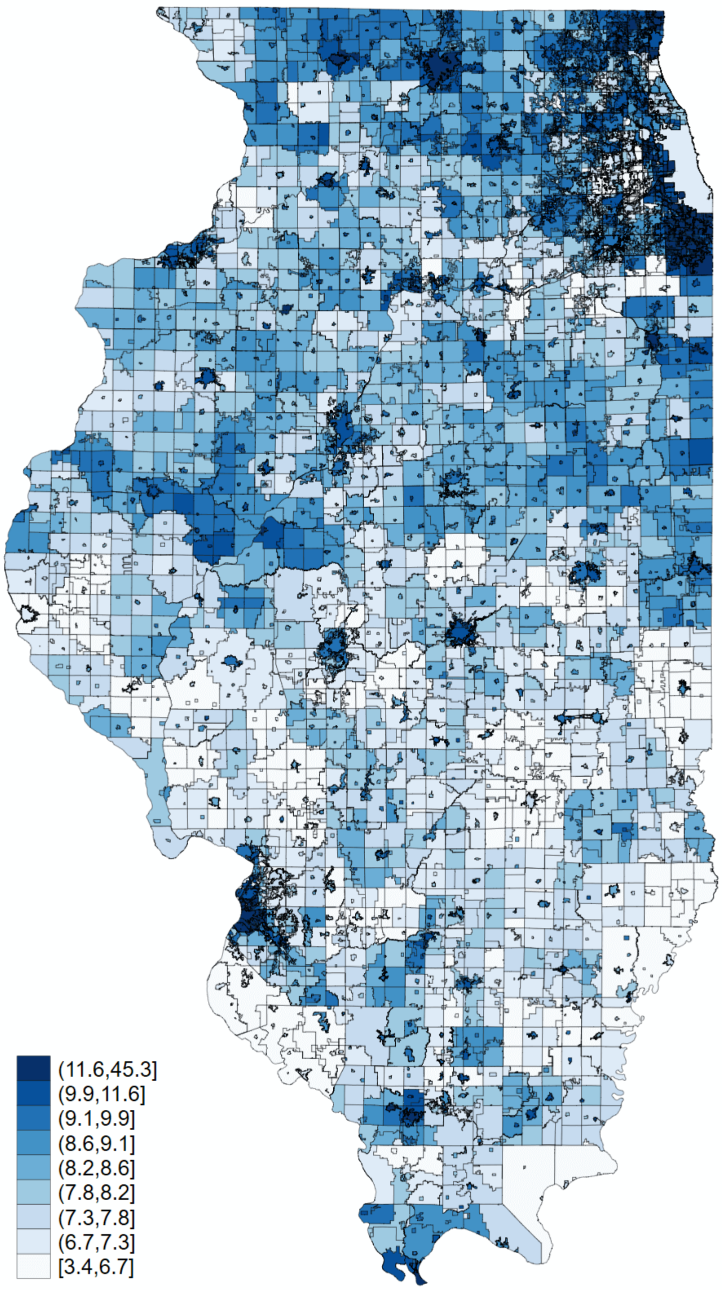
Figure E13: Property Tax Rates (pp) in Idaho in 2020



Notes: This map displays statutory property tax rates levied in Idaho in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, ambulance districts, cemetery districts, community center districts, community college districts, community infrastructure districts, extermination districts, fire protection districts, flood control districts, hospital districts, library districts, mosquito abatement districts, port districts, recreation districts, road and highway districts, sewer districts, sewer and water districts, water districts, and watershed districts.

E.14 Illinois

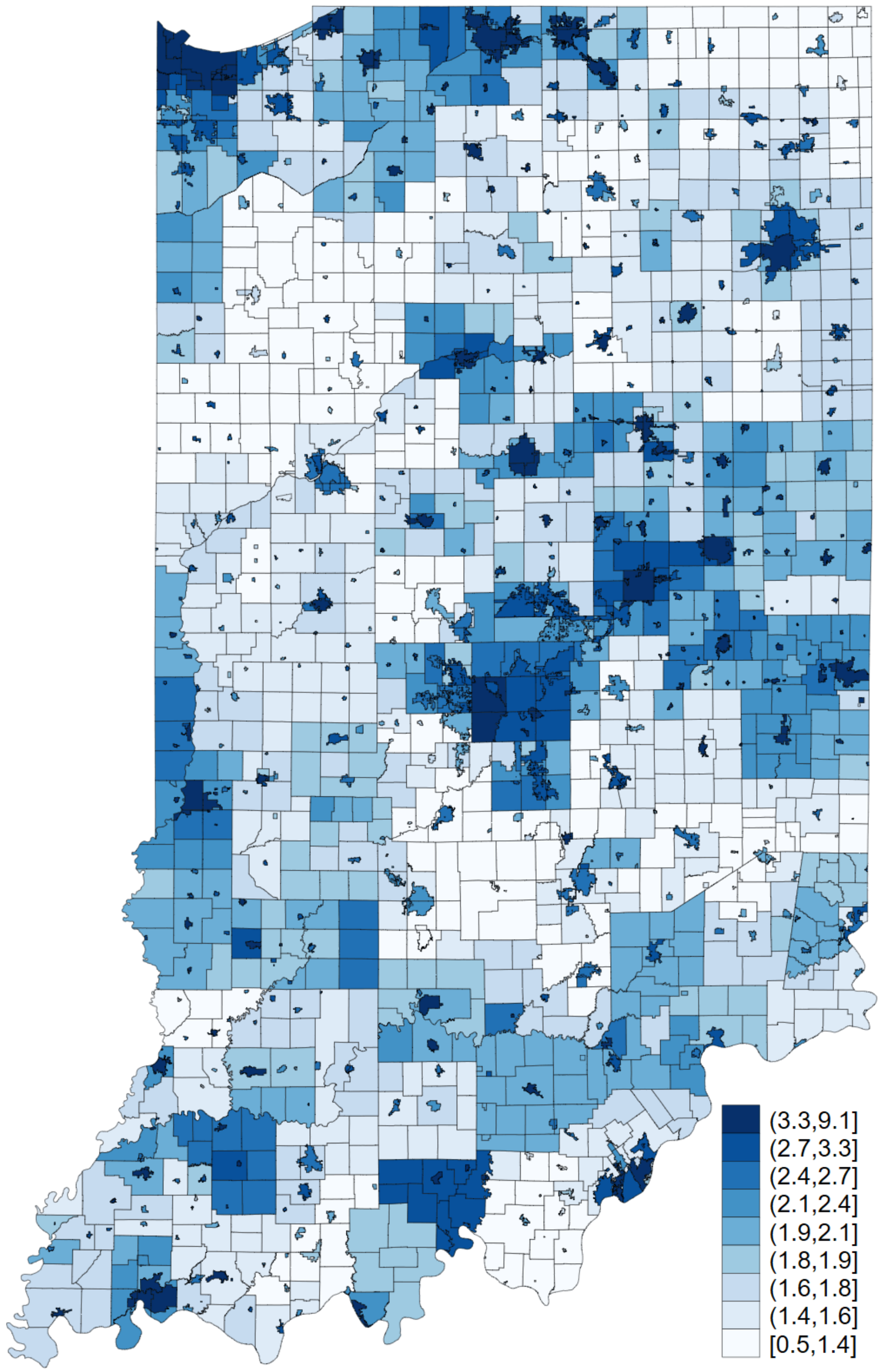
Figure E14: Property Tax Rates (pp) in Illinois in 2020



Notes: This map displays statutory property tax rates levied in Illinois in 2020. Tax areas are implied by unique intersections of counties, townships, municipalities, elementary school districts, high school districts, unified school districts, airport authorities, cemetery districts, community college districts, conservation districts, fire protection districts, flood control districts, forest preserve districts, health districts, hospital districts, library districts, mass transit districts, mosquito abatement districts, museum districts, park districts, rescue service districts, river conservancy districts, road districts, sanitary districts, soil and water conservation districts, solid waste disposal districts, street lighting districts, water authorities, water districts, water protection districts, and water reclamation districts.

E.15 Indiana

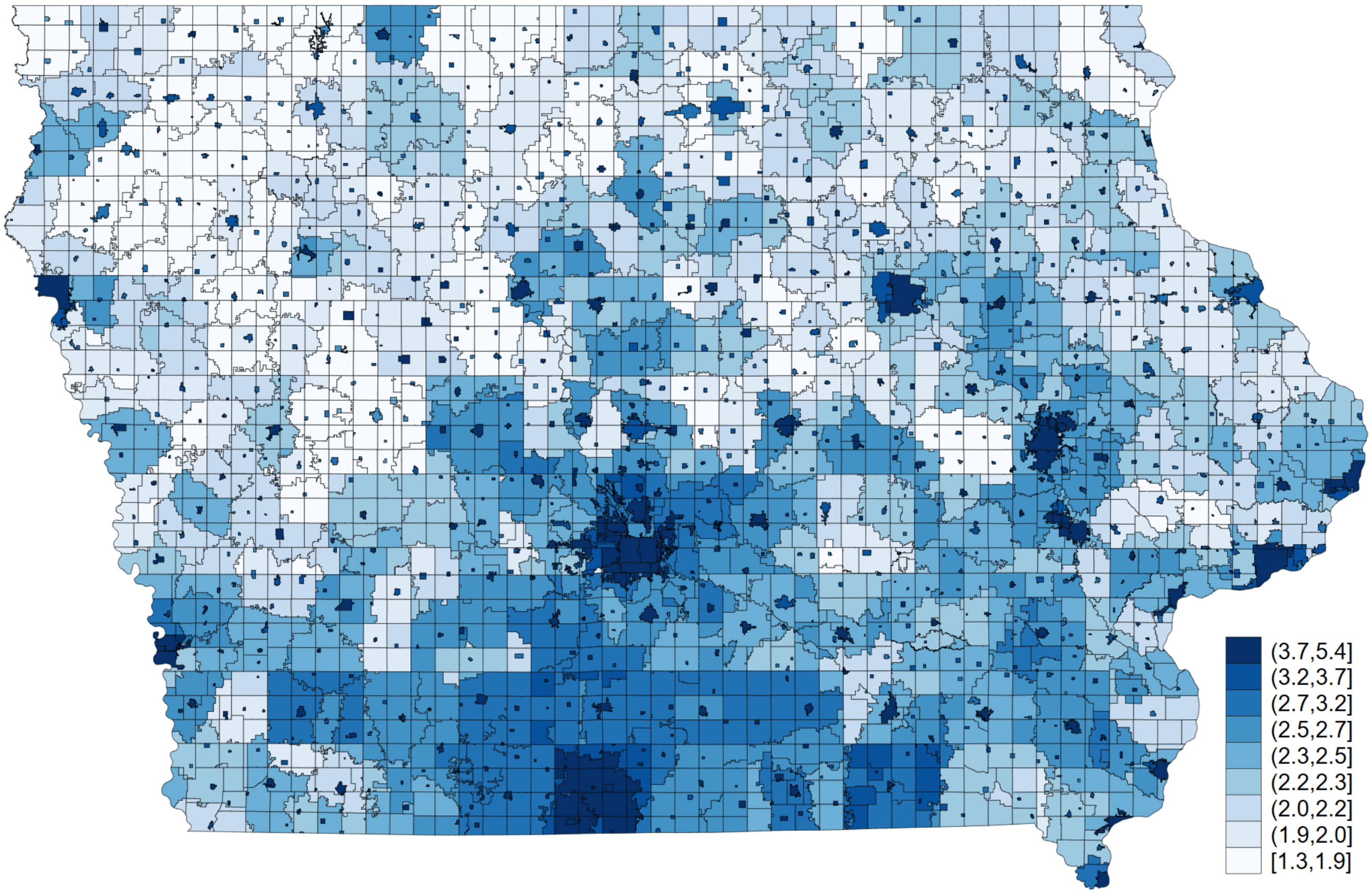
Figure E15: Property Tax Rates (pp) in Indiana in 2020



NOTES: This map displays statutory property tax rates levied in Indiana in 2020. Tax areas are implied by unique intersections of counties, townships, municipalities, school districts, airport districts, conservancy districts, fire protection districts, flood control districts, library districts, redevelopment commissions, sanitary districts, transportation districts, waste management districts, and water districts.

E.16 Iowa

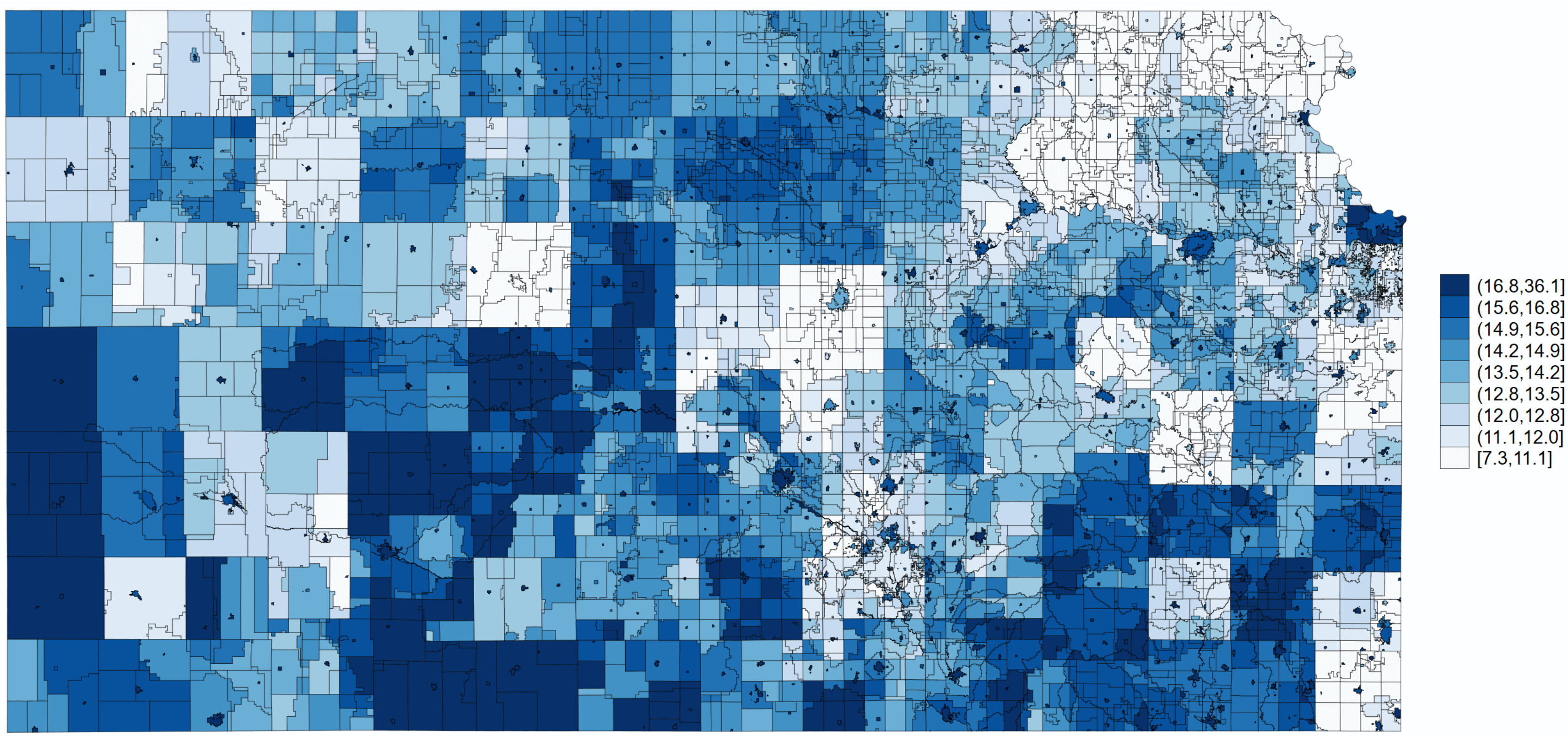
Figure E16: Property Tax Rates (pp) in Iowa in 2020



Notes: This map displays statutory property tax rates levied in Iowa in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, school districts, cemetery districts, community college districts, emergency medical services districts, fire protection districts, hospital districts, Iowa State University extension districts, land use districts, municipal improvement districts, recreation districts, regional transit authorities, rural improvement zones, sanitary districts, street lighting districts, and watershed districts.

E.17 Kansas

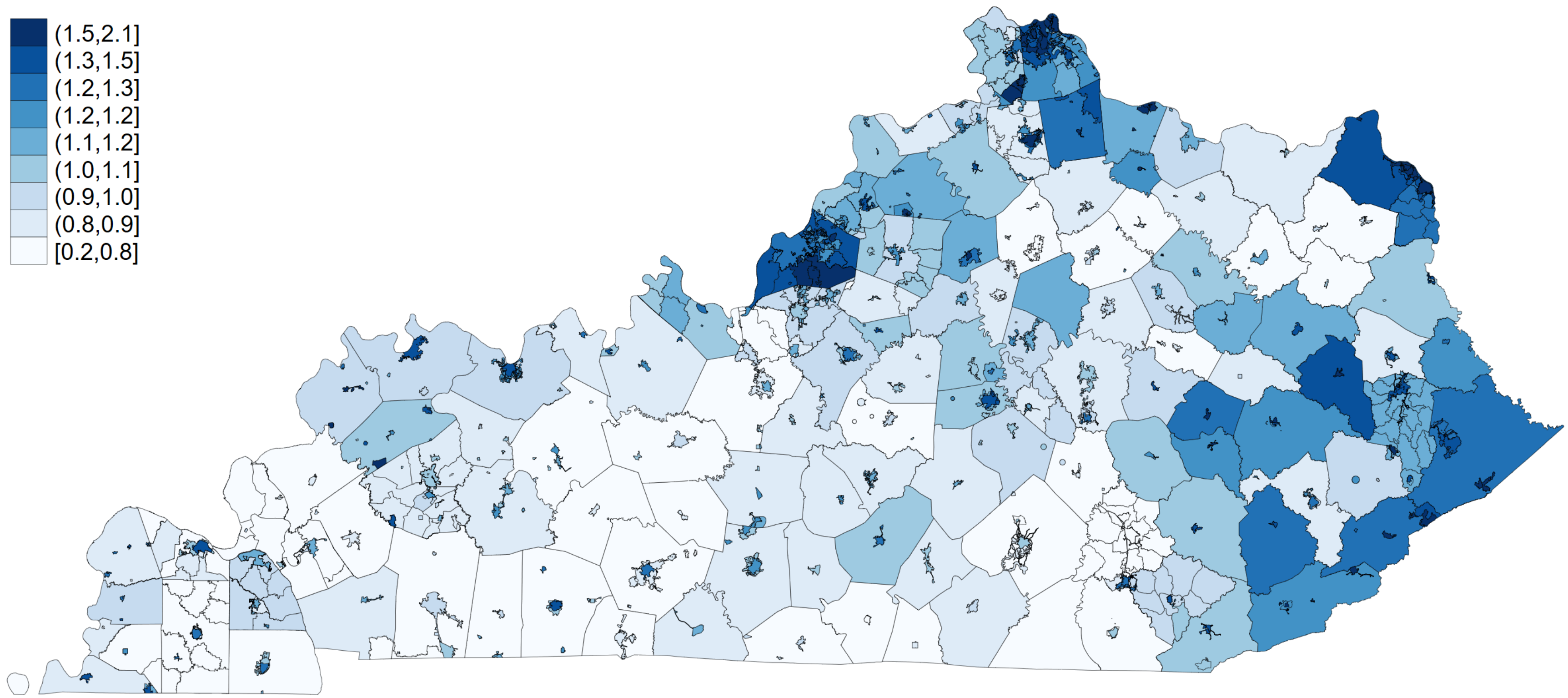
Figure E17: Property Tax Rates (pp) in Kansas in 2020



Notes: This map displays statutory property tax rates levied in Kansas in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, school districts, cemetery districts, community college districts, drainage districts, fire protection districts, hospital districts, Kansas State University extension districts, library districts, recreation districts, and watershed districts.

E.18 Kentucky

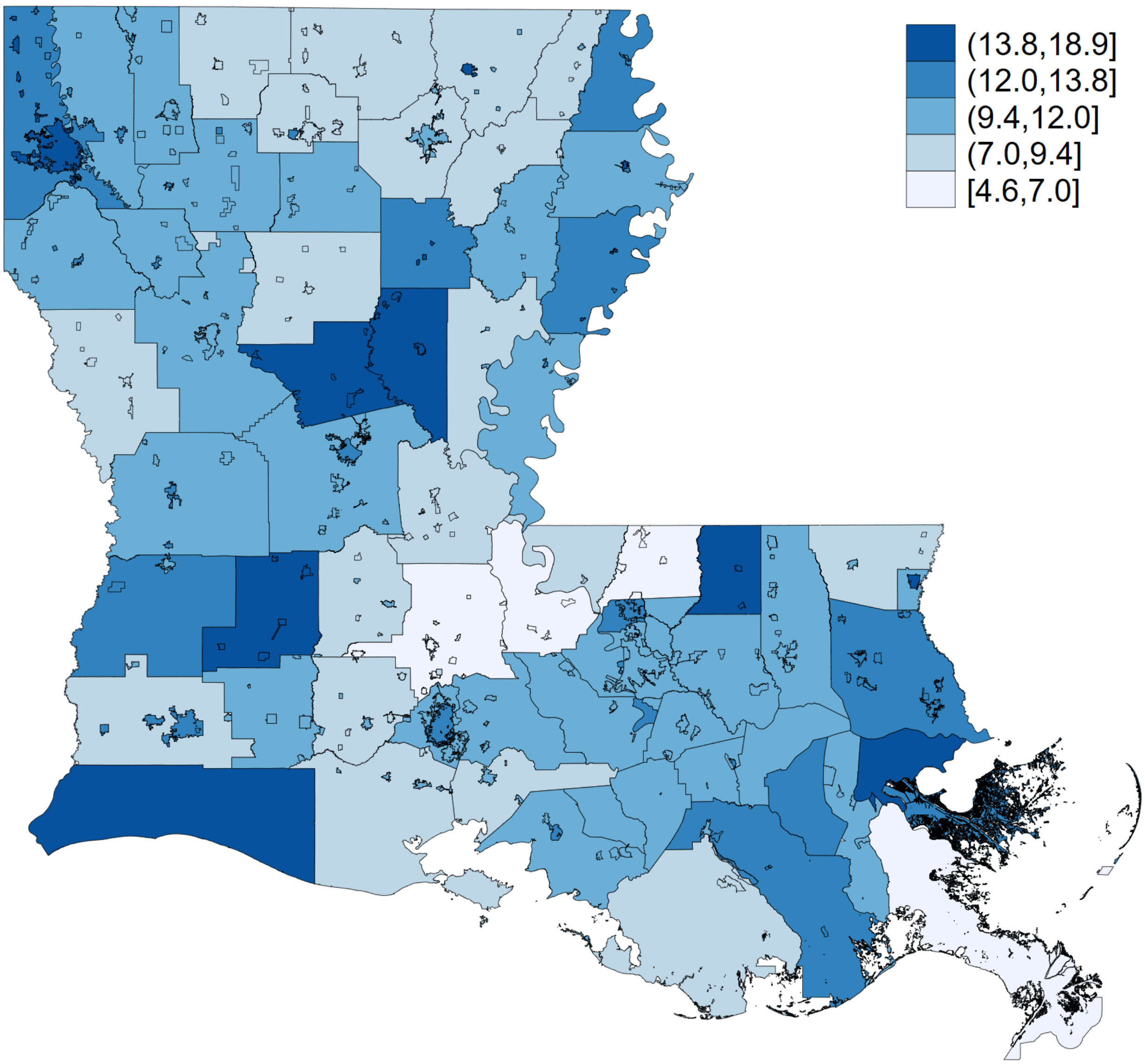
Figure E18: Property Tax Rates (pp) in Kentucky in 2020



Notes: This map displays statutory property tax rates levied in Kentucky in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, ambulance districts, community college districts, ditch districts, fire protection districts, flood control districts, municipal services districts, road districts, solid waste disposal districts, and watershed districts.

E.19 Louisiana

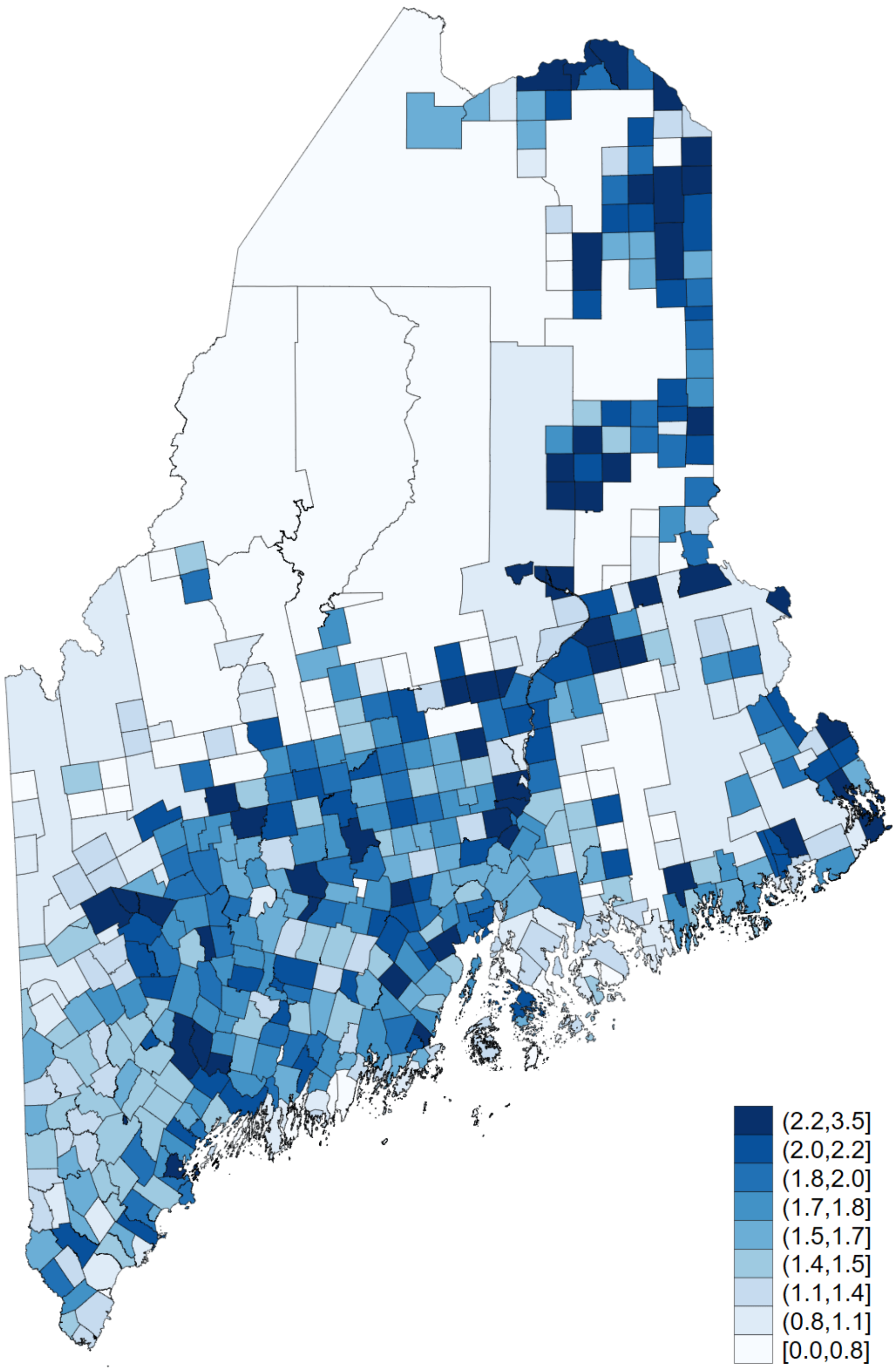
Figure E19: Property Tax Rates (pp) in Louisiana in 2020



NOTES: This map displays statutory property tax rates levied in Louisiana in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, airport districts, ambulance districts, cemetery districts, drainage districts, fire protection districts, hospital districts, Louisiana State University extension districts, levee districts, library districts, mosquito control districts, municipal services districts, port districts, recreation districts, road districts, sewer districts, solid waste disposal districts, street lighting districts, transit districts, utility districts, veterans districts, water districts, and water and sewer districts.

E.20 Maine

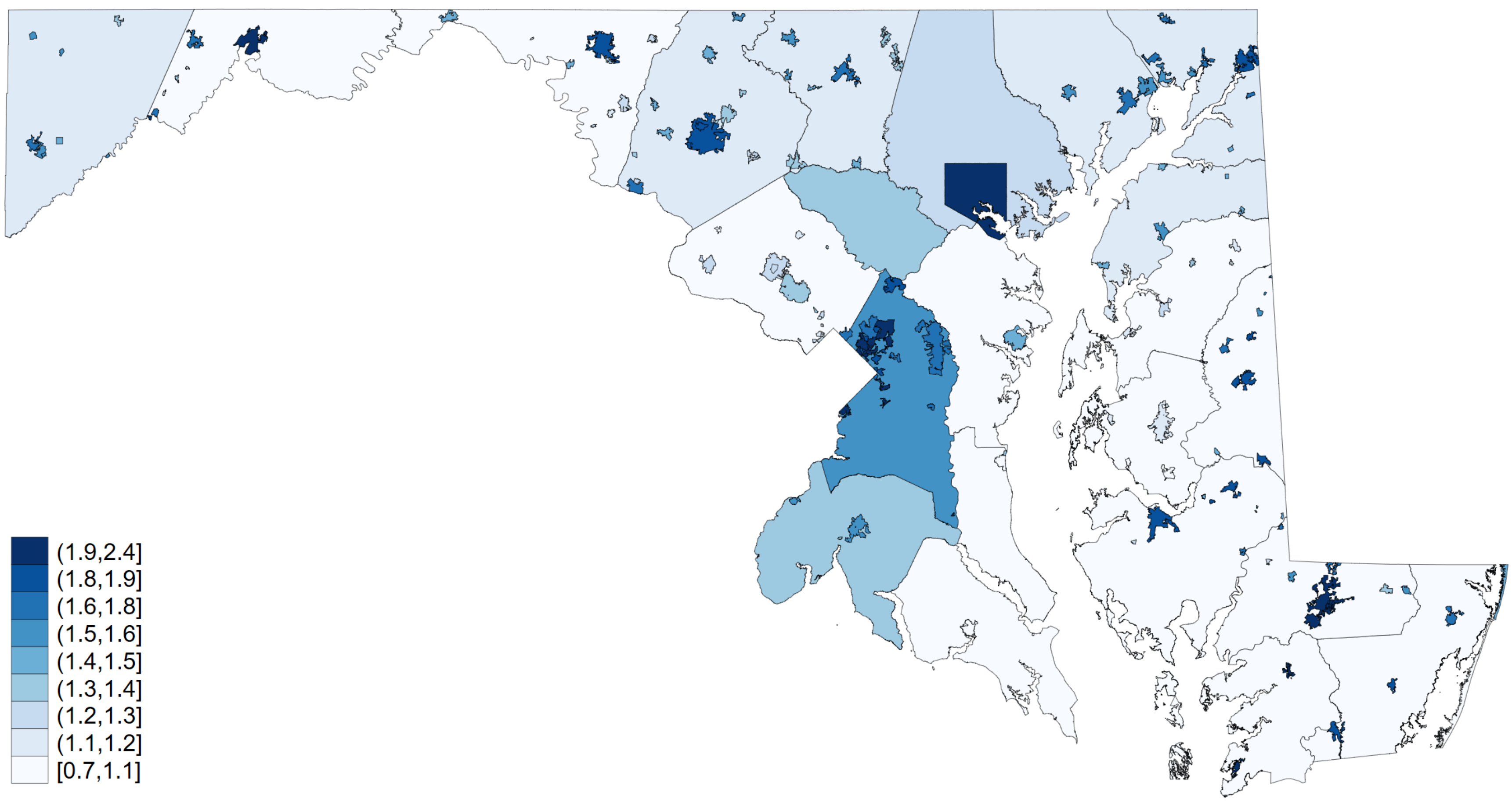
Figure E20: Property Tax Rates (pp) in Maine in 2020



NOTES: This map displays statutory property tax rates levied in Maine in 2020. Tax areas are implied by municipalities or unorganized territories.

E.21 Maryland

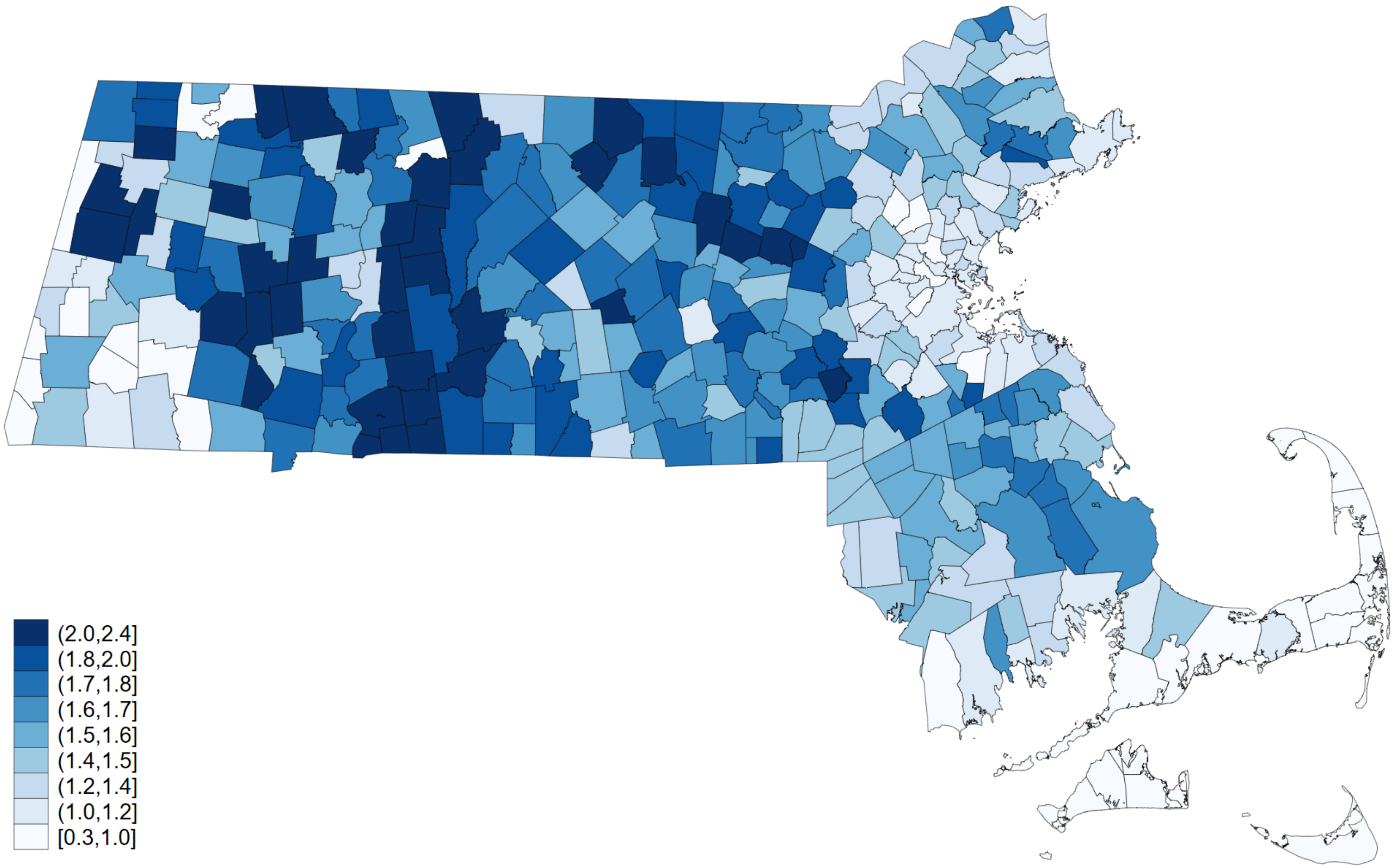
Figure E21: Property Tax Rates (pp) in Maryland in 2020



Notes: This map displays statutory property tax rates levied in Maryland in 2020. Tax areas are implied by unique intersections of counties, municipalities, and special service districts.

E.22 Massachusetts

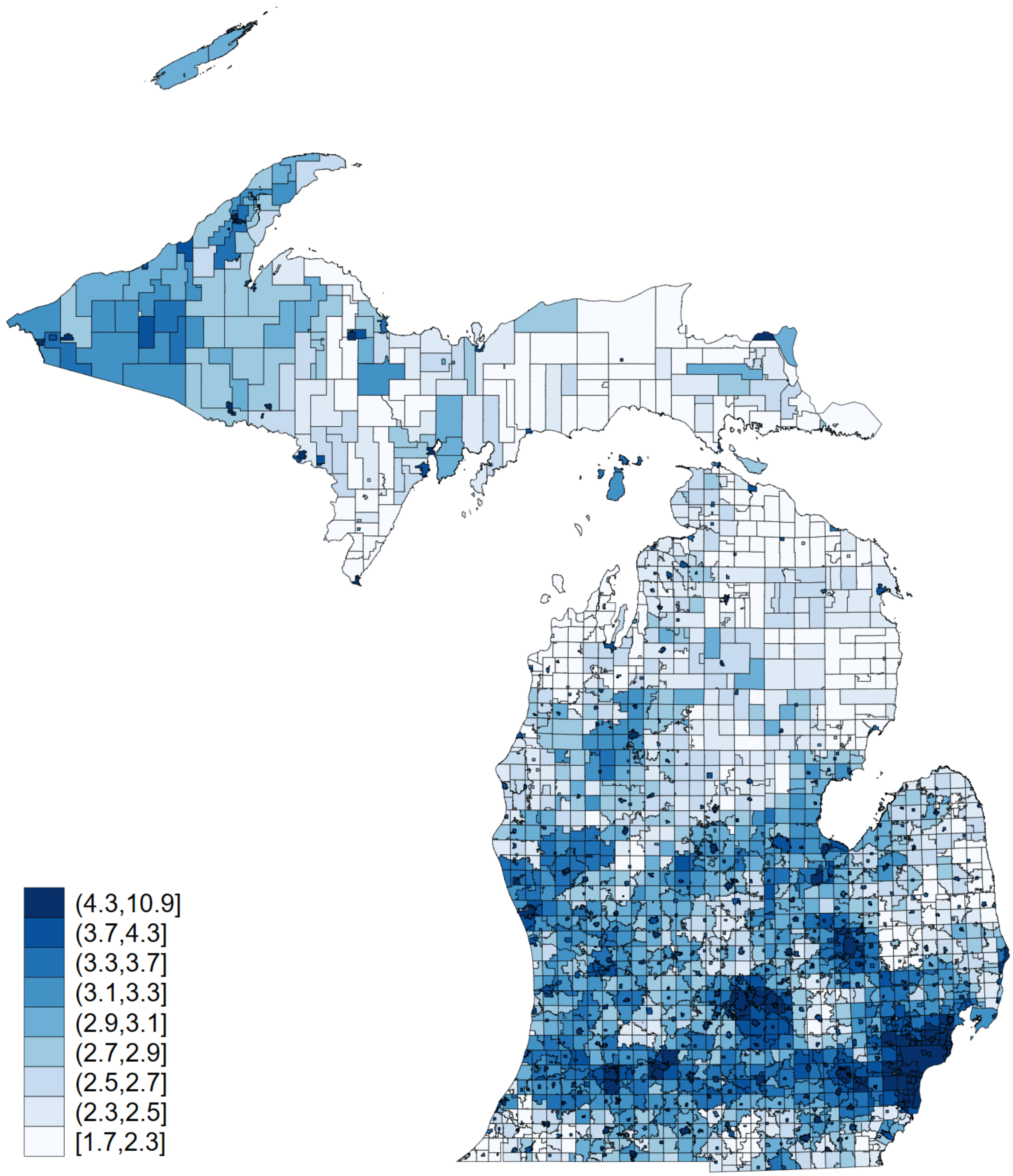
Figure E22: Property Tax Rates (pp) in Massachusetts in 2020



Notes: This map displays statutory property tax rates levied in Massachusetts in 2020. Tax areas are implied by unique intersections of municipalities, fire protection districts, lake maintenance districts, redevelopment authorities, road districts, street lighting districts, water districts, and watershed districts.

E.23 Michigan

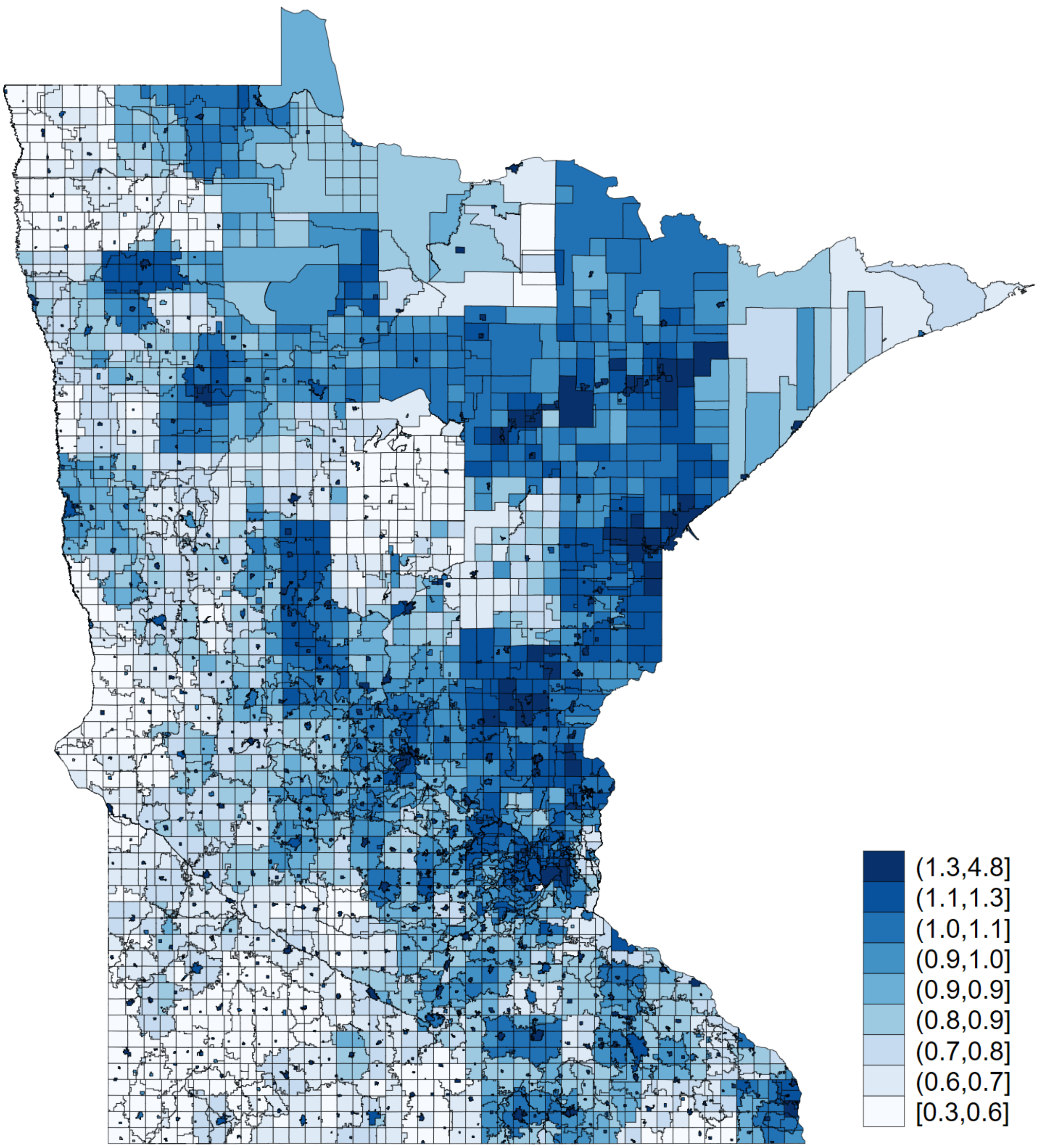
Figure E23: Property Tax Rates (pp) in Michigan in 2020



NOTES: This map displays statutory homestead property tax rates levied in Michigan in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, and school districts.

E.24 Minnesota

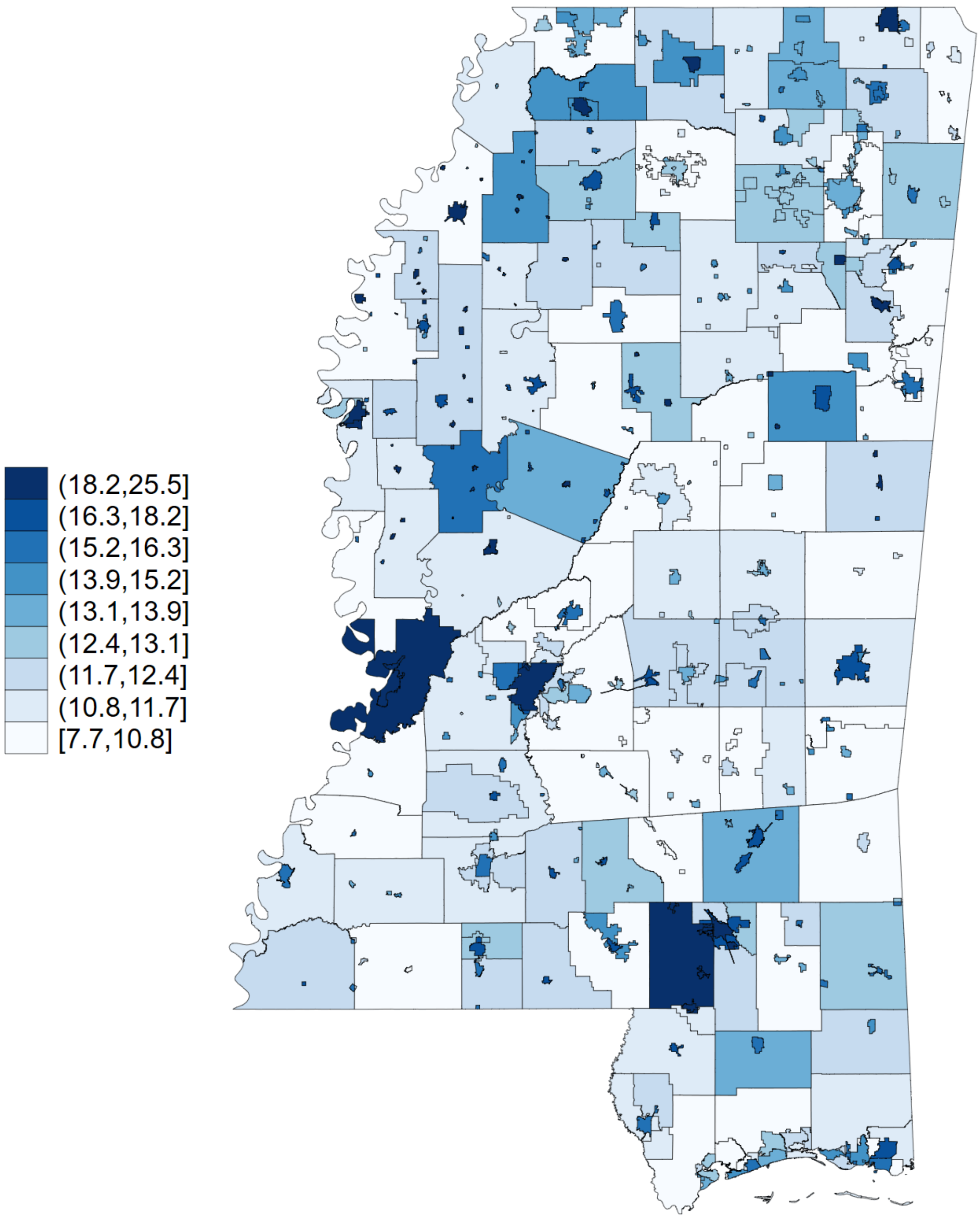
Figure E24: Property Tax Rates (pp) in Minnesota in 2020



Notes: This map displays statutory property tax rates levied in Minnesota in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, unorganized territories, school districts, airport authorities, ambulance districts, economic development authorities, fire protection districts, hospital districts, housing and redevelopment authorities, metro councils, park districts, port districts, railroad districts, regional development commissions, rural development authorities, sanitary districts, transit authorities, and watershed districts.

E.25 Mississippi

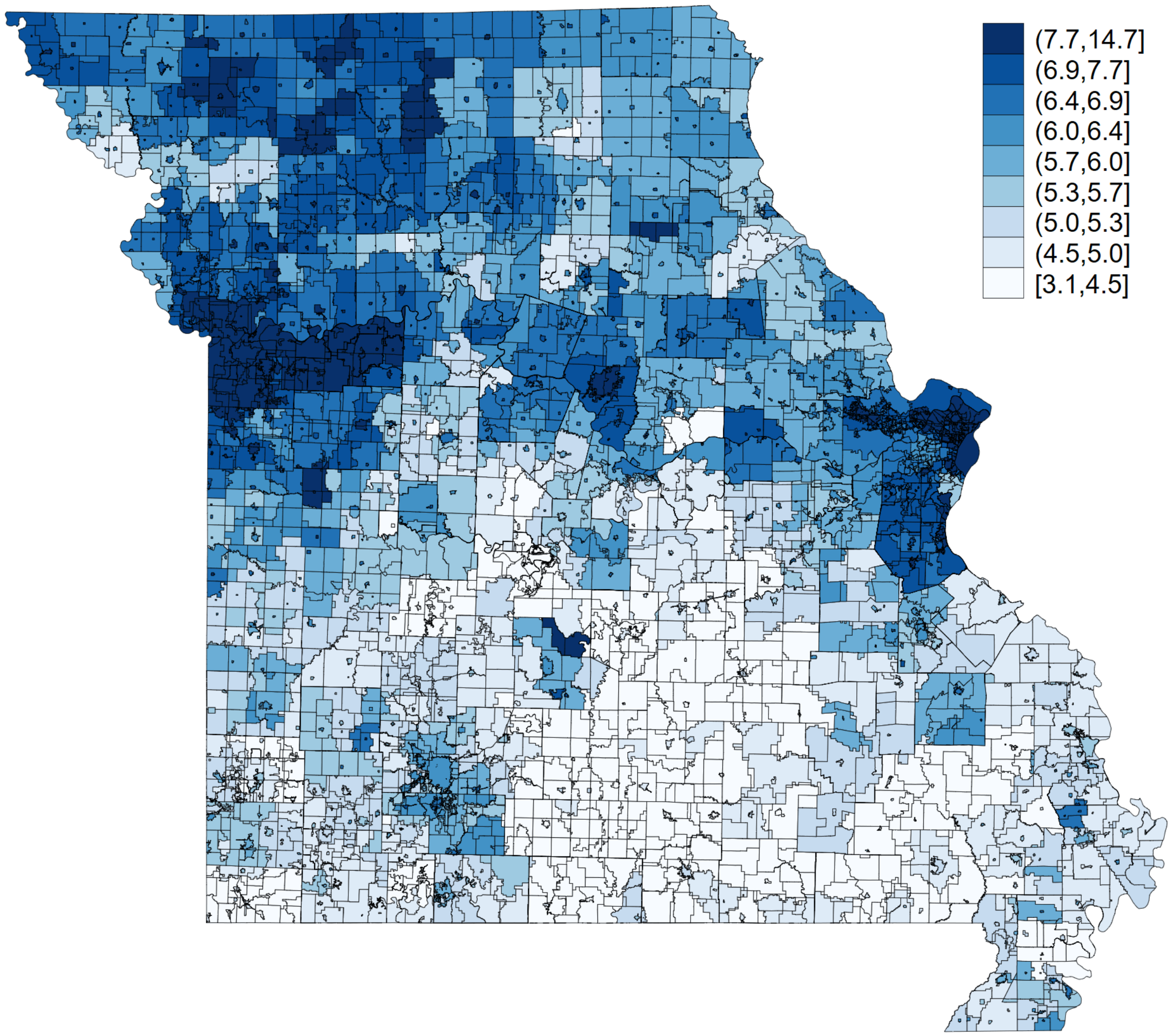
Figure E25: Property Tax Rates (pp) in Mississippi in 2020



NOTES: This map displays statutory property tax rates levied in Mississippi in 2020. Tax areas are implied by unique intersections of counties, municipalities, and school districts.

E.26 Missouri

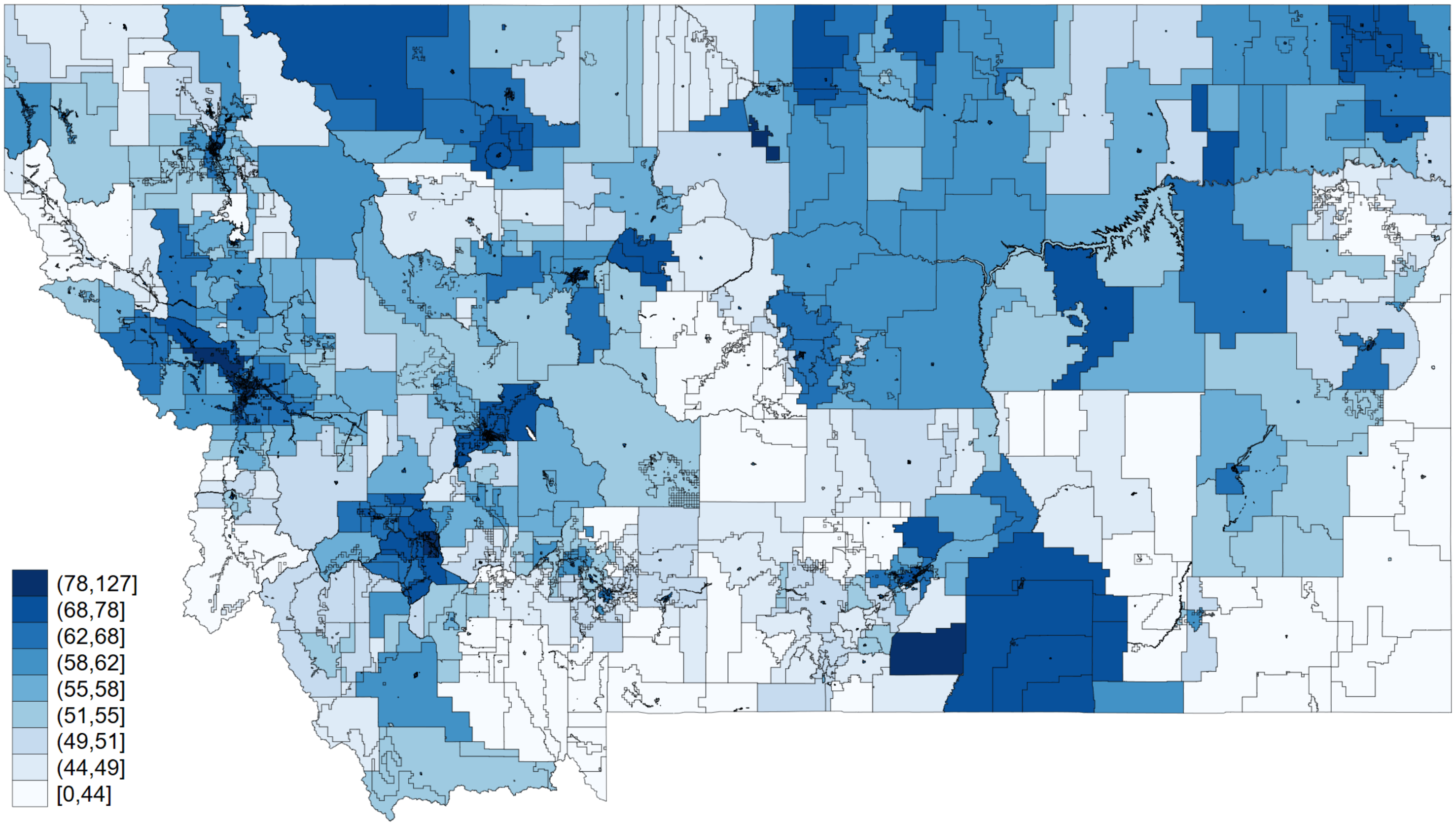
Figure E26: Property Tax Rates (pp) in Missouri in 2020



NOTES: This map displays statutory property tax rates levied in Missouri in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, school districts, ambulance districts, community college districts, community improvement districts, drainage districts, fire protection districts, hospital districts, levee districts, nursing home districts, park and museum districts, parking districts, road districts, Senate Bill 40 districts, sewer districts, special business districts, street lighting districts, transportation development districts, University of Missouri extension districts, water districts, and watershed districts.

E.27 Montana

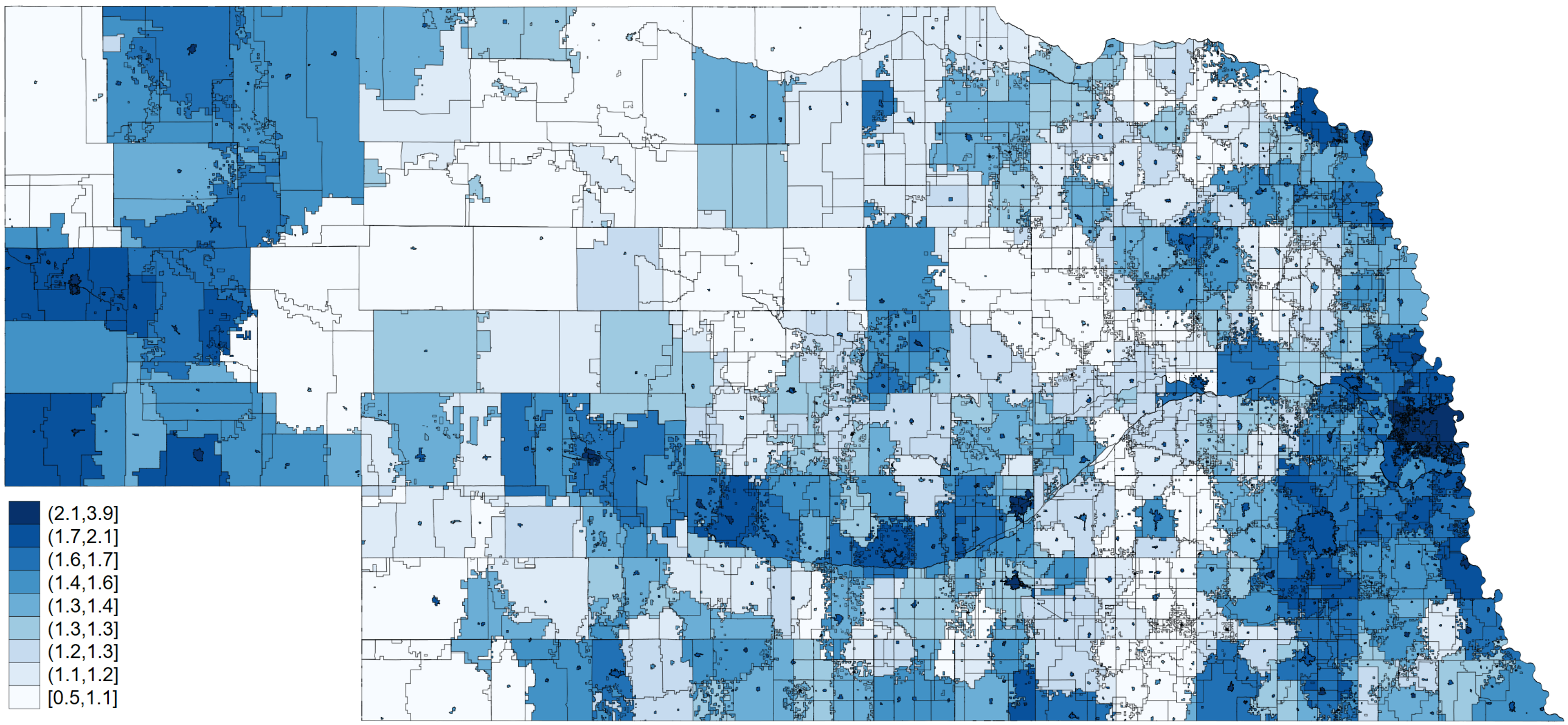
Figure E27: Property Tax Rates (pp) in Montana in 2020



Notes: This map displays statutory property tax rates levied in Montana in 2020. Tax areas are implied by unique intersections of counties, municipalities, elementary school districts, high school districts, airport districts, ambulance districts, cemetery districts, community college districts, development districts, emergency services districts, fire protection districts, healthcare districts, hospital districts, improvement districts, library districts, mosquito control districts, park and recreation districts, planning districts, public safety districts, road districts, sewer districts, soil conservation districts, street lighting districts, transportation districts, vocational-technical school districts, water districts, water and sewer districts, and weed control districts.

E.28 Nebraska

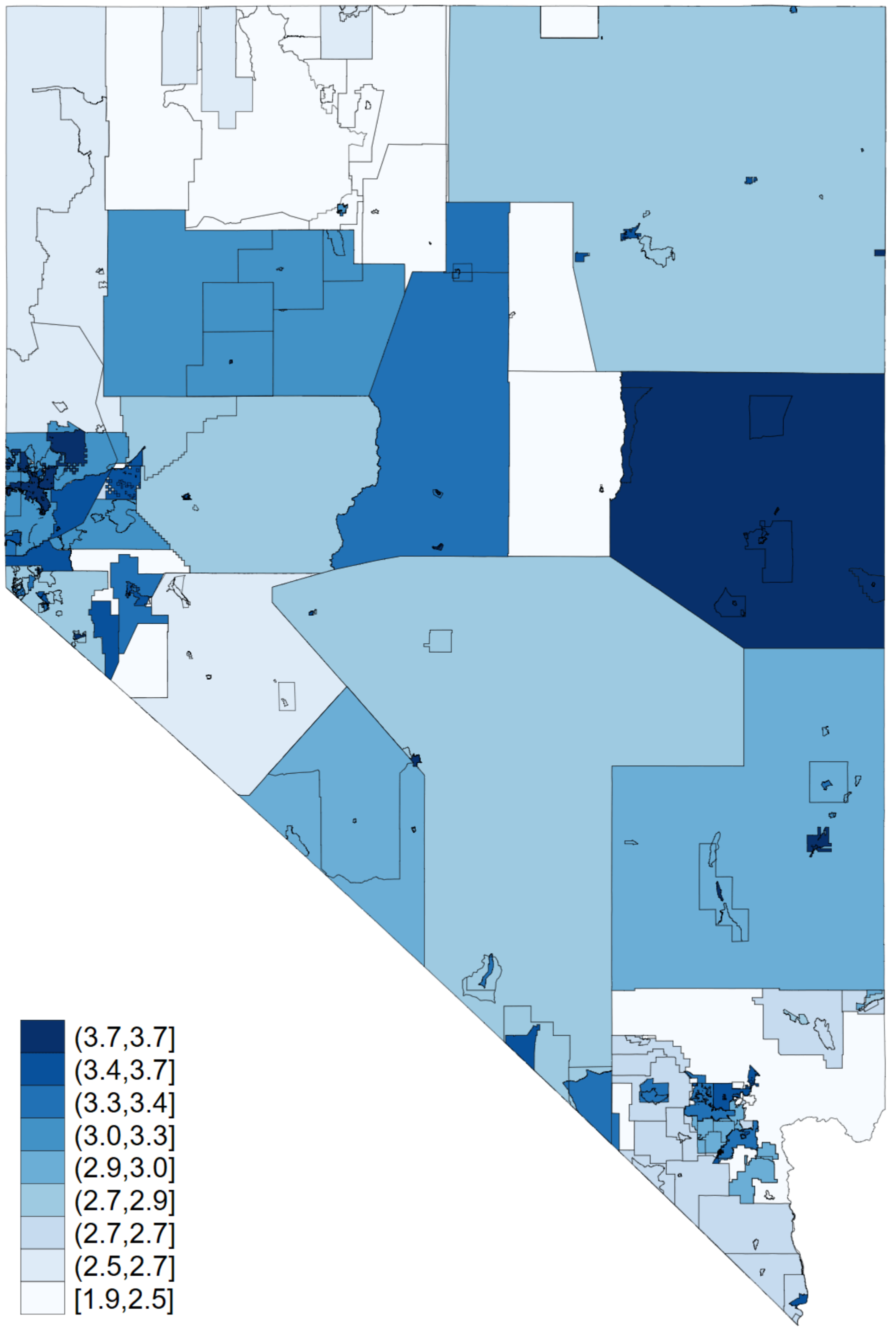
Figure E28: Property Tax Rates (pp) in Nebraska in 2020



Notes: This map displays statutory property tax rates levied in Nebraska in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, school districts, agricultural societies, airport districts, cemetery districts, community college districts, community redevelopment authorities, drainage districts, educational service units, fire protection districts, historical societies, hospital districts, joint public agencies, library districts, natural resource districts, offstreet parking districts, road districts, and sanitary and improvement districts.

E.29 Nevada

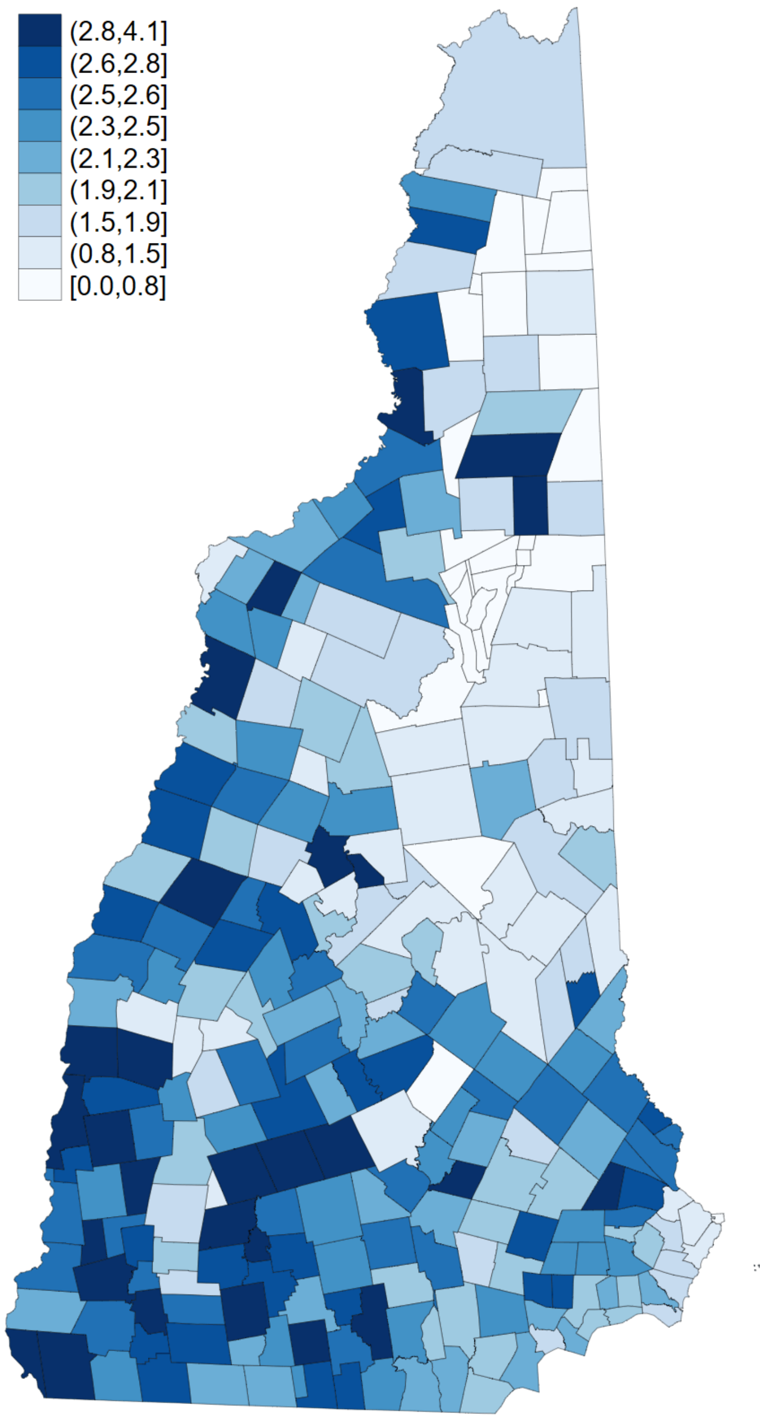
Figure E29: Property Tax Rates (pp) in Nevada in 2020



NOTES: This map displays statutory property tax rates levied in Nevada in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, ambulance districts, animal control districts, emergency medical services districts, fire protection districts, flood control districts, general improvement districts, health districts, hospital districts, library districts, police districts, power districts, redevelopment agencies, sewer districts, swimming pool districts, television districts, water conservancy districts, water districts, water and sewer districts, and weed control districts.

E.30 New Hampshire

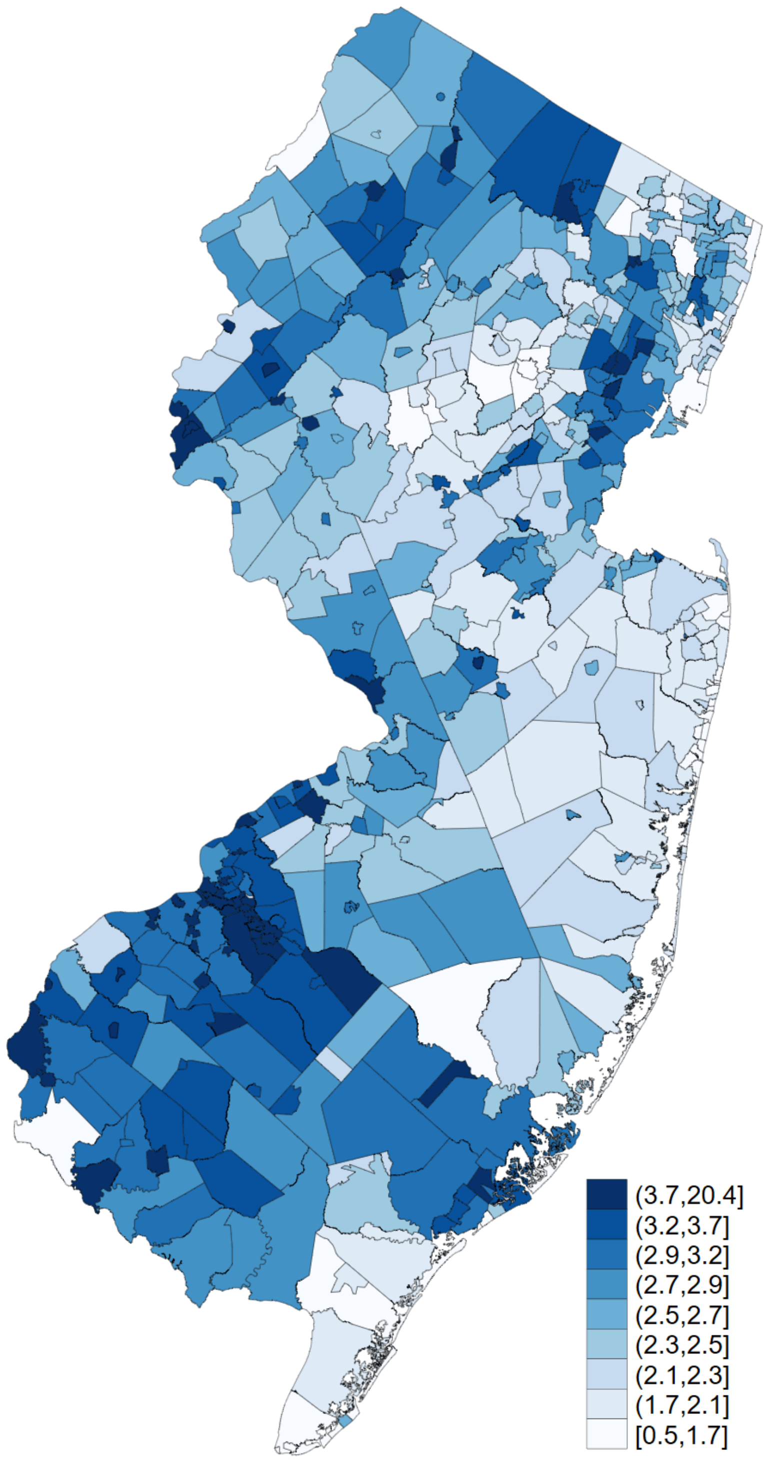
Figure E30: Property Tax Rates (pp) in New Hampshire in 2020



NOTES: This map displays statutory property tax rates levied in New Hampshire in 2020. Tax areas are implied by unique intersections of municipalities, fire protection districts, street lighting districts, sewer districts, and water districts.

E.31 New Jersey

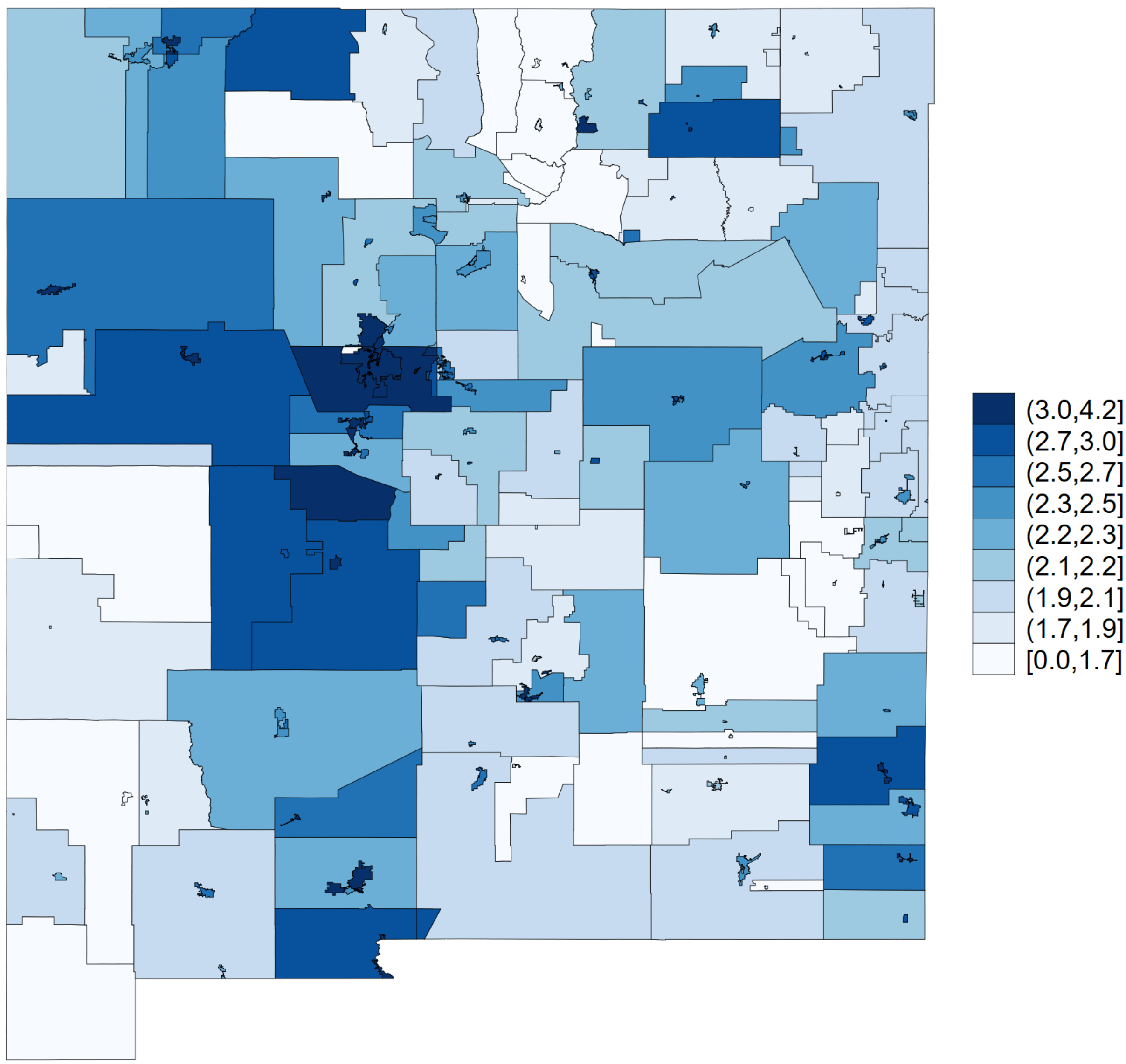
Figure E31: Property Tax Rates (pp) in New Jersey in 2020



NOTES: This map displays statutory property tax rates levied in New Jersey in 2020. Tax areas are implied by unique intersections of counties, municipalities, boroughs, and townships.

E.32 New Mexico

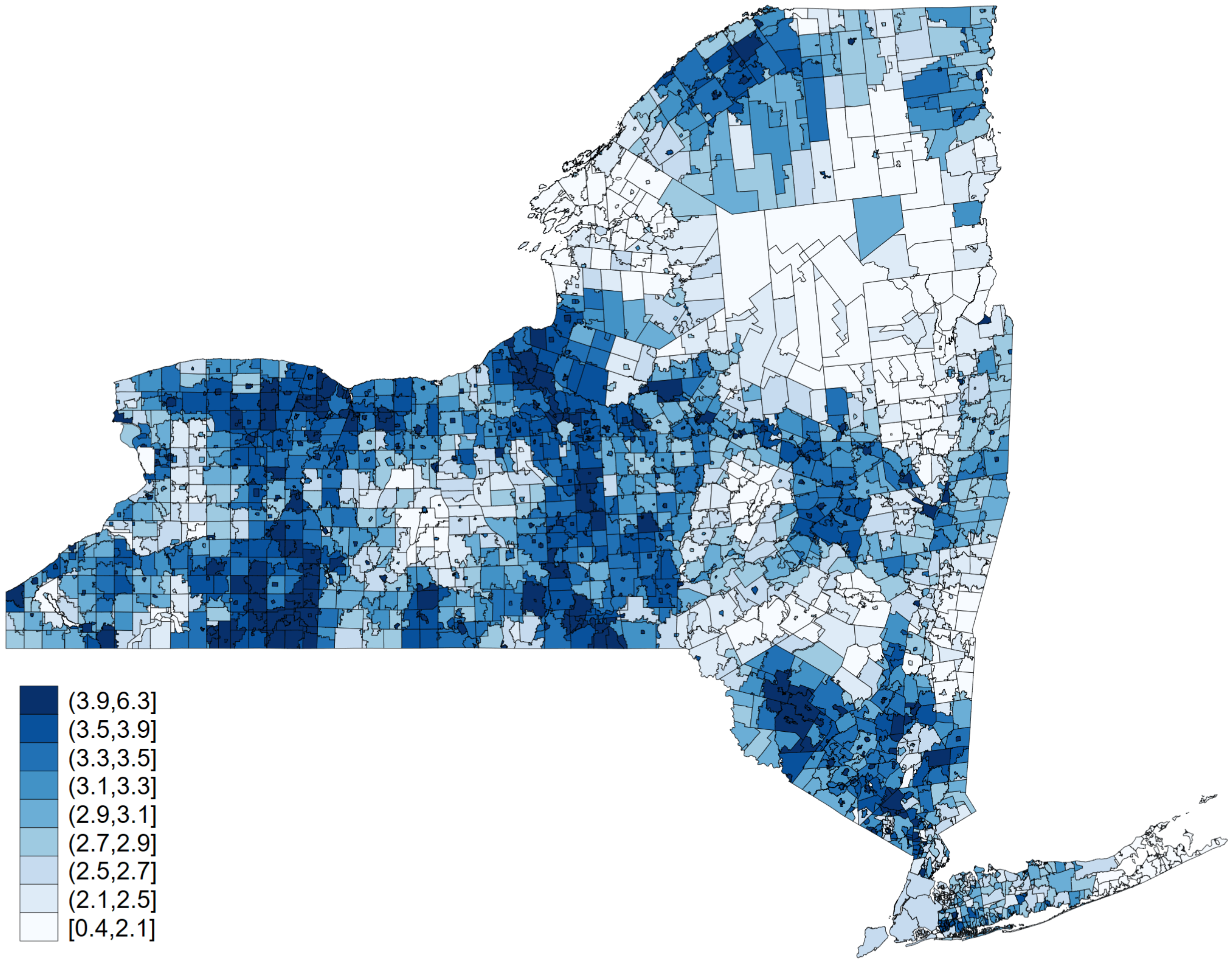
Figure E32: Property Tax Rates (pp) in New Mexico in 2020



NOTES: This map displays statutory property tax rates levied in New Mexico in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, community college districts, flood control authorities, hospital districts, sanitation districts, soil and water conservancy districts, water and sanitation districts, and watershed districts.

E.33 New York

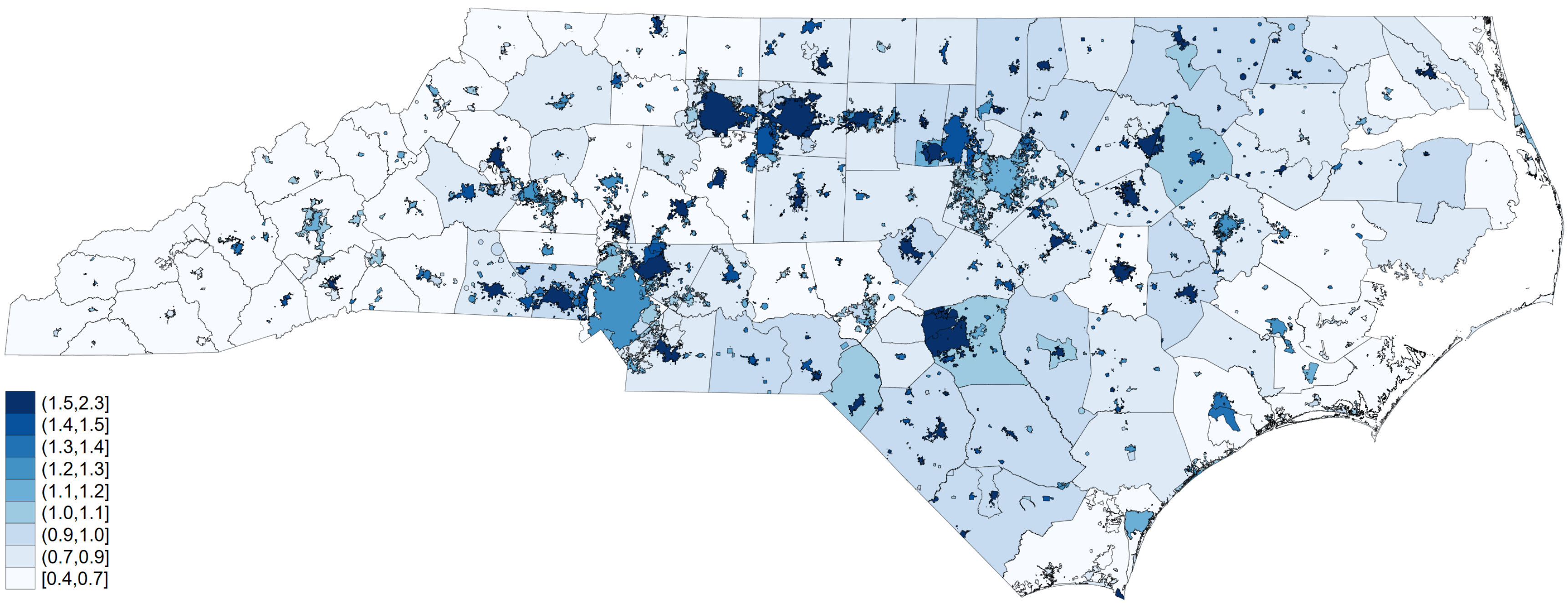
Figure E33: Property Tax Rates (pp) in New York in 2020



NOTES: This map displays statutory property tax rates levied in New York in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, fire protection districts, and other special purpose districts.

E.34 North Carolina

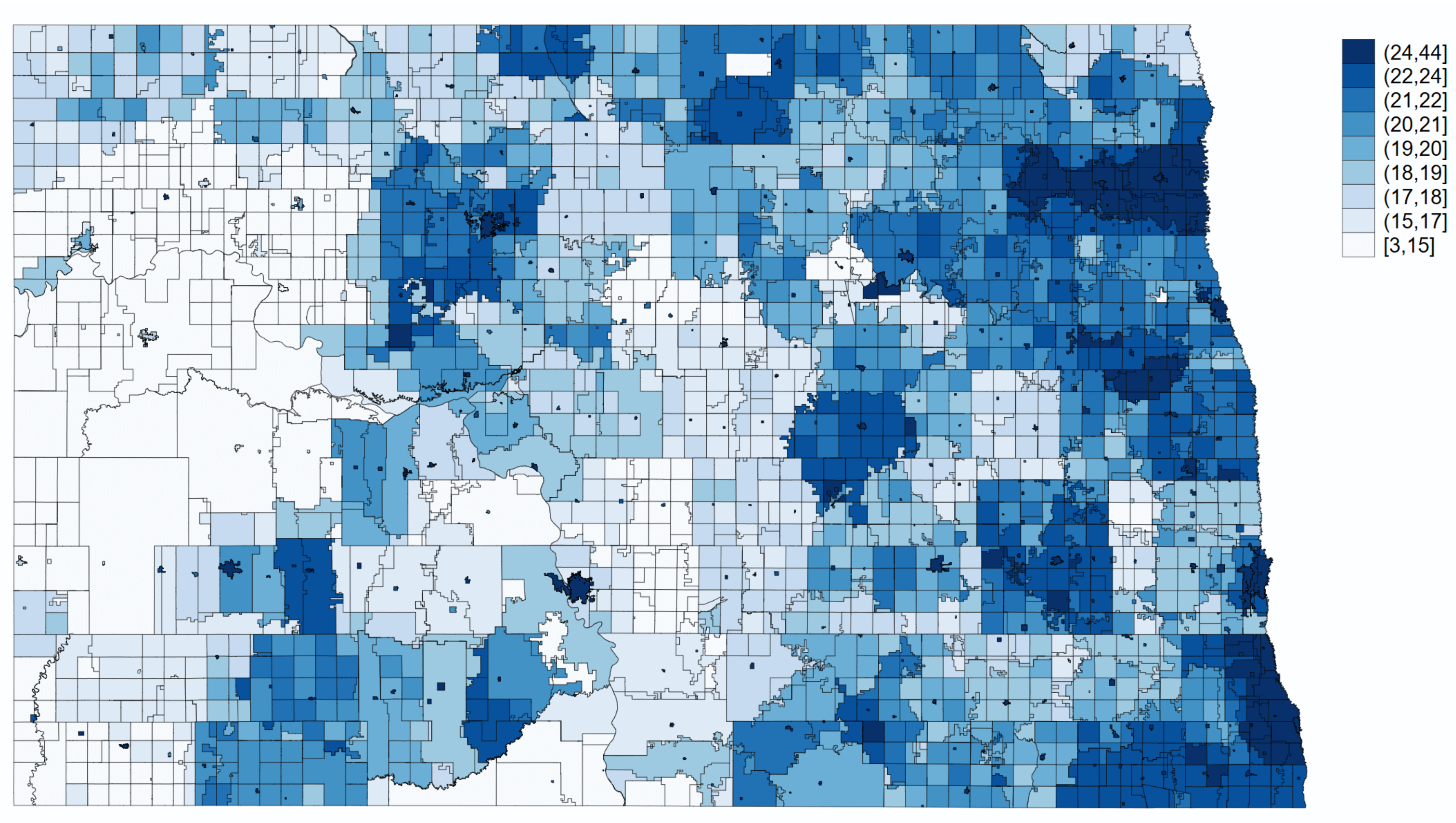
Figure E34: Property Tax Rates (pp) in North Carolina in 2020



Notes: This map displays statutory property tax rates levied in North Carolina in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, beach nourishment districts, drainage districts, fire protection districts, historical districts, hospital districts, mosquito control districts, municipal services districts, police districts, recreation districts, rescue service districts, road maintenance districts, sanitation districts, solid waste disposal districts, water districts, and watershed districts.

E.35 North Dakota

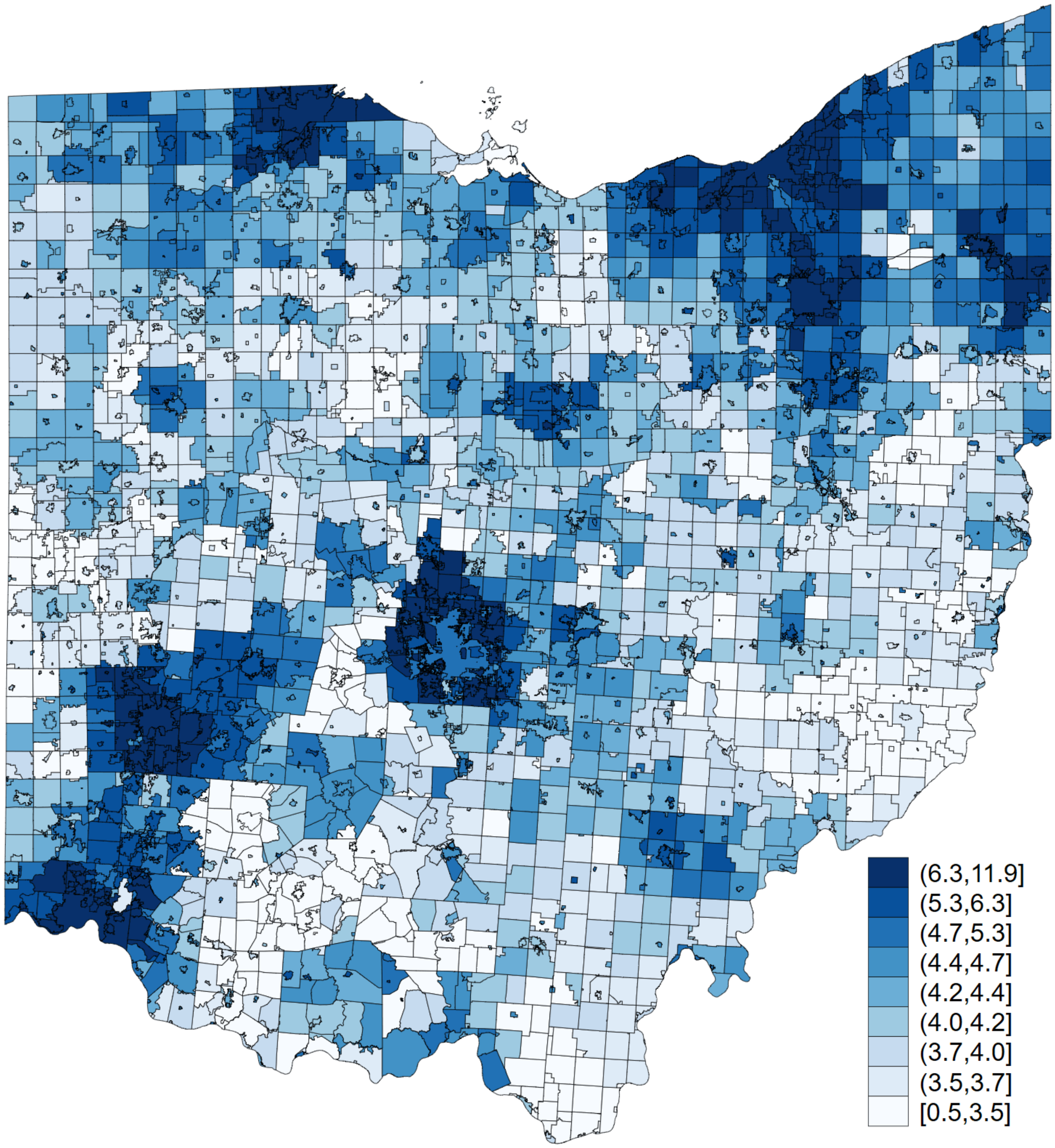
Figure E35: Property Tax Rates (pp) in North Dakota in 2020



Notes: This map displays statutory property tax rates levied in North Dakota in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, school districts, ambulance districts, fire protection districts, park districts, and water resource districts.

E.36 Ohio

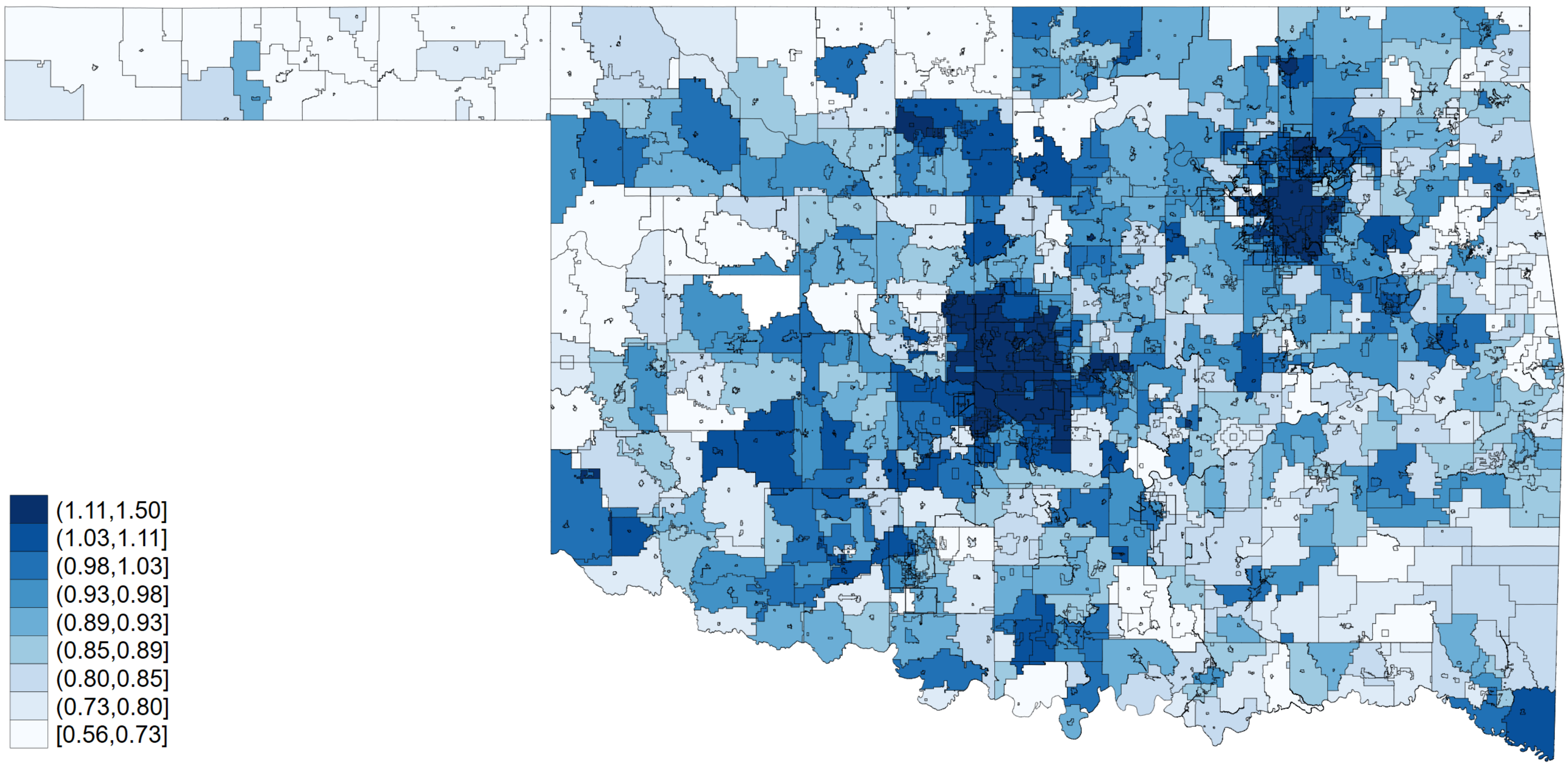
Figure E36: Property Tax Rates (pp) in Ohio in 2020



Notes: This map displays statutory property tax rates levied in Ohio in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, school districts, ambulance districts, cemetery districts, community college districts, fire protection districts, health districts, library districts, mental health districts, metropolitan park districts, park districts, police districts, port authorities, recreation districts, road districts, transit authorities, vocational-technical school districts, and water and sewer districts.

E.37 Oklahoma

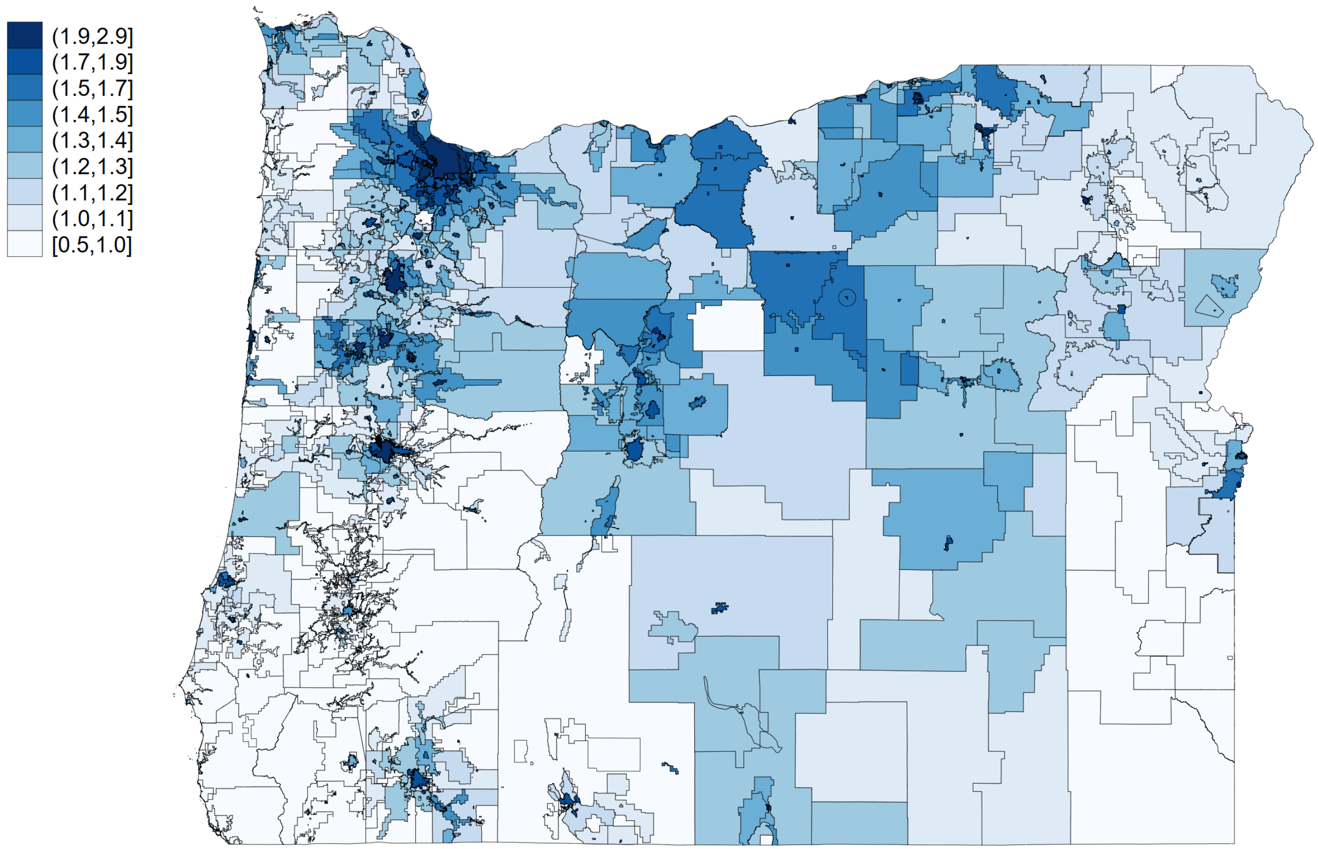
Figure E37: Property Tax Rates (pp) in Oklahoma in 2020



NOTES: This map displays statutory property tax rates levied in Oklahoma in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, emergency medical services districts, fire protection districts, and vocational-technical school districts.

E.38 Oregon

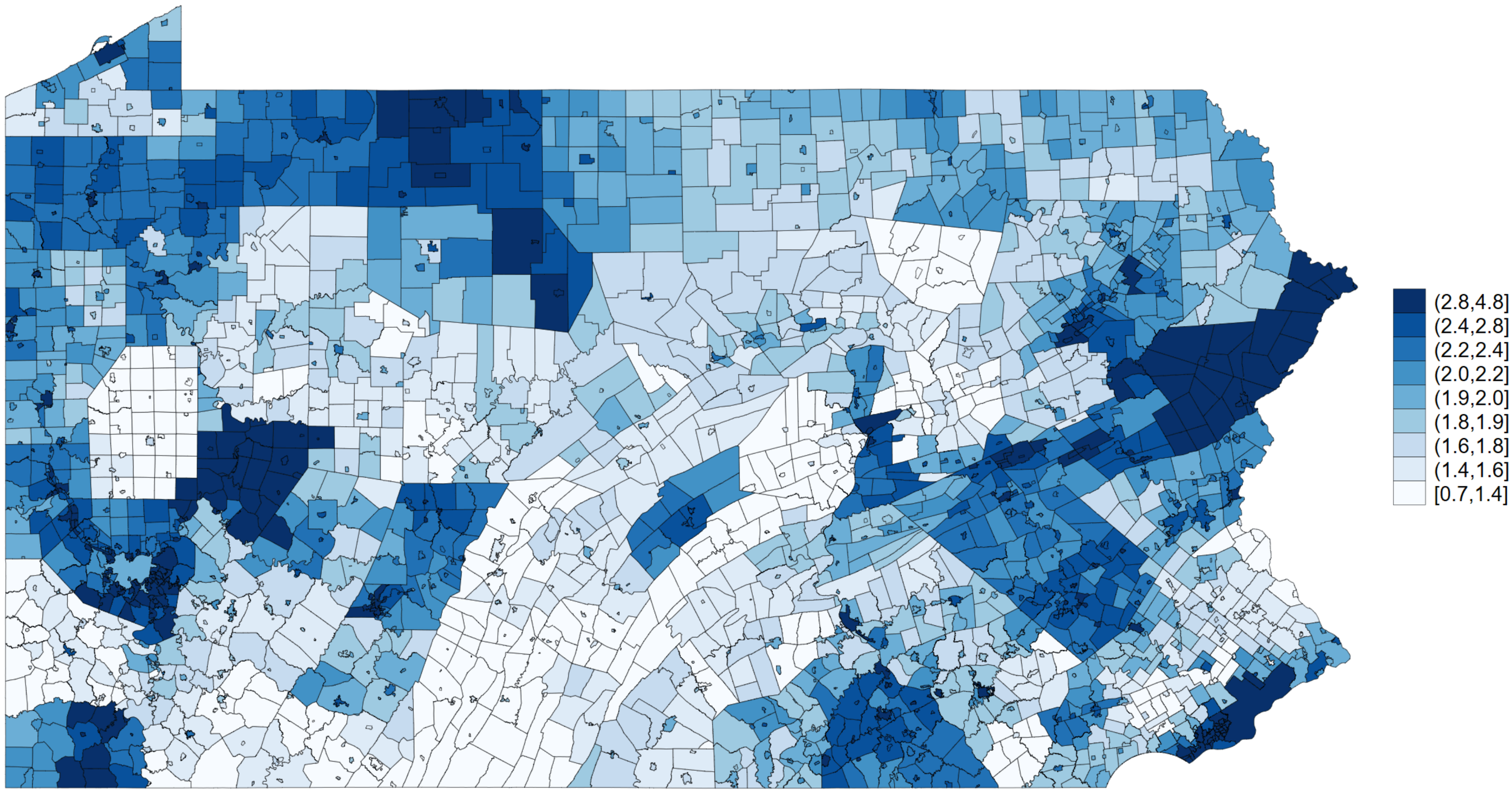
Figure E38: Property Tax Rates (pp) in Oregon in 2020



Notes: This map displays statutory property tax rates levied in Oregon in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, airport districts, animal control districts, cemetery districts, community college districts, education service districts, fire protection districts, health districts, law enforcement districts, library districts, Oregon State University extension service districts, park and recreation districts, port districts, road districts, sanitary districts, service districts, street lighting districts, transportation districts, vector control districts, water control districts, and water districts.

E.39 Pennsylvania

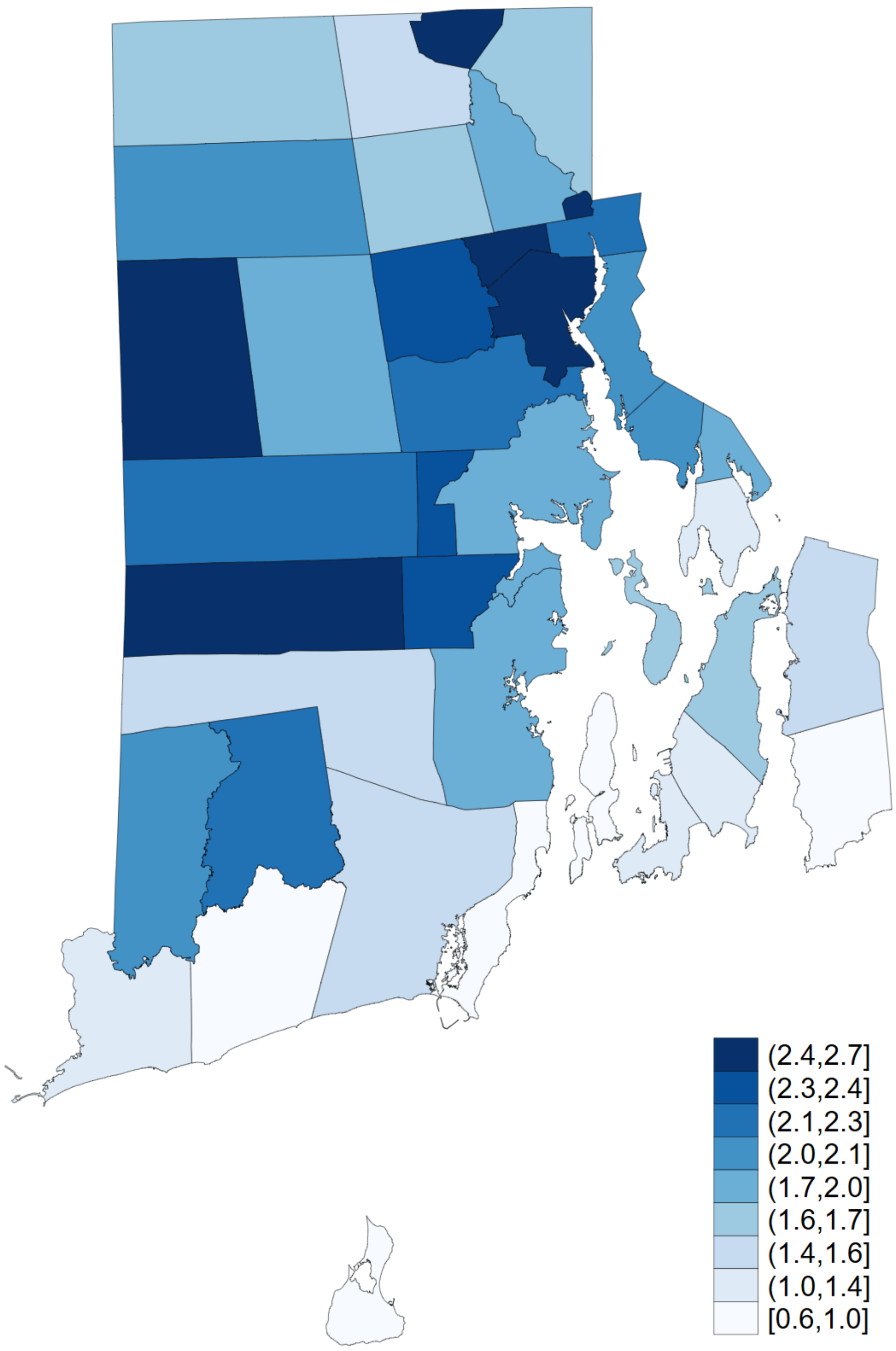
Figure E39: Property Tax Rates (pp) in Pennsylvania in 2020



Notes: This map displays statutory property tax rates levied in Pennsylvania in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, boroughs, and school districts.

E.40 Rhode Island

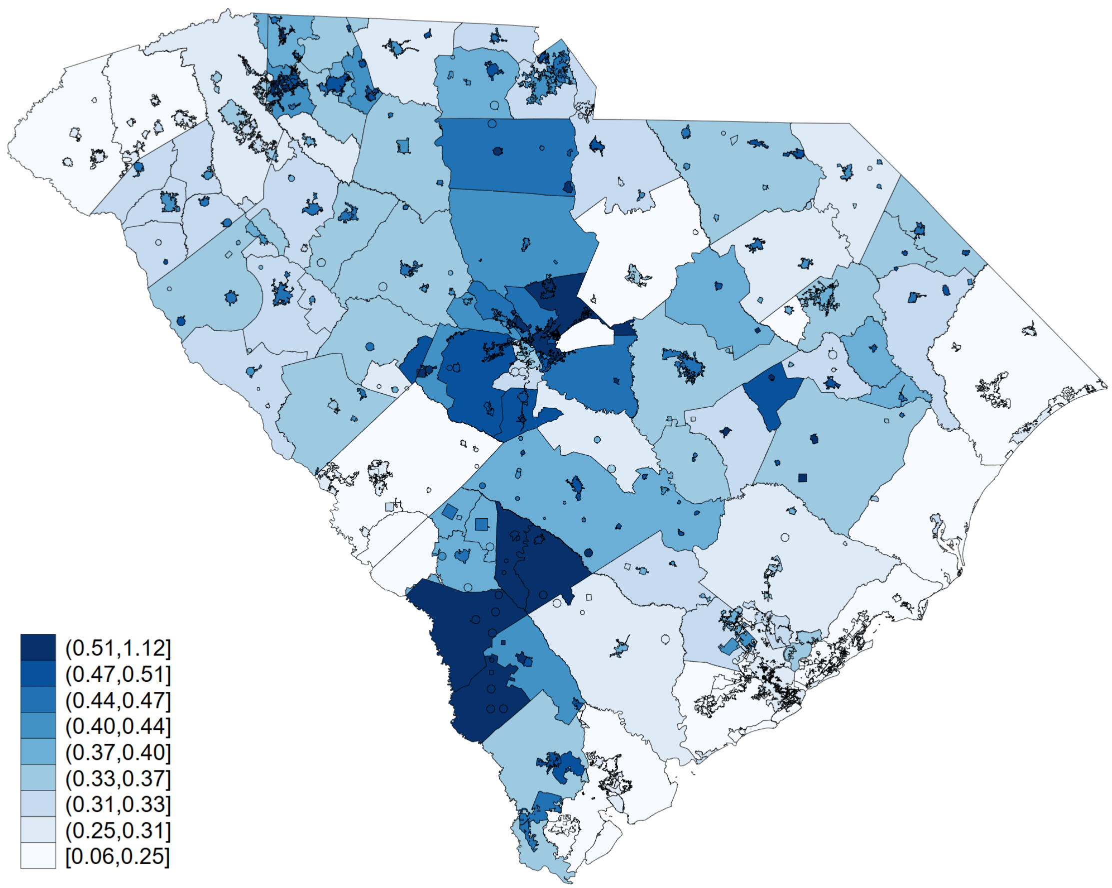
Figure E40: Property Tax Rates (pp) in Rhode Island in 2020



NOTES: This map displays statutory property tax rates levied in Rhode Island in 2020. Tax areas are implied by unique intersections of municipalities and fire protection districts.

E.41 South Carolina

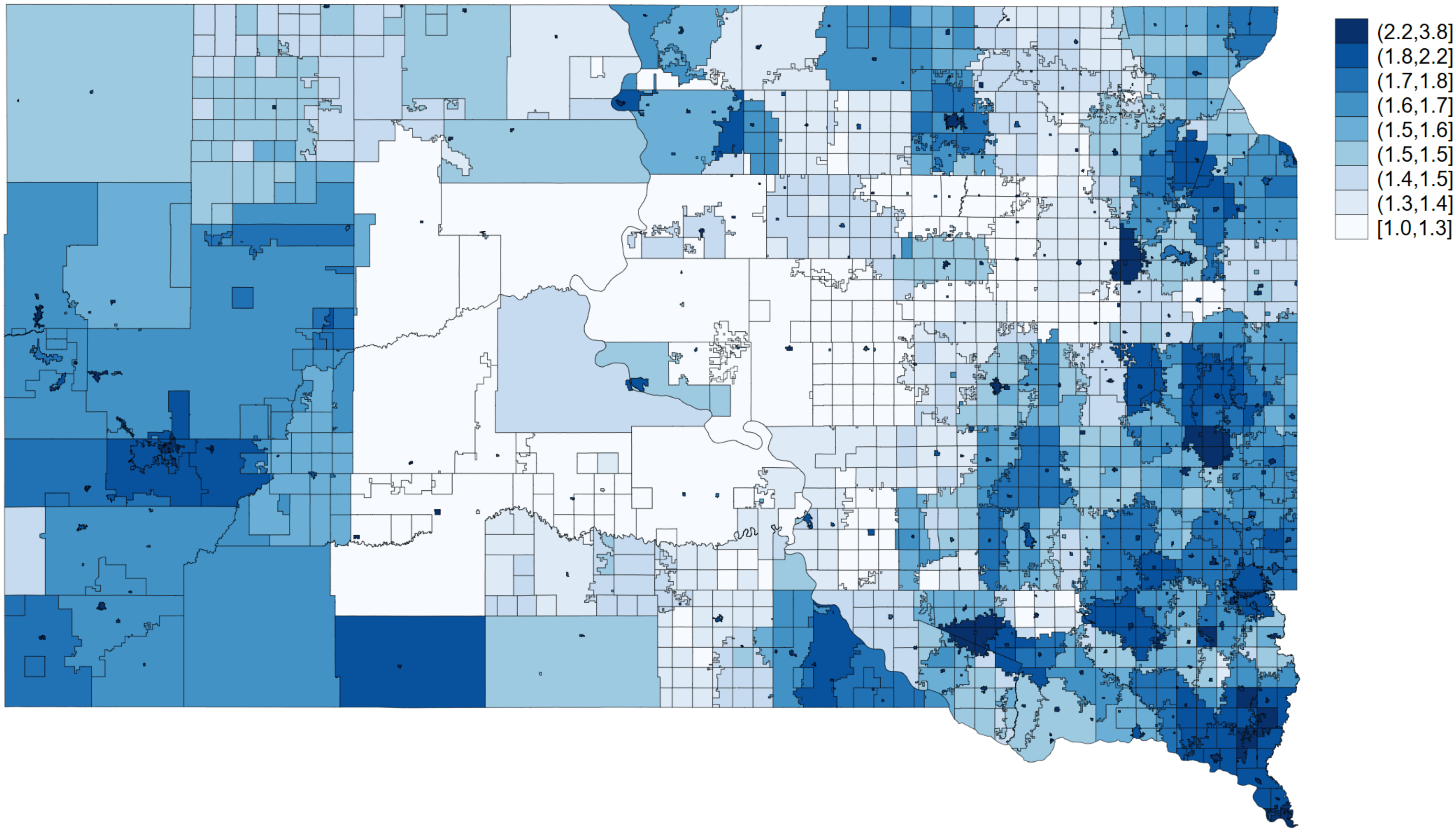
Figure E41: Property Tax Rates (pp) in South Carolina in 2020



Notes: This map displays statutory property tax rates levied in South Carolina in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, drainage districts, emergency medical services districts, fire protection districts, hospital districts, library districts, public service districts, recreation districts, road districts, sewer districts, solid waste disposal districts, street lighting districts, water districts, water and sewer districts, and watershed districts.

E.42 South Dakota

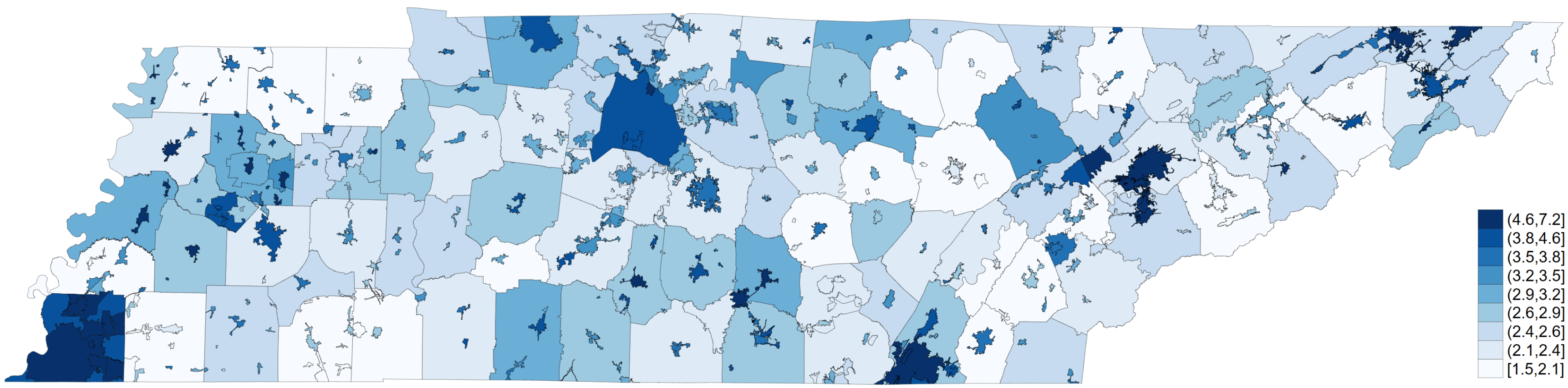
Figure E42: Property Tax Rates (pp) in South Dakota in 2020



Notes: This map displays statutory property tax rates levied in South Dakota in 2020. Tax areas are implied by unique intersections of counties, municipalities, townships, school districts, fire protection districts, library districts, road districts, and water districts.

E.43 Tennessee

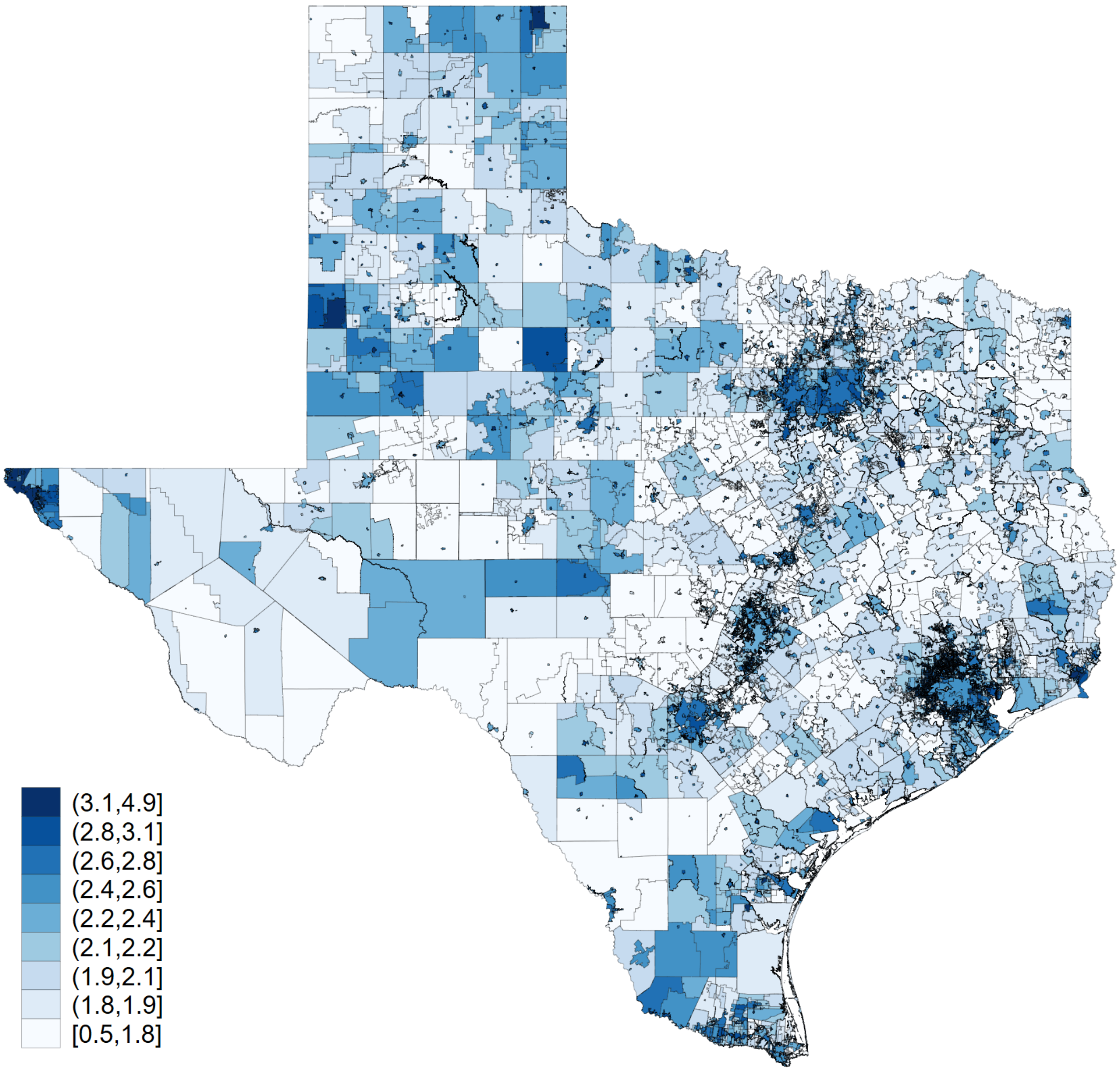
Figure E43: Property Tax Rates (pp) in Tennessee in 2020



Notes: This map displays statutory property tax rates levied in Tennessee in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, fire protection districts, and special school districts.

E.44 Texas

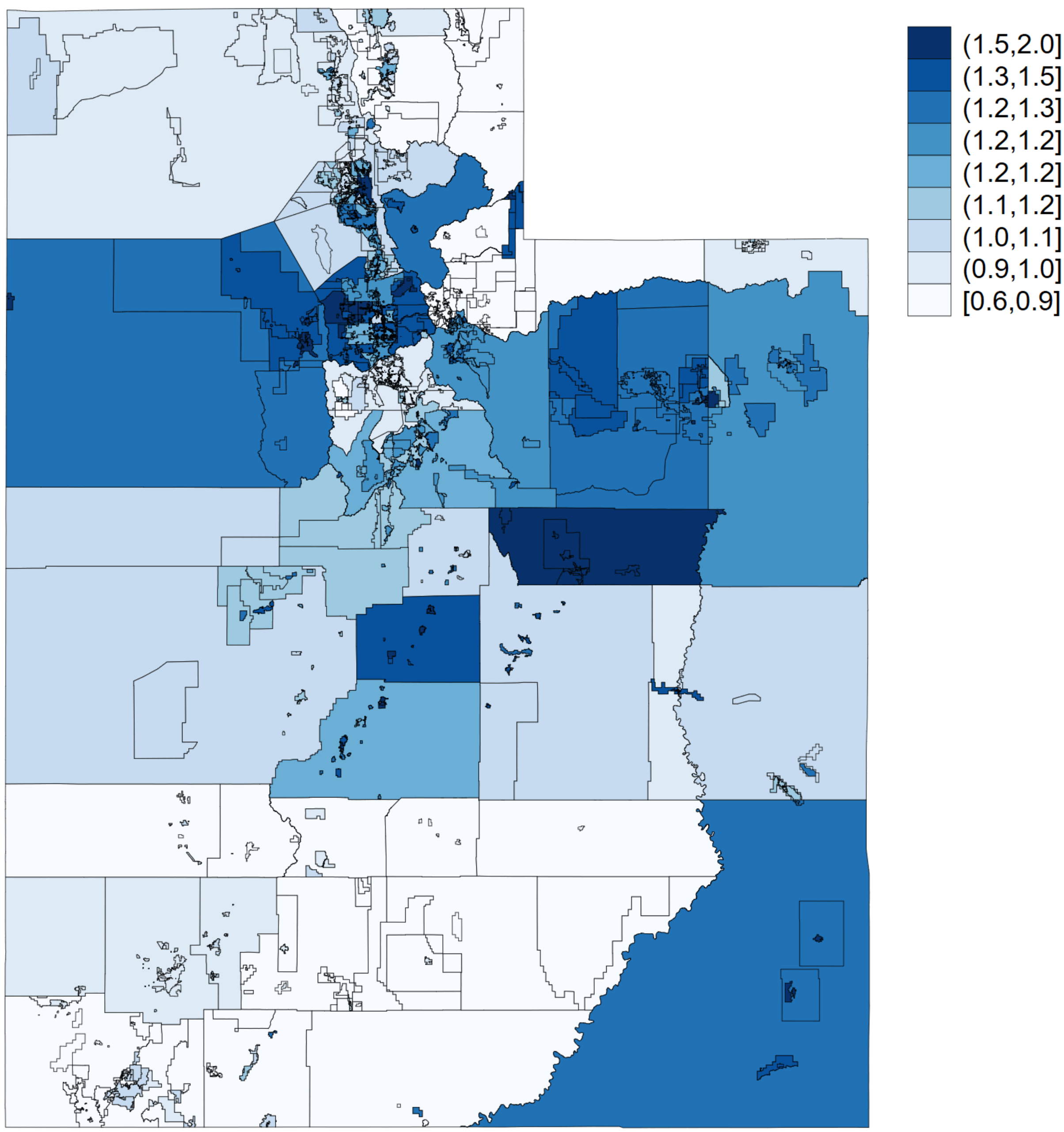
Figure E44: Property Tax Rates (pp) in Texas in 2020



NOTES: This map displays statutory property tax rates levied in Texas in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, community college districts, development districts, drainage districts, education districts, emergency services districts, flood control districts, hospital districts, improvement districts, levee improvement districts, library districts, limited districts, management districts, metropolitan park districts, municipal utility districts, navigation districts, port districts, river authorities, road districts, solid waste management districts, utility districts, water conservation districts, water conservation and reclamation districts, water control and improvement districts, water districts, watershed districts, and weed control districts.

E.45 Utah

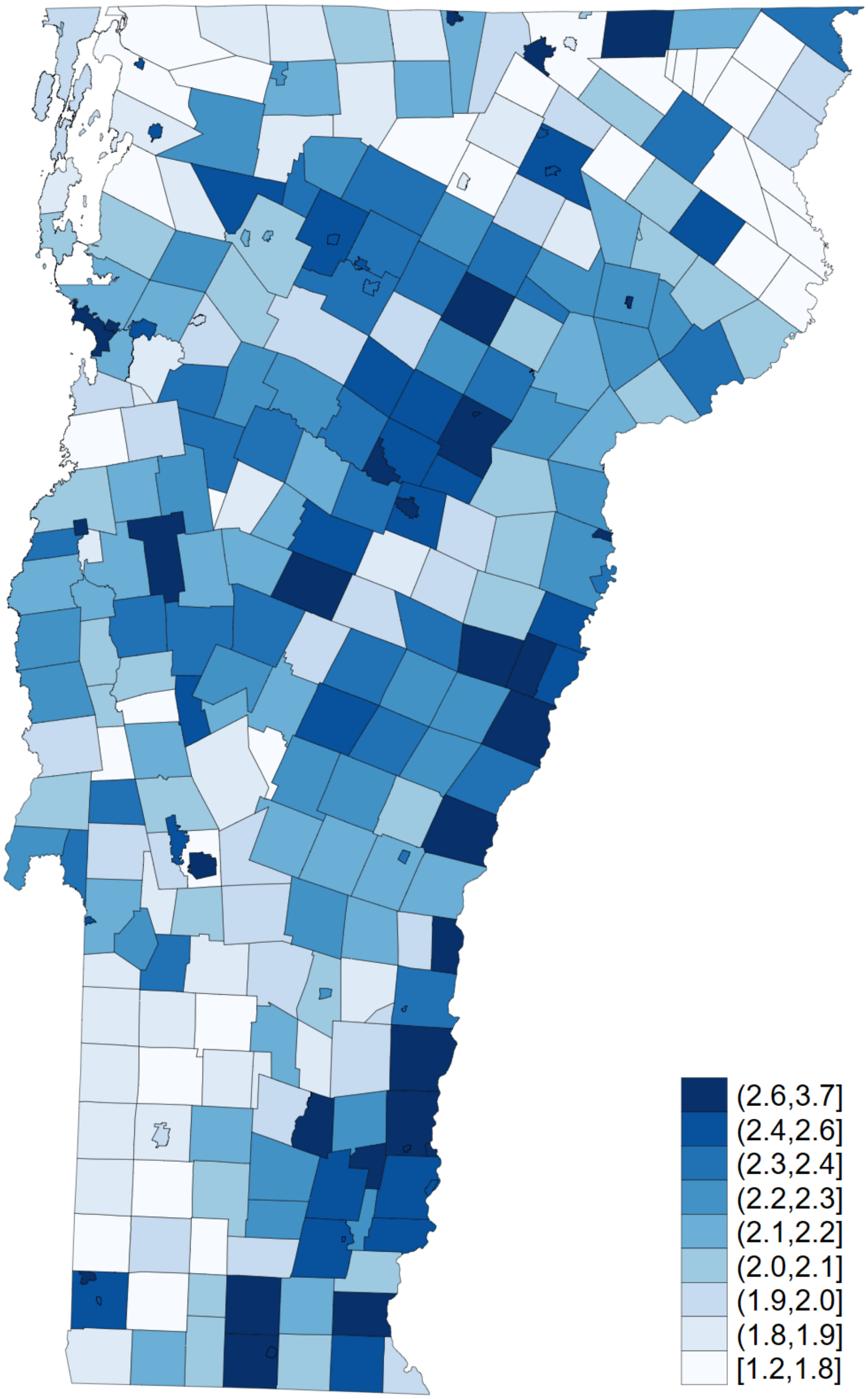
Figure E45: Property Tax Rates (pp) in Utah in 2020



NOTES: This map displays statutory property tax rates levied in Utah in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, cemetery districts, fire protection districts, flood control districts, hospital districts, library districts, mosquito abatement districts, park and recreation districts, public infrastructure districts, service areas, sewer districts, special service districts, water conservancy districts, and water districts.

E.46 Vermont

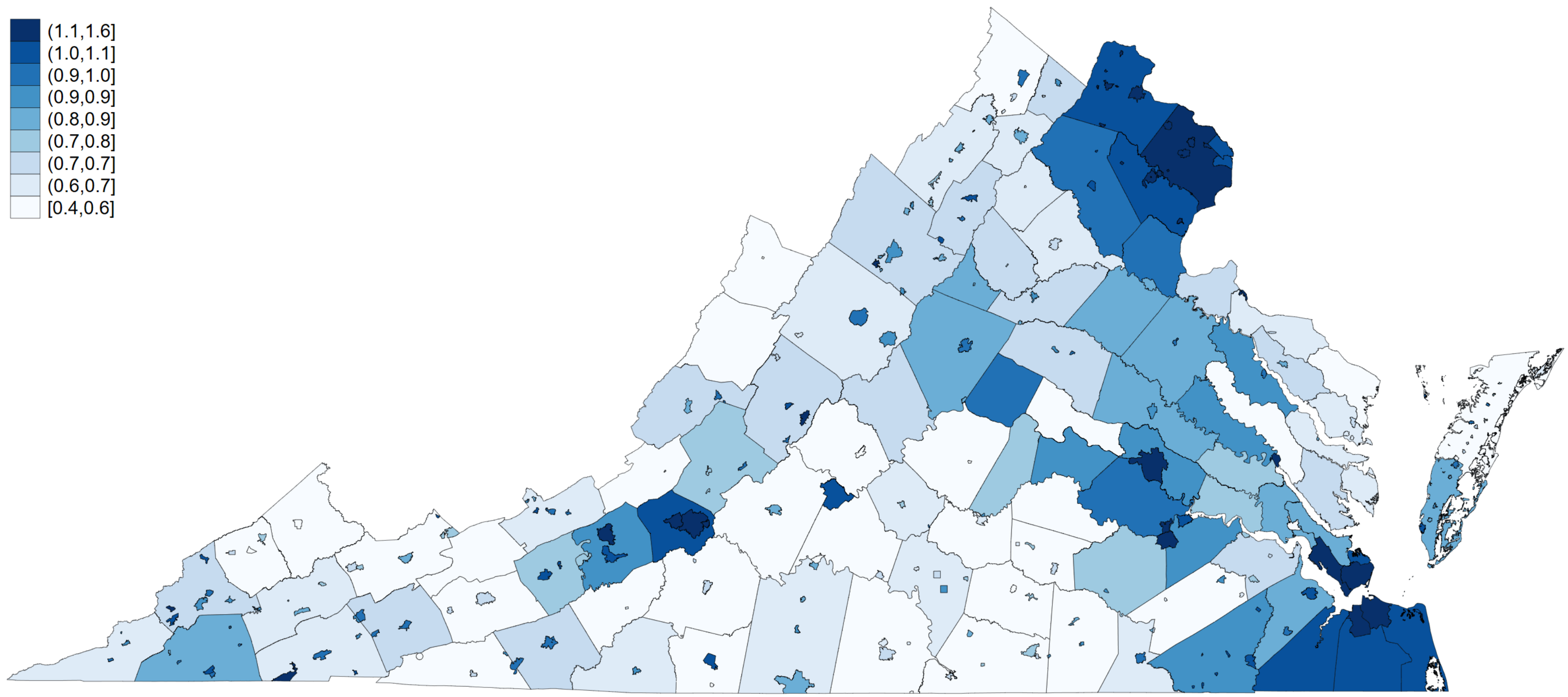
Figure E46: Property Tax Rates (pp) in Vermont in 2020



Notes: This map displays statutory homestead property tax rates levied in Vermont in 2020. Tax areas are implied by unique intersections of municipalities, downtown improvement districts, fire protection districts, police districts, and special service districts.

E.47 Virginia

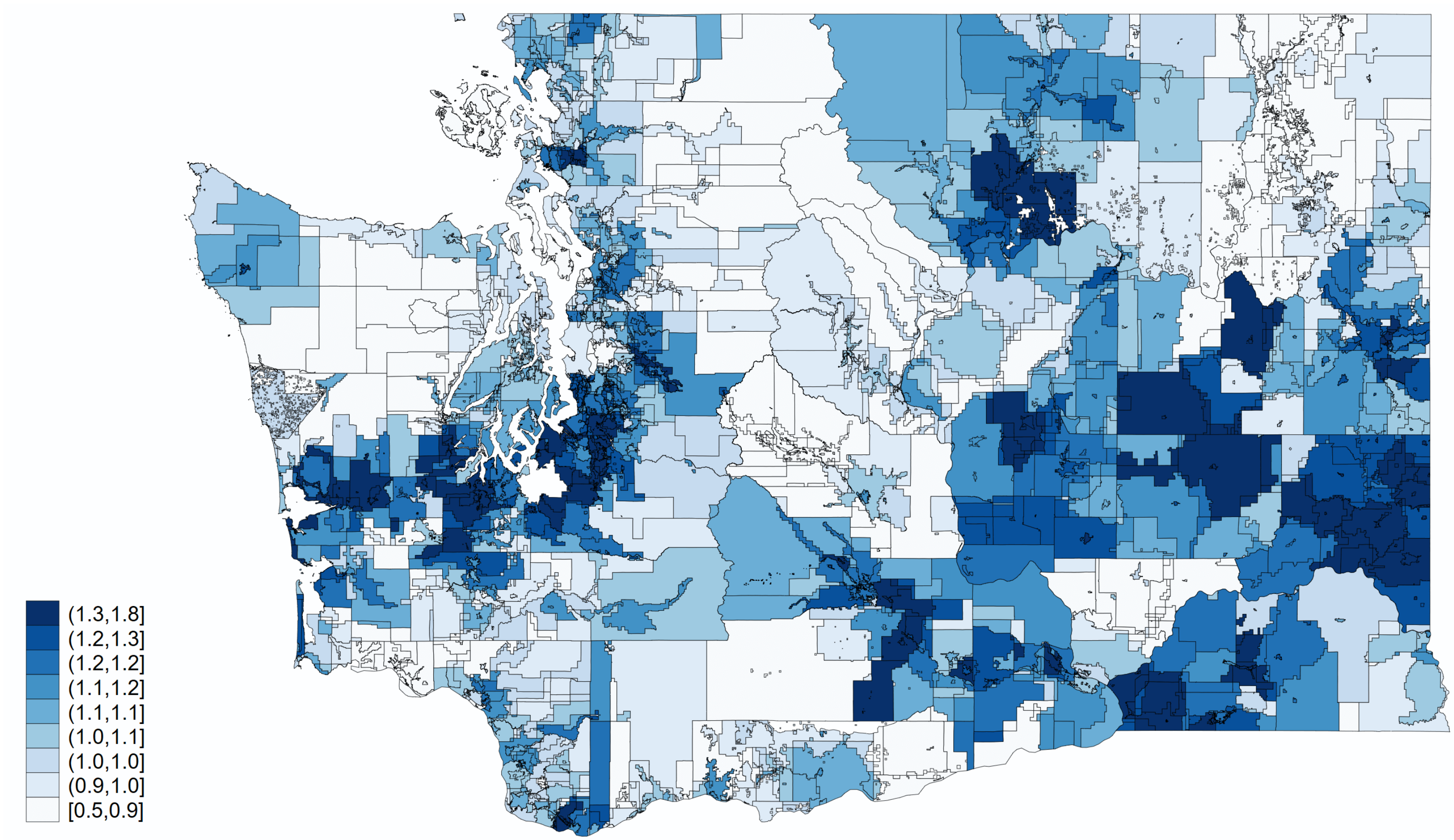
Figure E47: Property Tax Rates (pp) in Virginia in 2020



Notes: This map displays statutory property tax rates levied in Virginia in 2020. Tax areas are implied by unique intersections of counties and municipalities.

E.48 Washington

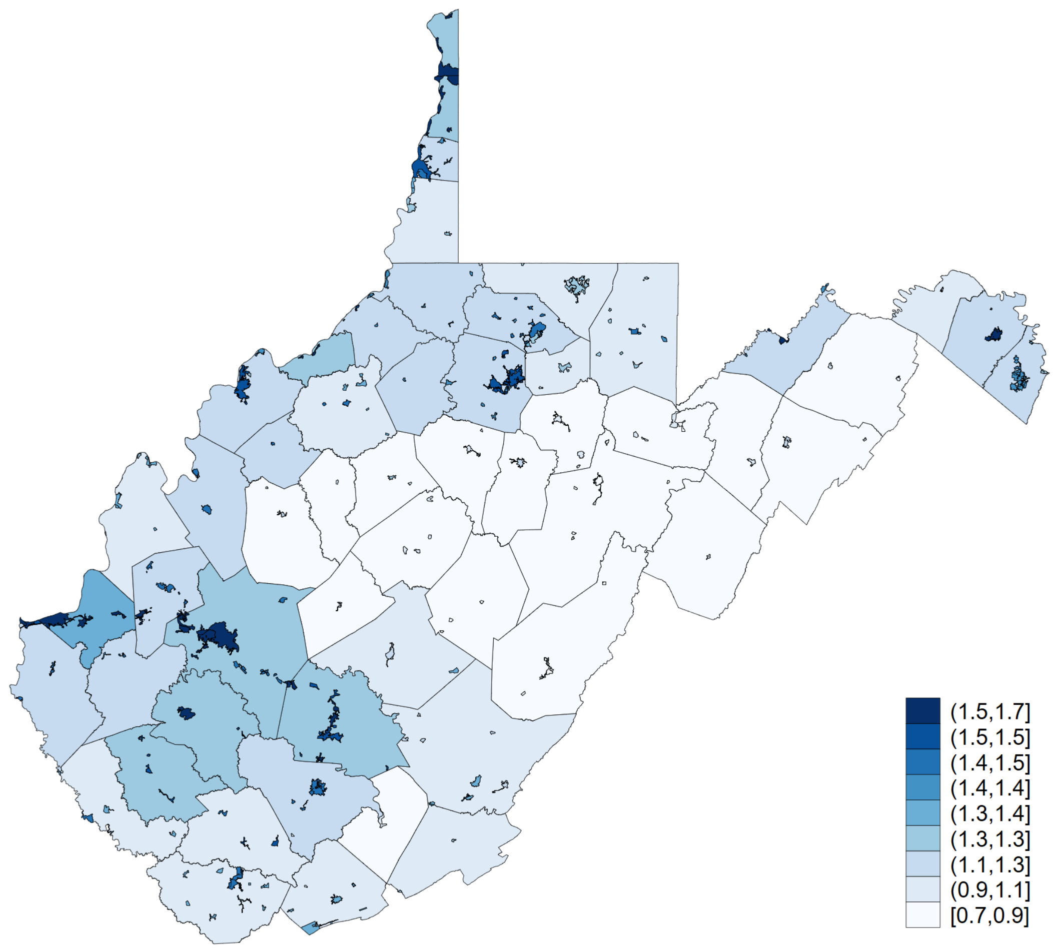
Figure E48: Property Tax Rates (pp) in Washington in 2020



Notes: This map displays statutory property tax rates levied in Washington in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, affordable housing districts, cemetery districts, emergency medical services districts, ferry districts, fire protection districts, flood control districts, hospital districts, library districts, metropolitan park districts, mosquito control districts, park and recreation districts, port districts, public utility districts, road districts, sewer districts, transportation districts, and water districts.

E.49 West Virginia

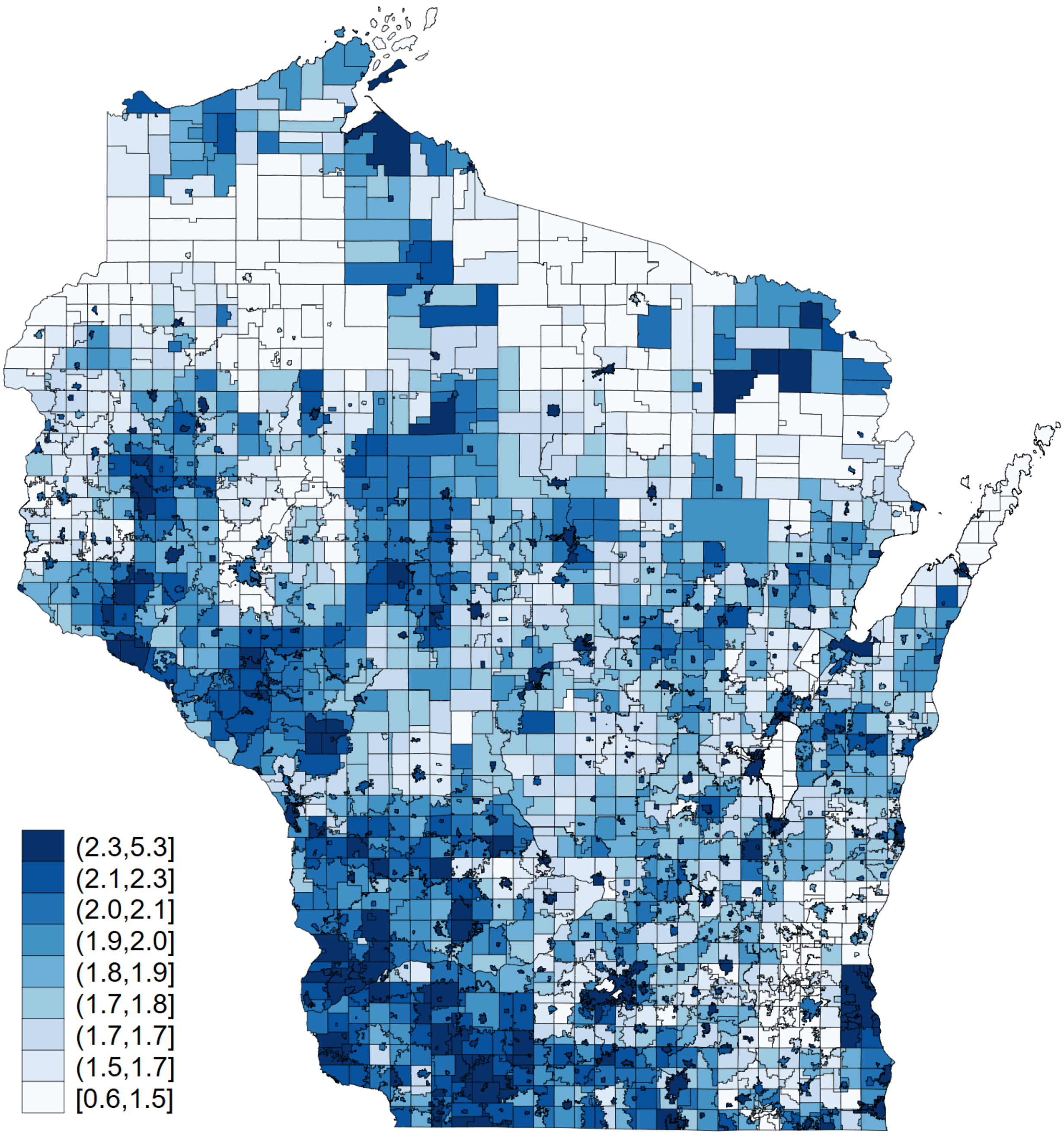
Figure E49: Property Tax Rates (pp) in West Virginia in 2020



NOTES: This map displays statutory property tax rates levied in West Virginia in 2020. Tax areas are implied by unique intersections of counties and municipalities.

E.50 Wisconsin

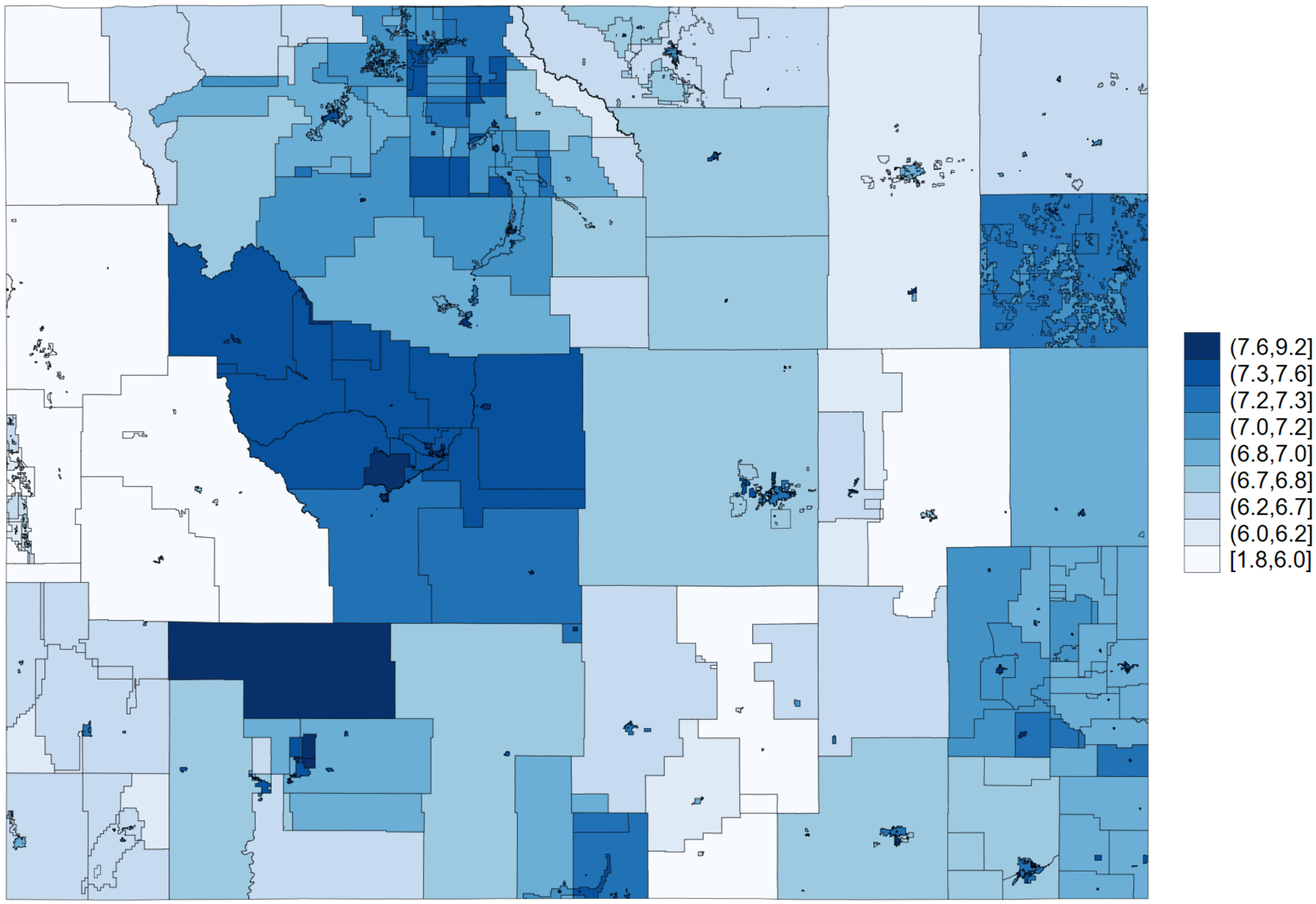
Figure E50: Property Tax Rates (pp) in Wisconsin in 2020



NOTES: This map displays statutory property tax rates levied in Wisconsin in 2020. Tax areas are implied by unique intersections of counties, municipalities, elementary school districts, high school districts, unified school districts, lake management districts, metro sewer districts, sanitary districts, and technical college districts.

E.51 Wyoming

Figure E51: Property Tax Rates (pp) in Wyoming in 2020



Notes: This map displays statutory property tax rates levied in Wyoming in 2020. Tax areas are implied by unique intersections of counties, municipalities, school districts, cemetery districts, community college districts, conservation districts, downtown development authorities, fire protection districts, hospital districts, improvement and service districts, museum districts, rural healthcare districts, senior citizen services districts, sewer districts, solid waste disposal districts, water conservancy districts, water districts, water and sewer districts, and weed and pest control districts.