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The Political Economy of School Finance Systems with Endogenous State and Local Tax Policies
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ABSTRACT

Beginning in the 1970's, many state courts declared the widespread inequality in education spending across schools to violate their state's constitution. Funding systems then emerged providing differing approaches to state and local support of education. We develop a theoretical framework and characterize outcomes under alternative systems. Our framework is distinctive in having voting over policies in both state and local elections. We also develop a calibrated computational model to compare equilibrium outcomes under the alternative school finance systems and to examine across state differences in expenditures. The model predicts that voters prefer systems with mixed state and local finance with designs mirroring those observed in practice.

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I Introduction

Provision of public education is arguably the most important function of state and local governments. While the federal government has some influence on state education policy through provision of a small share of funding mainly targeted to poor students (e.g., 8% of state expenditures in 2012-13[1]), the 10th Amendment of the U.S. Constitution de facto delegates responsibility to the states.[2] Public school finance policy varies across states and has varied over time. Roughly, school finance in the U.S. has evolved from primarily being determined at the community or district level to having states take steps to reduce funding inequities resulting from local finance, reforms driven significantly by state constitutional challenges beginning in the early 1970's. Figure 1 shows the long-term time trend in the shares of public educational expenditure financed by local, state, and federal government.[3] One can see the early dominance in local finance followed by an increasing state share until around the same in 1979-80, with usually slightly higher state finance share persisting thereafter. State policies include (nearly) pure state finance, state subsidies to all students with additional local finance, "foundation grant policies" that have the state dictate (usually) minimum "local effort," which means a minimum local property tax with subsidies to poorer communities, and state subsidies targeted to needy students in the form of categorical grants.[4] While variation and hybrid policies currently exist among the states, there has been convergence toward foundation grant policies. Jackson, Johnson, and Persico (2014) establish that foundation policies were utilized in 27 states by 1970, with the number increasing to 37 states by 2010. From her survey of school finance in the 50 states, Verstegean (2014) observes that 37 states report using a foundation system in 2010-11 and that if hybrids of foundation and systems that further equalize finance are counted, the number rises to 46 states. In spite of the convergence in policy structure, vast differences in levels of per student expenditure and in the share financed by the state exist. In 2020-21, expenditure per student ranged from $11,700 in Idaho to $32,200 in New York, with mean of $16,280.[5] The state

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[1] https://www2.ed.gov/about/overview/fed/role.html While varying a bit, this proportion of federal funding is typical, e.g., it was 8.2% in 2013-14. See also footnote 2.

[2] The U.S. Constitution makes no explicit reference to provision of education. Every state constitution contains a clause committing to provision of public education to its residents. The federal government provides limited funding mainly through Title I grants, which provide monies to districts with large numbers of low-income students, and through the Child Nutrition Act that provides monies for free or reduced-price lunches to sufficiently poor students. To obtain these supplements, schools must adhere to the Every Student Succeeds Act (2015) that requires states to develop school accountability standards. Other federal influence on schools derives from the 14th Amendment to the U.S. Constitution (Equal Protection Clause) and the Establishment Clause. The only federal element that plays a role in our model is the inclusion of some federal funding.

[3] Figure 1 is constructed from Table 201.10 at https://nces.ed.gov/programs/digest/d22/tables/dt22_201.10.asp .

[4] Another policy regime known as "power equalization" enacts transfers across districts to engineer effectively more equal local tax bases, and then lets districts choose their local taxes given these effective tax bases. Currently only two states have such a policy so we only analyze it in the appendix.

[5] Data are from the National Center for Education Statistics (https://nces.ed.gov/programs/coe/indicator/cmb/public-school-expenditure). Values are in constant 2022-23 dollars. New York is a bit of an outlier, but the second highest expenditure is in Vermont with $28,600 per student.

share ranged from .30 in Missouri to .88 in Vermont, with .46 mean (https://nces.ed.gov/programs/coe/indicator/cma/public-school-revenue).

Thus, expenditure in a student's public school depends on state, local, and federal finance policies, as well as tax levels and tax bases that vary with student residence. A student's peer group is also endogenous to residence. Moreover, a political process determines policies. Understanding the distribution of school expenditures and the demographics of their student bodies requires a rich general equilibrium model. Our first goal is to provide such a model to understand the impacts on educational quality and how it varies among diverse students under alternative state finance regimes with majority choice of state and local policy parameters. We derive general theoretical properties of current and historical regimes, including providing equilibrium existence conditions which can be problematic with majority choice.

We go on to investigate quantitative versions of the model with three goals. First, we examine a representative state to confirm existence in the several finance regimes studied and to compare alternative regime predictions about taxes, expenditures, and how they vary among students within the state. We then use this model to examine regime preference, with the finding that a majority prefer regimes that combine state and local finance consistent with the evolution of school finance in the U.S. regimes. Last, we calibrate the model for a number of states. We then examine how the model performs assuming a foundation regime with categorical grants. This is the most common regime and that we find to be majority preferred in our representative-state analysis. We show the model can predict observed differences in state expenditures, and we examine its performance in predicting the mix of state and local funding.

In our model, a state consists of a metropolitan area divided into districts and a rural area that makes up another district, each district characterized by a housing supply. Households vary in income and in preference for school quality. The populations of the rural area and metropolitan area are given. Households rent housing and sort among districts in the metropolitan area, anticipating equilibrium outcomes. Then all households vote for the state-policy taxation (in some regimes) and simultaneously vote in their district for local-policy taxation (in some regimes), with equilibrium having majority choice of each. District school quality is determined by per student expenditure and a peer-student measure linked to the strength of demand for quality of the student body. We believe the model captures crucial elements of school finance. The need for state and local finance, having heterogeneity of households, and sorting within urban areas does not require elaboration, with related literature discussed as we go on. Having a separate rural area (where school differentiation is more limited) can be motivated by the following parsimonious reduced-form regression that predicts per student public expenditure among U.S. states for the 2020-2021 school year.

$$\exp_s = \underset{(4474)}{-15,589} + \underset{(.0725)}{.200}\mu_{ys} + \underset{(.0716)}{.072}\sigma_{ys} + \underset{(6184)}{12,980}\,\text{Dem}_s + \underset{(4038)}{17,287}\,\text{RPop}_s; \tag{1}$$
$$N=50: R^2_{adj}=.5766;\ F=17.68;\ \text{std. err. in parens}$$

In (1), $\exp_s$ is per student expenditure in state s, (μ_{ys}, σ_{ys}) are the mean and standard deviation of household income in thousands for state s, Dem_s is the proportion voting Democratic in the presidential election of 2020, and RPop_s is the proportion of rural residents.[6] All variables but σ_{ys} are significant at the 5% level. The regression supports having a rural area in the model, and the Democratic variable supports the notion that tastes for public educational expenditures varies by state**,** which is an element of our model.

We now provide a bit more detail on the model and summarize findings and contributions. We examine canonical forms of all the aforementioned policies, which are enumerated in Column 1 of Table 1. We highlight that we model all of these as having majority choice of the relevant tax rates at both the state and district levels by the relevant electorates (when both have a role), with the relevant district electorates endogenous.[7] Consider, for example, the flat-grant policy regime with uniform state subsidies, add-on district finance, and an exogenously given federal tax rate. In this regime, statewide voting is over a state income tax, and local voting is over both a district property tax and income tax. After households have sorted and residences are established, all households in the state vote over an income tax to finance a uniform per student subsidy and, simultaneously, households in the urban and rural districts vote on a district property and income tax to supplement the state funding.[8] Then households consume, including experiencing school quality. We must resolve the local and statewide majority choice existence problem (Plott, 1967), keeping in mind a multidimensional type space and multiple tax instruments at the district level.[9] We specify a household utility function that satisfies single-crossing properties. We prove existence at the district level generally in all regimes and likewise confirm existence computationally at the state level for realistic parameters. The permissible policy elements differ across school finance regimes. For the most prevalent case of the foundation program, the state policy dictates a statewide property tax with proceeds shared uniformly or with a higher percentage going to poorer districts, and with additional district finance by district property and perhaps income tax if majority chosen locally.

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[6]The sources for variables in (1) are: $\exp_s$: National Center for Education Statistics at https://nces.ed.gov/programs/coe/indicator/cmb/public-school-expenditure;
μ_{ys} and σ_{ys} : mean and median state incomes from American Community Survey derived from https://data.census.gov/table?q=income&g=010XX00US$0400000&y=2020; Dem_s : Cook Political Report, at https://www.cookpolitical.com/2020-national-popular-vote-tracker; and
Rpop_s: World Population Review at https://worldpopulationreview.com/state-rankings/most-rural-states.

[7] We take a state's population as exogenous, i.e. do not permit moving among states.

[8] In fact, some states permit district income taxes while others do not. We examine both.

[9] Existence of majority choice equilibrium is a well known issue among public finance economists, whether due to non-single peaked preferences when the policy choice is single dimensional (see e.g. Atkinson and Stiglitz 1980, p. 303) or quite generally when the policy choice is multidimensional (Plott 1967).

We examine quantitatively for the representative state how the finance regimes compare regarding the levels and distributions of schooling expenditures and quality. We find a pure state regime has the lowest average per student expenditure, with the pure local regime the second lowest. Average school qualities in these two regimes are the opposite because of stratification and associated changes in district peer composition in the latter regime. The foundation and flat-grant regimes are reasonably similar in increasing average expenditure relative to the two just discussed policies, while both also increase expenditure and school quality in all districts relative to the pure local regime. The foundation and flat-grant policies both transfer monies to the central city, drawing in households that have stronger preference for school quality, and increasing the city's tax base and peer qualities. This has the effect of making the suburbs more elite, increasing their average peer quality and local add-on expenditures. The general equilibrium relocation effects then play a central role.

We stress the finding from the computational model that the majority preference is for regimes with mixed state and local finance. These regimes increase per student expenditure relative to pure local finance, substantially in poorer districts, but in the main analysis even in the rich districts. We do not find "leveling down." Leveling down occurs if expenditure in districts with high-demand households declines relative to expenditure increases in low-demand districts as the equalization policy effects transfers from the former to the latter. As noted, with centralization household relocation plays a role here in increasing tax bases in all urban districts. We also examine equilibria fixing locations at the baseline used for calibration, as if households are immobile in the shorter run. We continue to find a (weaker) majority preference for the centralized regimes, though these regimes are no longer preferred by rich households. Student expenditure in poorer districts increases as does average expenditure, but per student expenditure in the rich district hardly changes. This pattern of expenditure changes from centralization is consistent with the empirical evidence (Murray, Evans, and Schwab, 1998 and Jackson, Johnson, and Persico, 2016): Centralization significantly increases expenditure in poor areas with little effect in rich areas.

Following the analysis comparing regimes, we perform an across state analysis assuming the most common foundation regime in states for which a foundation-type regime is the best description. Using empirical counterparts, we calibrate differences in the states' urban and rural income distributions and in their relative urban and rural populations. Allowing tastes for educational quality to differ across states, we show the model can predict the empirical differences in per student expenditure. Thus, the model is very robust. We then examine the performance with regard to predicting empirical differences in the state share of finance. If we allow categorical funding, i.e., more state funding targeted to poorer districts, the model performs reasonably well in predicting state/local shares of funding.

Our paper analyzes majority choice of school finance policy parameters and policy regime. In fact, court-ordered reforms have been associated with the finance equalization movement in the U.S., which arguably runs counter to our analysis (see e.g. Table D.1 in Jackson, Johnson, and Persico, 2014). Several reasons for understanding majority choice in this context are as follows. For one, legislative reforms that are independent of court-ordered reforms have played a prominent role.[10] Second, court rejections of state-finance schemes generally leave it to the state legislature to implement reforms, where politics obviously plays a role. In a number of instances, the legislated reforms have been re-challenged. Third, majority preference for the elements and form of a reform would support persistence of the policy. Fourth, the convergence to similar regimes in the U.S. is remarkable, and potentially explained by what the electorate prefers. Finally, at a minimum, knowing what a majority would like is of interest in providing perspective.

Our paper relates to a large literature, briefly summarized in the next section. Here, we discuss the three papers most closely related in contrasting ways, these all seminal contributions to the study of school finance. Hoxby (2001) examines alternative school finance regimes, one focus being whether school finance equalization (SFE) policies that attempt to equalize per student expenditures relative to pure local finance induce leveling down. We do not find leveling down if moving to regimes that combine state and local finance as discussed, but do find leveling down relative to an income-based pure state finance policy, as Hoxby predicts. We relate our findings more thoroughly to Hoxby's later, which overall provide a nice complement. Another point of interest concerning Hoxby's paper is that she observes "an SFE may start out with mean state spending as its target, but the target will drift toward the *median* level of preferred spending in the state because the median voter is decisive (p. 1206)."[11] As we have already stressed a central contribution of our analysis is to examine school finance regimes with both state and district tax rates chosen by majority choice.[12]

In pioneering work, Nechyba (1996) develops a computable general equilibrium model of intergovernmental aid, applying it to the examination of several school finance regimes. Regimes Nechyba examines that have state financing as part of district educational expenditure are: (i) block grants to districts; (ii) regimes with state matching of local finance; and (iii) power equalization schemes, which have some equalization of district tax bases and state subsidies to finance local deficits. In all cases, majority choice of local property tax occurs. Thus, like us, Nechyba focuses on a general equilibrium with majority choice of local policy and interaction of state and local finance. Nechyba (2003) extends his model by introducing peer effects and private schools, studying state versus local public school finance, and a hybrid with exogenous state policy where state and local policies interact. In his analyses, Nechyba takes state educational policy as exogenous, and he takes the housing stock as fixed. Broadly, then, our objective is to build on his analysis by endogenizing state policy via majority rule while also incorporating both heterogeneity of household preferences with respect to quality of the local public good

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[10]Quoting from Jackson, Johnson, and Persico (2014): "First, even though most studies focus on court-mandated reforms, many states had legislative SRFs [state finance reforms] or substantive changes in how schools were funded that were not court mandated. Indeed, in 1996, while only 19 states had court-mandated reform, 31 states had some kind of legislative SFR, and 45 states had experienced some kind of change to school funding formula (p.7)."
[11] Note that Hoxby cites Silva and Sonstelie (1995) when making this point.
[12] Our analysis is theoretical/computational, while Hoxby estimates tax prices motivated by her modelling.

and housing markets with supply responsive to price. Households are homeowners in Nechyba, while we consider the simpler case of renters.

Fernandez and Rogerson (2003) examine school finance policies *with majority choice of state and local policy* in several regimes where both tiers of government can tax. Their framework permits an elegant theoretical and computational analysis of household preference among finance regimes. In their model, households differ by income and there are two goods, school quality, which is equated to per student expenditure (as in many models), and a numeraire. In cases with household sorting, it is "perfect"; each household optimizes as though in its own district. Thus, local majority choice in any district corresponds to individual optimization. Broadly, we build on their analysis by developing a framework with three goods (school quality, housing, and a numeraire); households that differ by preferences and income; states that enact a school finance regime and have scope for income taxation; and local jurisdictions that are finite, differ in size, and have scope for both local property and income taxation. While Fernandez and Rogerson are able to establish existence theoretically, we develop sufficient conditions that must, in some cases, be verified computationally.

In short, our contributions are the following: (i) We develop a positive theoretical model to analyze empirically relevant U.S. school finance regimes, unique with respect to inclusion of households that differ by income, taste-for-schooling, and urban or rural dwelling, with majority choice of state and local policy parameters by different electorates. (ii) We show a majority preference for finance regimes that combine state and local funding, detailing the general equilibrium effects that lead to widespread support for such policies. The most dominant regime we identify is a foundation regime that provides a higher percentage of funding to poorer districts. While such a regime is the best approximation to reality, we are the first to characterize it theoretically and examine it computationally. (iii) We apply the model to a number of states, demonstrating its robustness and power to predict policy differences.

Section II further discusses related literature. Section III presents the model for the case with flat state grants to districts financed by a state income tax. Section IV develops theoretical results for this regime. Section V examines the other regimes and extensions of the theoretical findings. Section VI provides the quantitative version of the model, differences in equilibrium properties among regimes, majority preference over regimes, and a comparative state analysis. Section VII examines modifications and extensions of the model and discusses key weaknesses. Section VIII concludes. Some technical analysis is in an online appendix.

II Literature Discussion

This paper relates to three large literatures, which we can only very selectively discuss here. These are the literatures on school finance, fiscal federalism, and multi-jurisdictional (Tiebout 1956) economies. The equilibrium among the urban school districts under several of the policy regimes in our model conforms to a "Tiebout equilibrium," so this paper relates to the expansive theoretical literature on

Tiebout-type economies with endogenous policy determination.[13] Much of this literature is focused on efficiency issues, while our main contributions are positive. Given state policy, we show existence of majority choice of local policies with both local income and property taxes. Thus, we confront the Plott (1967) existence problem. Limited positive research on multiple tax instruments exists, surely because of the latter problem, with a few exceptions. Bucovetsky (1991) provides sufficient restrictions on voters' utility function for existence of majority choice equilibrium in a single jurisdiction setting with multiple policy instruments. Henderson (1994) studies choice of tax instruments in a multi-jurisdictional setting with identical households, comparing voting equilibrium to developer equilibrium. The assumption of identical households resolves the existence problem among voters in the latter paper. Nechyba (1997) shows in a multi-jurisdictional model with mobile heterogeneous households that, with availability of both income and property taxes to finance public goods, only property taxation arises unless jurisdictions collude (or there is another centralized tier of government). Voting is over just the property tax, with community planners (or a central authority) setting income taxes. Our models differ in several ways, including our examination of majority choice in both tiers of government.[14] We resolve the existence problem using a (new) household utility function that we can map into a two-dimensional "composite public good space," and then use single crossing properties. We developed such an approach in Calabrese, Epple, and Romano (2015, 2023). A significant difference in the present paper is that we have both differences in household taste and income, while only income differences in the latter papers. Also, here we examine school finance regimes that vary in their structure, while our 2015 paper has only one tier of government and the 2023 paper examines redistribution in a fiscal federalism setting.[15]

Stratification arises in the urban area under most of the school finance regimes we examine. Such household sorting is at the heart of Tiebout-type equilibria. Westhoff (1977) is a seminal reference here. Gravel and Oddou (2014) provide general conditions for income sorting in Tiebout equilibria with exogenous public good levels and taxes. Household sorting in our model is by both taste and income. Epple and Platt (1998) develop such a structure (see also Schmidheiny, 2006; Kessler and Lulfesmann, 2005). Our model has peer effects that depend on both peer taste and income. Tiebout-type models with peer effects are developed in de Bartolome (1990), Benabou (1993,1996), Durlauf (1996), Nechyba (2000,2003), Epple and Romano (2003, 2015), and Calabrese, Epple, and Romano (2006, 2012).

[13] Important references in the development of this literature not discussed elsewhere in this paper are Ellickson (1971), Hamilton (1975), Wilson (1997), Wooders (1980), Wildasin (1980), Boadway (1982), Brueckner (2004), Zodrow (1984), Epple, Filimon, and Romer (1984), Epple and Romer (1991), and Wilson (1997). A strand of the literature concerns taxation of mobile capital, which is not an element of our model.
[14] Nechyba's model includes a national public good, which we do not have. Nechyba's consideration of state income taxation with local property taxation relates to the fiscal federalism literature discussed below.
[15] Other differences from our 2023 paper are inclusion of peer effects and having both a rural and urban area. As discussed further below, the 2023 paper regards direct redistribution, while the modelling of school finance regimes here regards theories of intergovernmental grants.

Another large literature on fiscal federalism concerns the vertical relationship between tiers of government. Much of the fiscal federalism literature is intended to explain decentralized (local) versus centralized (federal) provision of public goods, with Oates' (1972) Decentralization Theorem the centerpiece.[16] Within the fiscal federalism literature, papers most closely related to ours are those that examine equilibrium choice with two tiers of government. Part of this literature is focused on redistribution in light of local taxation incentives (see Boadway, Marchand, and Vigneault,1998, Gordon and Cullen, 2011, and Calabrese, Epple, and Romano, 2020). Our modelling of school finance regimes is more closely aligned with theories of intergovernmental grants. Bradford and Oates (1971) is the pioneering theoretical analysis of this setting, in particular examining equilibrium effects on local choices, including under local majority choice. Positive theory that endogenizes choice at both tiers of government is scarce. Exceptions are Dixit and Londregan (1998) and Bracco, Lockwood, Porcelli, and Redoano (2015), both of which develop models with upper level grants chosen to maximize election probability in the former and re-election in the latter. Knight (2002) models federal grants allocated by a legislature with one state controlling the agenda, followed by state majority choices of local supplements. Ours is, we believe, the only model including intergovernmental grants with majority choice by heterogenous populations at both tiers of government.

We discussed in the Introduction the three papers in the school finance literature to which our work is most closely related. Several papers discussed as part of the other literatures have school finance elements. Thus, we mention just a few more papers in the school finance literature. Regarding theoretical analysis of school finance, de Bartolome (1997) provides a model with two legislative committees that are each representative of the population, which by separate majority vote determine the parameters of a schedule that declines with district income of who receives any state aid and how much. Brunner and Sonstelie (2003) examine a model with centralized finance but with local voluntary supplementation (rather than majority choice), with emphasis on free rider issues at the local level.[17] Inman (1978) develops the first computational model of school finance regimes. Glomm and Ravikumar (1992) and Fernandez and Rogerson (1998) provide over-lapping generation dynamic models comparing decentralized school finance regimes to centralized school finance. Key papers that have estimated the effects of school finance reforms on the distribution of schooling expenditures are Murray, Evans, and

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[16] The thrust of the Theorem is that public good provision should be locally determined whenever no externalities outside the locality arise, this to facilitate local preference matching. See Oates (1999) for discussion and references and Epple and Nechyba (2004) for a wider survey and additional references. Some important papers are Gordon (1983), Johnson (1988), Wildasin (1991), Inman and Rubinfeld (1996), and Feldstein and Wrobel (1998). A second wave of research on centralization v. decentralization begins with the observation that centralized provision can vary across localities, thus expanding the inquiry about the relative advantage of decentralized provision. This branch of the literature shows alternative political regimes can explain whether centralization or decentralization is relatively efficient. See Lockwood (2006) for a survey and references.

[17] Epple and Romano (2003) provide a general model of public good provision with central provision by majority choice and with local voluntary provision.

Schwab (1998), Hoxby (2001), Card and Payne (2002), and Baicker and Gordon (2006). Estimation of the effects of school finance reform on student outcomes is conducted by Downes and Figlio (1997) and, again, by Hoxby (2001). Jackson, Johnson, and Persico (2016) exploit school finance reforms to study long-term effects of expenditure increases on student outcomes.

III Baseline Model

We develop the model initially for the policy regime with flat state grants to local jurisdictions. Such a regime dominated as state finance began to supplement local finance, though has significantly declined in relevance over the last 40 plus years. Having developed the model and theoretical results for this regime, we undertake modifications to examine others. We discuss in turn households, jurisdictions and policy, and the definition of equilibrium. Subsection D explains key modelling assumptions.

A. Households. Households vary in income y, and strength of preference for schooling, α. Households obtain utility U, from consumption of housing h, school quality Q, and a numeraire c: $U = U(h,c,Q;y,\alpha)$. School quality is a function of peer quality θ, and expenditure per student G: $Q = Q(\theta, G)$. Households reside in either urban or rural areas. We assume no movement between these areas, reflecting work or other preferences. Within urban areas, households can choose district of residence. The economy corresponds to a U.S. state and has a continuous and differentiable distribution of urban household types $F^u(y,\alpha)$ and a continuous distribution of rural types $F^r(y,\alpha)$. Each distribution has density everywhere positive on its respective support, S^u and S^r, both subsets of R_+^2. We normalize the state population to 1 and let n^u denote the number (proportion) of urban types and n^r the number (proportion) of rural types.

School quality is given by the Cobb-Douglas quality function $Q(\theta, G) = \theta^{\eta/\beta}G$. Household utility is additively separable in school quality and private goods. Each of the latter is a Cobb-Douglas form.[18] These private and public components are nested in a function that is a variable-elasticity generalization of a CES utility function. It is a generalization in two respects. First, the exponent on the private good component need not equal the exponent on the public good component. Second, the relative weight assigned by a household to education relative to private relative goods is determined by the product αy. This permits flexibility in specifying the relative weights on the public and private good components across the population via specification of the joint distribution of α and y.

(2) $$U(h,c,Q;y,\alpha) = c^\gamma h^\lambda + \alpha y Q^\beta = c^\gamma h^\lambda + \alpha y \theta^\eta G^\beta, \ \gamma > 0, \ \lambda > 0, \ \gamma + \lambda < 1, \ \eta > 0, \ \beta \in (0,1).$$

Weighting educational quality by αy instills the assumption that higher earning power is associated with higher value on education, while also having an element of taste for educational quality independent of earning power. We assume that $\gamma + \lambda < 1$. In the online appendix (part J), we establish that this implies

[18] The additive separability in the private goods and public good components simplifies finding a tractable indirect utility function employed in the voting analysis. Cobb-Douglas forms are not necessary, though homogeneity of the private goods component is, but the simple Cobb-Douglas forms are useful for parameterization.

normal demands for c, h, and Q, and that demand for Q increases with α. A higher preference (α) for educational quality might be due to having more children, a child (or children) with higher ability that benefits more from educational quality, local relatives with children (or more children or of higher ability), or just a stronger belief in the value of educational attainment.[19] Households might also be altruistic in their preference for local educational quality, e.g., those without children or without relatives with children. As noted, we assume a continuous distribution on (y,α), in particular without an atom at $\alpha = 0$. Thus, everyone places some value on locally provided education.

B. Jurisdictions and Policy. A state income tax m^s is determined by majority choice of all households, the proceeds of which finance a flat per student grant g^s for all households given state budget balance.

The rural area corresponds to its own local jurisdiction, and the urban area is subdivided into J local jurisdictions. We have a rural area to include a population that lacks significant public schooling options. That population is important to determine collective preferences over statewide policies. This is an innovation to this class of models. We frequently refer to the local jurisdictions as school districts or just districts. The districts in the urban area consist of the central city and J-1 suburbs. The district termed the central city is simply the poorest urban district, consistent with empirical evidence in the U.S. Each district is characterized by an exogenous housing supply function, $H_s^j(p_h^j)$, with $H_s^{j\prime} > 0$, where j = r indicates the rural area and j = 1,2,…,J indicates the particular urban district, and with p_h^j denoting the supplier (rental) price of a unit of housing. Housing markets are competitive with absentee housing owners for tractability; households are renters. We assume a constant housing supply elasticity to facilitate the analysis. Majority choice by residents of each district determines property tax t^j and local income tax m^j, with the proceeds used to finance the local per student schooling amount g^j given local budget balance. The consumer (tax-inclusive) price of housing is given by:

(3) $$p^j = (1+t^j)p_h^j.$$

To better match U.S. policy in the quantitative analysis, we include federal school funding as well, with federal income tax m^f and federal per student funding g^f. We treat these values as fixed and exogenous, satisfying a balanced budget condition specified below. Per student schooling expenditure in district j is then given by:

(4) $$G^j = g^f + g^s + g^j.$$

C. Equilibrium. Equilibrium unfolds in three stages. We outline these stages, and then provide detailed characterizations. In Stage 1, urban dwellers choose one of the J urban districts in which to reside. Rural dwellers have no choice here. In Stage 2, all state residents choose by majority vote the state income tax, taking as given local taxes and the exogenous federal policy. Simultaneously, residents of each school

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[19] One interpretation of (2) has $\alpha y^{\chi} Q^{\beta}$ denote achievement of the household's student, with y measuring parental human capital, α the student's ability, and with $\chi = 1$.

district choose by majority vote the local tax pair, taking as given the state income tax, other districts' tax pairs, and the exogenous federal policy. Thus, households vote simultaneously in two different "elections" with different electorates.[20] In Stage 3, consumption occurs and all government budgets balance. Households have fully rational expectations. We restrict attention to "Tiebout equilibrium" with all districts in the urban area differentiated (including endogenous stratification by income and the taste parameter) when such an equilibrium exists.[21]

We now describe equilibrium in more detail, working backwards from Stage 3. Entering Stage 3, each district has a fixed population with type distribution denoted $F^j(y,\alpha)$ and support S^j, $j \in \{(1,2,...,J) \cup r\}$. Henceforth, j takes on the latter values unless indicated otherwise; let J^+ denote the set of these values. Let n^j denote the number (state proportion) of households that reside in district j. The peer value in district j, θ^j, equals the mean of $\alpha y^{1-(\gamma+\lambda)}$ in j, and is determined prior to this stage. We delay explaining this peer measure until after Proposition 1, which provides insight into preferences. The state and federal income taxes (m^s,m^f), g^f, and local taxes (m^j,t^j) are also predetermined entering Stage 3. Let $M^j = m^f+m^s+m^j$ denote the aggregate income tax in local jurisdiction j. After-tax income is given by $y \cdot (1-M^j)$. Households choose private goods (h,c) to maximize utility (2) subject to the budget constraint (5), taking the housing price and Q^j as given:[22]

(5) $$c^j + p^j h^j = (1-M^j)y.$$

This yields the housing demand function:[23]

(6) $$h_d^j = \frac{\lambda}{\lambda+\gamma} \cdot \frac{(1-M^j)y}{(1+t^j)p_h^j}.$$

Housing markets clear:

(7) $$\int_{S^j} n^j h_d^j (p^j, y(1-M^j)) dF^j = H^s(p_h^j),$$

with (2) and (6) determining (p_h^j, p^j). Local budget balance determines g^j:

(8) $$g^j = t^j p_h^j \overline{H}^j + m^j \overline{y}^j \text{ where } \overline{H}^j \equiv \frac{\lambda}{\gamma+\lambda}\frac{(1-M^j)\overline{y}^j}{(1+t^j)p_h^j} \text{ and } \overline{y}^j \equiv \int_{S^j} y dF^j$$

Here $\overline{H}^j$ denotes average household housing consumption and $\overline{y}^j$ denotes mean income in district j.

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[20] The state-local majority choice equilibria we find are related to Shepsle's (1979) notion of a structure induced (political) equilibrium. A difference is that the local equilibrium in our model has multidimensional policy choice and we do not assume single peaked preferences with regard to the local policy choice.

[21] Equilibria with non-differentiated or "clone" urban districts can exist that we ignore when equilibrium with differentiated districts exist.

[22] Since households are atomistic, individual choices have no effect on G^j, hence Q^j is fixed from a household's perspective.

[23] Additive separability of the utility function in private goods and school quality implies that housing demand, h_d^j, is not affected by α or Q^j.

The state budget also balances in Stage 3, determining g^s:

(9) $g^s = m^s Y$

where Y is mean income in the state. In sum, (3) – (9) determine $(p_h^j, p^j, g^j, g^s, G^j)$ in Stage 3, as well as individual consumption levels. Uniqueness of equilibrium is easily established for any input vector.

Entering Stage 2, residences, and thus the peer measures, are set, as well as the federal policy values. In each district, households choose by majority vote (t^j, m^j) taking as given local taxes in other jurisdictions and the state income tax, and anticipating the implied Stage 3 continuation equilibrium values. The definition of majority choice is the standard one: A local tax pair is a majority choice equilibrium if no other policy pair is strictly preferred by a strict majority of voters. We show in the next section that majority choice equilibrium of local policies exists, a key result of the paper.[24] Note, too, that either tax could be disallowed or restricted as shown below. Simultaneously, all households choose by majority vote the state income tax, taking as given all local taxes and anticipating the implied Stage 3 continuation equilibrium values. We also provide conditions for existence of this element of equilibrium in the next section, which we later show to be satisfied in our computational model.

In Stage 1, urban dwellers choose their district to maximize their (correctly) anticipated utility. We show equilibrium will have households stratified by income and tastes in the urban area, meaning those with higher y and higher taste parameter will reside in districts with higher values of Q^j.

As noted, the model takes as exogenous the federal values, (m^f, g^f). In our computational model, we specify a federal government balanced budget condition, effectively assuming the state's income distribution has the same mean as that over all states. This is the same then as (9), but replacing the s superscript with f.

D. Modelling Assumptions. We have chosen elements of the model that we believe to be potentially important to understanding and quantifying school finance while also maintaining tractability. Here we elaborate on these choices, though not discussing assumptions that are obviously crucial (e.g., two tiers of government to study relevant school finance regimes). We discuss: (i) having taste and income heterogeneity; (ii) inclusion of a peer effect in determination of school quality; (iii) having an urban area and a rural area; (iv) housing supply with some elasticity; (v) how we model mobility; and (vi) assuming housing renters. We have already discussed in the Introduction reasons to examine majority choice of policy parameters and of policy itself.

Bayer, Ferreira, and McMillans' (2007) estimation leads them to write: "When we focus on heterogeneity in tastes for school quality, a household's willingness to pay increases with income, the presence of children, education, employment and age (pp. 626)." If we were to assume only income

[24] Our model investigates multiple taxes while making linearity assumptions on taxes. Bierbraurer, Boyer, and Peichl (2021) provide monotonicity conditions on nonlinear income tax schemes implying majority choice equilibrium exists in a single-jurisdiction model.

differences, stratification would imply no income mixing in urban districts, which has been rejected empirically (e.g., the latter and Epple and Sieg, 1999). The regression presented in (1) shows the proportion voting Democratic in a state is predictive. Finally, we show in our computational analysis in Section VI-C that taste differences can explain variation in expenditures among states. All this suggests a model with just income differences is unlikely to perform very well.

Peer effects in education have and continue to be extensively studied. Surveys of the vast and growing literature are Epple and Romano (2011), and Sacerdote (2011). The extent to which "good" student peers increases achievement and/or educational attainment has been a controversial topic. For our purposes, what matters is not whether a student's achievement is affected by peers but whether households demand "good" peers in their schools. *This is not controversial*. Compelling evidence is found in Rothstein (2006), Bayer, McMillan, and Ferreira (2007), Burgess, Greaves, Vignoles, and Wilson (2014), and Abdulkadiroglu, Pathak, Schellenberg, and Walters (2021).

Inclusion of a rural area, where there is more limited (none for simplicity) school quality differentiation, is an innovation in our model in the study of public finance. Those living outside of metropolitan areas make up a significant voting block and have different income distributions and tax bases than urban-area residents. Their implied different incentives call for their inclusion in examining statewide school finance, with the regression presented in (1) supporting that their role is relevant to understanding public educational finance in a state.

The evidence is that housing supplies are not inelastic (e.g., Green, Malpezzi, and Mayo, 2005), which is important both in analyzing property taxation (the main form of local taxation to fund education both empirically and as predicted by the model) and in residential choice. We do regard our analysis as long run.

Our main analysis has full mobility in the metropolitan area but with no moving between it and the rural area. Assuming *no* rather than limited movement between the urban and rural area is for tractability. Evidence of stronger attachment to rural communities is provided in Parker, Horowitz, Brown, Fry, Cohn, and Igielnik (2018). Regarding full mobility in the metropolitan area, again we regard the analysis as long run and also analyze to some extent shutting down mobility in Section VII. We find that mobility in the urban-area is important to obtain the strong political support for mixed finance systems. Related to how we have modeled mobility, one can question the timing of choices in our model. First, an appealing feature of our timing is that no one wants to move in the urban-area in equilibrium, this simply because districts are chosen correctly anticipating equilibrium outcomes. Does it matter that we have assumed consumption in the last stage, in particular of housing? Would it be different if housing were rented prior to voting? It would not if housing can be reoptimized after voting so we are assuming no friction here.

This brings us to what has bothered readers the most, our assumption of renting rather than owning housing. The central question is how much this distorts incentives to tax housing relative to income. We make the renting assumption for tractability, including simplifying examination of existence of majority choice at the state level. Our calibrated model below has the supply elasticity of housing equal to 3 and the demand elasticity equal to 1. Thus, general equilibrium effects aside, the rental housing price increase from a tax increase is three times the decrease in the supplier price at t = 0 and higher yet for t > 0 implying most incidence on renters. More completely, in a competitive housing market,

$\left|\frac{d[p_h(1+t)]/dt}{dp_h/dt}\right| = 3(1+t).$ Moreover, the model has no income tax distortion, which favors taxing income. Thus, bias from the renter assumption would not seem to be too serious (and might in fact favor income taxation). Having provided our defense, a superior model would include both renters and owners along with an income tax distortion. See Calabrese (2024) for such a model. We certainly acknowledge this simplification.

IV Theoretical Results: Baseline Model

Theoretical results for the baseline model are developed in this section.

A. Indirect Utility (Stage 3). We have already indicated that a unique equilibrium will exist in Stage 3 for any input vector. The backbone of the analysis is a simple indirect utility function over "composite public goods" implied by optimal household consumption in Stage 3. For simplicity, drop the district superscript. Using (2), (5), and (6), it is straightforward to write indirect utility as:

$$(10) \qquad v = y^{\lambda+\gamma}\kappa(1-M)^{\gamma+\lambda}[(1+t)p_h]^{-\lambda} + \alpha y Q^{\beta}, \; \kappa = \left(\frac{\gamma}{\gamma+\lambda}\right)^{\gamma}\left(\frac{\lambda}{\gamma+\lambda}\right)^{\lambda}$$

We can then more conveniently define indirect utility as in Proposition 1.

Proposition 1: Household type T has indirect utility:

$$(11) \qquad V = \Gamma + T\Omega \; \text{ where } \Gamma \equiv \kappa[1-M]^{\gamma+\lambda}[(1+t)p_h]^{-\lambda}, \; \Omega \equiv Q^{\beta}, \text{ and } T \equiv y^{1-(\gamma+\lambda)}\alpha.$$

Proof of Proposition 1: Factor $y^{\gamma+\lambda}$ out of v and use the definitions in (11) to get $v = y^{\gamma+\lambda}V$. Thus, any household can be characterized as maximizing V in any policy-related decisions. ■

The linearity of indirect utility in two "composite public goods" permits showing existence and stratification results in the model's equilibrium. We refer to the (Γ,Ω) as composite *public* goods because their arguments and thus values are public to a district. Higher T types have stronger relative preference for Ω, thus Q. Higher α implies higher T regardless of income, an unsurprising implication of direct utility (2). Higher income types also have higher T since $\gamma+\lambda<1$. The lower is $\gamma+\lambda$, the greater is this preference for school quality, and thus educational expenditure, relative to private goods (c and h). Higher income types are more averse to income taxation and property taxation, increases in either of the latter lowering Γ. Nevertheless, higher income types are more willing to trade Γ for Ω if $\gamma+\lambda$ is not too high due to their also having a stronger preference for Q. The empirical evidence on household sorting (e.g., Epple and Sieg, 1999) indicates $\gamma+\lambda<1$.

As discussed, evidence supports the notion that households prefer high quality peers regardless of whether this is because high-achieving peers enhance educational outcomes of other students or because parents want their children to go to school with high-achieving peers. Households might value district peers because students in their households have positive impacts on their own or relatives' children, whether academic or otherwise, and/or desire to share the district with households that are relatively stronger supporters of local schooling even if they have no children. In the context of our model, T is then the most natural measure of peer "quality". Thus, we use the mean of T in a district as our peer measure, which is denoted $\bar{T}$.

B. Majority Choice Equilibria (Stage 2). Consider first majority choice of local policies in a district. When voting over (t^j,m^j), residents of district j take as given residences, the state income tax rate, other districts' taxes, and the federal policy pair, and they anticipate the continuation equilibrium values in their district in Stage 3.[25] A voter's preferred policy is that which would maximize indirect utility in (11). Using equations (3) – (4) and (6) – (9), we can find the values that determine the continuation equilibrium (Γ,Ω) pair in j for any policy pair (t^j,m^j). We refer to the frontier of this set in the (Ω^j,Γ^j)-plane as the Local Government Budget Constraint (GBC^j), which we write as $\Gamma^j = \tilde{\Gamma}^j(\Omega^j)$. The preferred local policy of a type-T voter residing in district j solves:

(12) $\quad \text{Max}_{\Gamma^j,\Omega^j}\ \Gamma^j + T\Omega^j \text{ s.t. } \Gamma^j = \tilde{\Gamma}^j(\Omega^j).$

Proposition 2: Majority choice equilibrium of local policies in district j is the preferred choice of the median type, T^j_{med}, among those residing in j given any set of resident households, state tax, local taxes in other districts, and federal policy. Residents with higher (lower) value of T prefer policy implying higher (lower) G^j.

Proof of Proposition 2: The proof applies a standard single-crossing argument, detailed in the online appendix. The key to the proof is that indifference curves in the (Ω^j,Γ^j) become steeper as T increases; higher T types will trade off more Γ for an increase in Ω than will lower T types.

It bears emphasis that Proposition 2 relies only on the single-crossing property of the indirect utility function, in particular, GBC^j is unrestricted.[26] In turn, Proposition 2 holds under *any* local tax restrictions that might be imposed:

Corollary 1: Proposition 2 applies with any restrictions on the local income and/or property tax.

Next consider majority choice of the state income tax. The electorate corresponds to all households in the state. The majority choice problem shares some features with local majority choice of policy, but the choice sets differ among districts, implying stronger conditions are needed to guarantee

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[25] In the baseline model, tax policies in other districts are irrelevant, but this is not true under some policies analyzed below.

[26] Formally, GBC^j must be a compact set.

existence. When voting over m^s, households take as given residences, local tax rates, and the federal policy pair, and they anticipate the continuation equilibrium values in their district in Stage 3. Again, a voter's preferred policy is that which would maximize indirect utility in (11). Consider a voter residing in district j. Again, using equations (3) – (4) and (6) – (9), we can find the values that determine the continuation equilibrium (Γ,Ω) pair in j for any m^s. We refer to the frontier of this choice set as the state government budget set for j, denoted GBC_s^j. This frontier is *not* the same as the GBC^j, because m^s varies along GBC_s^j with (t^j,m^j) held constant at their equilibrium values. Because households in all districts vote and GBC_s^j varies among districts, weak assumptions about GBC_s^j are needed to prove existence. Proposition 3 provides sufficient conditions for existence. We show that these properties hold for the realistic parameterizations in our computational analysis.

Proposition 3: Concavity of GBC_s^j along with m^s increasing moving down GBC_s^j in every district $j\in J^+$, is sufficient for existence of majority choice equilibrium of the state income tax. In equilibrium, if anyone in a district prefers a higher (lower) state income tax, then all types with higher (lower) T also prefer a higher (lower) state income tax.

Proof of Proposition 3: Using the linearity of V in the (Ω^j,Γ^j) – plane, the assumptions on the $GBC_s^j{}'s$ imply single-peaked preferences of all households over m^s. Existence then follows by the Median Voter Theorem. The within district preference for a higher (lower) state income tax of higher (lower) T-types follows by the increasing steepness of indifference curves as T rises. ■

Remarks on Proposition 3:

1. The within district preference of higher-T types for a higher state income tax does *not* imply all households will be ordered by T in finding majority choice equilibrium. The median T-type in the state will not generally be the pivotal voter.[27] We will see that households in richer jurisdictions will tend to favor a lower state income tax in spite of being relatively high T types because their local choices will imply higher school quality. However, knowing the character of within jurisdiction preferences is useful to find equilibrium and is interesting in its own right.

2. One set of sufficient conditions for the properties of the $GBC_s^j{}'s$ in Proposition 3 are i) infinitely elastic housing supply and ii) local tax losses caused by decreased housing consumption from increasing the state income tax do not outweigh increased funding from the state tax increase. The housing supply assumption is unrealistic, but these sufficient conditions clarify that housing demand effects from income taxation complicate showing concavity. The computational analysis that follows demonstrates existence for realistic parameterization.

3. Concavity of the $GBC_s^j{}'s$ is sufficient, but not necessary, for existence.

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[27] The median type in the application of the Median Voter Theorem in the Proof of Proposition 3 is the household with median preferred m^s taking account of T and the district in which the voter lives.

C. Household Sorting (Stage 1). We focus on equilibria with differentiated urban districts. Rural households have no choice in this stage. Urban households anticipate equilibrium values when they decide in which district to live; thus they anticipate the composite public good values (Γ^j,Ω^j), j=1,…,J. They choose a district that maximizes indirect utility. Assume all districts are occupied and number the urban districts such that $\Omega^J>\Omega^{J-1}>\ldots>\Omega^1$. Proposition 4 summarizes properties most relevant to Stage 3.

Proposition 4: (i) Equilibrium has descending bundles: $\Gamma^J < \Gamma^{J-1} < \ldots < \Gamma^1$. (ii) A type T^j, j = 1,2,…,J-1 exists that is indifferent between living in districts j and j+1. All types with $T \in (T^j, T^{j+1})$ strictly prefer living in district j+1, those with $T < T^1$ strictly prefer to live in district 1, and those with $T > T^{J-1}$ strictly prefer to live in district J. (iii) Income and taste parameter stratification arise, meaning respectively that for fixed α (y), choice of district number j (and thus Q) is weakly increasing in y (α).

Proof of Proposition 4: (i) Given $\Omega^j > \Omega^{j-1}$, no one would live in district j-1 if $\Gamma^{j-1} \le \Gamma^j$, a contradiction. (ii) Indifference curves steepen as T increases, implying the sorting results in (ii). The existence of the indifferent T^j types follows from continuity of the implied distribution of T. (iii) The income and taste-parameter stratification results follow from (ii) and that $T = y^{1-(\gamma+\lambda)}\alpha$.■

The sorting results are very intuitive. Higher T types, who correspond to households with higher income and/or taste for education, choose to live in districts that are (correctly) anticipated to have higher Q in spite of higher taxes and/or higher housing price.

D. Analysis of Local Tax Incentives and Generalized Tax Prices. We allow local taxation to consist of a mixture of income and property taxation. In this subsection, we examine the incentives determining this mix of local taxes and introduce a notion of generalized tax prices.

Refer to indirect utility in (11) and consider the incentives to choose local taxes. We drop the superscript j for the district in this subsection. Note that p_h can be written as a function of (t,m), p_h determined after taxation, where m^s and m^f are held constant in this analysis since determined separately and simultaneously in the case of m^s and exogenously in the case of m^f. Then Γ is a function of the local taxes. Ω is not a function of taxes, other than through G, keeping in mind $\overline{T}$ is fixed when households vote on taxes. These observations imply that given G, all households in a district prefer the same local tax pair, i.e., that which maximizes Γ. Households differ in their preferences over G. Of course, the collectively preferred tax pair will vary as G changes.

We can use a generalized tax price to understand preferences for the local tax mix. Define a generalized tax price as the ratio of the *negative* of $d\Gamma/dtax$ to dG/dtax. This gives the "price" increase, measured in terms of the composite good Γ, necessary to increase G. If $-\frac{d\Gamma/dm}{dG/dm} > (<) -\frac{d\Gamma/dt}{dG/dt}$, then increasing the local property (income) tax is preferred to increase G. This governs movement toward the local GBC from inside it, as well as along it, though the focus here is on the former. If both t and m are positive in an equilibrium, these tax prices must be equal. Otherwise, substituting the tax with lower generalized tax price while maintaining G would be unanimously preferred.[28]

Let ε_s^H denote the housing supply elasticity. After some manipulation, one obtains:[29]

$$(13) \qquad -\frac{d\Gamma / dm}{dG / dm} > (<)(=) -\frac{d\Gamma / dt}{dG / dt} \quad \text{as} \quad 1 > (<)(=)\ t\varepsilon_s^H .$$

From (13), one obtains the following results:

<u>Proposition 5</u>:

(i) If any local income taxation arises, then property taxation arises.

(ii) If the preferred property tax without local income taxation is no higher than $1/\varepsilon_S^H$, then, allowing both taxes, this is the chosen property tax and no local income taxation arises.

(iii) If the preferred property tax without local income taxation is higher than $1/\varepsilon_S^H$, then the maximum chosen local property tax when income taxation is permitted is $1/\varepsilon_S^H$ and any remaining g is financed by a local income tax. Thus, allowing income taxation, the maximum local property tax that arises in an equilibrium is $1/\varepsilon_S^H$.

<u>Proof of Proposition 5</u>: Using (13), these results all follow from the fact that substituting one local tax for the other is preferred whenever the first has a lower tax price. ■

<u>Remarks on Proposition 5</u>:

1. The result shows a preference for property taxation at least up to a level $1/\varepsilon_S^H$. The model is one with renters, so there is an incentive to tax property due to some incidence on the absentee owners. A higher housing supply elasticity increases incidence on renters, reducing the maximum property tax that might be adopted. Whether the property tax rises to this level depends on the amount of schooling expenditure that is preferred by the pivotal voter. If $t = 1/\varepsilon_S^H$, is not enough to finance the pivotal voter's preferred g, then additional expenditure is financed by an income tax. Along this range of the local GBC, only m is increasing as g and G increases because of the lower income tax price. Note that preferred local taxes can have $t^j = m^j = 0$ if the G financed by the state and federal income taxes is high enough from the district pivotal voter's perspective. A sufficiently low ε_S^H will, however, imply at least some local finance.

2. Note that the level of M, and thus m, does not enter (13) or any of the results. This is because, perhaps surprisingly, the level of income taxes impacts each of the tax prices proportionally, and thus does not change the relative preference between them. The key reason for this proportionality is that housing expenditure is proportional to income, so the housing tax base is proportional to district income.

[28] We could alternatively work with the negative of the ratios of $d\Gamma / dtax$ to $dQ / dtax$, since these are both in the same proportion to our definition of the tax price. We prefer our definition because it is the closest (useful) analogue to a standard tax price in public finance. The results we obtain here are the same using either approach.

[29] Detailed derivation is in Part B of the online appendix.

Next, consider the generalized tax price in a district of the state income tax. This entails comparison of the expressions for $\frac{d\Gamma / dm^j}{dG / dm^j}$ and $\frac{d\Gamma / dm^s}{dG / dm^s}$. As shown in the appendix, this yields the following result where, recall that Y is mean state income and $\overline{y}^j$ is mean district income.

Proposition 6: The local-income-tax tax-price is higher than (lower than) (the same as) the state-income-tax tax-price whenever Y > (<) (=) $\overline{y}^j$.

Of course, this implies that poorer (richer) districts prefer a state (local) income tax to finance education. Households that prefer state income taxation to local income taxation might still prefer a local property tax, i.e., if its tax price is low enough. Also, Proposition 6 does not prove that richer (poorer) districts will (not) have a local income tax because the preference of the state pivotal voter will generally differ from that of local pivotal voters.

V Alternative Policy Regimes

A variety of education funding policies currently exist among the 50 states and have existed in the past. We investigate and compare the most empirically relevant cases, including the most important regimes from the past.[30] The baseline model is immediately adapted to examine the next two cases, which we then discuss first. In all the regimes, Proposition 1 continues to apply.

1. Pure Local Finance. Such a funding regime was approximated in the U.S. until state finance gradually began to play a role beginning in the mid-20th century. This regime imposes $m^s = 0$, implying of course that $g^s = 0$.[31] Propositions 1,2, 4, and 5 continue to apply, with Propositions 3 and 6 no longer relevant.

2. Pure State Finance. While only employed in Hawaii, we think this simple regime is of interest for comparison. This regime assumes no local districts, with then J = 1 and no local funding in either the urban or rural areas. State school finance is exclusively determined by majority choice of the state income tax, which can be supplemented by federal government funding. Propositions 2, 4, and 6 are irrelevant. No differentiation or sorting arises.[32] Proposition 3 applies with two areas, the urban and rural areas, with each area having t, m, and local g equal to 0.

3. Foundation Grants. As discussed in the Introduction, foundation grant programs have become dominant among the states. In these programs, the state guarantees a minimum per student funding level, while requiring a local contribution. Quoting Skinner (2019), "A typical Foundation Program includes a required local effort [i.e., required minimum local tax], state equalization, and leeway funds [local finance]. … Foundation Programs vary in their provision regarding local tax rates. In most states … a

[30] As noted above, the case of district power equalization is relegated to the appendix.

[31] This could also have $m^f = g^f = 0$, but we assume the same (m^f, g^f) when we compare equilibria among regimes.

[32] An alternative specification of pure state finance would have the urban area divided into school catchment areas with sorting and differences in school quality arising from peer effects. Epple and Romano (2003) and Avery and Pathak (2021) develop such models. We chose to examine a case with uniform school quality in the urban area, as would arise with pure state finance and frictionless public school choice, though could consider the alternative.

minimum [property tax] rate [is required and local education authorities] might be allowed to raise local taxes beyond the required level." Any additional revenues from local taxation, above the dictated minimum property tax, supplement local educational expenditure, these being the "leeway funds."

Along the lines of Hoxby (2001), we specify a simplified model of the typical foundation program as follows. There is no state income tax. State policy is a minimum required local property tax, t^s. State government budget balance determines the foundation grant g^s:

$$(14) \qquad \sum_{j \in J^+} (g^s - t^s p_h^j \bar{H}^j) n^j = 0.$$

Each district pays into a state fund $t^s p_h^j \bar{H}^j n^j$, divided equally among all students in the state. We assume "leeway" (local) funding is permitted, so local supplemental educational expenditure per student satisfies:

$$(15) \qquad g^j = t^j p_h^j \bar{H}^j + m^j \bar{y}^j.$$

Thus, the aggregate property tax rate in district j is given by $t^s + t^j$, and gross housing price by $p^j = (1 + t^s + t^j) p_h^j$.[33] Total per student district expenditure is given by (4).

Propositions 1 (indirect utility) and 4 (stratification) continue to apply as stated. Proposition 2, regarding local majority choice of (t^j, m^j), applies replacing "for any state income tax" with "for any state foundation property tax."

Showing majority choice equilibrium for the state foundation policy is also analogous to the baseline model, though the GBC relevant to state policy is a bit more complex due to housing market effects of changing t^s. Details are provided in the appendix.

As in the flat-grant case above, we also examine household incentives to choose between the two local taxes. Under the foundation regime, one obtains:

$$(16) \qquad -\frac{d\Gamma / dm}{dG / dm} > (<)(=) -\frac{d\Gamma / dt}{dG / dt} \quad \text{as} \quad 1 > (<)(=)\ t\varepsilon_S^H + t^s[\varepsilon_S^H - (1-n)(1+\varepsilon_S^H)].$$

We interpret this in comparison to the incentives to tax locally in the baseline case above of flat grants with state income taxation. First, note that (16) is the same as (13) if $t^s = 0$. In this boundary case of a foundation regime, Proposition 5 would apply here as well. In Proposition 5, we identified a "maximum" property tax level equal to $1/\varepsilon_S^H$. By solving the case of equality of (16) for t, we find the analogous maximum (with obvious notation):

$$(17) \qquad t_{max} = \frac{1}{\varepsilon_S^H} + t^s \left[(1-n) \frac{1+\varepsilon_S^H}{\varepsilon_S^H} - 1 \right].$$

Recall that n is district population, measured as the proportion of the economy (n < 1). Assume for the moment that t_{max} is positive, a sufficient condition being that districts are not too large $n < \frac{1}{1+\varepsilon_S^H}$ Proposition 5 carries over with t_{max} replacing $1/\varepsilon_S^H$ in parts (ii) and (iii). For large n, specifically

[33] Any additional property tax to supplement the foundation grant must, of course, be non-negative.

$n > \frac{1}{1+\varepsilon_S^H}$, and large enough t^s, t_{max} in (17) is negative. This would imply any local taxation beyond the required t^s would be income taxation.

Under the foundation policy, an externality exists in the incentive to tax property on top of the foundation tax. Rewrite (17) as: $t_{max} + t^s = \frac{1}{\varepsilon_S^H} + t^s(1-n)\frac{1+\varepsilon_S^H}{\varepsilon_S^H}$. Thus the district's maximum aggregate property tax that could be optimal exceeds that that without a foundation tax by the second term on the RHS of the latter expression. This term measures the externality. The cost of taxing property is reduced as lost revenues from a lower p_h are partially shared by spill over to other districts. The extent of such spill over increases with t^s, decreases with district size, and is inversely related to the elasticity of local housing supply.[34] We show this externality can have substantial effect in the computational analysis.

In reality, the subsidization to districts with lower property tax bases in foundation policies is drawn from general state funds, thus with state finance by other taxes than the minimum required property tax in the model. Modelling such a policy would expand the dimension of state parameters, presenting additional existence challenges, which we leave for future research.[35]

4. Foundation System with Categorical Funding. School finance regimes have for some time almost always entailed some elements that help needy students beyond the pure forms we have modelled, including along with foundation regimes. Using data provided at https://edbuild.org/content/category/tools, we determine that currently 45 states provide higher state funds for education to low-income students.[36] Amounts vary substantially across states. From Chingos and Blagg (2017), Figure 3 (for 2013-14), for example, poverty students in New Jersey receive about $5,000 more in state funding than non-poverty students, while around $2,000 in Pennsylvania and Rhode Island, and around zero in six states. We generalize the foundation regime to permit a higher proportion of state funds to go to more needy students, specifically the extra funding provided to the poorer districts (as in most state programs), which we generally find computationally to be the central city and rural area. Equation (14) from the foundation model above continues to apply: $\sum_{j \in J^+}(g^s - t^s p_h^j \bar{H}^j)n^j = 0,$ where t^s is the required majority-chosen foundation tax, but now interpret g^s as the *average* per student state subsidy.

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[34] The externality is akin to the vertical externality discussed in Boadway, Marchand, and Vigneaulty (1998) and Gordon and Cullen (2012) associated with local income taxation in a federation when the federal government also taxes income and there is a labor supply distortion. We have assumed no labor supply distortion from income taxation for tractability.

[35] A more realistic specification would have a state policy with a minimum required local property tax and a minimum per student expenditure, with districts that fail to finance the latter minimum receiving supplemental state funding perhaps financed by a state income tax. Additional local taxation would follow the same model as we have, this assuming leeway funds are permitted. This would imply two dimensions of the state policy, with another (major) existence challenge for majority choice.

[36]Only Alaska, Florida, Georgia, Idaho, and S. Dakota do not consider poverty in their state allocation, though Florida, for example, identifies and provides extra funding for at-risk students. Also, as discussed in the text, some programs provide only small amount of extra funding.

Let n^p be the population of the set of poor districts J^p, n^R the population of the set of rich districts J^R, and g^{poor} and g^{rich} be the per student subsidy from state or foundation funds in poor and rich districts. Replacing (4), the equation for aggregate district expenditure, is:

$$G^j = g^f + g^{poor} + g^j,\ j \in J^p;\ G^j = g^f + g^{rich} + g^j,\ j \in J^R$$

$$(18) \qquad n^p g^{poor} + n^R g^{rich} = g^s$$

$$g^{poor} = (1+\phi)g^s,\ \ \phi \in [0, \frac{1-n^p}{n^p}].$$

The value of ϕ parameterizes the program, with $\phi = 0$ corresponding to the foundation program above, having the same per student state subsidy to every district. The upper bound value of ϕ has all foundation monies go to the poor districts. A higher ϕ would take educational expenditure from the richer districts to give to the poorer districts, which we do not allow. All the other equations are the same as in the foundation system with $\phi = 0$. The state vote is again over t^s, determining g^s, with ϕ exogenous for now. Another way to characterize ϕ is to use (18) to write $\frac{g^{poor}n^p}{g^s} = (1+\phi)n^p$, which is the proportion of the state budget going to poor districts.

We highlight this regime because: (i) it is the most empirically relevant regime and yet has not been theoretically characterized; (ii) we will show it is majority preferred among regimes in our representative state analysis; and (iii) we apply it in the across state analysis.

VI Quantitative Model

A. Representative State Calibration. We develop a quantitative version of the model for several reasons. First, we confirm existence for all of the regimes we examine. Second, we examine the comparative predictions of the model regarding taxes, school qualities, and district choice; and we conduct welfare analysis. We also examine collective preferences among the regimes. We find that public preference is for choice of regimes that combine state and local provision of education. In addition, we examine how the model performs in an across state analysis. We take the calibration seriously in seeking to create a realistic computational model that incorporates available evidence.

We must calibrate the urban and rural type distributions and populations, the number of districts in the urban area, housing supply functions, the parameters of the utility function, and the federal income tax rate. We also account for the number of school-aged children per household. Calibration is to various empirical values for the academic year 2010-11, combining direct calibration of parameters when feasible and to model predicted variables otherwise. In the latter case, we use the foundation equilibrium values because it is most common empirically. Our strategy is to first calibrate to a "representative state" using average U.S. values in the comparative regime analysis. Then we examine across state differences in subsection B.3, holding constant a subset of calibrated values from the baseline analysis while varying key state characteristics (e.g., income distribution parameters) to capture differences in states. Note that our representative state is approximated well by Idaho, Wisconsin, Kansas, Indiana, and Michigan with regard to the mean state and rural incomes and the proportion of the rural population.

Both the urban and rural income distributions are assumed to be lognormal. The urban distribution is calibrated to match the 2010 U.S. Census values for mean and median metropolitan area household income ($67,392 and $49,276 respectively, Table H-6[37]), implying $\ln y \sim N(10.805, 0.791)$ there. The rural area income distribution is adjusted so that the relative median incomes in the urban and rural areas and their relative poverty rates are as reported in Bishaw and Posey (2016).[38] This implies the rural household income distribution is given by $\ln y \sim N(10.769, 0.667)$. Thus, the rural area is poorer, e.g., with household mean income of $59,364. We must also specify the relative urban and rural populations, calibrating the rural population to 29% of the state population.[39]

The taste distribution is also assumed to be lognormal, the same in both the urban and rural areas. The distribution is calibrated following Calabrese, Epple, and Romano (2012), specifically with $\ln\alpha \sim N(-2.364, 0.00991)$ and with α and y uncorrelated. Their calibration strategy was to approximate their (Tiebout-type) model prediction of the ratio of across district income variation to total income variation to data from Boston, specifically a ratio of .25. In the foundation version of the present model, this calibration predicts a somewhat higher ratio of .47. Another perspective is that the calibration implies the ratio of the variance of $\ln \alpha$ to $\ln T$ of .40, or that variation in the taste parameter explains 40% of variation in preference for educational quality with the rest explained by income variation.

To calibrate district housing supply functions, we assume price-taking housing producers combine a district's given developable land and perfectly elastically supplied non-land factors to produce housing according to a constant-returns-to-scale Cobb-Douglas production function. Combes, Duranton, and Gobillon (2021) provide evidence that this production function provides a first-order approximation to housing production. Under these assumptions, a district's housing supply is given by a constant elasticity supply function (see part E of the online appendix):

$$(19) \qquad H_s^j(p_h^j) = L^j (p_h^j)^{\frac{1-\mu}{\mu}} \left(\frac{1-\mu}{p_w}\right)^{\frac{1-\mu}{\mu}}, \ \varepsilon_H = \frac{1-\mu}{\mu};$$

where L^j is the land area of district j as a proportion of total (developable) land area in the economy (normalized to 1), μ is the ratio of land to non-land expenditure in the production of housing, ε_H is the housing supply elasticity, and p_w is the price per unit of non-land factors. Following Epple, Gordon, and

[37] https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-income-households.html

[38]Bishaw and Posey report poverty rates in rural and urban areas respectively of .13 and .16, and a median income ratio of .965. From these and log-normality, one can determine the rural income distribution given the urban income distribution. Note that median and mean income are lower in the rural area, but the poverty rate is higher in the urban area. https://www.census.gov/newsroom/blogs/random-samplings/2016/12/a_comparison_of_rural.html.

[39] From: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2010-urban-rural.html. Here we combined rural and "urban cluster" into rural.

Sieg (2010), we set the land share equal to .25; thus $\varepsilon_H = 3$.[40] Since the choice of p_w does not affect equilibrium variable values that impact households' relative utilities, we choose it so that $(\frac{1-\mu}{p_w}) = 1$ when $\varepsilon_H = 3$.[41] This implies p_w=3/4 and that a district's housing supply simplifies to $H_s^j(p_h^j) = L^j \cdot (p_h^j)^3$.

Related to the specification of land areas, first we assume the urban area has three districts. The idea is to have a central city district and two suburban districts. This allows some differentiation of suburbs, while keeping the computational model manageable. The central city is the largest district and has the lowest quality schooling when district differentiation arises (stratification as in Proposition 3). This is accomplished by assigning a higher proportion of the urban area's land to the city and by selecting the equilibrium that has households sort so that the so-named city is the area with the worst school.[42] Specifically, we assign 40% of the land area in the urban area to the city, and split the remaining urban land area between the two suburbs. We calculate the empirical proportion of urban dwellers that reside in the city to be 39%, guiding our choice of assigning 40% of land area available for housing development to the city.[43] Whenever district differentiation arises, there will then be a larger city having rightward shifted housing supply with the lowest quality schooling, and two suburbs with better schools, one "elite" with the best school and attracting the highest taste and income urban residents. Last, here, the land area assumed for the rural area is in proportion to its calibrated population of 29%.[44]

It remains to calibrate the parameters of the utility function, γ, λ, η, and β and the federal income tax rate. We match four of the parameters to the foundation model's predictions. Detailed documentation of the sources of numerical values is in Online Appendix I. The proportion of after-tax expenditure on housing in the model (recall (6)) is given by $\frac{\lambda}{\lambda+\gamma}$. We calibrate this so that the proportion of after-tax expenditure on housing is 20% of pre-tax income in the foundation equilibrium, this proportion frequently assumed in the literature (see e.g., Hanuschek and Quigley, 1980**)**. Specifically, $\frac{\lambda}{\lambda+\gamma}$=.2036. The ratio η/β

[40] This land share is well within the range of estimates found in the literature as is the housing supply elasticity of 3 (see e.g., Green, Malpezza, and Mayo, 2005).
[41] The choice of p_w does not affect equilibrium relative utilities because the percentage of income households spend on housing is independent of the price of housing, given the adopted utility function.
[42] In Tiebout-type models, typically multiple equilibria arise that have the strata of household types sort differently among different sized communities. For example, in our model we have a large district and two equal-sized districts (as defined by the land areas). Three stratified equilibria can result, one with the largest district the poorest, another with the largest the middle-income suburb, and the third with the largest the richest suburb. We specify a U.S-type model by selecting the equilibrium with the largest district the poorest and interpreted to be the city.
[43]Based on the results of the 2010 U.S. Census, the total U.S. population living in Metropolitan Statistical Areas (MSA's) was 258,317,763, of which 39%, or 100,742,583, live in principle MSA cities. As will be seen, the 40% land area in the city will not imply 40% of urban residents will live in the city because housing consumption will vary according to incomes and equilibrium prices.
[44] One might argue that the land to population ratio in rural areas is higher, but our model does not consider differences in production, in particular agriculture.

measures the relative importance of peers and expenditure in demanded school quality (see (2)). We set this to 2.623 using estimates of the Tiebout equilibrium in Calabrese, Epple, Romer, and Sieg (2006).

One can think of the two remaining parameters of the utility function, γ and β, as measuring the relative values of numeraire consumption and school quality in utility. To calibrate these and the federal income tax rate, we target the empirical values of educational spending per student and the empirical proportions of local, state, and federal education finance, also taking account of the empirical number of school-aged children per household. We calculate .494 school-aged children per household, with detail and sources in the appendix. Education expenditure per student in 2010-11 was \$10,665 (rounded to nearest \$5), this including expenditure from all sources, federal, state, and local, with respective proportions of 12.5%, 44.1%, and 43.4%. The federal per student expenditure is \$1,333, implying a per household federal income tax rate of $m^f = 1.01\%$ that we then assume. Then γ and β are calibrated so the foundation equilibrium predicts state and local per household and student expenditures corresponding to the empirical proportions with a per student expenditure from all sources of \$10,665. Thus, the model produces these fundamental values in majority choice equilibrium.

B. Properties of Equilibria under Five Policy Regimes.

B.1 Positive Analysis. Table 2 summarizes equilibrium properties under the five policy regimes we study. The bottom two rows regard average normative measures. We focus first on positive properties. District populations, average housing values, per student educational expenditures, peer measures, school quality indices, and taxes are presented. In the table, we use R to indicate the rural area, and Dj's to indicate the three urban districts, with D1 the city. It bears emphasis that we obtain equilibrium in each regime, these with stratification in the urban area except in the pure state regime where the urban area is just one district. We know from Proposition 2 that obtaining majority choice equilibrium of local tax policies is not problematic. We have verified the general equilibrium in all the cases computationally, in particular with also majority choice of the state policy.[45] Excepting in the pure state regime, equilibrium has school differentiation and household sorting in the urban districts following Proposition 4. Figures 2 and 3 show the "boundary loci" in type space delineating residences in the urban area for two of the regimes with household sorting, each figure showing the locus for one of the regimes contrasted with that under pure local finance. These are discussed below. Figure 4 depicts district per student expenditures and school qualities in the various regimes, omitting the pure state regime that has no district variation in per student expenditures.

Consider first the foundation equilibrium and refer to Table 2. The foundation property tax is 2.87% and funds all educational expenditure above the federal subsidy in the city, and most of it in the

[45] Existence of majority choice of the state policy is a nonissue in the pure local regime. Here the question is whether a stratified equilibrium arises, which does occur.

less elite suburb and the rural area.[46] Figure 2 shows how households sort in the urban area, with those household types above the upper foundation locus living in the elite suburb, those between the two foundation loci living in the less elite suburb, and those below the lower foundation locus the city residents. The city has 42.5% of the urban residents, the less elite suburb 26.7%, and the elite suburb 30.8%. Recall that we calculated the empirical proportion of city residents in urban areas to be 39% and have assigned 40% of developable urban land to the city.[47] Both suburbs and the rural area have an additional local property tax. The elite suburb further supplements local educational expenditure with a modest local income tax (1.61%). The property tax in the elite suburb is at the maximum level consistent with (17) implying that using local income taxation for additional local educational expenditure is optimal.[48] The aggregate property tax in the elite suburb is quite high as a result of the low tax price implied by the vertical externality. Average housing value rises substantially in the urban area going from the city to the suburbs, facilitating the expenditure hierarchy. Epple and Sieg (1999) report median housing values have a correlation of .85 with median incomes across the 92 districts in the Boston metropolitan area (p. 662). Given the type sorting, the peer measures also rises accordingly in the urban area. The elite suburb has markedly higher expenditure, peer measure, and school quality index than other districts. It is interesting that the rural area has lower peer measure than the less elite suburb, but spends enough more locally to produce a higher school quality. Average per student schooling expenditure is $10,655, which we targeted in the calibration.

Most comparable to the foundation regime is the regime with a flat state grant financed by a state income tax (see Column 3). We refer to this as the "flat-state-grant regime," though the foundation regime also provides a uniform per student subsidy. The equilibrium state income tax is 3.95%, funding the per student supplement to educational expenditure of $5,205, $502 higher than the state supplement in the foundation system. Stratification is similar to that in the foundation case, though the city grows a bit, making the suburbs a bit more "elite." The analogue to Figure 2 for this case is in the appendix. Local taxation is also similar. Property values are substantially higher with the state income tax, this because property is not taxed by the foundation requirement. Expenditure per student is higher in all districts except for the elite suburb, but school quality there is higher due to a stronger peer group. Average per student expenditure overall is slightly higher here than in the foundation regime (by $135 per student).

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[46] The model predicts property taxes on rents, which we have converted to rates on value following Poterba (1992). In his analysis of housing user cost, Poterba (1992) derives a conversion for which annualized rent (i.e., p_h) on housing services equal to 11% of housing value. Letting z denote the "user cost factor" and W the value of housing, the equilibrium rental rate of housing equals its user cost, according to: $p_h = z \cdot W$. The user cost factor is the sum of four values, $z = z_1+z_2+z_3+z_4$, where z_1 is the real interest rate, z_2 the risk premium from housing investment, z_3 is proportional maintenance cost, and z_4 is depreciation. Poterba's calculation yields $z \approx .11$, the value for the conversion we use. This is also used to compute housing value from p_h and units of housing rented.

[47] Density is a little higher in the city than in the suburbs, though our model does not predict density very well.

[48] To confirm this, one needs to work with the taxes on rents, not those on value reported here. See footnote 46.

However, almost every household prefers the foundation regime (97.95%), but we delay discussion of this.

Column 2 has no state finance, approximating the dominant regime prior to reforms, with then just local district finance, except we maintain the same low federal tax and supplement for comparison. Despite the latter, we refer to this as the "pure local regime." The city is particularly poor and school expenditure and quality are very low there (respectively, $2,450 per student and a quality index less than one half of any of the other regimes' city quality indices). Districts tax themselves more, to make up some for no state support, much more so in the suburbs and the rural area, these having much higher property and income tax bases than the city. This finance regime was dominant up to the 1930's, when state finance began to emerge, eventually exceeding local finance in proportion in 1978-79. Inequities and inadequacies under local finance drove the equalization movement.

Relative to the pure local regime, both regimes with state finance discussed above substantially increase expenditure and school quality in the city. We also find increases in schooling expenditure and school quality in the suburbs in these, especially in the elite suburb. Thus, our model does not predict "leveling down." Hoxby (2001) pointed out that a foundation policy has incentives that might level down, because the policy effectively transfers income from high demand to low demand districts (from districts with low property tax prices to those with higher ones).[49] Interestingly, we find leveling down does not occur in general equilibrium, with per student average expenditure rising, in fact in all districts. In the poorer districts, the state subsidy more than offsets local effort reduction, and household relocation makes the higher demand districts more "elite," then with the yet higher demand households voting for high enough local taxes so that expenditure rises. Relative to the pure-local regime in Figure 2, both of the regimes with state finance shift the boundary loci down somewhat, drawing households of middling income and taste parameter into the city, and drawing some households to the middle community from the low end of the income and taste parameter from the elite community. Hence, relative to the pure-local regime, these two regimes with state finance improve peer groups improve everywhere in the urban area. *However*, the nontrivial proportion of households that "move down" in these regimes relative to the pure local regime do experience substantially smaller per student expenditure and school quality. The incentive effects identified by Hoxby are manifest somewhat differently in the general equilibrium, in particular when households relocate. In Section VII-B, we shut down household relocation, but still find little in the way of leveling down for reasons discussed there.

[49] To be clear, Hoxby described the forces for leveling down inherent in a foundation regime, while making clear it is an empirical question. She made a theoretical argument that a foundation regime could be expected to level down relative to transfer schemes with equal transfers that rely on income, rather than property, taxation. While we do not examine this because our state policies in all regimes are majority choice ones with equilibrium household resorting, our comparative equilibrium findings are consistent with Hoxby's arguments. In particular, the flat state grant regime has higher average per student expenditure than the foundation regime.

The pure state regime (Column 4) has only a state income tax to finance uniform educational expenditure on top of the same federal supplement. Local taxes for education are not allowed. There is no sorting in the urban area; we assume it is one district, but it could be three clone districts.[50] Differences between the urban area and the rural area are just a function of the difference in the type distributions, implying very minor school quality differences. Not surprisingly, this equilibrium has the highest state income tax, funding the state per student expenditure of $7,432. The average expenditure per student is lowest here among the regimes' average expenditures. Rich and high taste households cannot increase educational expenditure; state policy is set by a type with T near the median.[51] Only Hawaii is approximated by this model, but it is of interest to examine its properties and our model does predict lack of political support for this regime as detailed presently.

Results for our preferred model are in Column 5, namely the foundation regime with a larger proportion of state funding going to the poorer districts, which in equilibrium are the city and rural area. We reference this regime as FCG. This equilibrium is parameterized by ϕ. We report values for $\phi = .11$, which is the majority preferred value, this discussed further in the next subsection. This implies 70.5% of state funds are distributed to the poorer districts, which have a higher population in aggregate. Comparing it to the pure foundation regime, per student expenditure, peer group quality, and school quality increase everywhere (except with the same peer quality in the rural area). More households are drawn into the city with suburbs smaller and yet more elite, this apparent in Figure 3.

One way to assess the credibility of the computational model is to compare its predictions about inequality in district schooling expenditure, which is not an element of our calibration, to empirical values. Evidence on this from the early 1970's forward is provided in Murray, Evans, and Schwab (MES 1998) and Jackson, Johnson, and Persico (2016), and for earlier periods in Hoxby (1998). As noted above, inequities in the pre-reform periods from domination of local finance was the impetus for the reform movement that began in the 1970's. Overall the evidence is that: (i) expenditure inequality was fairly constant until the reform movement; (ii) the reform movement has been successful in reducing expenditure inequality; and (iii) the latter is a result predominantly of increased expenditure in poor districts with little change in richer districts. If we compare the local regime to any of the mixed finance regimes, these qualitative elements are implied by the model. For example, the ratio of elite-suburb to city per student expenditure in going from the local regime to the foundation regime drops from 7.0 to 3.7. While this is a plus, these ratios are still too high, especially the ratio under the local regime. For

[50] We defined the state regime with the urban area being one district. If the urban area were three districts without the power to tax locally, it is an equilibrium to have three "clone" districts in the city. However, there would also then be equilibrium with sorting just by taste in the urban area, with differing school qualities. Such equilibria are studied in Calabrese, Epple, and Romano (2006), Epple and Romano (2015), and Avery and Pathak (2021). The latter models differ in various ways, but neither consider two tiers of government.

[51] Since rural and urban residents have different income distributions, the pivotal voter will not have exactly median T in the population.

example, MES (1998, Table 2) estimate the national average ratio of the top 5% district expenditure to the bottom 5% district expenditure in 1972 (with districts ordered by per student expenditure) to be "only" 2.72. However, our model uses the calibrated income distribution for 2010 to compare regimes, which has substantially more income inequality than in the early 1970's. Recalibrating the income distribution to 1970 data, we find this ratio in the local regime equilibrium equals 3.63 (see the online appendix for more detail), still somewhat higher than what the empirical evidence implies, but much closer. Also, this computed ratio is for the regime without any state expenditures, whereas the national average of actual state expenditures was 72% of local expenditures in 1972 (MES, Table 2), which would reduce the ratio even if evenly distributed. Nevertheless, our model exaggerates recent finance inequality, an issue we discuss further in section VII-C.

B.2 Regime Preferences and Welfare. We turn now to discussion of normative effects and related regime preferences. Our main interest is in regime preference of households, but we briefly discuss average welfare effects first. The bottom two rows of Table 2 show average household equivalent variation (EV) and the per capita change in homeowner surplus of going from the local regime to the column regime.[52] We have chosen the "classic" pure local regime as the benchmark here, though we are confident that, as usual, *relative welfare differences* between regimes would not vary significantly with the benchmark. From the perspective of households, the foundation regime has highest average welfare. The absentee housing owners have quite different preferences and the welfare maximizing regime is defined differently if their gains or losses are included. Counting household EV and housing rents the same, the flat state grant regime has highest average welfare and the foundation regime has the lowest. The two key factors that impact welfare are gains from Tiebout matching of preferences to local public goods provision and whether property or income taxation dominates in financing education. Generally, property taxation is inefficient relative to income taxation in the model. The usual distortion and deadweight loss from property taxation arises in the housing market, but we have no income tax distortion for tractability. Note that if we introduced an income tax distortion, this can be expected to reinforce the household preference we find for the foundation regimes! In the equilibrium outcomes, voters (households), who are renters, do not consider tax incidence on housing owners and have a general preference for property taxation. While, for example, the local regime has Tiebout sorting and thus matching of preferences to local provision

[52] Calculating EV to measure welfare is with several caveats. We choose EV as opposed to CV because it is more convenient to calculate. Our experience with such models is that EV and CV calculations are very close, this because the dollar amounts are not too large and then income effects are small. Second, we provide average welfare measures and do not consider policies that might redistribute gains to induce potentially Pareto Improvements. Note, though, we will see near Pareto Improvements among households in going from some policy regimes to others. Other caveats are associated with the central role of educational quality and its investment value. For one, capital market imperfections can imply the parental marginal value of education is below the household value even with altruistic parents. Second, education can have positive externalities in the workplace and/or in social interactions. Such externalities are not weighted in household utility. Both these imply the EV of an increase in educational quality is below the social value. *Our main use of EV is to understand household preferences over policies, for which EV is an appropriate measure.*

levels, the heavy use of property taxation makes it welfare inferior to even the pure state regime with no Tiebout sorting. The highest average welfare arises in the flat state grant case, which has Tiebout sorting. While it has a state grant, with then some departure from Tiebout preference matching, that grant is funded with the non-distorting income tax and the equilibrium has substantially less property taxation (e.g., than the pure local regime). The lower average welfare in the foundation schemes is due to almost exclusive reliance on property taxes. It is of interest to extend the analysis to cases where homeowners have political power as discussed further in Section VII-C.

Related to welfare effects on home owners, one can see the capitalization effects on housing values in Table 2. In going from one regime to another, housing value in a district is affected positively by increases in school quality and negatively by increases in property taxation. Such capitalization effects are strongly supported by the literature (see, e.g., Nguyen-Hoang and Yinger for a survey). Taking the example of going from the pure local to the flat-grant regime, note that school qualities rise in every district and property taxes fall or stay the same. Here, again, home owners gain on average. In other cases, these effects vary across districts. In going from the local regime to the foundation regime, while school qualities rise everywhere so too do property taxes. For example, effects on property values vary across the districts, with an *average* welfare loss for home owners.

Consider household preferences among the regimes. First, regarding the preference among households over relative state funding in the FCG regime between poorer and richer districts, Table 3 shows the percentage having higher welfare for alternative values of ϕ relative to the pure foundation regime ($\phi = 0$). Searching by two decimal places, we find the highest percentage prefer $\phi = .11$ among all values, recall implying 70.5% of all state funds are provided to the two poorer districts. The equilibrium characteristics reported in Table 2 for selected values of ϕ are provided in the appendix.

The panels of Table 4 then report household percentage favoring the row regime over the column regime for all the regimes we have studied, including the preferred FCG regime. The upper panel is for the entire population and the lower panel is for just the rural residents. For the entire population, a strict aggregate preference ordering arises: FCG, foundation, flat grant, pure local, and pure state; meaning the regimes as ordered are majority preferred to all that follow. Thus, for example, the FCG regime is a Condorcet winner among all the regimes. For the rural population, the same preference ordering arises, though the entire rural population have a unanimous preference for the FCG regime with all state funds going to the poor district (ϕ = max), which is not included in the tables.[53]

While the foundation regimes are preferred by large majorities over the flat-grant regime, the renter model has some bias for property taxation, and *the finding that we emphasize is the preference for regimes that combine state and local finance over those that have finance at just one government tier.* All

[53] In Table 3, the 28.57% that prefer ϕ = max among the FCG regimes are all and only the rural residents.

of the pure foundation, preferred FCG, and the flat-grant regimes soundly defeat both the pure local and pure state regimes. Why the strong preference for combining state and local finance?

The main forces are a preference for transfer from the richer to poorer among a majority and Tiebout gain effects in the urban area. First focus on the comparison of the flat-grant regime to the pure local regime. Table 4a indicates 93.8% of the population prefers the flat-grant regime. The contour plots in Figures 5a and 5b show the equivalent variations resulting from this regime change for urban and rural residents respectively. These and the analogously constructed figures that follow are accompanied by a side scale showing the dollar values associated with the shading in the contour plots.[54] The state income tax in the flat-grant regime is 3.95% with a uniform per student grant of $5,205 (see Table 2). About 85% of rural residents prefer the flat-grant regime over the pure local one. Rural residents net some subsidy from the richer urban residents and use a local property tax to add additional expenditure. Rural school quality is substantially higher. The 15% who lose are at the bottom of Figure 5b, low-income households with low taste for education. They prefer the local regime with a lower income tax and lower school quality. As one can see in Figure 5a, almost all urban residents prefer the flat-grant regime, which is more interesting.[55] The key to why gains arise in the urban area is the relocation that would take place going from the local regime to the flat-grant regime. Given the state subsidy to educational expenditure, with no state subsidy in the pure local regime, the city attracts a large proportion of households making it richer. The suburbs also become more elite. One can see this by comparing the population proportions in the urban districts in columns 2 and 3 of Table 2, keeping in mind the type stratification in both regimes. Observe, too, the substantially increased housing values in each of the urban districts. Both the income and housing tax bases rise in all urban districts, though only the elite suburb votes to tax income locally. Educational expenditures and school qualities rise markedly in all urban districts. It is then not at all surprising that less wealthy urban dwellers gain. The richer urban dwellers cross subsidize poorer households through the state income tax, but this is more than offset by the general equilibrium effects of their districts becoming more elite. Summarizing, most rural residents gain from some redistribution while being able to adjust local taxation, poor urban residents gain similarly, and richer urban residents gain as a result of efficient changes in Tiebout sorting and taxation.[56]

The even stronger preference for the pure foundation system over the pure local system, with EV gains shown in Figures 6a and 6b, is explained analogously and thus we need not elaborate.[57]

[54] The online appendix presents detailed cross-tabulations of EV in dollar values for each of the cases displayed in Figures 5 through 8. The contour plots, built from those tables, economize on space in the paper while also facilitating visual comparisons of EV of the different regimes on a single page.

[55] The plot masks a few who lose out in the city, about 2% who are very poor and/or have very low tastes.

[56] Calabrese, Epple, and Romano (2012) show that Tiebout sorting in a pure local regime can result in inefficient crowding of the suburbs to free ride. The state educational subsidy to the city here limits this effect.

[57] We have examined this level of detail for just the pure foundation regime among the foundation regimes.

Figures 7a and 8a respectively show the large gains to urban residents in going from the pure state to flat-grant and pure foundation regimes. As shown in the scales to the right of these graphs, the gains in going from pure-state to these two alternative regimes are much larger for urban residents than the corresponding gains in going from the pure local to the alternative regimes. For rural areas, comparison of Figure 5b to 7b reveals that the range of EV change is greater for pure local to flat grant than from pure state to flat grant. Comparison of Figure 6b to 8b shows that the same is true when the change is to a foundation grant. Comparing the scales to the right of these rural figures also shows that no one loses in a change from the pure state whereas some do lose from a change from pure local. Why are the regimes that combine state and local funding preferred to the pure state regime? The fundamentals underlying the preference for the two mixed funding regimes are again the same and again we discuss in more detail the case of a switch to the flat-grant regime. Everyone gains! The main shortcoming of the pure state regime is that it eliminates exercise of local preferences, inducing the pivotal voter to set a high state income tax (equal to 5.57%, see Table 2). A switch from the pure-state to the flat-grant equilibrium would have rural residents choose a combination of local taxes resulting in higher per student expenditure and school quality. In spite of a transfer in the state system, they would gain in utility and school quality from more efficient taxation. City residents in the flat-grant regime would tax less and spend less, then having lower school quality, but more aligned with their preferences. Suburbanites would benefit from sorting and their higher tax bases, with increased school quality and expenditure, especially in the elite suburb.

Overall, the middle ground of some transfers in the mixed regimes and local alignment to preferences and incomes drives the aggregate preferences. Keep in mind that these model predictions are for majority choice equilibrium tax rates and expenditures (not conditionally efficient ones).

Regarding equity of the finance regimes, we focus on the effects on the lowest three deciles of the income distribution, which we refer to here as poor households. As one can see in Figures 2 and 3, all or virtually all of urban dwellers that are poor live in the city in the regimes with household sorting. The appendix shows the same for the flat-grant case. One can easily see in Figure 4 that the three regimes with mixed funding lead to higher per student expenditure and school quality in the city than in the local regime. These findings also apply to the poor in the rural area (see Table 2). Not surprisingly, the pure state regime would, however, provide the highest school quality to all poor households. School quality effects are not the same as welfare effects due to tax and housing cost effects. Welfare for the poorest in the urban area is highest in the pure foundation regime, while highest for the rural poor in the FCG regime with all state funding going to poorer districts. More detail on these observations is provided in the appendix, but consistent with the voting preferences already discussed.

C. Comparative State Analysis. Here we investigate the model's power to predict variation in state expenditure patterns. We do this for the school year 2020-21. We focus on the forty-six states that Verstegean (2011) identifies as adopting foundation policies or variations of them, though we do not obtain an equilibrium for S. Dakota.[58] For the remaining 45 states, we calibrate the rural population and the urban and rural income distributions to data for each state, also letting the mean preference parameter vary by state.[59] Otherwise, we adopt the assumptions and parameters for each state from the baseline model, e.g., the parameters of the utility and education production function. We then examine whether the pure foundation model can predict the empirical variation in the per student expenditure amounts, recall from the Introduction varying from $11,700 in Idaho to $32,000 in New York. Varying the taste parameter, the model can predict these values exactly, demonstrating robustness of the model. We then examine how the predictions about the state shares in expenditures compare to the empirical values, which range from .30 in Missouri to .71 in New Mexico.[60] While matching a few states well, the model usually under-predicts state shares, including predicting 0 state share in some states. We find that this is associated with under-predicting populations in the city, which reduces support for state-level taxation. Too many poorer households are predicted to crowd the suburbs to free ride on higher tax bases of richer households while consuming little housing. Zoning restrictions on housing consumption in the suburbs and commuting costs would induce more households to live in the city, which are not elements of our model and not pursued here. In Section VII-C we discuss further such modelling weaknesses in light of model predictions.

Here, we go on to examine whether allowing the higher proportion of state funding in poorer districts in the FCG model can help to rectify these predictions. We examine this for a subset of 14 of the 45 states making sure to include some large and small states and from all regions of the country. Note that this includes states where the pure foundation model poorly predicts the state share.[61] In this analysis the mean state parameter is adjusted continue to produce an exact match to the per student expenditure, and the value of the ϕ parameter in the FCG regime is chosen to produce the closest match to the empirical state share. Table 7 reports results from this analysis. The first two numerical columns report the empirical and predicted state shares. The last two columns report respectively the value of ϕ and the equilibrium ratio of average expenditure from all sources per student in the poor districts (G^P) to average per student expenditure overall. The cases of 1.00 are when the pure foundation regime provides the best fit. For half of the states the model can predict well the state share, either an exact match or within a few

[58] In addition to excluding S. Dakota, Hawaii, Rhode Island, Wisconsin, and Vermont are not considered since their finance regimes are not foundation. We include N. Carolina in the initial analysis though it actually has a regime best matching our flat-grant regime, but we have seen this regime has similar predictions.

[59] More detail is in the appendix, including data sources, but the state calibration: (i) directly calibrates the rural populations; (ii) identifies the mean and variance of the urban area from the data continuing to assume a lognormal distribution; (iii) likewise identifies the mean rural income from the data (assuming lognormality); and (iv) uses empirical relative poverty rates in the urban and rural areas to identify the rural income variance and the state income poverty threshold.

[60] In the Introduction we reported a maximum share of .88, but this is for both Vermont and Hawaii which are not included in this analysis since not adopting foundation regimes.

[61] For example, the pure foundation model predicts a state share of 0 in New York, while the FCG model can predict an exact match to the empirical state share (see Table 7).

percentage points. When the model cannot predict well the state share, the proportion predicted to live in the city is usually too low (see numerical Columns 4 and 5, e.g., the last four rows). In most of these cases increasing ϕ and thus the share of state expenditures going to the poorer districts fails to attract more or enough households to move into the city who are relatively supportive of state taxation. Overall, the model performs fairly well.

An interesting aspect of the equilibria regards who supports the foundation (state) tax. One might guess that no support arises for state taxation in the suburbs because of the high local property tax bases (as well as incomes) there. This is, however, not generally true as one can infer from the fact that the total equilibrium populations of the poorer districts in a number of cases is below half the population (see numerical Column 6). In fact, there is a pivotal voter in the less elite suburb whose preferred foundation tax is the equilibrium one in 9 of the 14 states examined.[62] The preference of voters in the less elite suburb for a foundation tax is because their average housing value is actually below the average in the economy due to the high property values in the elite suburb. Take the example of California, with equilibrium population in the two poorer districts equal to 46.6%, 18.1% percent of those in the less elite suburb prefer a higher foundation tax than the equilibrium one of 3.04% (not shown in table). In contrast, all residents of the elite suburb prefer a lower foundation tax and would prefer to exclusively tax their own property (in every state). Note further that, given the foundation tax, additional local property taxation arises everywhere except in the city in some cases. Recall that there is an externality in taxing locally when there is a property tax and many households want more educational expenditure.[63]

VII Extensions, Modifications, and Discussion

A. Equilibria and Regime Preferences with No Local Income Taxation. Because many districts do not have authorization to fund schooling with local income taxation, we examine equilibria in the school regimes shutting down local income taxation. The equivalent of Table 2 that reports key equilibrium values is in the online appendix. Here we briefly summarize. As we have seen (Table 2), local income taxation is not much used when allowed, though sometimes modest levels, especially in the most elite suburb. As such, the main differences in the equilibria with local finance are somewhat higher property taxes in the elite suburb, though somewhat lower per student expenditure because of the inefficiency of an increase the property tax. For example, in the foundation regime, the property tax in the elite suburb is 5.09%, while 3.78% when local income taxation is allowed. Per student expenditure there drops, however, to $20,245 from $22,245. Note that the equilibrium foundation tax only changes by .04%.

[62] Section S of the on-line appendix provides equilibrium tax rates and information on voting coalitions regarding majority choice of the foundation tax. Note that there are multiple voters with the same preference for the equilibrium foundation tax in every state and living in different districts.

[63] For example, the local property tax in the elite suburb in this equilibrium is 2.88%.

Some change in regime preferences arises, *though the preferred FCG regime remains the Condorcet winner among the regimes studies.* Table 5 shows the population preferences among regimes, where the value of ϕ=.13 is most preferred among ϕ values (over a .01 grid) with no local income taxation. Here, though, the flat-grant regime defeats the (ϕ=0) foundation regime. All the regimes that combine state and local funding continue to defeat the pure state and pure local regimes. Overall, shutting down income taxation makes little difference.

B. No Mobility. We have allowed urban households to resort optimally as we vary regimes. We now consider the other extreme, fixing residences to investigate how this would affect transition from local finance to mixed state-local finance. One might think of this as comparing short run to long run effects. We fix the populations as in the foundation regime, because we used this case in our calibration.[64] The panels of Table 6 show expenditures and household preferences for the two mixed state funding regimes and for the local finance case. Details provided in Table 2 for the two new cases are in the online appendix. The foundation expenditure values are, of course, exactly as in Table 2. Keep in mind the residences are as in the foundation case of Table 2 under each of these regimes. Summarizing the expenditure effects in going from local finance to the two mixed-finance cases, there are: (i) large expenditure increases in the city; (ii) substantial expenditure increases in the rural area, non-elite suburb, and on average; and (iii) little expenditure change in the elite suburb (22% of the population), with a small increase in going to the foundation regime and a small decrease in going to the flat-grant regime. These findings are broadly consistent with the evidence in Murray, Evans, and Schwab (1998) and Jackson, Johnson, and Persico (2016). With, then, no relocation, we still do not find leveling down, though a small reduction in expenditure occurs in the elite suburb going from local finance to the flat-grant case. Given the subsidy from richer to poorer households in each case of centralization, why not then the same for a change to the foundation regime? The lower tax price of property taxation in the elite suburb from the vertical externality in the foundation regime induces high enough local taxes to increase expenditure there. This externality is not present in the flat-grant case, but only because we do not have an income tax distortion.

While expenditure and thus school quality rises everywhere in going from local finance to the foundation regime, suburban residents prefer the local regime, this in contrast to when resorting is allowed. The increased eliteness of the suburbs and the opportunity to move to preferred urban districts no longer arises. As reported in the lower panel of Table 6, 57.6% prefer the foundation regime, so it still

[64] To expand on the rationality of this choice, if households cannot relocate, then it makes sense to use the populations associated with the case used in the calibration when comparing regimes. Having said this, we do not believe, but have not verified, that the main points here are affected by this.

attracts a majority. Similarly, the flat grant regime is barely majority preferred to the local regime.[65] One can see in Table 6b that the regimes are aggregate preference ordered by foundation, flat-grant, and local.

C. Discussion. Here we briefly discuss potentially important issues relevant to school finance that our model does not address. These fall under five topics: the housing market; the number of urban districts; policy determination; education provision and preferences for education; and mobility. While we engage in some (likely biased) speculation, we consider these topics for future research. The key questions in our minds are how our model's main positive predictions about support for mixed finance regimes and school expenditure variation (where we predict too much) might be affected.

Returning again to the home ownership issue, we have assumed renting for tractability. We know that home owners have weaker incentives to tax property. Moreover, close to two-thirds of households are home owners in the U.S. As we have seen average welfare losses in three of the four mixed regimes relative to pure local finance when home owner surplus is considered (see Table 2), this calls into question the support for mixed regimes we taut. *However*, home ownership rates are less than 100% and rise with income. If one can extend the analysis taking this into account, the majority preference for the mixed regimes may well persist, and one must keep in mind that the quantitative model would need to be recalibrated with stronger preferences for education to maintain good predictions about expenditure levels. In addition, higher home ownership rates in the suburbs might curb relative expenditure there and provide better predictions about stratified expenditures. *More research is needed here.*

We have assumed three districts in urban areas in the quantitative analysis to allow variation in populations and school qualities while maintaining tractability and simplifying presentation of findings. In fact, metropolitan areas typically have substantially more districts. If we were to increase the number of urban districts, we would want to maintain a large central-city district consistent with reality. Having more suburbs would likely decrease support of the richest segment for mixed finance, these households then obtaining higher-yet school qualities in their districts. But this would be countered by increased incentives to free ride on their local finance as the lower income households in each jurisdiction curtail housing consumption to reduce their property taxes (see Calabrese, Epple, and Romano, 2012). These incentives would be reversed for not-so-rich suburbanites. Our belief is that the main results we highlight would not be significantly affected by such an extension.

Our paper is about majority choice and how it performs in understanding school finance in the U.S. The obvious and fair criticism here is that state supreme courts influence state school finance policies. Our prediction of too much expenditure stratification might be improved if courts are effective in curbing majority choice forces especially by forcing increased expenditure in poorer districts. The

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[65] Those preferring the flat grant regime to local finance consist of all city residents excepting 0.59% of them with the lowest valuation of schooling (lowest T) and 73.3% of rural residents, those with higher schooling valuations. These two groups make up 51.1% of the population. Those preferring the foundation regime to local finance are the same except with even fewer low valuation households in the city and rural area preferring local finance.

model's inability to predict the share of state expenditures in some states might be explained by binding legal constraints.

Regarding the model of education itself, we do not consider private education nor non-quality differentiation (among other things). Private education alternatives would be consumed by higher preference households, this likely evening out public education expenditures both because households in the suburbs would have weaker incentives to spend on public education and because this can increase tax bases in the city as those that consume private education move there (see Nechyba 2003). On the other hand, overall public support for public educational expenditure falls. In as much as some households, especially poorer households, are not driven in their educational choices by school quality our model's predictions about quality variation and perhaps expenditure variation lose credibility. Somewhat relatedly, an extension of interest would have a mass of households that do not care at all about school quality (but might care about housing value with ownership).

Finally, we have only examined cases with full or no household mobility; more exploration of the middle ground is of interest. Zoning can limit access of the poor to suburbs, which could change the incentives to support state funding by richer urban households. Incentives to move into the city might be limited by crime, pollution, and prejudices. Commuting costs limit district sorting. Because the general equilibrium effects associated with alternative sorting across regimes play a role in the strong support we find for mixed finance systems, consideration of more limited mobility could undermine this prediction (but at least does not in our limited analysis with no mobility). Some factors would tend to even out finance, while others would seem to cut the other way (zoning).

D. Other Intergovernmental Finance. The structure has the potential to be applied to other cases of multiple-tier governmental funding of local public goods as discussed in the online appendix.

VIII Conclusion

We provide a model with households that differ by income, taste for school quality, and by whether they live in a rural or an urban area. The urban area has multiple districts and mobile households, implying endogenous district electorates. A distinctive feature of our analysis is that majority choice at two governmental levels determines the state and local tax rates that finance schooling. A further distinctive feature is that we study five policy regimes, with some variations, that are either currently employed or have been employed in the past. We show that equilibrium exists for each of these regimes. We find that equilibrium with a mixture of state and district-level finance increases educational expenditure everywhere relative to the original U. S. system of local finance. We find a majority supports regimes that combine state and local funding, which have become the norm among U.S. states. This support is driven by a combination of preference for redistribution of poorer households and gains from Tiebout sorting changes in the urban area. We show that the model can predict the substantial variation among states in expenditure per student and can predict the state-local funding mix in half the states examined.

References.

Abdulkadiroglu, A, Pathak, P., Schellenberg, J., and Walters, C., "Do Parents Value School Effectiveness?" *American Economic Review* 110(5), May 2020, 1502-1539.

Arcidiacono, Peter, Foster, Gigi, Goodpaster, Natalie, and Kimsler, Josh, "Estimating spillovers using panel data, with an application to the classroom," *Quantitative Economics* 3 (2012), 421-470.

Atkinson, A. B. and Stiglitz, J. E., *Lectures on Public Economics*, Mc-Graw-Hill, New York, 1980.

Avery, Christopher and Pathak, Parag, "The Distributional Consequences of Public School Choice," *American Economic Review* 111(1), 2021, 129-152.

Baicker, Katherine and Gordon, Nora, "The effect of state education finance reform on total local resources," *Journal of Public Economics* 90, 2006, 1519-1535.

Bayer, P., McMillan, R. and Ferreira, F., "A Unified Framework for Measuring Preferences for Schools and Neighborhoods," *Journal of Political Economy*, 115(4), August 2007, 588-638.

Benabou, Roland, "Workings of a City: Location, Education, and Production," *Quarterly Journal of Economics*, 108 (1993), 619-652.

______________, "Equity and Efficiency in Human Capital Investment: The Local Connection," *Review of Economic Studies,* 63 (1996), 237-264.

Bierbrauer, Felix, Boyer, Pierre, and Peihl, Andreas, "Politically Feasible Reforms of Nonlinear Tax Systems," *American Economic Review* 111(1), 2021, 153-191.

Bishaw, Alemayehu and Posey. Kirby G., "A Comparison of Rural and Urban America: Household Income and Poverty," Social, Economic, and Housing Statistics Division, Dec. 8, 2016,

Boadway, Robin, Maurice Marchand, and Marianne Vigneaulty, "The Consequences of Overlapping Tax Bases for Redistribution and Public Spending in a Federation," *Journal of Public Economics*, 68(1998), 453-478.

Bracco, Emanuele, Lockwood, Ben, Porcelli, Francesco, and Redoano, Michela, "Intergovernmental grants as signals and the alignment effect: Theory and evidence," *Journal of Public Economics* 123, 2015, 78-91.

Bradford, David, and Oates, Wallace, "The Analysis of Revenue Sharing in a New Approach to Collective Fiscal Decisions," *The Quarterly Journal of Economics* 85(3), August 1971, 416-439.

Brueckner, Jan, 2004. Fiscal decentralization with distortionary taxation: Tiebout vs. tax competition. International Tax and Public Finance 11(2), 133-153.

Brunner, E. and Sonstelie, J., "School Finance Reform and Voluntary Fiscal Federalism," *Journal of Public Economics* 87 (9-10), 2003, 2157-85.

Bucovetsky, Sam, "Choosing Tax Rates and Public Expenditure Levels Using Majority Rule," *Journal of Public Economics*, 46 (1991), 113-131.

Burgess, S., Greaves, E., Vignoles, A., and Wilson, D., "What Parents Want: School Preferences and School Choice," *The Economic Journal* 125, September 2014, 1262-1289.

Calabrese, Stephen, "Household Mobility an the Political Economy of Welfare Effects of Local Tax Limits," *Journal of Urban Economics* 142, 2024, 1-17.

Calabrese, Stephen, Epple, Dennis, and Romano, Richard, "Non-Fiscal Residential Zoning," in *The Tiebout Model at Fifty: Essays in Public Economics in Honor of Wallace Oates.* William A. Fischel, ed., 2006. pp. 211-230.

______________________________, "Inefficiencies from Metropolitan Political and Fiscal Decentralization: Failures of Tiebout Competition," *Review of Economic Studies*, 79 (July 2012), 1081-1111.

______________________________, "Majority Choice of Tax Systems in Single- and Multi-Jurisdictional Economies," *Journal of Public Economics,* 131 (November 2015), 58-70.

______________________________, "Majority Choice of Taxation and Redistribution in a Federation," *Journal of Public* Economics, 217, 2023, 19-39.

Calabrese, Steve, Epple, Dennis, Romer, Thomas, and Sieg, Holger, "Local Public Good Provision: voting, Peer Effects, and Mobility," *Journal of Public Economics*, 90, 2006, 959-981.

Card, D. and Payne, A., "School Finance Reform, the Distribution of School Spending, and the Distribution of Student Test Scores," *Journal of Public Economics* 83(1), 2002, 49-82.

Chingos, Matthew, and Blagg, Kristen, "Do Poor Kids Get Their Fair Share of School Funding?" Urban Institute (www.urban.org), May 2017.

Combes, Pierre-Phillippe, Duranton, Gilles, and Gobillon, "The Production Function for Housing: Evidence from France," *Journal of Political Economy* 129(10), October 2021, 2766-2816.

de Bartolome, Charles, "Equilibrium and Inefficiency in a Community with Peer Group Effects," *Journal of Political Economy*, 98 (1990), 110-133.

_______________, "What Determines State Aid to School Districts? A Positive Model of Foundation Aid as Redistribution," *Journal of Policy Analysis and Management* 16(1), Winter 1997, 32-47.

Dixit, Avinash and Londregan, John, "Fiscal Federalism and Redistibutive Politics," *Journal of Public Economics* 68, 1998, 153-180.

Downes, Thomas and Figlio, David, "School Finance Reforms, Tax Limits, and Student Performance: Do Reforms Level Up or Dumb Down?" mimeo, University of Oregon, 1997.

Durlauf, Steven, "A Theory of Persistent Income Inequality," *Journal of Economic Growth* 1 (March 1996), 75-93.

Ellickson, Robert C., "Jurisdictional Fragmentation and Residential Choice," *American Economic Review*, 61, 2 (1971), 334-339.

Epple, Dennis, Filimon, Radu, and Romer, Thomas, "Equilibrium among local jurisdictions: toward an integrated treatment of voting and residential choice," *Journal of Public Economics* 24(3), 1984, 281-399.

Epple, Dennis, Brett Gordon, and Holger Sieg, "A New Approach for Estimating the Housing Production Function," *American Economic Review* 100(1), June 2010, 905-924.

Epple, Dennis, and Nechyba, Thomas, "Fiscal Decentralization," *Handbook of Regional and Urban Economics* 4, Chapter 25, December 2004, 2423-2480.

Epple, Dennis and Platt, Glenn, "Equilibrium and Local Redistribution in an Urban Economy when Households Differ in both Preferences and Incomes," *Journal of Urban Economics* 43(1), 1998, 23-51.

Epple, Dennis and Romano, Richard, "Public Provision of Private Goods," *Journal of Political Economy*, 104, February 1996, 57-84.

______________________________, "Public School Choice and Finance Policies, Neighborhood Formation, and the Distribution of Educational Benefits," Chapter 7 in *The Economics of School Choice*, Caroline Hoxby, ed., National Bureau of Economic Research, University of Chicago Press, 2003, 227-286.

_____________________________, "Peer Effects in Education: A Survey of the Theory and Evidence," *Handobood of Social Economics 1B*, Benhabib, Jess, Bisin, Alberto, and Jackson, Matthew eds., 2011, 1053-1163.

_____________________________, "Equilibrium and Efficient Provision of Local Public Goods with Peer Effects," *Research in Economics*, Vol. 69 (September 2015), pp. 291-319.

Epple, Dennis, and Romer, Thomas, "Mobility and Redistribution," *Journal of Political Economy* 99(4), August 1991, 665-898.

Epple, Dennis, and Sieg, Holger, "Estimating Equilibrium Models of Local Jurisdictions," *Journal of Political Economy* 107(4), August 1999, 645-681.

Fernandez, Raquel and Rogerson, Richard, "Equity and Resources: An Analysis of Education Finance Systems," *Journal of Political Economy*, v. 111 (4), 2003, 858-897.

_________________________, "Public Education and Income Distribution: A Quantitative Analysis of Education Finance Reform," *American Economic Review*, 88 (1998), 813-833.

Feldstein, Martin and Marian Wrobel, "Can State Taxes Redistribute Income," *Journal of Public Economics*, 68 (1998), 369-396.

Gordon, Roger H., "An Optimal Taxation Approach to Fiscal Federalism," *Quarterly Journal of Economics*, 98 (1983), 567-586.

Gordon, Roger H. and Julie Cullen, "Income Redistribution in a Federal System of Governments," *Journal of Public Economics,* 96 (2012), 1100-1109.

Gravel, Nicolas and Oddou, Remy, "The Segregative Properties of Endogenous Jurisdiction Formation with a Land Market," *Journal of Public Economics*, 117 (2014), 15-27.

Green, Richard, Malpezzi, Stephen, and Mayo, Stephen, "Metropolitan-Specific Estimates of the Price Elasticity of Housing, and Their Sources," *American Economic Review Papers and Proceedings,* 95, 2 (May 2005), 334-339.

Hamilton, Bruce, "Zoning and Property Taxation in a System of Local Governments," *Urban Studies*, 1-2 (June 1975), 205-211.

Hanuschek, Eric and Quigley, John, "What is the Price Elasticity of Demand for Housing?" *The Review of Economics and Statistics* 62(3), 1980, 449-454.

Henderson, J. Vernon, "Community Choice of Revenue Instruments," *Regional Science and Urban Economics*, 24, 2 (1994), 159-183.

Hoxby, Caroline, "How Much Does School Spending Depend on Family Income? The Historical Origins of the Current School Finance Dilemma," *American Economic Review* 88(2), May 1998, 309-314.

_____________, "All School Finance Programs Are Not Created Equal," *Quarterly Journal of Economics* 116 (4), 2001, 1189-1231.

Inman, Robert, "Optimal Fiscal Reform of Metropolitan Schools: Some Simulation Results," *The American Economic Review* 68(1), March 1978, 107-122.

Inman, Robert and Daniel Rubinfeld, "Designing Tax Policies in Federalist Economies: An Overview," *Journal of Public Economics*, 60 (1996), 307-334.

Jackson, C.Kirabo, "Can High-Achieving Peers Explain the Benefits to Attending Selective Schools? Evidence from Trinidad and Tobago," *Journal of Public Economics* 108, Dec. 2015, 63-77.

Jackson, C. Kirabo, Johnson, Rucker, and Persico, Claudia, "The Effect of School Finance Reforms on the Distribution of Spending, Academic Achievement, and Adult Outcomes," NBER Working Paper 20118, May 2014.

____________________________, "The Effects of School Spending on Educational and Economic Outcomes: Evidence from School Finance Reforms, *The Quarterly Journal of Economics* 131(1), February 2016, 157-218

Kessler, Anke and Lulfesmann, Christopher, "Tiebout and Redistibution in a Model of Residential and Political Choice," *Journal of Public Economics* 89 (2005), 501-528.

Knight, Brian, "Endogenous Federal Grants and Crowd-out of State Government Spending: Theory and Evidence from the Federal Highway Aid Program," *The American Economic Review* 92(1), March 2002, 71-92.

Murray, Sheila, Evans, William, and Schwab, Robert, "Education-Finance Reform and the Distribution of Education Resources, American Economic Review 88(4), Sept. 1998, 789-812.

Nechyba, Thomas, "A Computable General Equilibrium Model of Intergovernmental Aid," *Journal of Public Economics*, 62, 1996, 363-397.

__________, "Local Property and State Income Taxes: The Role of Interjurisdictional Competition and Collusion," *Journal of Political Economy*, 105, 2 (1997), 351-384.

__________, "Centralization, Fiscal Federalism, and Private School Attendance," *International Economic Review*, February 2003, 44(1), 179-204.

Nguyen-Hoang, Phuong and Yinger, John, "The Capitalization of School Quality and Housing Values: A Review," *Journal of Housing Economics*, 20 (2011), 30-48.

Oates, Wallace E, Fiscal Federalism, 1972, New York: Harcourt Brace Jovanovich.

___________, "An Essay on Fiscal Federalism," *Journal of Economic Literature*, 37 (September 1999), 1120-1149.

Parker, Kim, Horowitz, Juliana, Brown, Anna, Fry, Richard, Cohn, D'Vera, and Igielnik, Ruth, "What Unites and Divides Urban, Suburban, and Rural Communities, PEW Research Center, May 2018.

Plott, Charles, "A Notion of Equilibrium and its Possibility under Majority Rule," *American Economic Review*, 57, 4 (September 1967), 787-806.

Poterba, James, "Taxation and Housing: Old Questions, New Answers," *American Economic Review*, 82, 2 (1992), 237-242.

Rothstein, Jesse, "Good Principals or Good Peers? Parental Valuation of School Effectiveness, Tiebout Equilibrium, and the Incentive Effects of Competition among Jurisdictions," *American Economic Review*, 96(4), Sept. 2006, 1333-1350.

Sacerdote, Bruce, "Peer Effects in Education: How Might They Work, How Big Are They and How Much Do We Know Thus Far?" *Handbook of the Economics of Education* 3, 2011, Chapter 4, 249-277.

Schmidheiny, Kurt, "Income Segregation from Local Income Taxation when Households Differ in both Preferences and Incomes," *Regional Science and Urban Economics* 36 (2006), 270-299.

Shepsle, Kenneth A., "Institutional Arrangements and Equilibrium in Multidimensional Voting Models," *American Journal of Political Science* 23(1), Feb. 1979, 27-59.

Tiebout, Charles. M., "A Pure Theory of Local Expenditures," *Journal of Political Economy*, 64 (1956), 416-424.

Verstegen, Deborah, "Policy Brief: How Do States Pay for Schools? An Update of a 50-State Survey of Finance Policies and Programs," Association for Education Finance and Policy Annual Conference," March 15, 2014.

Westhoff, Frank, “Existence of Equilibrium in Economies with a Local Public Good,” *Journal of Economic Theory,* 14 (February 1977), 84-112.

Wildasin, David, “Locational Efficiency in a Federal System,” *Regional Science and Urban Economics*, 10 (1980), 453-471.

Wilson, J., “Property Taxation, Congestion, and Local Public Goods,” *Journal of Public Economics*, 64 (1997), 207-217.

Wooders, Myrna, “The Tiebout Hypothesis: Near-optimality in Local Public Good Economies,” *Econometrica*, 48 (1980), 1467-1485.

Zodrow, George, “The Incidence of Metropolitan Property Tax Base Sharing and Rate Equalization,” *Journal of Urban Economics*, 15, 2(1984), 210-229.

Table 1: School Finance Regimes			
	Properties[*]		
Regime	**State**[**]	**Local**[**]	**Urban Sorting**[***]
Foundation:	Property Tax w Uniform Subsidy	District Property Tax District Income Tax	Yes
Flat State Grant:	Income Tax w Uniform Subsidy	District Property Tax District Income Tax	Yes
Pure State	Income Tax w Uniform Subsidy	No Local Taxation	No
Pure Local	No State Taxation	District Property Tax District Income Tax	Yes
Foundation w Categorical	Property Tax w Set Proportion Total Proceeds to Poor and Rich Districts	District Property Tax District Income Tax	Yes

[*]The same exogenous federal income tax provides a uniform subsidy in every regime.
[**]Relevant tax(es) chosen by majority choice of relevant electorate.
[***]Household sorting is allowed in urban districts.
[****]Analyzed in the online appendix.

Table 2: Equilibrium Properties under Alternative Schooling Regimes					
	Foundation	**Pure Local**	**Flat State Grant**	**Pure State**	**Found. w Categorical (ϕ=.11)**
Positive Properties					
Sorting:					
n^1=	30.36%	22.53%	32.43%	71.43%	34.98%
n^2=	19.07%	18.04%	17.97%		15.24%
n^3=	22.00%	30.86%	21.03%		21.21%
n^R=	28.57%	28.57%	28.57%	28.57%	28.57%
Avg. Housing Value					
D1	$40,831	$33,324	$49,076	$116,512	$39,779
D2	$66,775	$67,934	$90,534		$77,595
D3	$153,492	$150,931	$179,502		$153,816
R	$76,915	$81,407	$93,732	$102,660	$78,563
Per Student Exp.					
g^f=	$1,333	$1,333	$1,333	$1,333	$1,333
g^s=	$4,703	$0	$5,205	$7,342	$4,838 (D1&R) $3,523 (D2&D3)
Per Student Exp. All Sources					
$G^{1=}$	$6,037	$2,450	$6,538	$8,675	$6,171
G^2=	$7,683	$6,111	$8,783		$9,220
G^3=	$22,245	$17,224	$21,644		$22,308
G^R=	$8,660	$7,638	$8,923		$8,664
G^{avg}=	$10,665	$9,152	$10,800	$8,675	$10,770
Peer Measure					
θ^1=	0.3718	0.3635	0.3738	.4125	0.3762
θ^2=	0.4169	0.4036	0.4194		0.4213
θ^3=	0.4648	0.4535	0.4663		0.4660
θ^R=	0.4098	0.4098	0.4098	0.4098	0.4098
Property Taxation (Poterba Adjusted):					
t^s=	2.87%	n/a	n/a	n/a	2.66%
t^1=	0.00%	1.65%	0.00%	n/a	0.00%
t^2=	1.22%	3.47%	1.22%	n/a	2.78%
t^3=	3.78%	3.67%	3.67%	n/a	3.95%
t^R=	1.68%	3.67%	1.26%	n/a	1.57%
Income Taxation:					
m^f=	1.01%	1.01%	1.01%	1.01%	1.01%
m^s=	n/a	n/a	3.95%	5.57%	n/a
$m^{1=}$	0.00%	0.00%	0.00%	n/a	0.00%
m^2=	0.00%	0.00%	0.00%	n/a	0.00%
m^3=	1.61%	2.06%	0.64%	n/a	1.86%
m^R=	0.00%	0.22%	0.00%	n/a	0.00%
Quality Index					
Q^1=	223	85	244	420	235
Q^2=	382	279	444		472
Q^3=	1,473	1,069	1,445		1,487
Q^R=	412	363	425	413	412
Normative Properties					
EV^{avg}=	$179	baseline	$164	-$318	$203
Δ House Rents =	-$219	baseline	$138	$531	-$228

Table 3: Percent Households Preferring FCG to Pure Foundation Regime									
$\phi=.01$	$\phi=.05$	$\phi=.09$	$\phi=.1$	$\phi=.11$	$\phi=.12$	$\phi=.13$	$\phi=.15$	$\phi=.20$	$\phi=\max$
58.75%	58.75%	55.56%	58.11%	89.43%	66.60%	37.41%	28.57%	28.57%	28.57%

Table 4a: Percent Households Preferring Row Regime over Column Regime - Urban and Rural Population Combined					
Regime	Pure Local	Foundation	FCG $\phi=.11$	Flat Grant	Pure State
Pure Local	NA	2.07%	1.10%	6.16%	94.82%
Foundation	97.93%	NA	10.57%	97.95%	100%
FCG ϕ=.11	98.90%	89.43%	NA	100%	100%
Flat Grant	93.84%	2.05%	0.00%	NA	100%
Pure State	5.18%	0.00%	0.00%	0.00%	NA

Table 4b: Percent Households Preferring Row Regime over Column Regime - Rural Pop					
Regime	Pure Local	Foundation	FCG $\phi=.11$	Flat Grant	Pure State
Pure Local	NA	3.94%	0.00%	14.53%	81.86%
Foundation	96.06%	NA	0.00%	92.83%	100%
FCG ϕ=.11	100%	100%	NA	100%	100%
Flat Grant	85.47%	7.17%	0.00%	NA	100%
Pure State	18.14%	0.00%	0.00%	0.00%	NA

Table 5: Percent Households Preferring Row Regime over Column Regime - Urban and Rural Population Combined (Local Income Taxation Not Allowed)

Regime	Pure Local	Foundation	FCG $\phi=.13$	Flat Grant	Pure State
Pure Local	NA	8.98%	3.42%	13.40%	97.67%
Foundation	91.02%	NA	41.64%	45.35%	100%
FCG ϕ=.13	96.58%	58.36%	NA	73.86%	100%
Flat Grant	86.60%	54.65%	26.14%	NA	100%
Pure State	2.33%	0.00%	0.00%	0.00%	NA

Table 6a: Expenditures Schooling Regimes with No Resorting			
	Foundation	**Pure Local**	**Flat State Grant**
Per Student Exp. All Sources			
G^{1}=	$6,037	$3,351	$7,192
G^{2}=	$7,683	$6,452	$7,994
G^{3}=	$22,245	$21,649	$21,546
G^{R}=	$8,660	$7,638	$9,097
G^{avg}=	$10,665	$9,192	$11,046

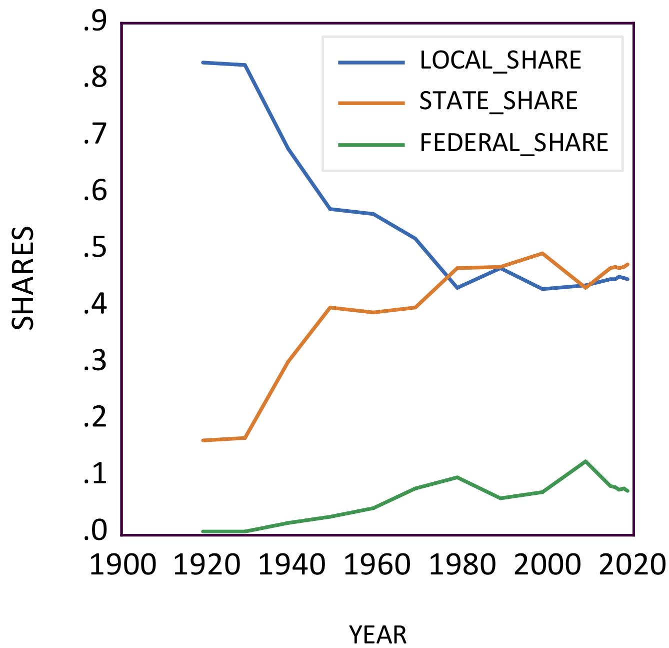
Table 6b: Percent Households Preferring Row Regime over Column Regime with No Resorting - Urban and Rural Population Combined

Regime	Pure Local	Foundation	Flat Grant
Pure Local	NA	42.4%	48.9%
Foundation	57.6%	NA	69.2%
Flat Grant	51.1%	30.8%	NA

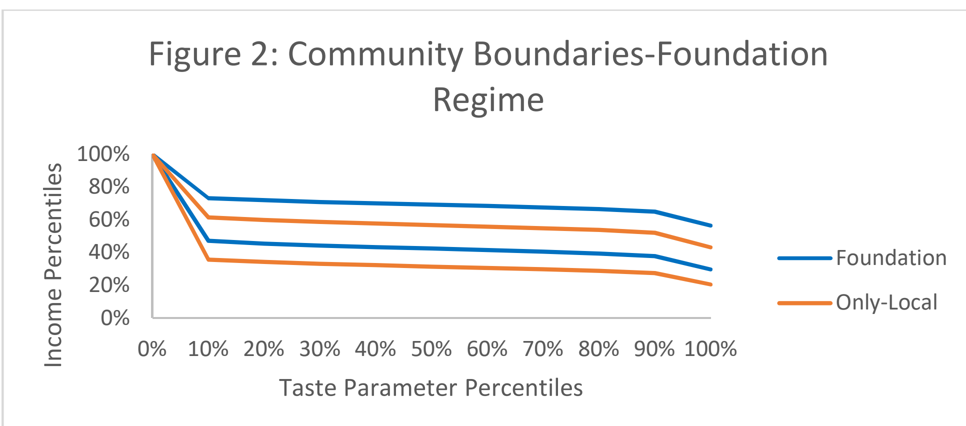
Table 7: FCG Regime Predicted State Shares								
State	**Emp. Share**	**Pred. Share**	**Pred. % HH in City**	**Emp. % HH in City***	**Rural Prop.**	**City+Rur Prop**	**ϕ**	**G^{P}/G^{avg}**
CA	.537	.501	40.8%	45.5%	5.8%	46.6%	0.00	1.00
AL	.538	.501	28.8%	23.4%	42.3%	71.1%	.170	1.17
NY	.376	.376	24.5%	47.4%	12.6%	37.1%	.097	1.10
PA	.371	.243	16.8%	31.1%	23.5%	40.3%	.005	1.01
AZ	.479	.470	39.2%	50.2%	10.7%	49.9%	0.00	1.00
AR	.477	.477	22.2%	27.9%	44.5%	66.7%	.144	1.44
CO	.374	.374	36.9%	45.6%	14.0%	50.9%	.167	1.17
CT	.361	.361	37.0%	33.2%	13.7%	50.7%	.323	1.32
IN	.602	.498	37.7%	30.4%	28.8%	66.5%	.230	1.23
KS	.661	.488	37.8%	27.1%	27.7%	65.5%	.235	1.24
MD	.435	.101	19.7%	37.8%	14.4%	34.1%	0.00	1.00
MA	.396	.290	24.7%	39.2%	8.7%	33.4%	0.00	1.00
NJ	.455	.288	24.3%	41.9%	6.2%	30.5%	0.00	1.00
WA	.678	.386	29.1%	40.5%	16.6%	45.7%	0.00	1.00

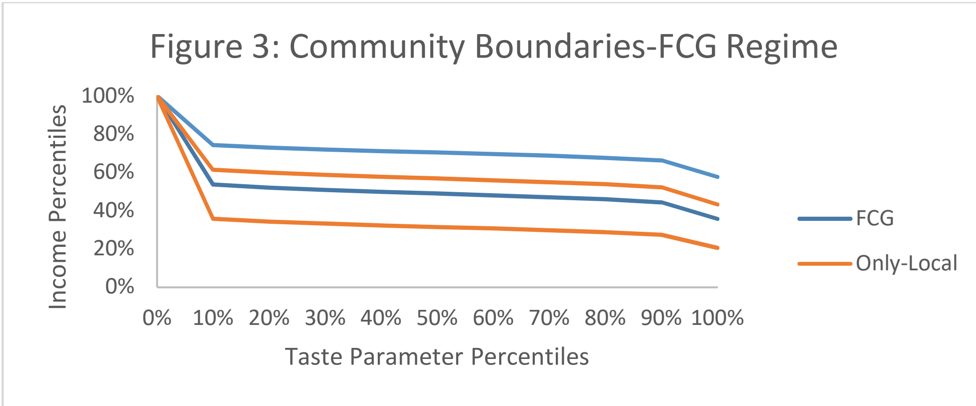
*From 2000 U.S. Census Data.

Figure 1: Long-Term Trends in Public School Finance Shares



Source: https://nces.ed.gov/programs/digest/d22/tables/dt22_201.10.asp





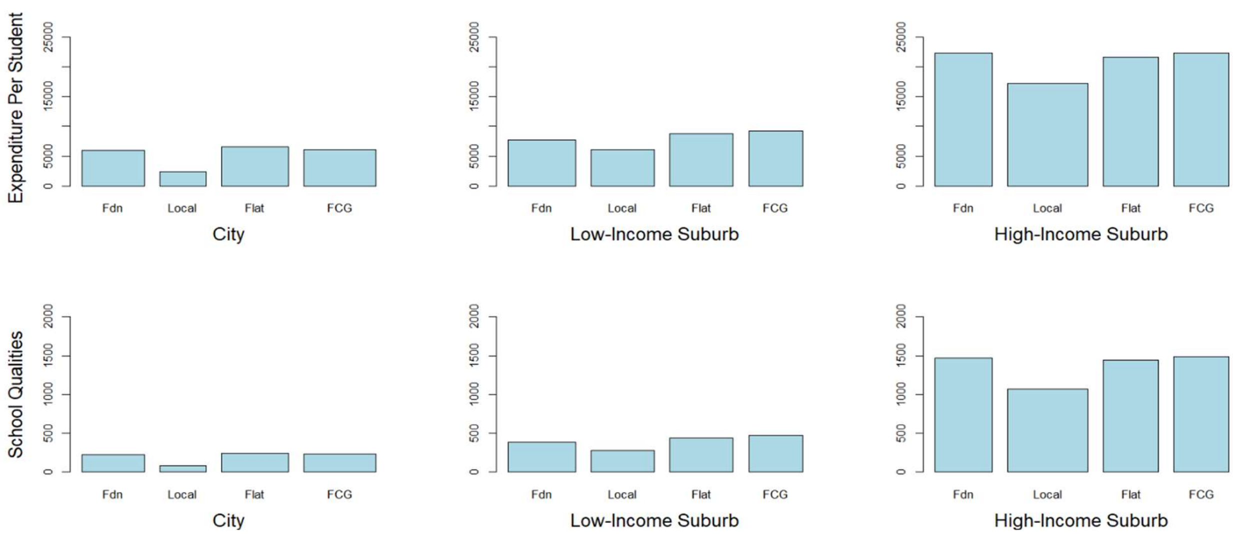


Figure 4: Per Student Expenditures and School Qualities in School Finance Regimes*

(Heights show expenditures and quality indices and widths population shares.)

*The pure state regime is omitted given the lack of district variation.

Figure 5a
Equivalent Variation ($) Urban Area
Pure Local to Flat Grant

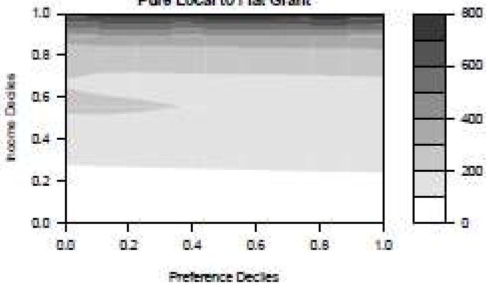


Figure 5b
Equivalent Variation ($) Rural Area
Pure Local to Flat Grant

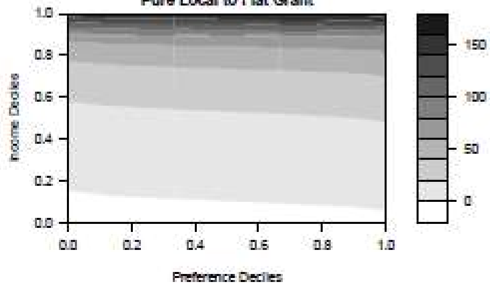


Figure 6a
Equivalent Variation ($) Urban Area
Pure Local to Foundation

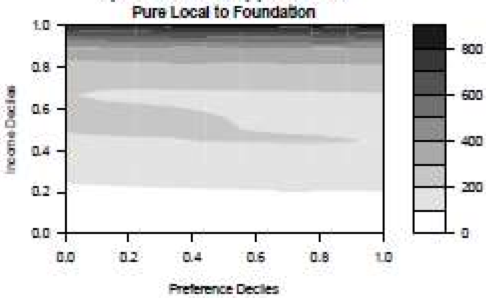


Figure 6b
Equivalent Variation ($) Rural Area
Pure Local to Foundation

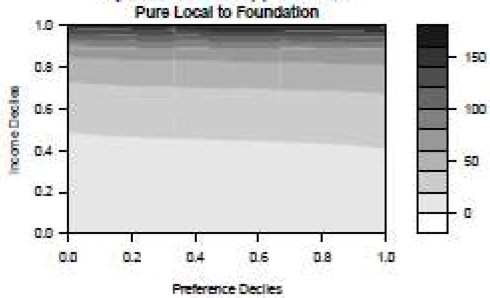


Figure 7a
Equivalent Variation ($) Urban Area
Pure State to Flat Grant

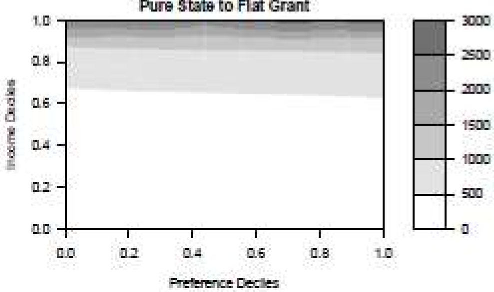


Figure 7b
Equivalent Variation ($) Rural Area
Pure State to Flat Grant

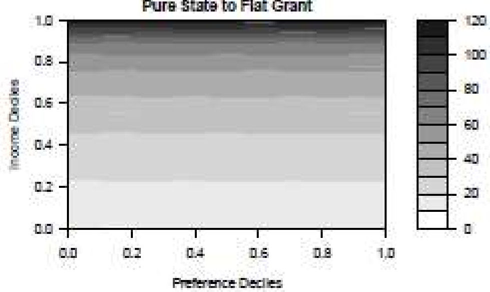


Figure 8a
Equivalent Variation ($) Urban Area
Pure State to Foundation

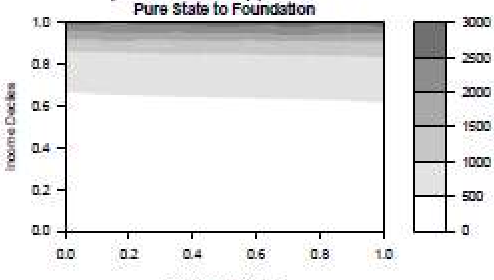


Figure 8b
Equivalent Variation ($) Rural Area
Pure State to Foundation