Household Mobility and the Political Economy and Welfare Effects of Local Tax Limits

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ABSTRACT

I apply a Tiebout model of local jurisdictions to study the political economy and welfare effects of state limitations on the taxing powers of local governments, investigating the effects of such restriction on housing markets, community composition, and the types of expenditures undertaken by local governments. The Tiebout model in this paper is distinguished by voters choosing values of multiple local policy (tax and expenditure) instruments, a mixture of renters and owners residing in each community, and different degrees of household mobility. I am able to characterize and provide sufficient conditions for voting equilibrium even with multiple policy instruments and varying housing tenure by developing a novel application of the Besley and Coate (1997) model of representative democracy. These sufficient conditions are verified in the computational model that is based on parameter values that are broadly consistent with empirical evidence. The different degrees of household mobility following introduction of tax limits have significant impacts on equilibrium values, the predicted level of political support, and the welfare effects associated with these tax limits. For instance, in the computational model, all the local tax limits investigated in this paper are predicted to garner statewide majority political support if only 1% of households are mobile, but not all these tax limits garner majority support if all households in the state are mobile. In addition, almost none of the tax limits increase overall welfare in the computational models, even though many gain majority support. The only case that is predicted to have majority support and increases welfare is when all households are mobile, head and income taxes have previously been constrained, and property taxes are then limited. In this case, the political support comes from households who initially reside in communities that are not impacted by the property tax limitation. These households support this restriction because it incentivizes some residents of these communities to move to other communities, which then benefits not only the emigrants but also the households who remain in these communities. These results accord well with the hypothesis of Vigdor (2001)—that much political support for tax limits comes from a desire by individuals to limit taxes in localities other than their own.

Key Words: Local Tax Limits, Majority Voting, Household Mobility, Intergovernmental Relations, Local Publicly Provide Goods, and Local Redistribution

JEL Codes: H, H2, H3, H4, H7, R
1. Introduction

States impose many restrictions on the taxing powers of local governments. Best known are the property tax limits imposed by popular referenda in California and Massachusetts. These are only the tip of the iceberg, however. Forty-eight states place some form of restriction on local property taxes, the exceptions being Connecticut, Hawaii, New Hampshire, and Vermont. Rate limits impose maximum rates on jurisdictions (e.g., counties, municipalities, and school districts) and apply to property market value.1 Maximum authorized property tax rates range from 0.5 percent (Kentucky) to 5% (Michigan) of property value.2 In addition to setting upper limits on local tax rates, states also limit the instruments that localities are permitted to use. Local governments are creatures of state governments and may use only tax instruments authorized by their state governments. For instance, in most states, local governments are required to have authorization from the state legislature to impose an income or payroll tax. That authorization usually dictates the form of the tax, the permissible range of rates, and the treatment of non-residents. Only 16 states authorize some form of local income taxes, and only 8 have any municipalities that impose income taxes.3 In addition, local head taxes are not commonly observed in practice because local jurisdictions in the U.S. generally do not seem to have the authority to impose these taxes.4

The facts listed in the opening paragraph raise many questions including why voters support state referendum to limit local government taxing powers and the impacts of these limits on efficiency and welfare. Hence, in this paper I apply a Tiebout model of local jurisdictions to study the political economy and welfare effects of state limitations on the taxing powers of local governments, investigating the effects of such restriction on housing markets, community composition, and the types of expenditures undertaken by local governments. The Tiebout

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3 Advisory Commission on Intergovernmental Relations, 1988, and 1995(b), Table 20, pg. 70.
4 Local taxing authority in the U.S. varies by state, with some federal constitutional restrictions. The disallowance of local lump-sum taxes is in many cases implicit in the character of what taxation is permitted in state constitutions. There are “occupational privilege taxes” used in localities of some states, which are also sometimes of a fixed amount. But these are collected by employers, on employees that earn a minimum amount, and generally linked to location of the employer rather than the employee’s residence. It is an interesting legal question as to whether use of local lump-sum taxes would satisfy federal law. Federal law requires that taxes are nondiscriminatory, but whether local lump-sum taxes would be legally discriminatory is unclear.
models in this paper are distinguished by different degrees of household mobility. The degree of household mobility is an important parameter of a Tiebout model because it affects the efficiency of local public goods provision and the amount of local redistribution that is possible. Efficiency is achieved if households with similar preferences for local public goods are able to reside in the same communities. Thus, the greater is household mobility, the greater the potential efficiency of local public good provision. However, if local communities redistribute through direct transfers, the ability of people to move freely from one jurisdiction to another is generally seen as a constraint on the amount of redistribution that each jurisdiction can undertake. Moreover, the more mobile are households, the more severe are the location inefficiencies caused by local redistribution, as the rich will leave the poor and the poor will chase the rich (Musgrave (1971)).

Besides the degree of household mobility, much of the efficiency and equity issues related to local public good provision and redistribution depends on the type of taxation local communities employ to finance these local expenditures, which depends of course on the type of tax limitations that are imposed, if any at all. This is the reason to investigate the relationship between the degree of household mobility, local government fiscal structures, the level of political support, and aggregate welfare effects of limiting the taxing powers of local governments.6

Unlike most of the theoretical Tiebout (1956) literature on multi-jurisdictional economies with endogenous policy determination, in this paper households in each community vary in tenure (renter or owner) as well as in income. Also, as alluded to above, my analysis shows that for understanding the effects of tax limits, it is essential to consider both public-good expenditures and redistributive expenditures. In addition, to understand limitations on the set of tax instruments that municipalities are permitted to use, it is clearly necessary to consider more than one tax instrument. I study the equilibrium among local jurisdictions that emerges when localities are permitted use two or more tax instruments. I then investigate whether there will be majority support for state-level restrictions on local taxes by investigating the equilibrium that emerges when tax limits are imposed.

This two dimensional heterogeneity of households combined with the multi-dimensional set of policy alternatives and possible tax limits, implies that existence of a majority voting
equilibrium in each community is not guaranteed. In order to address the existence issue, I develop and apply an idealized city-council model that is based on Besley and Coate’s (1997) model of representative democracy. Using this political structure, which is explained in detail below, I prove sufficient conditions for a majority voting equilibrium in any community with both renters and owners represented on the city-council and verify computationally these conditions are satisfied. I also use the utility function specification presented in Calabrese, Epble, and Romano (2015; CER (2015) henceforth). However, because of the more complex setting in this paper in which the model has a mixture of owners and renters, I use a “utility taking” assumption concerning voter’s beliefs, while a Nash assumption is made in CER (2015). The utility-taking assumption means that households assume when voting in their community over local policies all variables in the other communities are fixed at equilibrium values.

In general, regardless of the level of household mobility, I find through computational analysis tax limitations have substantial effects on housing prices, spending, and the composition of communities. Compared to no tax limits, adjustments following introduction of tax limits result in decreases in median incomes in all communities as there is migration out of the poorer communities into the richer communities. The electorates in each of the communities then adopt policies quite different from those that prevail in the absence of tax limitations. Tax limits thereby have striking effects on the structure of local government spending.

One interesting result of the model is that if all households are mobile, and if communities are already limited in their use of head taxes, rich communities will use income taxes to restrict the migration of lower income households into their communities and poorer communities will increase redistribution expenditures to reduce migration of relatively richer households into their communities. The rich want to minimize the number of “free-riders” of the local public good and the poor want to minimize the impact on housing prices from richer households moving into their communities. On the other hand, if households are relatively immobile, richer communities do not need to impose local income taxes and poor communities do not need to inflate redistribution expenditures to deter in-migration if head taxes are limited. This latter result leads to statewide support of head tax limitation only if households are relatively immobile, but political support for jointly limiting head taxes and income taxes regardless of household mobility.

Another result and prediction of the model is since local head and income taxes are in general limited by states, and the cost of moving has steadily fallen over time leading to greater

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8 Plott (1967)
9 The Nash assumption used in CER (2015) is that households assume when voting in their community housing prices and public good provision in other communities vary due to in- or out-migration.
household mobility (Rhode and Strumpf (2003)), local property tax limits should have become more common. This is because if households are mobile they may want to limit the property tax rate in a locality in which they do not reside because either they would move to that locality if the tax rate there was lower, or they benefit by households leaving their community to move to the other community. Hence, the more mobile are households, the more likely it is they would support property tax limits. This result supports a fundamental insight of Vigdor (2001), who noted that much political support for tax limits comes from a desire by individuals to limit taxes in localities other than their own.\textsuperscript{10}

This paper proceeds as follows. In sections 2.1 to 2.3, I present the structure of the model in which I characterize households, jurisdictions, housing supplies, and the City-Council Model of Representative Democracy. In section 2.4, I explain the differences in the budget constraints and preferences between owners and renters and how these differences affect policy preferences. In section 2.5, I define the possible different types of equilibria of the model and discuss that with mobile households equilibrium in this model must be characterized by income stratification across communities. In section 2.6, I proof three necessary conditions of an income-stratified equilibrium. The existence of a majority voting equilibrium within communities in which all city-council members are renters or all are owners is proven in section 2.7. Also in section 2.7, I prove a sufficient condition for the existence of a majority voting equilibrium within communities in which both renters and owners are represented on the city-council. This sufficient condition is verified for the computational analysis, the development of which is presented section 3.1 of the paper. In the subsequent parts of section 3, I summarize the distributional and welfare computational results of various types of tax limitations with high and low levels of household mobility. I determine under which levels of mobility the different types of local tax limitations garner majority support and quantify the associated welfare effects of the possible tax limitations. I also discuss testable predictions of the model. I summarize and discuss potential extensions and research directions in section 4.

2. Model and Properties

2.1 Households. The economy of the model consists of a continuum of households that differ in their endowed income $y$. The distribution of income is represented by the continuous distribution $f(y)$ on its support $[0, y_{\text{max}}] \subseteq \mathbb{R}^+$. Normalize the economy’s population to equal 1. An exogenous

\textsuperscript{10}Other factors may play a key role as well. See Fishel (1989) and O’Sullivan, et. al. (1995) for alternative explanations for the popularity of California’s Proposition 13.
 proportion \( \rho \in (0,1] \) of each income type are mobile, the precise meaning clarified below.\(^{11}\) Also, an exogenous proportion \( \omega(y) \in [0,1] \) of households with income \( y \) are renters; the proportion of renters varies with income. Households obtain utility from consumption of a local publicly provided good, \( g \), the quality/quantity of housing consumed, \( h \), and numeraire consumption, \( b \). Households have the same utility function of the form:

\[
U(g,h,b) = v(g)u(h,b)
\]

with all functions increasing and twice differentiable, and with \( u(h,b) \) quasi-concave and homogeneous of degree 1.\(^{12}\) While obviously restrictive, (1) permits substantial variation in preferences, and income affects demands in a realistic way. There is variation in estimates of the income elasticity of housing demand, but unitary elasticity implied by this specification falls well within the range of empirical estimates (e.g., Harmon 1988). Higher income households obtain a higher marginal benefit from increases in the local public good.

2.2 Jurisdictions, Housing Supplies, and City-Council Model of Representative Democracy. The economy is divided into an integer number of jurisdictions, \( J \), each characterized by a non-decreasing housing supply function, \( H_j'(p_j^h) \), \( j = 1, 2, \ldots J \), where \( p_j^h \) denotes the supplier price of housing services. Throughout I use a \( j \) superscript to indicate a value for jurisdiction \( j \), though dropping it where obvious by context. The notation \( \cdot - j \) indicates the set of jurisdictions other than \( j \). Each community \( C_j \), implements a policy consisting of a property tax, \( t^j \geq 0 \), local income tax, \( m^j \geq 0 \), local lump-sum or head tax (or lump-sum transfer if positive), \( r^j \), and expenditures on a publicly provided good, \( g^j \).

With households varying in income, tenure (renter or owner), and the multi-dimensional nature of the set of policy alternatives, existence of a political economy majority voting equilibrium in each community is problematic. To resolve this existence issue, I adopt an idealized city-council model. I believe this city-council model to be well motivated from an institutional point of view and an illuminating way to characterize the majority outcome with both owners and renters. In a subsequent section below, I explain that an equilibrium must be characterized by income stratification among communities, which means each community contains households with incomes in a single interval. I assume that within a community, households sort into neighborhoods based on income. Neighborhoods are single-member districts

\(^{11}\)In the computational equilibrium developed below, I examine two different extreme cases of mobility. The two cases are \( \rho = 1 \) or 100% and \( \rho = 0.01 \) or 1%

\(^{12}\) My results apply to an extended version of the utility function with \( U = v(u+\varphi) \), with \( \varphi \) a constant.
with the same “small” population, and each sends a representative to city-council. There are a large enough number of districts that, within districts, income heterogeneity is negligible. Thus, within a neighborhood, the only difference in preferences arises because some own houses and others rent. The council member serves his/her own interests, which are also the interests of the type in the majority in his/her council district. Let the function for the percentage of renters at each income level be $\omega(y)$. In a neighborhood with endowed income $y$, the councilperson is a renter if $\omega(y) > .5$ and an owner-occupant if $\omega(y) < .5$.

The composition of the council will be as follows. Let $y_l$ and $y_h$ be the lower and upper endowed income boundaries of the community. The income distribution of the council will be a replica of the population income distribution, $f(y)$, in the interval $[y_l, y_h]$. The median-income member of the council will have the median income of the community. Let $y_c$ solve $\omega(y_c) = .5$. All council members with endowed incomes less than $y_c$ will be renters and all with incomes greater than $y_c$ will be owners.

I assume that the council in turn elects a member to implement its policy. Members cannot make binding commitments. Hence, the elected member will implement his or her most preferred (ideal) policy. This city-council thus functions under precisely the same terms as the citizenry in Besley and Coate’s (1997) model of representative democracy. I show in the computational model that the most-preferred policy of the median income council member is a Condorcet (majority choice) winner among the set of council member ideal points by verifying the sufficient conditions presented in proposition 5 below are satisfied. If follows from Besley and Coate (Proposition 2, Corollary 1) that the policy of the median-income council member is adopted.

2.3 Policies and Timing of Choices. Equilibrium unfolds in five stages. All households have rational expectations and behave at each stage perfectly anticipating how equilibrium will unfold in the following stages. In Stage 1, households statewide choose by majority vote whether to implement a local tax limitation proposal, anticipating how equilibrium will unfold in the following four stages. In Stage 2 households select a jurisdiction and a neighborhood where they plan to live given any local tax limitation approved in Stage 1, and again anticipating how equilibrium will unfold in the following 3 stages. Owner households in Stage 2 sign a contract with a competitive housing supplier in the community they initially select to build them a house.

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13 Operationally, I assume a continuum of districts.
14 A detailed explanation of the differences in preferences between owners and renters is provided in subsequent sections.
15 These stages are based on the stages summarized in CER (2015), but are modified to include the state-wide vote over a proposed tax limitation, the existence of owners and renters in the same community, and the vote in city-council over local tax/expenditure policies.
in Stage 5 of quality/quantity $h(y)$, at agreed upon price per unit of $h(y)$. The contract may be renegotiated in Stage 5 when housing is actually built and consumed. The housing price and housing quantity in the contract must equal the ultimate equilibrium housing price and quantity since all agents have rational expectations, but it is convenient here to have different notation for the equilibrium contract price, $p'_{he}$ and housing quantity, $h'_e(y)$.

It should be noted that in Stage 2 since households are atomistic and thus individually have no effect on policy, mobile households are actually indifferent to their initial community choice. I then restrict attention to “no-relocation equilibria,” which assumes mobile households select the community where they will ultimately reside, thus no household relocates on the equilibrium path. A no-relocation equilibrium is also the only type of equilibrium if households discover whether they are mobile after having chosen their initial community.\(^{16}\)

In Stage 3, the city-council in each community $j$ elects a member to implement his/her preferred policy consisting of a property tax, $t^j \geq 0$; local income tax, $m^j \geq 0$, and local lump-sum transfer (or tax if negative), $r^j$. When voting, all city-council members anticipate the continuation equilibrium values of other variables in the economy in Stages 4 and 5. The potential policies that can be implemented are constrained by any local tax limits that were approved in Stage 1.

Entering Stage 4, mobile households can costlessly relocate to another jurisdiction. The 1 – $\rho(y)$ immobile households with income $y$ are locked into the community they chose in Stage 2. I investigate computationally below how varying $\rho(y)$ affects equilibrium with different tax limitation combinations. Following the literature on club goods, I assume mobile households are “utility takers” in making their own relocation choice and in anticipating relocation choices of others. To clarify this simplifying assumption, note first that no one relocates in equilibrium as explained above, but relocation can occur off the equilibrium path. Utility taking means that households in community $j$ take the equilibrium policies and prices in communities $k \neq j$ as given, and then compute utilities of any mobile households under this assumption in predicting moving after the vote on $(t^j, m^j, r^j)$ in stage 3. This is an approximation since this utility would not generally equal the continuation utility if there were a finite population change in community $k$.\(^{17}\) Note that households correctly anticipate all continuation variable values in their initially chosen community given the latter relocations.

\(^{16}\) Specifically, then let $\rho(y)$ denote the known probability that a household with income $y$ will be mobile, an individual’s mobility discovered following initial location but before Stage 3 commences.\(^{17}\) Since $(t^j, m^j, r^j)$ are committed before Stage 4, it is the values of $g^j$ and $p^j$ that can change following finite relocations and then change utility from the models’ equilibrium utility. Utility taking then means
Also, for computationally tractability and to be consistent with the utility-taking assumption, in stage 3 I assume city-council members consider only possible capital gains/losses of their particular constituents and in stage 4 housing contracts of owners are voided if they relocate to another community. While no capital gains or losses arise on the equilibrium path, consumption adjustments for out-of-equilibrium policies and associated capital gains/losses and relocation by mobile households could change the supplier price of housing in a community. Specifically, housing value of a contracted housing quantity would change by \((p'_h - p'_w)h'_c(y)\) out of equilibrium. This potential for a gain or loss for owners causes the preferred policies of owners and renters with the same income to be significantly different. These differences in policy preferences between owners and renters is further explained in more detail below in section 2.4.

In Stage 5, housing is chosen and local housing markets clear determining \(p'_h\) and the buyer price of housing \(p' - (1 + t')p'_w\) in each community, and the local governments’ budgets balance determining \(g'\) in each community. The owner households in stage 5 can optimally “buy out” of their housing contract with the housing supplier and adjust consumption to the level of \(h\) equal to demand at price \((1 + t')p'_w\) and with income including capital gain/loss equal to \((p'_h - p'_w)h'_c(y)\). Housing suppliers would be just as well off under the “buy-out”, and owners would be better off. If \(p'_h > p'_w\), the buyer would experience a capital gain, the housing supplier would pay the buyer \((p'_h - p'_w)h'_c(y)\) not to build, and the housing supplier would be just as well off since the supplier could supply \(h'_c(y)\) in the market at price \(p'_w\). If \(p'_h < p'_w\), then the buyer must compensate the supplier \((p'_w - p'_h)h'_c(y)\) not to build as was agreed. Buyers are better off since they can adjust their housing consumption reflecting the that households do not have fully rational expectations off the equilibrium path. As explained below this assumption greatly simplifies computation of equilibrium and some proofs, and I have found it in closely related analysis (e.g., CER (2015)) to have very minor quantitative effects relative to assuming full rationality and subgame perfection.

18 The first part of this simplification means that city-council members do not anticipate income effects of capital gains or losses off the equilibrium path of households who are not members of their constituency. The second simplification means that households do not realize capital gains or losses if they relocate to another community than the one chosen in stage 2, again off the equilibrium path, this consistent with the utility taking assumption (though not to suggest this is realistic).

19 One might alternatively assume suppliers and buyers share in capital gains/losses, by specifying the capital gain/loss to buyers equal to \(\theta(p'_h - p'_w)h\), with \(\theta \in (0, 1)\); and with the remainder accruing to the supplier.
change in housing price. Note that these prospective capital gains/losses imply the full incidence of property taxes falls on buyers.

2.4 Differences in Household Budget Constraints and Preferences between Renters and Owners

In this section, I explicitly explain the differences in renters’ and owners’ household budget constraints and thus their preferences over policies. I first must explain how I model the effects of income tax distortions on a household’s income. In my model, endowed income is exogenous and there is no labor market, and thus the deadweight loss due to labor market distortions that can potentially be created by a local income tax is not directly captured. Also not necessarily captured is the deadweight loss caused by the effect of local income taxes on tax avoidance through the substitution of tax-exempt compensation (e.g. employer-paid health insurance) for non-exempt compensation and through the substitution of fully or partially deductible consumption (e.g. owner-occupied housing) for non-deductible consumption. Feldstein (1999) shows that deadweight loss of tax avoidance through changes in the form of compensation and through changes in the patterns of consumption can be evaluated as the deadweight loss of an excise tax on non-deductible consumption. Since the property taxes create a deadweight loss, a possible artifact of my model if I do not account for the potential deadweight loss associated with income taxes is a voter bias for the use of income taxes to finance local expenditures. Hence, in order to include any potential deadweight loss associated with income taxes, I model the budget constraint of a renter household with income \( y \) that locates in a particular community, \( j \), as follows:

\[
y(1 - (1 + \gamma)m^j) + r^j = p^j h + b
\]

where \( \gamma > 0 \). It can be shown that given \( \gamma \) and \( m^j \), the reported or taxable income, \( x \), of a household with endowed income \( y \) that locates in community \( j \) is\(^20\):

\[
x = \frac{y(1 - (1 + \gamma)m^j)}{1 - m^j}.
\]

Given \( u(h,b) \) is homogeneous of degree 1, household \( y \)'s housing demand in community \( j \), \( C^j \), can be represented by \( (y(1 - (1 + \gamma)m^j) + r^j)h_y(p^j) \). Linear homogeneity of \( u(h,b) \) also implies that the corresponding indirect utility function is linear in after tax/transfer income (Lau 1969), a property that will prove central in my analysis of voting equilibrium:

\(^{20}\)The derivation of equation (3) is available on request.
As mentioned above, owner households experience capital gains/losses out of equilibrium. For this section of the paper let \( (p_{e}^{j}, r_{e}^{j}, g_{e}^{j}, m_{e}^{j}, p_{he}^{j}) \) represent the equilibrium variable values in community \( j \) and values without the subscript \( e \) represent out of equilibrium values.\(^{21}\) Let \( h_{e}^{j} \) be the amount of housing purchased in equilibrium by an owner household in community \( j \) with endowed income \( y \). When making decisions about whether to change its consumption bundle out of equilibrium, and assuming capital gains are not taxed, this owner household faces the budget constraint:

\[
y(1 - (1 + \gamma)m^{j}) + r^{j} + (p_{e}^{j} - p_{he}^{j})h_{e}^{j} = p^{j}h + b
\]

Again, given linear homogeneity of the utility function in housing and numeraire consumption, the housing demand function is then of the form:

\[
h = (y(1 - (1 + \gamma)m^{j}) + r^{j} + (p_{e}^{j} - p_{he}^{j})h_{e}^{j})h_{e}(p).
\]

Substituting this function into both the budget constraint and the utility function, I obtain the indirect utility function for this owner:

\[
V(y) = v(g^{j})(y(1 - (1 + \gamma)m^{j}) + r^{j} + (p_{e}^{j} - p_{he}^{j})h_{e}^{j})w(p^{j}),
\]

The housing demand in equilibrium given the equilibrium values \( (p_{e}^{j}, r_{e}^{j}, g_{e}^{j}, m_{e}^{j}, p_{he}^{j}) \) for a household with income \( y \) is:

\[
h_{e}^{j} = h(p_{e}^{j}, y(1 - (1 + \gamma)m^{j}) + r^{j}) = (y(1 - (1 + \gamma)m^{j}) + r^{j})h_{e}(p_{e}^{j})
\]

Assume that the majority of households with income \( y \) are owners and thus the city-council member who represents this income level is an owner. When voting such an owner may contemplate voting for a fellow city-council member who prefers a tax/expenditure policy that this particular owner anticipates would cause prices, taxes, and expenditures to change to \( (p^{j}, r^{j}, g^{j}, m^{j}, p_{he}^{j}) \) from the equilibrium values \( (p_{e}^{j}, r_{e}^{j}, g_{e}^{j}, m_{e}^{j}, p_{he}^{j}) \). If such a change were to occur, based on equations (6) and (7) this owner’s utility at \( (p^{j}, r^{j}, g^{j}, m^{j}, p_{he}^{j}) \) would be:

\[
V(y) = v(g^{j})(y(1 - (1 + \gamma)m^{j}) + r^{j} + (p_{he}^{j} - p_{he}^{j})h_{e}(p))w(p^{j}),
\]

This owner’s utility given the equilibrium values of the variables so that \( p_{he}^{j} = p_{he}^{j} \) is:

\[\text{21In section 2.3 above, } p_{he}^{j} \text{ represented the contract price for owners agreed upon in stage 2. Because households have rational expectations and perfect foresight, } p_{he}^{j} \text{ is ultimately the equilibrium net tax price.}\]
Thus, when voting, owner $y$ will vote for an alternative government policy which results in the variable values \( (p', r', g', m', p_{\text{he}}') \) over the equilibrium policy that results in variable values \( (p_{\text{e}}', r_{\text{e}}', g_{\text{e}}', m_{\text{e}}', p_{\text{he}}') \) if the utility in (8) is higher than it is in (9). While renters care only about $p'$, it is clear from (8) that owners care about $p_{\text{he}}'$ as well. Because of this difference, owners and renters with same endowed income have different preferred policy outcomes. Thus, the equilibrium outcomes will vary depending on if the pivotal city-council member is an owner or a renter. However, owners and renters with the same income have the same utility in equilibrium.

2.5 Existence of Equilibrium, Community Differentiation, and Equilibrium Selection.

Given any possible local tax limitation imposed by the state, an equilibrium can be summarized as an allocation of households across communities such that:

1. Within each community:
   a) majority rule among city-council members’ ideal points determines the government’s policy \( (t', m', r') \) conditional on any local tax limitation imposed in Stage 1.
   b) the housing market clears determining $p'$ and $p_{\text{he}}'$
   c) the government's budget is balanced determining $g'$

2. Each community is occupied, and no one wants to move.

The first part of the definition of equilibrium above specifies conditions for internal equilibrium. This together with the second condition specifies conditions for intercommunity equilibrium.

I do not have a general existence proof, but I develop sufficient conditions below for existence that can be checked computationally. I confirm that these conditions hold in my quantitative (computational) analysis below. I also demonstrate in my computational analyses that equilibrium exhibits stratification of households by income across all jurisdictions. That is each community contains households with incomes in a single interval. By contrast, in many multi-jurisdictional models where equilibria with differentiated communities exists, equilibria also exist in which two or more jurisdictions have the same income distributions and the same
I do not find such “clone community” equilibria due to household mobility. In such equilibria, households anticipate the same populations and policies, and then are indifferent to where they locate initially, thus are content to sort to have clone communities. Moreover, with the same community populations, equilibrium policy choices will be the same. However, provided some households are mobile (i.e., $\rho(y)$ is bounded above 0) and the same local policies and populations characterize communities, then a marginal policy change in one jurisdiction will induce finite population relocation. I find that the pivotal city-council member would generally prefer a small policy change to induce “massive” desirable household relocations (e.g., increasing the local lump-sum tax if not constrained to draw in richer households, while driving out poorer households). With jurisdictions stratified by income, marginal local policy changes induce marginal relocations so that equilibrium can exist.

Regarding equilibria with income stratification, a multiplicity issue arises if jurisdictional housing supplies differ. Suppose, for example, that $J=2$ and one jurisdiction has rightward shifted housing supply relative to the other. Any stratified equilibrium has a rich and a poor jurisdiction. Two such equilibria can then arise, one with the “larger” community being the rich one, and the other with the larger community the poor one. The threshold income separating the two income strata in the two equilibria will generally differ. More generally, there can be $J!$ alternative stratified equilibria. To resolve this multiplicity, I designate one community to be the city and assume it is the poorest community. I further assume the remaining communities are suburbs that have the same land areas. Thus, when voting in Stage 1 on the possible tax limitation and when making their initial community choices in Stage 2, households anticipate among any multiplicity of stratified equilibria the latter type equilibrium. Note, too, that if each jurisdiction has the same housing supply, this multiplicity issue does not arise.

2.6. Conditions of Intercommunity Equilibrium.

Proposition 1 presents conditions characterizing stratified intercommunity equilibrium that are applied in the computational quantitative analysis below.

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22 Models where this arises that include housing markets assume that jurisdictional housing supplies are proportional, e.g., the same. This permits equilibrium housing prices to be the same in every jurisdiction.

23 DeBartolome and Ross (2002) provide a dynamic analysis that predicts the relative wealth of the city as compared to the suburbs.
Proposition 1: Consider an allocation in which all communities are occupied and each community contains households with incomes in a single interval. Intercommunity equilibrium is characterized by:\(^{24}\)

a) **Boundary Indifference:** Order communities from lowest to highest income levels. Between each pair of adjacent communities in this ordering is a household that is indifferent between the two communities.

b) **Ascending Bundles:** Incomes ascend across communities in the same order as

\[ v(g^k)(1-(1+\gamma)m^k)w(p^k) \]

**Proof:** Choose any pair of adjacent communities, \(C_j\) and \(C_k\). The difference in utility between communities \(C_j\) and \(C_k\) for a household with income \(y\) is:

\[ \Delta V(y) = v(g^j)(y(1-(1+\gamma)m^j)+r^j)w(p^j) - v(g^k)(y(1-(1+\gamma)m^k)+r^k)w(p^k) \]

Assume \(C^k\) has a higher income level than \(C^j\). This means the average income in \(C^k\), \(\bar{y}^k\), is greater than the average income in \(C^j\), \(\bar{y}^j\). This assumption combined with both communities occupied and utility linear in income implies the following inequalities must hold in a stratified equilibrium:

\[ \Delta V(0) > 0 \Rightarrow v(g^j)r^jw(p^j) > v(g^k)r^k w(p^k) \]

\[ \frac{\partial \Delta V(y)}{\partial y} < 0 \Rightarrow v(g^j)(1-(1+\gamma)m^j)w(p^j) < v(g^k)(1-(1+\gamma)m^k)w(p^k) \]

Equation (11) means that in stratified income, the household with no income must prefer the community with the lower level of overall income, i.e. utility as a function of \(y\) for the poorer community must have a greater intercept than the utility function for the richer community. Equation (12) means that the slope of the utility function for the richer community must be greater than the slope of the poorer community’s utility function; otherwise, the richer community would not be occupied. The linearity of \(\Delta V(y)\) coupled with (11) and (12) imply that there exists a unique \(\hat{y} > 0\) for which \(\Delta V(\hat{y}) = 0\). This establishes part (a) of the proposition. Inequality (12) establishes part (b).

Remark: As income rises, the demand for \(g\) rises, and the dollar cost of an income tax also rises. In addition, as income rises, the demand for housing rises, causing the dollar cost of an increase in the unit price of housing to rise with income. The expression

\(^{24}\) Proof of this proposition builds on the approach developed in Calabrese (2001).
\[v(g')(1-(1+\gamma)m')w(p')\] impounds the effects of changes in the three variables \((g, m, p)\) into a single term that is valued increasingly highly as income rises.

As part of the quantitative computational analysis below, I examine and compare equilibria results if local income taxes are permitted and if local income taxes are prohibited by the state. I prove equilibrium conditions for these two cases in propositions 2 and 3.

**Proposition 2:** Assume local communities are able to employ a proportional income tax as a revenue-generating instrument. Suppose WLOG that \(\bar{y}' < \bar{y}'\). The following relationships are implied by Intercommunity Equilibrium:

i) If \(m' < m^\star\)
   a) then \(r' > r^\star\).
   b) and if \(g' > g^\star\) then \(p' > p^\star\).
   c) and if \(p' > p^\star\) then \(g^\star > g'\).

ii) If \(r' < r^\star\)
   a) then \(m' > m^\star\).
   b) and if \(g^\star > g'\) then \(p' < p^\star\).
   c) and if \(p' > p^\star\) then \(g' > g^\star\).

**Proof:** Parts (ia) and (iia) follow from equations (11) and (12). Parts (ib) and (ic) follow from (12). Parts (iib) and (iic) follow from (11).

I expect that it will generally be the case that the poorest of a pair of communities will have both a higher income tax rate and a higher level of redistribution. However, this need not always be the case. The conditions in Proposition 2 characterize restrictions on allocations in cases in which the income tax rate and the per capita grant do not have the same order. Condition (i) of Proposition 2 states that a community with a relatively low income tax rate may be occupied by poor households if the community offers a relatively high per capita grant. In this case, the higher-income households may prefer the community with the higher income tax rate if the level of government services is higher and/or the housing price is lower. Proposition 2 (ii) provides the conditions for a very unlikely equilibrium allocation in which the grant is lower and the income tax rate is higher in the low income community. An allocation satisfying these conditions can be an equilibrium only if public good provision is extremely high and/or the price of housing is extremely low in the poor community relative to the wealthy community.
Proposition 3: Assume local income tax as a revenue-generating instrument is prohibited. The following conditions are necessary for an allocation to be an Intercommunity Equilibrium:

i) Descending lump-sum grants. The grant level is decreasing in average community income, i.e. \( \bar{y}' < \bar{y}^k \Rightarrow r' \geq r^k \).

ii) If \( g' > g^k \) then \( p' > p^k \).

iii) If \( p' < p^k \) then \( g' < g^k \), and if \( p' = p^k \) then \( g' \leq g^k \).

Proof: If local communities cannot employ income taxes, then equation (12) becomes:
\[
(13) \quad v(g')w(p') < v(g^k)w(p^k)
\]
Part (i) follows from (11) and (13), while (ii) and (iii) follow from (13).

Condition (i) accords well with intuition—low-income households migrate to the community with the highest level of redistribution. If community j also offers higher public good provision, then clearly the price must be higher in j, as stated in (ii). Alternatively, if the price in j is lower than in k, then public good provision must be lower in j than in k. Note that the above conditions do not rule out the possibility that the price in j is higher than in k and public provision in j is lower than in k. This can happen, for example, if the redistributive grant is substantially higher in j than in k.

2.7. Internal Equilibrium: Jurisdictional Majority Choice Equilibrium

Recall that the conditions for internal equilibrium are that, in each community, given any state tax limitation, there is a majority rule among city-council members’ ideal policies determining local tax and expenditure policy, the local housing market clears, and the local government's budget is balanced.

Define the set of all possible \((t, m, r)\) combinations for community j as the set of Possible Government Policies (PGP). In a PGP any tax limitation is predetermined in Stage 1 of the continuation equilibrium, and from the definition of internal equilibrium from above, the associated \((g, p, p_h)\) combination for any member of PGP satisfy the government’s balanced budget and housing market clearing conditions, and \( p_h = \frac{p}{1 + t} \). It should be noted again here that since household perfectly anticipate equilibrium values, and in Stage 2 households locate in the community that provides them with the highest utility among all the communities in equilibrium, the utility taking assumption implies that households would never anticipate being
made better off than they are in equilibrium by moving to another community. That is, for example, if in stage 3 of the equilibrium an alternative out-of-equilibrium local government policy was implemented in a community, then some households who prefer the equilibrium policy to the alternative policy may have an incentive to move to another community in stage 4 to avoid the alternative policy. It is possible in this case that if a finite group of households moved to another community they would distort the values of $p$, $p_b$, and $g$ from equilibrium values in this other community (note: $(t, m, r)$ are determined before stage 4 moving) and make some of them better off than under the equilibrium policy in their initial community. However, since the utility-taking assumption means that households assume when voting in their community all variables in the other communities are fixed at equilibrium values, they would never anticipate the possibility that by relocating they could be made better-off than they are in equilibrium in their initially chosen community. This fact simplifies the proofs below of majority voting equilibrium within a community.

In the city-council model, a government policy in community $j$ consisting of $(\bar{t}, \bar{m}, \bar{r})$ is a Majority Voting Equilibrium (MVE) if it is a city-council member’s ideal policy in $PGP_j$ and there is no other city-council member’s ideal policy preferred to $(\bar{t}, \bar{m}, \bar{r})$ by a majority of the city-council members. If all city-council members are renters or all are owners, then following proposition provides the proof of an MVE in a community.

**Proposition 4:** If all council members are renters or all are owners, the Majority Voting Equilibrium in a community is the policies among Possible Government Policies most preferred by the community’s median-income council member.25

**Proof:** Assume all council members in a community are renters. Let $\bar{x} = (\bar{t}, \bar{m}, \bar{r})$ denote the policy most preferred by the median income council member, $\bar{y}$, $(\bar{p}, \bar{p}_b, \bar{g})$ equilibrium values associated with $\bar{x}$, and assume $\bar{x}$ is the MVE. To form a contradiction that $\bar{x}$ is not the MVE suppose there exists another council member’s ideal policy $x = (t, m, r)$ that defeats $\bar{x}$. Let $\Delta V(y)$ be the difference in utility that voter $y$ obtains between $\bar{x}$ and $x$:

$$\Delta V(y) = v(\bar{g})(y(1 - (1 + \gamma)\bar{m}) + \bar{r})w(\bar{p}) - v(g)(y(1 - (1 + \gamma)m) + r)w(p),$$

25The strategy of proof of this proposition is due to Cassidy (1990) who exploits the linearity of the indirect utility function in income to study voting equilibrium in a model with a flat grant financed by a property tax.
It cannot be the case that $\Delta V(y) < 0$ for all $y$. This would contradict the assumption that $\bar{x}$ is the point most preferred by the median-income voter. Alternatively, if $\Delta V(y) > 0$ for all $y$, then $\bar{x}$ is unanimously preferred to $x$. If all voters are indifferent between $\bar{x}$ and $x$ (i.e., $\Delta V(y) = 0$ for all $y$), then I adopt the convention that $\bar{x}$ is chosen.

This leaves cases where some voters strictly prefer $\bar{x}$ to $x$ while others strictly prefer $x$ to $\bar{x}$. For these cases, the linearity of $\Delta V(y)$ implies that there is a unique $\hat{y}$ such that $\Delta V(\hat{y}) = 0$. There are two possibilities. One is that voters preferring $x$ to $\bar{x}$ have incomes less than $\hat{y}$. If $x$ defeats $\bar{x}$, these voters comprise more than half the population. This implies $\hat{y} < \hat{y}$ which in turn implies that $\hat{y}$ prefers $x$ to $\bar{x}$. This is a contradiction since $\hat{y}$’s most preferred outcome on the BPF. The other alternative is that voters with income greater than $\hat{y}$ prefer $\bar{x}$ to $x$. Since $x$ defeats $\bar{x}$, these voters comprise more than half the population. This implies $\hat{y} > \hat{y}$ which implies that $\hat{y}$ prefers $x$ to $\bar{x}$. This is again a contradiction since $\hat{y}$ prefers $\bar{x}$ to $x$.

The logic of the proof for the all the owners case is the same except based on equations (8) and (9) and $p_h = \tilde{p}_h$ in equilibrium, $\Delta V(y)$ from equation (14) becomes:

$$
\Delta V(y) = v(\tilde{g})(y(1-(1+\gamma)\tilde{m}) + \tilde{r})w(\tilde{p}) - v(g)(y(1-(1+\gamma)m) + r + (p_h - \tilde{p}_h)(y(1-(1+\gamma)m) + \tilde{r})h_{\delta}(\tilde{p}))w(p)
$$

By contrast, there is no extension of Proposition 4 for a community when both owners and renters on city-council that preserves the generality of the result. The multi-dimensional nature of the set of alternatives underlies the lack of generality. Proposition 5 provides a proof a sufficient conditions that can be verified computationally for a MVE over a city-council members’ ideal points with a mix of renters and owners. Consistent with above, the income distribution in a community is in the range of $[y_l,y_h]$ and all council members with endowed incomes less than $y_c$ are renters and all with incomes greater than $y_c$ are owners.

**Proposition 5:** If $\hat{y} > (<) y_c < y_h$ in a community, $\bar{x}$ is the MVE if any other city-council member’s ideal policy, $x$, makes $y_h (y_l)$ better off, then this policy also makes the two city council members who represent $y_c$ and $y_l (y_h)$ worse off.

**Proof:** If $\bar{x}$ is the MVE, the utility $y$ obtains as an owner under an alternative policy $x$ is:

$$
V_\alpha(y;x) = v(g)(y(1-(1+\gamma)m) + r + (p_h - \tilde{p}_h)(y(1-(1+\gamma)m) + \tilde{r})h_{\delta}(\tilde{p}))w(p)
$$

26 This proposition implies that the well-known Plott (1967) conditions hold for our model.

19
The utility \( y \) obtains as a renter under an alternative policy \( x \) is:

\[
V_y(y; x) = v(g)(y(1 - (1 + \gamma)m) + r+)w(p)
\]

Given that \( \tilde{x} \) is the MVE, the functions \( V_o(y; \tilde{x}) = V_r(y; \tilde{x}) \) because there are no capital gains in equilibrium.

i) First case: \( \tilde{y} > y_c \), which means \( \tilde{y} \) is an owner.

If \( V_o(y_{\tilde{y}}; \tilde{x}) > V_o(y_{\tilde{y}}; x) \), then \( \tilde{x} \) defeats \( x \) in pair wise vote in the city-council because \( V_o(y; \tilde{x}) > V_o(y; x) \) and \( \Delta V_o = V_o(y; \tilde{x}) - V_o(y; x) \) is linear in \( y \), thus all \( y > \tilde{y} \) must prefer \( \tilde{x} \) to \( x \).

If \( V_o(y_{\tilde{y}}; \tilde{x}) < V_o(y_{\tilde{y}}; x) \), all owners with \( y < \tilde{y} \) prefer \( x \) to \( \tilde{x} \) because \( V_o(y_{\tilde{y}}; \tilde{x}) > V_o(y_{\tilde{y}}; x) \) and \( \Delta V_o = V_o(y; \tilde{x}) - V_o(y; x) \) is linear in \( y \). Thus, if \( V_r(y_{\tilde{y}}; \tilde{x}) > V_r(y_{\tilde{y}}; x) \) and \( V_r(y_{\tilde{y}}; \tilde{x}) > V_r(y_{\tilde{y}}; x) \), all renters prefer \( \tilde{x} \) to \( x \) because \( \Delta V_r = V_r(y; \tilde{x}) - V_r(y; x) \) is linear in \( y \).

Hence, at least all \( y < \tilde{y} \) prefer \( \tilde{x} \) to \( x \).

ii) Second case: \( \tilde{y} < y_c \), which means \( \tilde{y} \) is a renter.

If \( V_r(y_{\tilde{y}}; \tilde{x}) > V_r(y_{\tilde{y}}; x) \), then \( \tilde{x} \) defeats \( x \) in pair wise vote in the city-council because \( V_r(y; \tilde{x}) > V_r(y; x) \) and \( \Delta V_r = V_r(y; \tilde{x}) - V_r(y; x) \) is linear in \( y \), thus all \( y < \tilde{y} \) must prefer \( \tilde{x} \) to \( x \).

If \( V_r(y_{\tilde{y}}; \tilde{x}) < V_r(y_{\tilde{y}}; x) \), all renters with \( y > \tilde{y} \) prefer \( \tilde{x} \) to \( x \) because \( V_r(y_{\tilde{y}}; \tilde{x}) > V_r(y_{\tilde{y}}; x) \) and \( V_r(y_{\tilde{y}}; \tilde{x}) > V_r(y_{\tilde{y}}; x) \), all owners prefer \( \tilde{x} \) to \( x \) because \( \Delta V_o = V_o(y; \tilde{x}) - V_o(y; x) \) is linear in \( y \).

Hence, at least all \( y > \tilde{y} \) prefer \( \tilde{x} \) to \( x \).

3. Quantitative model

3.1 Development of Computational Equilibrium

To show existence and development of more specific implications about the features of equilibrium requires more specific information about preferences, technology, the distributions of income and housing tenure, the number of jurisdictions and the land area of each. I therefore turn to numerical computations based on the theoretical model above to illuminate properties of the model. The parameterization of the functions are based on the values calibrated in CERS (2015).

As a summary, I utilize functional forms and parameter values that are broadly consistent with empirical evidence on housing supply and demand functions, government expenditures, and the
distribution of income in the U.S. I chose the following Cobb-Douglas utility function, which is consistent with the assumptions for equation (1):

\[ U(g, h, b) = g^\alpha h^\beta b^{1-\alpha} \]  

I chose values for \( \alpha \) and \( \beta \) such that, if \( g, h, \) and \( b \) were all privately purchased goods, the gross-of-tax expenditure on housing would be 20% and the fraction spent on local public goods would be 9%, which is approximately the share of GDP spent on local public goods. This yields \( \alpha = 0.21978 \) and \( \beta = 0.098901 \). In CER (2015) the value of the income tax distortion was calibrated as \( \gamma = 0.2471 \).

To calibrate the housing supply functions, I assume price taking housing producers combine the community’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. Under these assumptions, a community’s housing supply is given by a constant elasticity supply function:

\[ H_j(p') = L_j(p''_j)^{1-\mu} \left( \frac{1-\mu}{w} \right)^{\frac{1-\mu}{\mu}} \mu^\mu \]  

where \( L_j \) is the land area of community \( j \) as a proportion of total (developable) land area in the economy (normalized to 1), \( \mu \) is the ratio of non-land to land expenditure in the production of housing, \( \varepsilon_H \) is the housing supply elasticity, and \( w \) is the price per unit of non-land factors. Based on available evidence regarding the share of land and non-land inputs in housing (Epple, Gordon, and Sieg, 2010), \( \varepsilon_H \) is set equal to three. Since the choice of \( w \) does not affect equilibrium variable values that impact households’ relative utilities, I choose \( w \) so that

\[ \left( \frac{1-\mu}{w} \right) = 1 \text{ when } \varepsilon_H = 3. \]  

This implies \( w = \frac{3}{4} \).

---

27 The share of aggregate income spent on housing of 20% is in the range of values estimated in the literature.
28 Data for this approximation are from the 2008 Statistical Abstract Tables 442 and 645 for 2004.
29 In CERS 2015 I calibrated \( \gamma \) by using data for the federal income tax and thus assuming a 1 community model. Using the 2010 U.S. Census, I calculate aggregate household income of $7,865,744,350,464. Total U.S. Federal Income tax receipts in 2010 were $898,549 million. Hence, I estimate the average 2010 federal household income tax rate as 11.4%. Given the other calibrated parameters, I find the \( \gamma \) such that the baseline equilibrium in CERS 2015 has \( m = 11.4 \). This implies \( \gamma = 0.2471 \).
30 See Epple and Zelenitz (1981). This derivation is also provided in the on-line appendix.
31 The choice of \( w \) 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 in equation.
I assume the economy’s income distribution is lognormal. The distribution is calibrated using the 2010 U.S. Census findings of mean and median household income of $67,392 and $49,276, respectively.\textsuperscript{32} These values imply \( \ln y \sim N(10.805, 0.791) \).

In order to estimate the fraction of renters at each income level, I estimated the parameters of the following function:

\[
\rho(y) = \begin{cases} 
\psi y^{-\delta} & \text{for } y > \psi^{1/\delta} \\
1 & \text{for } y \leq \psi^{1/\delta}
\end{cases}
\]

The American Housing Survey (AHS) presents data on the number of renter- and owner-occupied housing units in different income classes.\textsuperscript{33} The AHS data is only provided for odd numbered years, so I used the results from the 2011 Survey to try to be consistent as possible with the 2010 census findings on mean and median household income that I used to calibrate the income distribution. I only used the AHS data that was based on Urbanized Areas of 50,000 or more people. In estimating this equation, I drop the highest and the lowest income categories from the total of 14 categories.\textsuperscript{34} I computed average income, \( \bar{y} \), in each income class, using the lognormal distribution of household income that I calibrated. Regressing the log of the proportion of households who are renters, \( \rho \), against the \( \ln \bar{y} \) gives estimates of \( \psi \) and \( \delta \).

The resulting regression, with t-statistics in parentheses is:

\[
\ln \rho = 4.4054 - 0.50694 \times \ln \bar{y}, \quad R^2 = .90 \\
(7.66) \quad (9.22)
\]

This equation implies \( \psi = \exp(4.4054) = 81 \), \( \delta = 0.507 \). Based on this function, \( y_c \) is estimated to = $23,330.

In the computations equilibrium I consider a metropolitan area with 3 local jurisdictions—a large city and 2 smaller suburbs that have equal land area. The city has 40% of the total metropolitan land area and each of the suburbs has 30% of the land area. I assume that the city is the poorest jurisdiction.\textsuperscript{35}

In these computations, in order to test the impact of mobility on equilibrium, I examine two extreme cases of mobility. The first case is 100% of households are mobile, which means \( \rho = 1 \). The second case is only 1% of each income type is mobile, so \( \rho = 0.01 \).

\textsuperscript{32} U.S. Census Bureau, 2011, Table H-6 from Historical Income Tables.

\textsuperscript{33}https://www.census.gov/programssurveys/ahs/data/interactive

\textsuperscript{34}The estimated function is used to calculate the income at which the fraction of households switches from being majority renter to being majority of owner occupant. Thus, fit in the interior of the income distribution is our primary concern.

\textsuperscript{35}This ratios or land areas are the same or very similar used in many other local community models. This papers include Epple/Romer 1991, Calabrese 2001, Calabrese et al (2002, 2007, and 2012)
Based on the theoretical results and assumption above, and given calibrated functions and parameter values, computed stratified equilibrium assuming utility-taking households and no tax limitations is derived by first simultaneously solving the constraint optimization problem for each community j:

If the median city-council member \( \tilde{y}^j \) is a renter:

\[
\text{Max}_{g^j, m^j, r^j, \tilde{y}^j} v(g^j)(\tilde{y}^j(1-(1+\gamma)m^j + r^j))w(p^j)
\]

If the median city-council member \( \tilde{y}^j \) is an owner:

\[
\text{Max}_{g^j, m^j, r^j, \tilde{y}^j} v(g^j)(\tilde{y}^j(1-(1+\gamma)m^j) + r^j + \left(\frac{p^j}{1+t^j} - \frac{\tilde{p}^j}{1+t^j}\right)(y(1-(1+\gamma)m^j) + \tilde{r}^j)h_j(\tilde{p}^j))w(p^j),
\]

where \( \frac{p^j}{1+t^j} = \frac{\tilde{p}^j}{1+t^j} \) in equilibrium.

In either case, the constraints are:

\[
\text{(23)} \quad \text{s.t.} \quad t^jL^j\left(\frac{p^j}{1+t^j}\right)^{\frac{1}{u}} + \frac{m^j(1+(1+\gamma)m^j)}{1+m^j} \int_{y^j}^\gamma yf(y)dy - \left(g^j + r^j\right)\int_{y^j}^\gamma f(y)dy
\]

\[
\text{(24)} \quad \frac{\alpha}{p^j} \left[\left(1-(1+\gamma)m^j\right)\int_{y^j}^\gamma yf(y)dy + r^j\int_{y^j}^\gamma f(y)dy\right] - L^j\left(\frac{p^j}{1+t^j}\right)^{\frac{1-u}{u}}
\]

\[
\text{(25)} \quad v\left(g^{j-1}\right)(y^{j-1}(1-(1+\gamma)m^{j-1} + r^{j-1}))w(p^{j-1}) = v\left(g^j\right)(y^{j-1}(1-(1+\gamma)m^j + r^j))w(p^j)
\]

\[
\text{(26)} \quad v\left(g^j\right)(y^j(1-(1+\gamma)m^j + r^j))w(p^j) = v\left(g^{j+1}\right)(y^j(1-(1+\gamma)m^{j+1} + r^{j+1}))w(p^{j+1})
\]

Equation (23) is the government’s balanced budget condition and equation constraint (24) is the housing market clearing condition. Equations (25) and (26) are the boundary indifference conditions from Proposition 1. Community \( j-1 \) is the next lower income community from \( j \) and \( j+1 \) is the next higher income from \( j \). Household \( y^{j-1} \) is the boundary household who is indifferent between communities \( j-1 \) and \( j \), and is thus the lowest income household in
community $j$. Household $y^{j}$ is the boundary household who is indifferent between communities $j$ and $j+1$ and is thus the highest income household in community $j$.\textsuperscript{36}

The following equation for each community must also be satisfied in equilibrium to determine $\tilde{y}^{j}$:

$$
(27) \quad \left( \int_{0}^{y^{j}} f(y) dy - \int_{0}^{y^{j+1}} f(y) dy \right) = \left( \int_{0}^{y^{j}} f(y) dy - \int_{0}^{y^{j+1}} f(y) dy \right) \frac{1}{2}
$$

The next step in the computing equilibrium is to verify if $\tilde{y}^{j} < y_{c}$, then equation (21) is maximized and not equation (22). Equation (22) is maximized if $\tilde{y}^{j} > y_{c}$. In addition, if any community has a city-council consisting of a mixture renters and owners, the final step in computationally deriving equilibrium is to verify that the conditions from Proposition 5 are satisfied.

3.2. Computational Equilibria, Distributional, and Welfare Effects of Tax Limitations with varying Household mobility.

3.2.1. No local tax limits-Baseline Case

When local tax rates are not constrained by a higher-level government and 100\% of households are mobile, the computational equilibrium outcome is reported in column (1) of Table 1. Only community 1 has a mixture of owners and renters on its city-council, and thus only for this community the conditions of Proposition 5 had to be verified to ensure a MVE over city-council members’ ideal points exists. The pivotal city council member has an endowed income $33,092, and thus is an owner. In the other two richer communities all the city-council members are owners, so Proposition 4 is applicable and a MVE is guaranteed. The equilibrium results indicate that local income taxes are not used as all three communities prefer to use head taxes and a very small amount of property taxes to finance public expenditures.\textsuperscript{37} Even though local pivotal (median income council members) voters have income below the local mean implying some

\textsuperscript{36}When solving this optimization problem, if the percentage of households that are mobile are less than 1, which in this paper means $\rho =0.01$, then in the F.O.C.s for the boundary incomes ($y^{j+1}$ and $y^{j}$) the population density at the boundary income is multiplied by 0.01.

\textsuperscript{37}These reported computed property tax rates are on services (rent) not value. Poterba (1992) estimates a conversion rate of property values to annualized flow between 7\% and 9\%. Thus, the property tax rate of 9.11\% for community 3 is converted to between 0.6\% and 0.8\% on value.
incentive to redistribute, no community redistributes or uses income taxes because the differences in median and mean income is small and thus any incentive to redistribute is relatively weak and largely (or completely) offset by the income tax distortion. The small level of property taxes is due to the fact housing owners have a weak incentive to tax property because none of the tax incidence can be transferred to absentee landlords, as would be the case if they were renters.

The effects on the equilibrium values with no local tax limits of reducing the percentage of households at each income level that are mobile to 1% are presented in column (1) of Table 2. The main differences compared to the 100% household mobility case are that the level of public good provision in each community is lower, but the property tax rates in the richer communities are slightly higher. One of the main benefits of increasing public good provision financed by head taxes for the pivotal voter in the richer community is to drive out lower income households, who impose a fiscal externality on richer households. When 99% of households at each income level are immobile, however, this benefit from head taxes is lost, which causes the pivotal voter to prefer lower head taxes and consequently lower public good provision. Also, since for the most part households are immobile, increasing property taxes slightly to offset the loss in revenue from lower head taxes does not lead to influx of lower income households who could otherwise move into the community and partially “free-ride” on the public service by purchasing or renting a small amount of housing.

Two further points are of interest with respect to the result just described. One is that this allocation does not satisfy the Plott (1967) conditions that guarantee a majority voting equilibrium. There are feasible alternatives that defeat in pair-wise majority voting the policy preferred by the median-income voter in each community. However, those alternatives are not the most-preferred policy of any city-council member and thus fail the credibility restriction adopted by Besley and Coate. This result illustrates the power of the Besley-Coate framework. The second observation concerns the role of our city-council formulation. Suppose candidates not nominated by their districts could nonetheless garner the resources to run. There would then be candidates whose ideal points defeat the ideal point of the median-income council member. Such ideal points are not equilibria, however. My city-council formulation assures that such candidates do not represent their respective districts on the city-council.

The main purpose of this paper is to provide positive and normative analyses of local tax limitation and how varying household mobility affects these results. This is what I do in the subsequent sections.

38 Details documenting all claims in this paragraph are available on request.
3.2.1. Head Tax Limitations

The computations in the preceding section indicated that the median city-council member in each community prefers using a head (or lump-sum) tax to almost fully finance the publicly provided good. However, local head taxes are not commonly observed in practice. In fact, local jurisdictions in the U.S. generally do not seem to have the authority to impose head taxes in that very few states authorize local head taxes. \(^39\) In light of these facts, in this section I examine the distributional and welfare effects of limitation on local head taxes. I derive computational equilibria results when local head taxes are limited to 5% of local public good expenditures and explore whether there is political support for this type of limitation and hence provides an explanation on why head taxes are usually limited in practice. \(^40\) The overall welfare impacts of a head tax limitation are also examined. I limit the local head tax to be small (5%) but not 0 because even when the lump-sum residential taxation is prohibited, numerous small effectively fixed taxes exist. \(^41\)

The computational results for limiting local head taxes to 5% of public good provision with 100% household mobility are reported in column 2 of Table 1. One key result is that when local head taxes are limited, the pivotal voter in the city is a renter with income less than $23,330 as opposed to an owner as in the no tax limit case. The richer households in each of the two lower income communities reside in higher income communities. Also, even though the median in community 1 is greater than the mean (opposite of what occurs with no head tax limit), the median still prefers a redistribution lump-sum grant instead of a head tax. This is because the pivotal voter in the city is quite poor and has income only slightly above the mean, and so chooses a tax package that includes a lump-sum grant to deter richer households from residing in the city in order to keep down the rental price of housing. As is shown in table 2 column 2, when household mobility is only 1%, and thus the pivotal voter in the poorest community does not need to be concerned with deterring richer households from locating in the community when deciding on a tax package, a head tax is imposed instead of lump-sum grant. Also, the pivotal renter in the city prefers a high level of property taxation regardless of household mobility because a substantial portion of the tax burden is transferred to the absentee landlords. Property taxes are

\(^39\) Local taxing authority in the U.S. varies by state, with some federal constitutional restrictions. The lack of authority local communities have in general to impose lump-sum taxes is in many cases implicit in the character of what taxation is permitted in state constitutions.

\(^40\) This is the same restriction on head taxes used in Calabrese et. al 2012 and 2015.

\(^41\) For instances there are “occupational privilege taxes” used in localities of some states, which are also sometimes of a fixed amount. Also, many communities have other fixed taxes such as license taxes, garbage collection, mosquito abatement, etc. To be clear, the choice of 5% is arbitrary, just a low amount. The essential findings carry over for other “low amounts.” Note, however, that shutting down completely lump-sum taxation causes existence problems unless I modify the utility function.
also substantially higher in the middle-income community 2 to finance the local public good, not surprisingly given the loss of potential tax revenues from the head tax limitation and the reluctance to tax income. However, with 100% household mobility, the pivotal owner in the richest community 3 prefers income taxes over property taxes to offset the loss in tax revenue. This must again be due to the richer community wanting to deter poorer households from locating in the community to avoid the resulting negative fiscal externality. The negative fiscal externality is greater with property taxes than income tax because housing consumption is endogenous. This effect is highlighted by the result shown in Table 2 that with 1% household mobility the pivotal voter in the rich community prefers relatively high property taxes and almost no income taxes.

Since a significant level of local head taxes are rarely if ever implemented in practice, the computational model should predict that in a state-wide referendum that includes the combined electorate of the city and suburbs a majority of households in the economy should prefer a local head tax limitation. Since households have rational expectations and anticipate continuations equilibrium outcomes, I test this prediction of majority support for a head tax limitation by comparing the utilities households obtain in the equilibria with and without the local head tax limitation.\textsuperscript{42} The model predicts, as expected, that lower income households are better-off with a head tax limitation. However, only when household mobility is very low, such as 1%, does a majority of households, 52.18%, prefer the head tax limitation. Only a minority of households, or 45.71%, are better-off with the head tax limitation when all households are mobile.\textsuperscript{43} As mentioned above, with 100% household mobility, the richest community reluctantly imposes an income tax to deter poorer households from locating in the community. But when there is a low level of household mobility, the richer communities can impose its preferred property tax with a very minimal negative fiscal externality effect. Hence, even a significant proportion of the lower income households in the richest community prefer the head tax limitation when only 1% of the households are mobile and this results in a majority of households in the state electorate supporting a local head tax limitation. Thus, if households are relatively immobile, a state government, serving both city and suburban residents, would find political support for a head tax limitation, which is consistent with what is observed in practice.

\textsuperscript{42} Since housing contracts are signed after the restriction is voted on in a state-wide referendum, there are no capital gains along the equilibrium path beginning in stage 2 for any local tax or expenditure limitation. That is, voting on the tax restriction takes place before anything else. Thus, I just compare the utility households get in equilibrium with no restrictions to the utility households get in equilibrium with the tax restriction, not considering any capital gains that may occur if the restrictions were imposed after housing contracts were signed.

\textsuperscript{43} Of course if a majority of state-wide households have higher utility without the head tax limitation, the predicted equilibrium would be the no tax limit case.
The welfare effects of the head tax limitation are reported at the bottom column 2 of Tables 1 and 2 for the 100% and 1% household mobility cases respectively. I calculate the aggregate welfare effects as measured by per-capita equivalent variation plus changes in per-capita economic rents using no tax limits equilibrium as the baseline. As the tables show, even for the case in which there is majority support for the tax limitation (the 1% household mobility case) there is a loss in welfare. This result is not surprising given the known efficiency results of financing public expenditures through a head tax. A minority of households in the state are made worse-off by the head tax limitation, but these households are rich households who experience large welfare losses, causing an overall welfare loss.

3.2.2. Head Tax Limitations Combined with a Prohibition on Local Income Taxes

In the computational results with no local tax limits described above local income taxes are not implemented. Only when the head taxes are limited do the computations indicate some local income taxes would be used to offset the loss in tax revenue, and only at a significant level for the richest community for the 100% household mobility case. As explained above, this relatively high income tax rate (6.56%) is imposed by the richest community to minimize the fiscal externality of poorer households moving in. If in combination with a limit on local head taxes, income taxes are also prohibited, then the richest community loses this key instrument to limit this fiscal externality and must rely almost exclusively on property taxes to finance the public good. Hence, without income taxes and a head-tax limit, relatively poorer households have a greater incentive to reside in the richest community and partially “free-ride” on the richer households by consuming a below average amount of housing and hence paying a below average amount of property taxes, but benefiting from a higher level of public good provision. This is exactly what the computational results presented in column 3 of table 1 indicate. These results show that many households that reside in the middle-income community 2 when only head taxes are limited, reside in the rich community 3 when there is also a prohibition on local income taxes, and these households are better-off. These households, who do not support just a head tax limitation, do support a combination of a head tax limitation and an income tax prohibition to the case with no tax limitation. Hence, with 100% household mobility, a majority of the state-wide electorate supports a head-tax limitation only if it is combined with a prohibition on income taxes. In addition, for the case with 1% mobility, a majority supports a head tax limitation combined

\[\text{\textsuperscript{44}}\text{In this computation with 100% household mobility, all the city council members are renters (owners) in community 1 (3), so Proposition 4 is applicable and a MVE is guaranteed. Community 2 has a mixture of owners and renters on its city-council, and thus the conditions of Proposition 5 had to be verified to ensure a MVE.}\]
with an income tax prohibition to only a head tax limitation, even though the computational results are similar. These predicted results are consistent with the fact noted in the introduction that several states explicitly ban the use of income taxes and limit head taxes by local municipalities, either in state statutes or in constitutions.

With 100% household mobility, the combination of a head-tax limit and income tax prohibition does cause a negative per-capita equivalent variation, but this loss is less than when only head-taxes are limited. However, because property taxes must be imposed in community 3, and community 3 has over 54% of the total population, average housing consumption is much lower and thus the concomitant decrease in per-capita rents is much greater (-$529 compared to -$106 when only head-taxes are limited), and thus the overall welfare loss is greater. In the 1% mobility case, the respective welfare loses associated with the two tax packages are similar.

3.2.2. Property Tax Limitations

State restrictions on local property taxes are very common. As noted in the introduction, 48 states limit property taxes, the exceptions being Connecticut, Hawaii, New Hampshire, and Vermont. Rate limits impose maximum rates on jurisdictions (e.g., counties, municipalities, and school districts) and apply to property market value. Maximum authorized property tax rates range from 0.5 percent (Kentucky) to 5% (Michigan) of property value. Motivated by the passage of property tax limits in jurisdictions in the U.S., I study the political economy of state limits on local property taxes by examining the effects of a 50% limit on property taxes as a percentage of annual implicit rent, which implies about 4.5% on housing value using a Poterba conversion rate of 9%. (The Poterba conversion is explained above in footnote 37). This restriction on property taxes is in upper end of the range of observed property tax rates in the U.S., which vary between about 0.2% and 4.5% of home value. I do this with the same limit on local head taxes as discussed above because significant levels of local head taxes are not generally observed in practice, and because when head taxes are not limited property taxes on implicit rent are all under 50% (or all under 4.5% of housing value) in the computations.

As is indicated by the second columns in Tables 1 and 2, when there is a limit on local head taxes and local income taxes are not prohibited, only the poorest community 1 would be impacted by a 50% limit on property taxes with 100% or 1% household mobility. In fact,

47Siniavskaia, 2016.
comparing columns 2 and 4 in both tables, the only significant difference in equilibrium between a local head tax limit and a combination of local head tax and property tax limits is in the 100% mobility case in which community 1 substitutes a higher income tax (3.36% for 0.97%) to offset the property tax constraint. Otherwise, the distribution of households across the communities and the values of almost all the other variables in each community are very similar.

Therefore, since limiting property taxes when head taxes are already limited does not meaningfully affect equilibrium, it is of interest to examine the effects of limiting local property taxes when both head and income taxes are also limited. In fact, for the model in this paper to be consistent with what is generally observed in practice, it should predict that combining limitations on head and property taxes with a prohibition on income taxes should generate the greatest amount of political support among all other combinations of limitations presented in the paper. Column 5 in tables 1 and 2 present the equilibrium results for this strictest tax limitation package analyzed in this paper; that is, property taxes are limited to 50% of implicit rent, head taxes are limited to 5% of public good expenditures, and income taxes are prohibited.\(^\text{48}\) As can be seen from Table 1, with 100% household mobility this particular tax package gets the greatest political support among all possible tax limitation combinations. That is, over 51% of the state-wide population are better-off compared to the no limitation case, which is the greatest amount of support compared to any other tax limitation package. When household mobility is 1%, it is shown in Table 2 that this combination of limits on property, head taxes, and income taxes also gets strong political support.

In addition, as mentioned above, very few states authorize income taxes or head taxes, hence examining the effect of a state mandated limit on property taxes when head and income taxes are have already been limited, and thus property taxes are the only significant tax instrument used by local communities, is more illustrative of the common limitations observed in practice. In fact, as shown in column 2 of Table 3, over 87% of the population is better-off when all three taxes are limited than when only head and income taxes are limited. What is of particular interest in comparing these two tax limitation packages in columns 1 and 2 in Table 3, is that most of the 87% of the households that support including a property limitation reside in communities with property tax rates already near or below the proposed maximum rate. That is, all households with income above $20,100 support a property tax limitation if head and income taxes have already been limited, and almost all of these households reside in community 2 or 3 without the property

\(^{48}\)Also in this computation with 100% household mobility, all the city council members are renters (owners) in community 1 (3), so Proposition 4 is applicable and a MVE is guaranteed. Community 2 has a mixture of owners and renters on its city-council, and thus the conditions of Proposition 5 had to be verified to ensure a MVE.
tax limit. As indicated in column 1 of table 3, community 3 is well below the limit with only a 31.57% property tax rate, and community 2 is just above the limit with a 50.96% property tax rate. The reason households who are not directly impacted by a property tax limit but still support it traces to the distortionary effects of high central city taxes emphasized by Mieszkowski and Mills (1993). The property tax limit only significantly affects community 1, which is the central city. Forcing community 1 to lower its property tax rate from 85.51% to 50% makes most of the households in community 1 worse off, but leads to the movement to community 1 of the poorer community 2 households, and the movement to community 2 of the poorer community 3 households, resulting in richer per-capita suburbs. The out-migration of lower-income households permits remaining residents in the suburbs to increase public good consumption per capita without increasing tax revenue generated by property taxes. This result provides support for a fundamental insight of Vigdor (2001). He offers the hypothesis that support for local tax limits comes not necessarily from voters wishing to limit the taxes their own locality imposes, but from the desire of voters to limit tax rates in localities in which they do not reside. He observes that voters in one locality may wish to limit the tax rate in another locality because they would either prefer to live in that locality if the tax rate there were lower or because even if they do not wish to relocate they benefit by the movement of other poorer households out of their community.49 This result of course depends on the degree of household mobility and only occurs in the model if households are highly mobile. Hence, Vigdor’s result does not hold if only 1% of the households are mobile. As shown in columns 3 and 4 of Table 3, with 1% mobility only 4.02% of the households support property tax limits if head and income taxes have already been limited. Thus, another testable prediction of the model is that as households have become more mobile over time, property tax limits should have become more common.

4. Conclusion

The key purpose of this paper is to study the political economy and welfare effects of local tax limits and the impacts of varying household mobility on these effects. In order to study these effects, I first develop a multi-community Tiebout model where local tax/expenditure policies are determined by majority voting within each community. Local tax/expenditure polices consist of property and income taxes, expenditures on a local public good, and either a lump-sum redistributive grant or a lump-sum tax. Both renters and owners reside in each community. Households also vary by income. A renter and an owner with the same income have

49 Other factors may play an key role as well. See Fishel (1989) and O’Sullivan, et. al. (1995) for alternative explanations for the popularity of California’s Proposition 13.
different preferences for local fiscal policies since these policies affect housing values and thus capital gains (losses) for owners. Because of the multi-dimensional policy space and the two-dimensional characterization of households, Plott’s conditions for the guaranteed existence of a majority voting equilibrium over all possible polices are not satisfied. Thus, I adopt an idealized city-council model based on the Besely and Coate (1997) model of representative democracy. This political structure limits the possible policy alternatives to the ideal polices of city council members. Each city-council member’s ideal policy is the policy most preferred by the tenure type (renters or owners) majority at a given income level. In Proposition 4, I prove the existence of a majority voting equilibrium given this idealized city-council model political structure if city council members are either all renters or all owners. In Proposition 5, I prove sufficient conditions for a majority voting equilibrium if there is a mixture of owners and renters on the city council. In the quantitative models, when necessary I verify computationally Proposition 5’s sufficient conditions are satisfied.

I examine the effects of tax limits on the computed equilibria outcomes of this Tiebout model and test whether there is state-wide political support for tax limits by computing the percentage of state-wide households who are made better-off in the tax limits equilibria compared to the no tax limits equilibrium. I also measure the overall welfare changes due to tax limits. The tax limits I examine include limits on local head taxes, income taxes, property taxes, and combinations of these tax limits. Although most tax limits and combinations of tax limits do not lead to overall welfare gains, in general there is state-wide political support for tax limits. The level of political support predicted by the computations depends on the assumed degree of household mobility. For instance, if only 1% of households are assumed to be mobile, the computations predict all of the tax limits and combinations examined in this paper garner state-wide majority support. However, if 100% of the households are mobile, the computations do not predict majority state-wide support for all possible tax limits and combinations. For instance, with 100% household mobility, a limit on head taxes does not garner majority support. This is because the richest community imposes an income tax instead of a property tax to offset the loss in tax revenue. This is done because of the negative fiscal externality caused by the poorer households residing in and moving into the community is greater with a property tax. This results in even the relatively poorer households in the rich community made worse off, even though it would seem these household should benefit from a reduction in local head taxes. However, these households are made worse off because of the income tax. When only 1% of the households are mobile, the rich community does not need to be concerned with that part of fiscal externality due to poorer households moving in and thus can implement the preferred property tax instead of an
income tax. Thus, the poorer households the richest community are made better-off, and combined with the households in the two poorer communities, a majority of the state supports a head tax limit. Note there is political support even with 100% mobility for some of the combinations of different types of tax limits, with limits on all three types of taxes garnering the most political support.

Although most tax limits are supported by a majority in the state, especially when households are relatively immobile, as mentioned above these limits do not in general lead to overall welfare gains compared to no limits. The rich households in the state prefer local head taxes. When head taxes are constrained, these rich households experience large welfare losses as measured by equivalent variation. These rich households are made worse off because more relatively poorer households are willing to live with the richer households when local head taxes are limited, imposing negative fiscal externality on these rich households. These rich households are in the a minority so they to do not have the political power to prevent these limits, but their welfare losses are so large that overall average welfare decreases even though a majority made better-off. The one exception in which welfare does increase is when households are mobile, head and income taxes have previously been constrained, and property taxes are then limited. In this case, most of the support for limiting local property tax rates comes from households who reside in the rich suburbs where the property tax rates are already below the proposed maximum. These households benefit by constraining the property tax rate in the poor city because some of these households wish to live in the city when the property tax rate is reduced, and this movement out of the suburbs into the city also benefit the households who remain in the suburbs. This result provides support for Vigdor’s (2001) hypothesis that support for local tax limits does not necessarily come from voters wishing to limit the taxes their own locality imposes, but from the desire of voters to limit tax rates in localities in which they do not reside. While I propose a somewhat different mechanism than Vigdor as driving support for state tax limitations, his insight that support for tax limits comes from voters wishing to constrain taxes in other communities is nonetheless fundamental. A further insight of Vigdor’s is also ratified by our analysis: Tax limits can have effects in communities that are not bounded by the limit in equilibrium. The change in community composition induced by a tax limit in turn leads to a change in the pivotal voter, and hence in the policies that voter adopts.

Finally, my analyses provides various positive predictions that can be tested in future research. One result of the computations is that overall households prefer multiple or combinations of tax limits compared just a single tax limit. That is, the predicted greatest political support compared to no tax limits is for a combination of limits on head, property, and
income taxes. However, the level of political support for different types of tax limits combinations does vary by household mobility. For instance, head tax limits only get majority support if households are relatively immobile, but there is majority support for jointly limiting head taxes and income taxes regardless of household mobility. In addition, the computational model predicts that adding a property tax limit to existing head and income tax limits only garners political support if households are mobile. This means that since local head and income taxes have historically rarely been implemented, the model predicts that property tax limits should have become more common over time as households have become more mobile.
Table 1 - 100% Household Mobility

<table>
<thead>
<tr>
<th>Positive Properties</th>
<th>(1) No Tax Limitations</th>
<th>(2) Head Tax Limitation</th>
<th>(3) Head Tax Limitation and Prohibition on Income Tax</th>
<th>(4) Head Tax and Property Tax Limitations</th>
<th>(5) Head Tax and Property Tax Limitations and Prohibition on Local Income Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Tax or Per-Capita Grant</td>
<td>r₁</td>
<td>-$2,784</td>
<td>$538</td>
<td>$491</td>
<td>$510</td>
</tr>
<tr>
<td></td>
<td>r₂</td>
<td>-$7,189</td>
<td>-$148</td>
<td>-$130</td>
<td>-$146</td>
</tr>
<tr>
<td></td>
<td>r₃</td>
<td>-$12,260</td>
<td>-$372</td>
<td>-$280</td>
<td>-$371</td>
</tr>
<tr>
<td>Income Tax Rates</td>
<td>m₁</td>
<td>0.00%</td>
<td>0.97%</td>
<td>0.00%</td>
<td>3.36%</td>
</tr>
<tr>
<td></td>
<td>m₂</td>
<td>0.00%</td>
<td>0.25%</td>
<td>0.00%</td>
<td>0.24%</td>
</tr>
<tr>
<td></td>
<td>m₃</td>
<td>0.00%</td>
<td>6.56%</td>
<td>0.00%</td>
<td>6.56%</td>
</tr>
<tr>
<td>Property Tax Rates on Implicit Rent</td>
<td>t₁</td>
<td>3.42%</td>
<td>77.95%</td>
<td>85.51%</td>
<td>50.00%</td>
</tr>
<tr>
<td></td>
<td>t₂</td>
<td>1.81%</td>
<td>49.80%</td>
<td>50.96%</td>
<td>49.95%</td>
</tr>
<tr>
<td></td>
<td>t₃</td>
<td>9.11%</td>
<td>0.00%</td>
<td>31.57%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Per-Capita Public Good Expenditure</td>
<td>g₁</td>
<td>$3,007</td>
<td>$1,259</td>
<td>$1,155</td>
<td>$1,224</td>
</tr>
<tr>
<td></td>
<td>g₂</td>
<td>$7,488</td>
<td>$2,960</td>
<td>$2,604</td>
<td>$2,926</td>
</tr>
<tr>
<td></td>
<td>g₃</td>
<td>$15,469</td>
<td>$7,446</td>
<td>$5,596</td>
<td>$7,411</td>
</tr>
<tr>
<td>Median Household Income</td>
<td>ỹ₁</td>
<td>$33,092</td>
<td>$17,255</td>
<td>$16,361</td>
<td>$16,990</td>
</tr>
<tr>
<td></td>
<td>ỹ₂</td>
<td>$81,694</td>
<td>$37,015</td>
<td>$33,252</td>
<td>$36,588</td>
</tr>
<tr>
<td></td>
<td>ỹ₃</td>
<td>$159,471</td>
<td>$87,603</td>
<td>$79,611</td>
<td>$87,094</td>
</tr>
<tr>
<td>Mean Household Income</td>
<td>ỹ₁</td>
<td>$33,844</td>
<td>$16,609</td>
<td>$15,763</td>
<td>$16,386</td>
</tr>
<tr>
<td></td>
<td>ỹ₂</td>
<td>$84,121</td>
<td>$37,476</td>
<td>$33,471</td>
<td>$37,038</td>
</tr>
<tr>
<td></td>
<td>ỹ₃</td>
<td>$184,075</td>
<td>$107,850</td>
<td>$101,103</td>
<td>$109,204</td>
</tr>
</tbody>
</table>

Normative Properties-No Tax Limitations Baseline (column (1))

| Equivalent Variation | -$3,036 | -$2,767 | -$3,082 | -$2,727 |
| EV + Δ Rents          | -$3,142 | -$3,296 | -$3,170 | -$3,239 |
| Interval Better Off   | <$45,200 | <$49,500 | <$44,700 | <$50,400 |
| % Better Off          | 45.71% | 50.28% | 45.04% | 51.09% |
Table 2 – 1% Household Mobility

<table>
<thead>
<tr>
<th>Positive Properties</th>
<th>(1) No Tax Limitations</th>
<th>(2) Head Tax Limitation</th>
<th>(3) Head Tax Limitation and Prohibition on Income Tax</th>
<th>(4) Head Tax and Property Tax Limitations</th>
<th>(5) Head Tax and Property Tax Limitations and Prohibition on Local Income Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Tax or Per-Capita Grant</td>
<td>r₁</td>
<td>-$2,675</td>
<td>-$74</td>
<td>-$74</td>
<td>-$68</td>
</tr>
<tr>
<td></td>
<td>r₂</td>
<td>-$5,941</td>
<td>-$131</td>
<td>-$128</td>
<td>-$131</td>
</tr>
<tr>
<td></td>
<td>r₃</td>
<td>-$6,388</td>
<td>-$372</td>
<td>-$368</td>
<td>-$372</td>
</tr>
<tr>
<td>Income Tax Rates</td>
<td>m₁</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>m₂</td>
<td>0.00%</td>
<td>0.68%</td>
<td>0.00%</td>
<td>0.63%</td>
</tr>
<tr>
<td></td>
<td>m₃</td>
<td>0.00%</td>
<td>0.43%</td>
<td>0.00%</td>
<td>0.43%</td>
</tr>
<tr>
<td>Property Tax Rates on Implicit Rent</td>
<td>t₁</td>
<td>2.05%</td>
<td>57.22%</td>
<td>57.21%</td>
<td>50.00%</td>
</tr>
<tr>
<td></td>
<td>t₂</td>
<td>3.70%</td>
<td>40.92%</td>
<td>45.55%</td>
<td>41.39%</td>
</tr>
<tr>
<td></td>
<td>t₃</td>
<td>23.48%</td>
<td>42.68%</td>
<td>45.72%</td>
<td>42.70%</td>
</tr>
<tr>
<td>Per-Capita Public Good Expenditure</td>
<td>g₁</td>
<td>$2,802</td>
<td>$1,488</td>
<td>$1,478</td>
<td>$1,356</td>
</tr>
<tr>
<td></td>
<td>g₂</td>
<td>$6,468</td>
<td>$2,621</td>
<td>$2,559</td>
<td>$2,611</td>
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<tr>
<td></td>
<td>g₃</td>
<td>$12,930</td>
<td>$7,460</td>
<td>$7,367</td>
<td>$7,447</td>
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<tr>
<td>Median Household Income</td>
<td>ӯ₁</td>
<td>$31,101</td>
<td>$18,359</td>
<td>$18,243</td>
<td>$18,258</td>
</tr>
<tr>
<td></td>
<td>ӯ₂</td>
<td>$71,700</td>
<td>$35,431</td>
<td>$35,258</td>
<td>$35,268</td>
</tr>
<tr>
<td></td>
<td>ӯ₃</td>
<td>$136,966</td>
<td>$80,475</td>
<td>$80,322</td>
<td>$80,309</td>
</tr>
<tr>
<td>Mean Household Income</td>
<td>ӯ₁</td>
<td>$31,444</td>
<td>$17,752</td>
<td>$17,635</td>
<td>$17,650</td>
</tr>
<tr>
<td></td>
<td>ӯ₂</td>
<td>$73,164</td>
<td>$35,640</td>
<td>$35,466</td>
<td>$35,475</td>
</tr>
<tr>
<td></td>
<td>ӯ₃</td>
<td>$162,919</td>
<td>$102,039</td>
<td>$101,874</td>
<td>$101,860</td>
</tr>
</tbody>
</table>

Normative Properties-No Tax Limitations Baseline (column (1))

| Equivalent Variation | -$2,203 | -$2,179 | -$2,217 | -$2,194 |
| EV + Δ Rents | -$2,742 | -$2,758 | -$2,751 | -$2,768 |
| Interval Better Off | <$51,500 | <$52,000 | <$51,200 | <$51,700 |
| % Better Off | 52.18% | 52.66% | 51.88% | 52.37% |
Table 3: The Effects of Property Tax Limitation when Head and Income Taxes Already Limited

<table>
<thead>
<tr>
<th></th>
<th>100% Mobility</th>
<th>1% Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>Head Tax</td>
<td>Head Tax and</td>
</tr>
<tr>
<td></td>
<td>Limitation and</td>
<td>Property Tax</td>
</tr>
<tr>
<td></td>
<td>Prohibition on</td>
<td>Limitations</td>
</tr>
<tr>
<td></td>
<td>In Income Tax</td>
<td>and Prohibition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>on Local Income Tax</td>
</tr>
<tr>
<td>Positive Properties</td>
<td>r_1</td>
<td>$491</td>
</tr>
<tr>
<td></td>
<td>r_2</td>
<td>-$130</td>
</tr>
<tr>
<td></td>
<td>r_3</td>
<td>-$280</td>
</tr>
<tr>
<td>Income Tax Rates</td>
<td>m_1</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>m_2</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>m_3</td>
<td>0.00%</td>
</tr>
<tr>
<td>Property Tax Rates</td>
<td>t_1</td>
<td>85.51%</td>
</tr>
<tr>
<td></td>
<td>t_2</td>
<td>50.96%</td>
</tr>
<tr>
<td></td>
<td>t_3</td>
<td>31.57%</td>
</tr>
<tr>
<td>Per-Capita Public</td>
<td>g_1</td>
<td>$1,155</td>
</tr>
<tr>
<td>Good Expenditure</td>
<td>g_2</td>
<td>$2,604</td>
</tr>
<tr>
<td></td>
<td>g_3</td>
<td>$5,596</td>
</tr>
<tr>
<td>Median Household</td>
<td>y_1_1</td>
<td>$16,361</td>
</tr>
<tr>
<td>Income</td>
<td>y_1_2</td>
<td>$33,252</td>
</tr>
<tr>
<td></td>
<td>y_1_3</td>
<td>$79,611</td>
</tr>
<tr>
<td>Mean Household</td>
<td>y_2_1</td>
<td>$15,763</td>
</tr>
<tr>
<td>Income</td>
<td>y_2_2</td>
<td>$33,471</td>
</tr>
<tr>
<td></td>
<td>y_2_3</td>
<td>$101,103</td>
</tr>
</tbody>
</table>

Normative Properties-No Property Tax Limitation Baseline (columns (1) and (3))

|                      | Equivalent Variation | EV + ∆ Rents | Interval Better Off | % Better Off |
|                      | $45                  | $63          | >$20,100            | 87.07%       |
|                      | -$17                 | -$11         | <$12,400            | 4.02%        |

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ACKNOWLEDGEMENTS

I would like to thank Richard Romano and Dennis Epple for many valuable discussions of the issues in this paper.