Tiebout and Redistribution in a Model of Residential and Political Choice *

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Final Version

Abstract

The paper considers a two-community model with freely mobile individuals. Individuals differ not only in their incomes, but also for their tastes for a local public good. In each jurisdiction, the amount of public services is determined by majority vote of the inhabitants, and local spending is financed by a residence-based linear income tax. In making their residential and political choices, individuals thus face a trade-off between the provisionary and redistributive effects of policies. We analyze this trade-off and show that Tiebout-like sorting equilibria often exist. If the spread in tastes among individuals is very large, an almost perfect sorting according to preferences emerges; otherwise, a partial sorting prevails and stratification into rich and poor communities is more pronounced. Importantly, we demonstrate that all these sorting equilibria exist whether or not individuals are allowed to relocate after voting.

Keywords: Local Public Goods, Migration, Fiscal Federalism, Tiebout.

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1 Introduction

In his pioneering article, Tiebout (1956) viewed the provision of local public goods in a system of several jurisdictions as being analogous to a competitive Walrasian market for private goods. His idea was that individuals 'shop among jurisdictions' if they are sufficiently mobile, i.e. they reveal their preferences by migrating into communities which offer the public good bundle closest to their needs. He further argued that, in a world of free mobility, competition among jurisdictions would lead to an efficient allocation both in the provision of local public goods and in the distribution of the population over communities.

In the present paper we revisit Tiebout's hypothesis in a multi-community model of residential and political choice. Individuals derive utility from a composite consumption good and a local public service with constant returns to community size. The level of public good provision in each jurisdiction is determined by majority vote of the inhabitants and is financed by a residence-based linear income tax. Individuals are heterogeneous with respect to their income and with respect to their intrinsic taste for the public service. The natural assumption that individuals differ in preferences as well as in earning abilities allows us to isolate two forces that drive equilibrium characteristics. First, the differences in tastes facilitate distinct public good bundles and the sorting of the population across communities according to intrinsic preferences. Second, this Tiebout-type migration is mitigated by the redistributive nature of the taxes levied on income to finance local spending. In making their residential choice, individuals thus face a trade off between the loss (gain) incurred through redistributive taxation and the benefit (loss) from (not) living in the community which offers a public good provision closest to their intrinsic tastes.

As a main result, we demonstrate that Tiebout-type sorting equilibria always emerge if intrinsic preferences for the public good are sufficiently spread among the population. For simplicity, we confine our attention to the case of two communities and assume that individuals can be grouped in two classes of intrinsic preferences for the public service. Three types of sorting equilibria are then identified. If the income of the poorest member of society is above some minimum, there will be perfect sorting according to tastes in the sense that high and low demanders live in separate communities. Equilibria of this type, however, cease to exist if the endowment of poor individuals is too low in which case all those individuals migrate to the community which offers the highest provision of public services, irrespective of their intrinsic preferences.[1] Conversely, for wealthy individuals there is a trade-off between the redistributive and the provisionary aspect of income taxes. We show that in such a situation two hybrid sorting equilibria coexist: a) a 'partially revealing' equilibrium in which all individuals with strong tastes for the public service live together with the poor in one community, whereas middle and high income individuals with low preferences live in a separate community; and b) a 'mixed' equilibrium where agents of either type live in both communities. In this latter type of situation, the wealthiest (respectively poorest) individuals of both preference classes cluster together.

Importantly, we demonstrate the prevalence of those sorting equilibria employing two alternative equilibrium concepts. Both concepts have been used in the literature on local public goods and are formally developed in an integrated manner by Caplin and Nalebuff (1997). In the main part of the analysis, we assume that jurisdictions take their local population as given when determining their policies. This approach can be motivated by a sequential model where individuals cannot relocate once the local tax rate and public good supply has been chosen, and avoids the issue of jurisdictions competing to attract (or repel) certain individuals.

Although widely used in the literature, the empirical evidence on this approach has not been supportive: in their estimation of a multi-community model, Epple et al. (2001) conclude that it fits the data poorly and that their findings are more in favor of a model where communities recognize policy-induced migration. As an extension, we therefore account for the possibility that jurisdictions do not treat their local population as fixed when policies are determined. Being fully aware of the migration effects of their policy choice given the policies selected elsewhere, jurisdictions can compete for members by choosing policies which appeal more to some individuals than others. The sequential model that corresponds to this approach allows individuals to relocate immediately following the policy choice in a jurisdiction. We argue that a complete characterization of equilibria in this extended model is infeasible. However, we find that the set of

[1]This phenomenon is similar to 'the poor chasing the rich' which has been stressed in the literature as a reason for decentralized redistribution to fail. See, e.g., Henderson (1979) and Oates (1972).

equilibria in the formulation without relocation is a subset of the set of equilibria when individuals are allowed to move after voting. Our sorting results for the model without relocation therefore continue to apply.

While an empirical test of our model must await future research, the basic framework we employ recognizes that decentralized personal income taxes are often an important source of revenue for jurisdictions within federations. In the United States, property taxes are the most prominent revenue source for municipal governments. Nevertheless, income taxes play a considerable role at the state level, and the data display a large dispersion of state personal income taxes within the US.[2] Similar figures are reported for Switzerland. Swiss cantons have the right to set income taxes. The tax proceeds are widely used for redistribution purposes (Kirchgässner and Pommerehne, 1996) and personal income taxes vary considerably among the cantons.[3] Analyzing cross-sectional data from 26 Swiss cantons, Feld (2000) finds that the differences in cantonal marginal tax rates and local public services have a significant impact on the regional composition of households in all income classes. The probability that an individual with high income resides in a canton decreases in the cantonal tax rate, which is in line with our theoretical predictions. Similarly, there is a positive correlation between the probability of a low-income household living in a canton, and the tax rates faced by high-income households. According to these findings, Switzerland display a strong impact of decentralized income taxes on the residency decisions of taxpayers.

The present paper is in the tradition of multi-community models with heterogeneous agents and explicit public choice mechanisms (majority rule) that determine political outcomes. Westhoff (1977) constructs a model with a pure public good financed by income taxation and shows that equilibria where households sort across communities according to income classes exist. A similar result is obtained by Epple et al. (1984, 1993) who consider local public services and property taxation. Hansen and Kessler

[2]See Legislative Fiscal Bureau, State of Wisconsin (2001). In 1999, for instance, no personal income taxes were levied in eight U.S. states, including Florida, Texas and Nevada. On the other hand, the 1999 marginal tax rate in the top-bracket was about 9% per cent in California, Iowa, Minnesota, Montana or Oregon. Also, these states derive a major part of their revenue from income taxes: in the 1999/2000 fiscal year, personal income tax revenues in California were about USD 40 billion compared to total state tax revenues of about USD 87 billion (State of California, Dept. of Finance, http://www.dof.ca.gov/).

[3]Defining the the weighted average in the year 1990 as 100, the index varied from about 56 per cent in Zug to about 154 in Valais (Feld, 2000).

(2001a) study local income redistribution and show that stratified equilibria emerge provided housing markets are sufficiently tight.[4] In contrast to the present paper, this previous line of research assumes that individuals differ solely along one dimension, typically their income. The notable exception is Epple and Platt (1998) who study a setting where a redistributive local policy is financed by property taxation and households differ in both incomes and preferences for housing. While their paper shows that equilibria will no longer display complete stratification according to income, it neither proves existence nor does it analytically relate equilibrium characteristics to the parameters of the model. Avoiding the restriction on preferences and public good technologies employed in earlier work, Konishi (1996) and Nechyba (1997) provide general existence proofs. While Konishi does not investigate whether there is sorting in equilibrium, Nechyba states conditions for the equilibrium to be stratified. Due to its generality, however, it is again not possible in his model to formally relate the existence or non-existicence of sorting equilibria and their characteristics to underlying parameters as in our framework.[5] A more closely related paper is Hindriks (2001). He considers pure redistribution in a spatial framework where individuals differ not only in their exogenous incomes (which are binary in his model), but also in their attachment to home. This attachment imposes a restriction on individual mobility and allows to sustain equilibria with asymmetric population and asymmetric redistribution.[6] In contrast to most other papers in the literature (for an exception, see Kessler et al. 2002) and in line with our approach, Hindriks also adopts an equilibrium concept which requires regional budgets to balance even out-of-equilibrium.[7]

[4] More policy-oriented contributions to this literature include Epple and Romer (1991), Fernandez and Rogerson (1996), and Fernandez (1997), among others. A general result on situations where stratification equilibria do not exist in multi-community models can be found in Hansen and Kessler (2001b). For a comprehensive survey of the work in this area and further references, see Ross and Yinger (1999).

[5] Another important difference is that Nechyba considers (indivisible) housing and local property taxation. To avoid non-existence problems raised in the earlier literature (Rose-Ackerman, 1979), the author assumes that the housing stock and, hence, community size is fixed.

[6] More specifically, this result prevails for a situation where the rich individuals form the majority in one of the jurisdictions, and refrain from implementing any positive taxes. Pursuing a local approach, Hindriks also explores potential (symmetric) equilibria that are characterized by a positive degree of redistribution in both communities. However, his local approach does not necessarily ensure the existence of an equilibrium.

[7] Equilibrium concepts differ in that Hindriks incorporates a reduced-form dynamic component by requiring that locally chosen fiscal policies do not alter the majority composition in a community.

The remainder of this paper is organized as follows: Section 2 introduces the basic model. In Section 3, we prove existence and characterize equilibria in a setting where individuals first choose a region of residence and then select fiscal policies. The subsequent Section 4 analyzes an extended version of the model where relocation is allowed. Section 5 concludes.

2 The Model

To study both redistributive and provisionary aspects of local policies, we consider the following simple model of residential and political choice, which is borrowed from Bolton and Roland (1996).[8] The economy is divided into two given jurisdictions (countries, communities) indexed by $j = A, B$ and populated by a continuum of individuals who can move freely between jurisdictions but live in only one. They derive utility from the consumption of a composite commodity, c, and a local public service, g_j. The latter is a publicly provided private good such as health care or education, so that the cost of providing g_j to one more resident of jurisdiction j is constant and without loss of generality normalized to one.[9] Individuals are heterogenous with respect to their exogenously given incomes, w, and their preference intensities γ for the public good. The utility function of individual i is given by

$$U(c, g; \gamma_i) = c + \gamma_i g. \tag{1}$$

Preference intensities can either be high or low, $\gamma_i \in \{\underline{\gamma}, \bar{\gamma}\}\ \forall\, i$, where $\bar{\gamma} > \underline{\gamma} \geq 1$ and are distributed independently from income, i.e., within each income group there is the same proportion of individuals of any given type.[10] The mass of individuals in each preference class is normalized to unity and their income is distributed according to a distribution function $F(w)$ with density $f(w) > 0$ on the interval $[\underline{w}, \bar{w}] \subset \mathbb{R}_0^+$. In

[8] See Section 4 for a comparison of our findings to their results.

[9] Bergstrom and Goodman (1973) and Edwards (1990) report empirical evidence that most goods provided by local governments do not exhibit economies of scale in public consumption.

[10] Most of the simplifying assumptions of the model are made for analytical or expositional convenience only. In particular, it is possible to show that our results carry over to a continuous interval of intrinsic preferences. Furthermore, it will become clear below that our findings also apply to more general frameworks which do not incorporate particular specifications of utility functions and technologies. A discussion on how the results generalize to the case of more than two jurisdictions is provided in Section 3.

what follows, we will for simplicity confine our analysis to the empirically relevant case where the median income in the global population is strictly smaller than the mean income.

Jurisdictions finance the supply of their public service by a linear income tax $t_j \geq 0$ which is imposed on the regional residents. Denoting the average income in jurisdiction j by y_j, the local budget constraints (satisfied with equality) are

$$g_j = (t_j - \frac{1}{2}t_j^2)y_j \,, \qquad j = A, B. \tag{2}$$

These constraints entail costs of public funds (e.g. losses from distortive taxation) which are for analytical simplicity represented by the term $\frac{1}{2}t_j^2 y_j$. Because jurisdictions are constrained to run a balanced budget, the level of public services in jurisdiction j depends on the composition of the local population (local average income) for a given tax rate t_j.

At the same time, residential decisions depend on the local policies. Individuals are perfectly mobile between regions but can live in only one. From their point of view, all jurisdictions are identical except for the local fiscal policy, which consumers take as given.[11] Specifically, a (w, γ)-type individual chooses to reside in the jurisdiction whose policy $x_j = (t_j, g_j)$ maximizes his (indirect) utility,

$$V(t_j, g_j; w, \gamma) = (1 - t_j)w + \gamma g_j. \tag{3}$$

We will call the induced distribution of the population a *migration equilibrium* for a given vector of local policies $\{x_j\}_{j=A,B}$, and describe it by the measure of individuals with characteristics (w, γ) who live in jurisdiction j. Denoting this measure by $f_j(\gamma, w)$ with $\sum_{j=A}^{B} f_j(\gamma, w) = f(w), \forall(\gamma, w)$, let $\alpha_j = \int_{\underline{w}}^{\bar{w}} [f_j(\underline{\gamma}, w) + f_j(\bar{\gamma}, w)]dw$ be the size of the overall population that resides in j. Note that there may be individuals who are indifferent and can be assigned arbitrarily to either jurisdiction.

It remains to specify how jurisdictions select their policies $x_j = (t_j, g_j)$. Throughout the paper, we assume that this is done according to the majority rule as a social choice function that maps the preferences of jurisdictions' members into the set of feasible policies. In particular, we will call a policy vector (x_A, x_B) a *political equilibrium* if

[11] Recall that a single agent is an infinitesimal small part of the local population. No person therefore believes that he can influence the policy outcome by his own migration decision.

x_j is preferred to any other feasible policy by a majority of the given inhabitants of jurisdiction $j = A, B$. Both the set of local feasible policies and the preferences of local residents over policies are laid out in more detail below. In general, these will depend on the policies selected elsewhere and on whether jurisdictions consider migrational responses to their policy choice or not.

To summarize, there is an interdependency of residential choice and political outcomes in this model: the policy that each jurisdiction adopts is determined by the characteristics of its local population, and the local population structure is determined by the policies of all jurisdictions. An overall equilibrium requires the migration and the political equilibrium to be consistent in a sense to be made precise now. As mentioned in the introduction, we will employ two different equilibrium concepts in turn. We start our analysis with the case where inter-jurisdictional competition for a mobile population does not arise because jurisdictions take their membership as fixed when deciding upon local policies. This approach, which has been called 'membership-based' (Caplin and Nalebuff, 1997) or 'voter myopia' (Epple and Romer, 1991) has been applied by the majority of the literature that studies the interplay of political and residential choice, including Westhoff (1977), Rose-Ackerman (1979), Epple et al. (1984, 1993), Nechyba (1997), Fernandez and Rogerson (1996) and Fernandez (1997).

Thus, suppose that when selecting x_j, jurisdictions take their respective membership (the local population structure) as fixed. For a given tax rate, local public good supply g_j is then fully determined by local average income due to the balanced budget (2). Let $X(y_j) = \left\{(t_j, g_j) | \, t_j \in [0, 1], \, g_j = (t_j - \frac{1}{2}t_j^2)y_j\right\}$ be the set of feasible policies in jurisdiction j, which has a local population structure described by $f_j(\gamma, w)$ and the corresponding per capita income of y_j. Recall that policies are chosen by exogenous majority rule. Hence, the political equilibrium (majority rule outcome) in a jurisdiction j with a local population $f_j(\gamma, w)$ is the feasible policy $x_j \in X_j(y_j)$ that is preferred according to (3) to any other feasible policy $x'_j \in X_j(y_j)$ by a majority of the residents of this jurisdiction. Similarly, the migration equilibrium requires individuals to optimally choose which jurisdiction to join according to (3), anticipating the policy outcomes that result. Equilibrium is a fixed point where no agent wants to move and no jurisdiction wants to change policy.

Definition 1. Suppose jurisdictions treat their local population as fixed when determining local policies. An interjurisdictional equilibrium is then a vector of local policies $\{(t_j^*, g_j^*)\}_{j=A,B}$ and a distribution of the population over jurisdictions $\{f_j^*(w,\gamma)\}_{j=A,B}$ with $\alpha_j^* > 0$ such that, for $j = A, B$

a) given $\{(t_j^*, g_j^*)\}_{j=A,B}$, the distribution of the population forms a migration equilibrium, i.e., $\forall(\gamma, w)$

$$f_j^*(\gamma, w) > 0 \quad \Rightarrow \quad V(t_j^*, g_j^*; \gamma, w) \geq V(t_k^*, g_k^*; \gamma, w), \;\; j, k = A, B.$$

b) given $f_j^*(w,\gamma)$ and the associated average income y_j^*, policies form a political equilibrium, i.e., $(t_j^*, g_j^*) \in X_j(y_j^*)$ and

$$V(t_j^*, g_j^*; \gamma, w) \geq V(t_j, g_j; \gamma, w) \quad \forall (t_j, g_j) \in X(y_j^*)$$

for a majority of the residents in j.

Equivalent definitions of equilibrium can be found in, e.g., Westhoff (1977), Epple et al. (1984, 1993), Nechyba (1997), and Caplin and Nalebuff (1997), among others. Observe that because we require jurisdictions to be populated in equilibrium, the majority rule outcome is well-defined.

As noted by Fernandez and Rogerson (1996) and Fernandez (1997), the above notion of equilibrium can be rationalized by the following sequence of events. At an initial date 0, individuals simultaneously choose the jurisdiction in which they reside. Given the local population, each jurisdiction determines the tax to be implemented by majority rule at date 1. Once local taxes are decided, public goods are provided according to (2), and individuals consume at date 2. The perfect foresight equilibria in this sequential formulation coincide with the equilibria in our setting because policies are decided after residential choices have already been made so that jurisdictions take their population structure as fixed at date 1. At the same time, individuals choose their location rationally ex ante given the anticipated location decisions of all other individuals (the distribution of the population) and the resulting policy choices. Hence, residential choices at stage 0 and the corresponding equilibrium policies are always such that nobody would want to move ex post. In the extension of the model (Section 4), we turn to a scenario where jurisdictions do not perceive their population structure as fixed. The corresponding sequential formulation accordingly assumes that individuals can relocate after policies are selected.[12]

[12]See also Caplin and Nalebuff (1997) who argue that what they call the 'membership-based' and

3 Equilibrium Analysis

We start the equilibrium analysis with the determination of the majority rule outcome. For a fixed local population structure, the per-capita tax base y_j is taken as given. Since feasible policies $x_j \in X_j(y_j)$ satisfy (2), we can substitute for g_j in (3) to obtain

$$v(t_j, y_j; \gamma, w) \equiv (1 - t_j)w + \gamma(t_j - \frac{1}{2}t_j^2)y_j \tag{4}$$

which summarizes the preferences of a (γ, w)-type individual who lives in community j over the local tax rate t_j. Maximizing (4) yields the most preferred tax rate of a resident of j who has income w and preference intensity γ,

$$t_j = \max\{1 - \frac{w/\gamma}{y_j}, 0\}.$$

By inspection, preferences are single peaked and can be ordered according to the variable $\omega \equiv w/\gamma$ to which we refer as an individual's 'hedonic' income (see Bolton and Roland, 1996) in what follows. Next, let ω_{mj} denote the median 'hedonic' income in region j. Applying the median voter theorem, the unique majority-preferred income tax rate in jurisdiction j is given by

$$t_j^* = 1 - \frac{\omega_{mj}}{y_j} = 1 - \frac{w_{mk}/\gamma_{mj}}{y_j} \tag{5}$$

for $\omega_{mk}/y_j \leq 1$ and $t_j^* = 0$ otherwise. Ceteris paribus, tax rates are decreasing in the local ratio of median to mean income and increasing in the median voter's preference intensity. Employing (5) and the local budget constraint (2), the equilibrium provision of public services (for $t_j^* > 0$) is

$$g_j^* = \frac{1}{2}\left(1 - \frac{\omega_{mj}^2}{y_j^2}\right) y_j = \frac{1}{2}\frac{y_j^2 - \omega_{mj}^2}{y_j}. \tag{6}$$

Before proceeding with the formal analysis, we should note that the symmetric equilibrium where the composition of both jurisdictions is the same always exists in this

'position-based' approaches can be seen as two different representations of a dynamic model, depending on whether the policy formation stage follows or precedes the (final) membership decisions. The model with relocation is analyzed in Bolton and Roland (1996). As we will see below, introducing a interjurisdictional competition for a mobile population (a relocation stage) either endangers equilibrium existence or, if one adopts suitable assumptions to ensure existence, gives rise to multiple equilibria that display the same characteristics than the equilibria in the model without relocation.

model: if the population is distributed symmetrically over both jurisdictions such that in each region the income and preference distributions are identical and equal to the overall distributions, median and average incomes are equalized across regions and so are tax rates and the provisions of the public service. Facing identical policies, every individual is (for the presumed equilibrium behavior of other individuals) indifferent between jurisdiction A and B and the considered symmetric distribution constitutes a migration equilibrium. Thus, we have an overall equilibrium in which both jurisdictions implement the same policy and have identical population structures. Notice also that a continuum of these equilibria exist that are characterized by differing absolute population sizes of communities. Furthermore, the outcome in any of these equilibria is equivalent to the outcome under a centralized political process.

While these arguments already establish the general existence of equilibrium, the symmetric equilibria are unsatisfactory because they fail to reflect the taste differences across individuals: as put forward by Tiebout (1956), in an economy where policies are determined locally and individuals are heterogeneous, mobility should lead to the revelation of preferences through 'voting with one's feet' and to the (efficient) diversification of jurisdictions in their supply of public goods. A natural question is therefore whether there exist equilibria in this economy where jurisdictions offer distinct policy schemes and individuals choose their residency according to their preferences over different bundles (t_j, g_j). To provide an answer to this question, it is useful to start with the following thought experiment. Suppose both regions pursue different policies (t_j, g_j) which are feasible and majority-preferred for a given composition of communities [part b) of Definition 1]. To analyze how individuals locate over jurisdictions if they take these asymmetric policies as given [part a) of Definition 1], differentiate (3) totally which yields

$$\frac{dg}{dt}|_{V=\bar{V}} = \frac{w}{\gamma} = \omega. \tag{7}$$

The slope of an indifference curve in the t/g - space is positive and strictly increasing in 'hedonic' income ω. Therefore, in a situation where agents expect a partition of individuals across jurisdictions that gives rise to majority rule outcomes $(t_A, g_A) > (t_B, g_B)$, individuals with large 'hedonic' income migrate into jurisdiction B because they prefer lower taxes and public good levels, ceteris paribus. In the same situation, agents with lower 'hedonic' income settle in jurisdiction A since they prefer higher taxes combined with a higher level of the public good. Accordingly, for distinct tax-public services packages to be sustainable in an equilibrium, some boundary hedonic income type $\tilde{\omega}$ must be indifferent as both jurisdictions are populated.[13] We can also infer that the public service provision in the high-tax community must exceed that in the low-tax community: since the migration decisions of each individual is in equilibrium based on the correct tax rates and public services, everybody would otherwise want to live in the jurisdiction with low taxes and high spending, a contradiction.

Combining these observations, we have identified several necessary conditions for the existence of asymmetric equilibria, which are well known in the literature on local public goods and migration. First, in any such equilibrium one jurisdiction must have a lower tax rate and a lower level of the public service. Without loss of generality, we will in what follows adopt the convention that jurisdiction A sets the higher tax rate and supplies more of the public good. Second, the monotonicity of preferences induces a partition of the population according to ω across communities. Following the literature, we will refer to this phenomenon as *sorting* or *stratification according to 'hedonic' incomes*. Third, an equilibrium requires some boundary individual with 'hedonic' income $\tilde{\omega}$ who is indifferent between the jurisdictions. In a sorting equilibrium comprising $(t_A, g_A) > (t_B, g_B)$, all individuals with $\omega \leq \tilde{\omega}$ then live in community A, and all other individuals with $\omega \geq \tilde{\omega}$ live in community B. Observe that since preference intensities are distributed independently from income, we also must have $y_A \leq y_B$ in this case, with strict inequality if $\tilde{\omega} > \underline{w}/\bar{\gamma}$.

For subsequent reference it is convenient to classify the potential sorting equilibria according to the degree of a spatial separation in tastes. To start with, there may exist an equilibrium with perfect sorting of the population in the sense that all individuals with high intrinsic taste parameter $\underline{\gamma}$ for the public service live in jurisdiction B, whereas all $\bar{\gamma}$-individuals live in jurisdiction A.[14] Obviously, a necessary condition for this *fully revealing equilibrium* to exist is that $\bar{w}/\bar{\gamma} < \underline{w}/\underline{\gamma}$. In addition to this pure Tiebout-type equilibrium, there may also exist equilibria which display some sorting, but where in-

[13]For convenience, we refer to this boundary type as a single individual. One should keep in mind, however, that it comprises a continuum of individuals from two distinct preference and income classes, namely, all types $(w, \overline{\gamma})$ and $(w', \underline{\gamma})$ such that $\tilde{\omega} = w/\overline{\gamma} = w'/\underline{\gamma}$.

[14]The existence of such an equilibrium clearly hinges on our assumption that the number of jurisdictions weakly exceeds the number of preference classes.

dividuals from both types live together in at least one community. From our previous reasoning on the necessary characteristics of the boundary individual, two subtypes of such equilibria can emerge. First, there may be equilibria where some individuals with low preference intensities live in A but none of the high-preference types lives in B. We will call this type of equilibrium *partially revealing*. Secondly, there may be *mixed equilibria* in which each community is inhabited by people with different tastes for the public service.

To understand the forces at work in this framework intuitively, recall that individuals not only differ in preference intensities for the public good but also in their income. Furthermore, taxation is redistributive in nature. For this reason, individuals with identical taste parameters will not always live together in equilibrium. Instead, they weigh in their locational decisions the income loss (gain) due to redistribution against the gain (loss) in utility from (not) living in the jurisdiction which offers a level of public services closest to their tastes. This argument notwithstanding, we will show hat there exist all three types of sorting equilibria in our model where individuals reveal their intrinsic preferences through type-dependent residential choices for a wide range of parameter values. Apart from confirming the intuition of Tiebout, we also find that only sorting equilibria can be stable. The symmetric equilibrium characterized above, in contrast, is locally unstable: a small perturbation in the population structure leads to a divergence in policies chosen at date 1 which in turn triggers migration according to 'hedonic' incomes, further increasing the differences between communities.[15]

Denote the mean and median income of the entire population by y and w_m, respectively. We begin by providing conditions under which a fully revealing equilibrium exists.

Proposition 1. *A fully revealing equilibrium with exists if and only if the income distribution $F(w)$ and the preference intensities $\{\underline{\gamma}, \bar{\gamma}\}$ are such that*

$$\bar{w} \leq \frac{1}{2}\frac{\bar{\gamma}+\underline{\gamma}}{\underline{\gamma}} w_m \tag{8}$$

$$\underline{w} \geq \frac{1}{2}\frac{\bar{\gamma}+\underline{\gamma}}{\bar{\gamma}} w_m. \tag{9}$$

Proof. Suppose the population locates in a way that all $\bar{\gamma}$-individuals move to jurisdiction A and all $\underline{\gamma}$ individuals to jurisdiction B. Since the proportion of preference

[15]See Fernandez and Rogerson (1996) for a more formal argument along similar lines.

types is the same in each income class, the distribution of income will be the same in each jurisdiction. Thus, $y_A = y_B = y$ and $w_{mA} = w_{mB} = w_m$. The majority rule equilibrium policies for the presumed composition of jurisdictions are then given by $t_A^* = 1 - \frac{w_m/\bar{\gamma}}{y} > 0$ and $t_B^* = 1 - \frac{w_m/\underline{\gamma}}{y}$. Observe that $t_A^* > t_B^*$ and $g_A^* > g_B^*$ from (6), as required in any sorting equilibrium. For presumed population structure to be a migration equilibrium, each individual with taste parameter $\bar{\gamma}$ must weakly prefer to live in jurisdiction A. By our earlier arguments, this condition is satisfied if and only if the $\bar{\gamma}$-individual with the largest hedonic preferences from that group - the individual with the highest income - prefers region A, i.e.,

$$(1 - t_A^*)\bar{w} + \bar{\gamma} g_A^* \geq (1 - t_B^*)\bar{w} + \bar{\gamma} g_B^*.$$

Similarly, the lowest-income individual with preference intensity $\underline{\gamma}$ must weakly prefer to live in jurisdiction B, i.e.

$$(1 - t_B^*)\underline{w} + \underline{\gamma} g_B^* \geq (1 - t_A^*)\underline{w} + \underline{\gamma} g_A^*.$$

Substituting the expressions for t_j^* and g_j^* and rearranging yields (8) and (9). To show that these conditions are also necessary, suppose by way of contradiction that either one does not hold. Then, given the population structure in the presumed equilibrium and the corresponding vector of local policies, those individuals in A with highest incomes or those residents of B with lowest incomes are strictly better of in the respective other jurisdiction, a contradiction to part a) of Definition 1. □

Observe that communities do not differ with respect to their income distribution if the residential choice is fully revealing. Thus, the stratification according to 'hedonic' preferences in equilibrium does not translate into a divergence of local incomes. Using Proposition 1, one also can explicitly address the issue of political integration and the incentives of countries to separate or unite: assume that under unification, the policy is determined by centralized majority vote and consider the incentives of individuals to vote for political integration if they anticipate the fully revealing equilibrium to prevail under decentralized decision making. Since in this equilibrium average income in each region is identical to overall average income, budgets are unaffected by unification. A centrally determined policy, however, would not allow for public spending to vary with local tastes as does the equilibrium under non-integration. It follows that a majority of the population in *each* jurisdiction would favor a decentralized (federal) structure over unification.[16] In addition to being preferred to the allocation resulting in a centralized political process by a majority, the allocation in a fully revealing equilibrium has the desirable property that it is locally stable. To see this, suppose we slightly perturb equilibrium population structure by relocating a positive mass of individuals. As long as average incomes and corresponding tax policies do not differ too much, each of these individuals has a strict incentive to move back to the region where similar preference types cluster. Thus, migration would ensure that perfect sorting is again achieved.

Yet, it is important to note that Proposition 1 immediately implies the nonexistence of a fully revealing equilibrium if the income $\underline{w}$ of the poorest consumer is very low, e.g., if $\underline{w} = 0$. Technically speaking, we then have $\underline{w}/\underline{\gamma} < \bar{w}/\bar{\gamma}$ so that the hedonic preferences of the richest individual with high preference intensity $\bar{\gamma}$ are not below those of the poorest individual with low preferences $\underline{\gamma}$.[17] Accordingly, the supports of hedonic preferences for these two γ-classes overlap in a way that by our earlier arguments a Tiebout-like complete separation according to intrinsic tastes γ cannot be attained. To provide some intuition, consider individuals who do not pay taxes either because they earn no income or, equivalently, because the tax system includes an (exogenously fixed) tax allowance. Since utility is increasing in g_j, these individuals will always – irrespective of taxes and tastes – settle in the jurisdiction with a higher level of public good provision, violating the full separation requirement. Hence, for $\underline{w}$ sufficiently small, (9) cannot hold independent of the other parameter values. Observe, however, that no such argument can be made for the equivalent condition of the highest-income individual: even if $\bar{w}$ is very large, it is always possible to find sufficiently high values of $\bar{\gamma}$ to satisfy (8). Intuitively, while a wealthy individual always benefits from low tax rates, she still had no incentive to move to the low tax region B provided that her utility from the additional amount of the public service she enjoys in A is sufficiently high.

The above argument renders a complete sorting of the population according to γ impossible for the case where $\underline{w} = 0$. Nevertheless, the proposition below establishes that

[16] Observe that individual migration decisions can be disregarded under unification because the global constituency determines a uniform fiscal policy. Also, if the continuation equilibrium following a vote against unification is the symmetric equilibrium, governance structure does not matter: local policies will be identical to those of a unified nation.

[17] Of course, (8) or (9) can be violated even if $\underline{w}/\underline{\gamma} > \bar{w}/\bar{\gamma}$ holds for $\underline{\omega} > 0$.

sorting equilibria continue to exist if the taste differential between the two classes of preferences is sufficiently large.[18]

Proposition 2. *Suppose $\underline{w} = 0$. Then, for each value of $\underline{\gamma}$, there exists some $\bar{\gamma}^*(\underline{\gamma})$ such that for all $\bar{\gamma} \geq \bar{\gamma}^*$, sorting equilibria characterized by a boundary individual $\tilde{\omega} \in (0, \bar{w}/\underline{\gamma})$ exist. In particular,*

a) there exists a partially revealing equilibrium in which all (low-preference) individuals with 'hedonic' types $\omega = w/\underline{\gamma} > \tilde{\omega} \geq \bar{w}/\bar{\gamma}$ live in B and all $\bar{\gamma}$-types as well as a positive mass of $\underline{\gamma}$-types with 'hedonic' incomes $\omega \leq \tilde{\omega}$ live in jurisdiction A;

b) there exists a mixed equilibrium in which a positive mass of both preference types live in jurisdiction A as well as in jurisdiction B. In this case, $0 < \tilde{\omega} < \bar{w}/\bar{\gamma}$.

Proof. Consider an arbitrary allocation in which individuals are stratified into communities according to their intrinsic preferences ω (necessary condition). Let $\tilde{\omega} = \tilde{w}/\tilde{\gamma}$ be the boundary individual in this allocation. By convention, individuals with 'hedonic' incomes $\omega \in [0, \tilde{\omega}]$ reside in region A whereas individuals from the complementary set $\omega \in [\tilde{\omega}, \bar{w}/\underline{\gamma}]$ live in region B. Given the boundary individual $i = \tilde{\omega}$, the resulting tax rate and the level of public services in both communities are fully determined by applying the majority rule to the set of feasible policies [part b) of Definition 1]. Accordingly, $t_j^*(\tilde{\omega})$ and public services $g_j^*(\tilde{\omega})$ in each community j are uniquely given by (5) and (6). Let $V_j(\tilde{\omega}) \equiv V(t_j^*(\tilde{\omega}), g_j^*(\tilde{\omega}); \tilde{\gamma}, \tilde{w})$ be the utility of the boundary individual if she resides in region $j = A, B$ holding our presumed equilibrium composition and the corresponding policies fixed. We can then define

$$\begin{aligned} \Delta(\tilde{\omega}) &= [V_A(\tilde{\omega}) - V_B(\tilde{\omega})]/\tilde{\gamma} \\ &= [g_A^*(\tilde{\omega}) - g_B^*(\tilde{\omega})] - \tilde{\omega}[t_A^*(\tilde{\omega}) - t_B^*(\tilde{\omega})] \end{aligned}$$

as the utility difference of the boundary individual from residing in A rather than in B, which depends on $\tilde{\omega}$ only. In order to establish the existence of sorting equilibria,

[18] The case $\underline{w} = 0$ is analyzed in Bolton and Roland (1996) who then conclude that only symmetric equilibria can exist. As the proposition shows, this conclusion is flawed (see also Section 4). The following results carry over to arbitrary but sufficiently low values of $\underline{w}$ violating (9). We should also emphasize that while our analysis is confined to the case where there are only two possible levels of γ, the subsequent line of argument can be also be applied to prove existence of sorting equilibria if γ is distributed according to some arbitrary distribution function on the interval $[\underline{\gamma}, \bar{\gamma}]$.

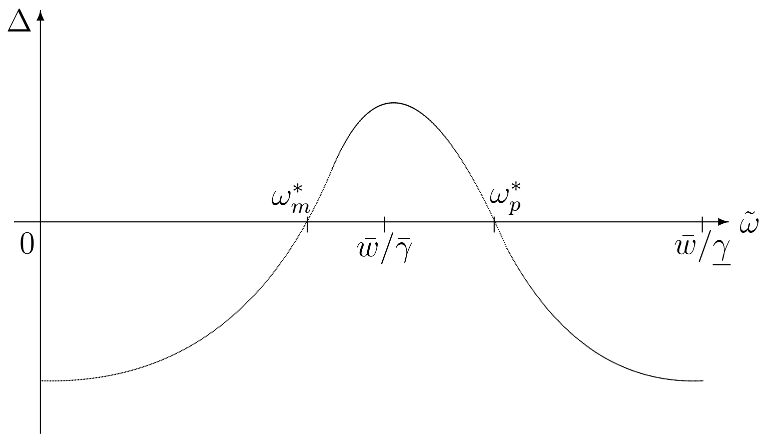

Figure 1: Utility Difference of Boundary Individual

we proceed to show that there exist parameter values for which $\Delta(\tilde{\omega}) = 0$ so that the supposed boundary individual $\tilde{\omega}$ is indifferent with respect to her residential decision. We then argue that for these parameter values the necessary condition $(t_A > t_B, g_A > g_B)$ is satisfied so that all other individuals display strict preferences for our presumed assignment of the population to the respective jurisdictions. This step establishes part a) of Definition 1 and completes the existence proof.

To show that $\Delta(\tilde{\omega}) = 0$ for some $\tilde{\omega} \in (0, \bar{w}/\underline{\gamma})$, suppose first $\tilde{\omega} \to \omega^{min} \equiv 0$ so that $g_A^*(\cdot) \to 0$, for any finite values of $\underline{\gamma}$ and $\bar{\gamma}$. Then, $\lim_{\tilde{\omega}\to 0} \Delta(\tilde{\omega}) < 0$ since $g_B^*(\tilde{\omega})$ approaches the level of g chosen in a centralized system. Similarly, suppose $\tilde{\omega} \to \omega^{max} \equiv \bar{w}/\underline{\gamma}$. Then, $t_B^*(\tilde{\omega})$ approaches the most preferred tax rate of the highest-income individual in community B and average income there approaches $y^{max} = \bar{w}$. Consequently, $\lim_{\tilde{\omega}\to \bar{w}/\underline{\gamma}} \Delta(\tilde{\omega}) < 0$ and the individual $\tilde{\omega}$ again prefers to live in jurisdiction B. We thus find that a composition where 'almost everybody' lives in region A or in region B, respectively, cannot be part of an equilibrium allocation because the supposedly indifferent boundary individual would in fact strictly prefer region B.[19]

Our next goal is to find an assignment of the population under which the supposed boundary individual exhibits strict preferences for region A rather than B, i.e., $\Delta(\tilde{\omega}) > 0$. If this composition exists, continuity of $\Delta(\cdot)$ ensures that $\Delta(\cdot) = 0$ for some

[19]By continuity of $\Delta(\cdot)$ in $\tilde{\omega}$, the above findings also imply that any existing asymmetric equilibrium cannot be unique. See also Figure 1 and the arguments that follow.

ω. Consider a value $\tilde{\omega} = \bar{w}/\bar{\gamma}$, i.e. the wealthiest individual with high tastes for the public good is the individual with highest hedonic income in jurisdiction A. Given $\underline{\gamma}$, we proceed to show that we can find a threshold level $\bar{\gamma}^*$ such that $\Delta(\tilde{\omega} = \bar{w}/\bar{\gamma}) \geq 0$ with strict inequality $\forall\, \bar{\gamma} > \bar{\gamma}^*$ and $t_A^*(\tilde{\omega} = \bar{w}/\bar{\gamma}) > t_B^*(\tilde{\omega} = \bar{w}/\bar{\gamma})$. To this end, observe first that $\tilde{\omega} = \bar{w}/\bar{\gamma}$ is decreasing in $\bar{\gamma}$ with $\lim_{\bar{\gamma}\to\infty} \bar{w}/\bar{\gamma} = 0$ for any finite value of $\bar{w}$: the proportion of $\underline{\gamma}$ individuals who are assigned to A in our presumed allocation decreases as the preference intensity $\bar{\gamma}$ increases. Using (5) and (6) the limit values of the equilibrium policies for $\tilde{\omega} = \bar{w}/\bar{\gamma}$ and $\bar{\gamma} \to \infty$ are

$$t_A^* = 1 \quad \text{and} \quad g_A^* = \frac{1}{2}y$$
$$t_B^* = 1 - \frac{w_m/\underline{\gamma}}{y} \quad \text{and} \quad g_B^* = \frac{1}{2}\left(1 - \frac{(w_m/\underline{\gamma})^2}{y^2}\right)y.$$

Since average incomes in both regions approach the overall average income y, only the differences in tastes matter for policy choice for $\bar{\gamma} \to \infty$. Hence, $t_A^* > t_B^*$ and $g_A^* > g_B^*$ and consequently, $\lim_{\bar{\gamma}\to\infty} \Delta(\bar{w}/\bar{\gamma}) > 0$. The intuition has already been laid out in the discussion following Proposition 1: if an individual's preference intensity is sufficiently large, she will always prefer to live in the community which offers the highest level of public services, *even* if tax rates there are very high and a large fraction of her income is lost in redistribution. Expressed differently, a $(\bar{w}, \bar{\gamma})$-type individual's preferences are then closer to the policy preferred by the $\bar{\gamma}$-type median voter in jurisdiction A than to the policy preferred by the $\underline{\gamma}$-type median voter in jurisdiction B.

Since $\Delta(\bar{w}/\bar{\gamma})$ is continuous in $\bar{\gamma}$, our previous arguments imply the existence of a critical value $\bar{\gamma} > \underline{\gamma}$ such that $\Delta(\bar{w}/\bar{\gamma}) = 0$.[20] If there are several such values, pick the largest and denote this value by $\bar{\gamma}^*$, holding $\underline{\gamma}$ fixed. Defining $\bar{\gamma}^*$ in this way also ensures that $t_A^*(\bar{w}/\bar{\gamma}^*) > t_B^*(\bar{w}/\bar{\gamma}^*)$. To see why, suppose to the contrary that $t_A^*(\bar{w}/\bar{\gamma}^*) \leq t_B^*(\bar{w}/\bar{\gamma}^*)$. By continuity of $t_j^*(\cdot)$ in $\bar{\gamma}$ and from our previous result for $\bar{\gamma} \to \infty$, it must be the case that $t_A^*(\cdot) = t_B^*(\cdot)$ for some $\bar{\gamma}' \geq \bar{\gamma}^*$. But then $g_A^*(\cdot) < g_B^*(\cdot)$ since $y_A < y_B$ for *any* choice of $\tilde{\omega} > 0$. Given equal tax rates and a higher level of public service in jurisdiction B, $\Delta(\bar{w}/\bar{\gamma}') < 0$ and there would be an additional value of $\bar{\gamma} > \bar{\gamma}'$ for which $\Delta(\cdot) = 0$, a contradiction to the definition of $\bar{\gamma}^*$. Thus, for $\bar{\gamma} = \bar{\gamma}^*$, there exists a sorting equilibrium with the property that the 'hedonic' income of the

[20] To show $\bar{\gamma}^* > \underline{\gamma}$, note that the limit values of the equilibrium policies in jurisdiction B at the partition $\tilde{\omega} = \bar{w}/\bar{\gamma}$ as $\bar{\gamma} \to \underline{\gamma}$ are $t_B^* = 1 - 1/\underline{\gamma}$ and $g_B^* = \frac{1}{2}(1 - 1/\underline{\gamma}^2)\bar{w}$. Since t_B^* is the most preferred tax rate of an individual with preferences $\omega = \bar{w}/\underline{\gamma}$ and y_B approaches $y^{max} = \bar{w}$, $\lim_{\bar{\gamma}\to\underline{\gamma}} \Delta(\bar{w}/\bar{\gamma}) < 0$.

boundary individual is $\tilde{\omega} = \bar{w}/\bar{\gamma}^*$.

Notice that $\Delta(\bar{w}/\bar{\gamma}) > 0$ for all values $\bar{\gamma} > \bar{\gamma}^*$, and recall that - for any finite values of $\underline{\gamma}, \bar{\gamma}$ - $\Delta(\omega) < 0$ if $\omega \rightarrow \tilde{\omega}^{min} = 0$ or $\tilde{\omega} \rightarrow \omega^{max} = \bar{w}/\underline{\gamma}$, respectively. Accordingly, continuity of $\Delta(\cdot)$ implies the existence of (at least) two types $\tilde{\omega}$ – denoted by ω_m^* and ω_p^* in Figure 1– for which $\Delta(\omega) = 0$. Again, if there are several such types, pick the largest values. Applying our reasoning above, one can conclude that $t_A^*(\cdot) > t_B^*(\cdot)$ for $\tilde{\omega} \in \{\omega_m^*, \omega_p^*\}$. Since $\omega_p^* > \bar{w}/\bar{\gamma}$, all individuals with high tastes for the public good live in jurisdiction A at this partition of the population (partially revealing equilibrium). Conversely, at $\omega_m^* < \bar{w}/\bar{\gamma}$, a positive mass of both preference types live in jurisdiction A as well as in jurisdiction B (mixed equilibrium), which completes the proof. $\square$

Proposition 2 establishes the existence of 'partially revealing' and 'mixed' sorting equilibria if the difference in tastes across the two groups of individuals is sufficiently pronounced. Note that the line of arguments which establish this result is largely independent of our specification of utility functions and technologies and could be applied to a much broader class of frameworks. Also, the condition on $\overline{\gamma}$ given in the proposition is only a sufficient condition. If the value of $\bar{\gamma}^*$ is unique and $\Delta(\omega)$ has the monotonicity properties displayed in Figure 1, $\bar{\gamma} \geq \bar{\gamma}^*$ is also necessary, but in general sorting may emerge for smaller taste differences as well.[21] What remains true, however, is that *some* taste differences are a necessary condition for sorting equilibria to exist in this framework: using the same argument as in Hansen and Kessler (2001b), it is straightforward to show that for $\underline{\gamma} = \bar{\gamma} \geq 1$, all equilibria must be symmetric, i.e., stratification does not arise. Intuitively, if local taxation is redistributive in nature, middle-income households are reluctant to stay in poorer jurisdictions where they are net contributors to a large public budget. Rather, they strictly prefer to locate in wealthy communities, which are attractive because middle class households tend to be net beneficiaries of public spending there, and their policy provides a more balanced mix of private and public consumption. As our analysis illustrates, large differences in tastes is one mechanism that can prevent this type of migration into rich communities because their policy bundle can be undesirable if the public good provision is sufficiently small.

[21] These properties critically depend on the distribution function $F(w)$ and it is therefore impossible to derive more general conclusions. In the case of a uniform distribution of income, for example, we found in simulations that $\bar{\gamma} \geq \bar{\gamma}^*$ is both necessary and sufficient for sorting.

We can also use Figure 1 to shed some light on the stability properties of partially revealing and mixed sorting equilibria. Consider the partially revealing equilibrium at ω_p^* where $\Delta(\cdot)$ crosses the horizontal axis from above. This equilibrium is locally stable: suppose the border individual's 'hedonic income' $\tilde{\omega}$ exceeds the equilibrium value ω_p^*. Then, $\Delta(\tilde{\omega}) > 0$ and this individual strictly prefers to live in A. If she moves according to her preferences, the 'hedonic' income of the new border individual is lower. Similarly, $\Delta(\tilde{\omega}) < 0$ for $\tilde{\omega} < \omega_p^*$ and the border individual moves to B. Thus, those individuals wishing to relocate would move in the direction toward equilibrium. Conversely, equilibria where $\Delta(\cdot)$ crosses the horizontal axis from below (the mixed equilibrium at ω_m^* as drawn in the figure) are unstable.[22]

To summarize, we have seen that for sufficiently strong differences in preference intensities, Tiebout-style sorting equilibria always exist even if the poorest individuals in the society have a zero income. In those equilibria, low income individuals cluster in the region which offers a higher provision of the public service, irrespective of their preferences. For wealthy individuals, in contrast, there is a trade-off between the redistributive and the provisionary aspect of income taxes. Depending on their preference intensity, either effect may dominate. If the difference in tastes between individuals is very strong, sorting is (almost) perfect and the income differences between jurisdictions vanish. The smaller the taste differential, the stronger the motive for wealthy individuals to escape taxation and the stratification into rich and poor communities is more pronounced.

Let us briefly indicate how the above results generalize to situations with an arbitrary finite number of jurisdictions $k = 1, .., K$. Clearly, the symmetric equilibrium characterized by the equalization of policies and mean incomes continues to exist. So do the equilibria described in Propositions 1 and 2 if one considers a K-community allocation that replicates in per-capita terms the allocation in a two-community equilibrium. Specifically, take any asymmetric (partially revealing or mixed) equilibrium for the two region case $\{(\hat{t}_j, \hat{g}_j), \hat{f}_j(w, \gamma)\}_{j=A,B}$ with $\hat{\alpha}_j > 0$ as the fraction of the total population that lives in j. Now consider a situation with $k = 1, .., K$ jurisdictions. Partition the set of these jurisdictions into two subsets K_A and K_B and let $f_k^*(w, \gamma) = \alpha_k \hat{f}_j(w, \gamma)/\hat{\alpha}_j$ for

[22]For a similar argument, see Westhoff (1979) who considers a related setting with scale effects of public goods. In his model, the scale effects of population size and the implied non-convexities in local budgets either give rise to multiple equilibria or, if a unique equilibrium exists, it will be unstable.

$k \in K_j$ where α_k can be chosen arbitrarily subject to $\sum_{k \in K_j} \alpha_k = \hat{\alpha}_j$, $j = A, B$. In the resulting equilibrium, the population structure in each jurisdiction $k \in K_j$ is a smaller copy of the population structure of jurisdiction $j = A, B$ and the local policy is simply $(t_k^*, g_k^*) = (\hat{t}_j, \hat{g}_j)$. This straightforward argument allows to construct equilibria in multi-community economies from existing ones in the two-community case. One should keep in mind, however, that these equilibria will generally be unstable because (local) stability requires all jurisdictions to implement distinct policies.[23] Again, a stable fully revealing equilibrium with distinct policies would exist under conditions analogous to those of Proposition 1 if the number of preference classes happens to coincide with the number of jurisdictions. Otherwise, only partially revealing or mixed equilibria can emerge that display the same characteristics (sorting according to hedonic incomes and ordered bundles) as those in Proposition 2.

Before closing this section, it is instructive to relate our previous findings to the results in the recent literature on multi-jurisdictional sorting. In line with Nechyba (1997) and Epple and Platt (1998), our framework incorporates mobile consumers with different endowments *and* heterogeneous preferences, and policies that are decided upon at the community level by majority rule. Epple and Platt (1998) characterize necessary conditions for an allocation with sorting/stratification to be an equilibrium in a model where individuals have distinct preferences over housing, and where the proceeds from property taxation are used for purely redistributive purposes. Similar to our results, they show that equilibria will not display complete stratification according to incomes but rather 'incomplete sorting': high-income households will live together with poorer households with a strong taste for housing in communities where gross-of-taxes housing prices and public transfers are low, and vice versa. Assuming two communities and setting one local property tax exogenously to zero, the authors then calibrate their model to 1980 data from the Boston metropolitan area. In accordance with our theoretical predictions for the case of income taxation, their simulations show that the high-tax community does not lose all wealthy residents. However, the fraction of households in a given income class who live there is indeed decreasing in income.

Nechyba (1997) establishes existence of equilibrium in a very general multi-community

[23] Recall that small perturbations of the equilibrium population structure of any two jurisdictions which implement the same policy cause migration that further distracts the presumed equilibrium allocation.

model with property taxes and voting. Communities are composed of a given number of heterogenous houses of fixed size, which are owned by agents. Because the model imposes no additional structure on individual preferences and because agents' incomes are endogenous, preferences do not a priori display the single-crossing property that is needed to define some form of sorting exogenously. Using the respective equilibrium values of agents' net incomes and their marginal willingness to pay (for housing or for the local public good) instead, Nechyba provides sufficient conditions for equilibria to display several notions of sorting according to incomes and preferences. If all houses are identical and agents have no intrinsic preferences for communities, for instance, equilibria are preference stratified in that agents sort themselves by marginal willingness to pay for the local public good. If, in addition, everybody has the same preferences, there will be 'complete stratification' in the sense that sorting is both with respect to marginal willingness to pay and to net incomes in equilibrium. In contrast to our model, wealthy communities then produce a higher level of public goods than poorer communities. This discrepancy arises because with property taxes and homogeneous housing, the redistributive aspects of taxation disappear: the property tax burdens of all citizens are equalized and, as a result, not only individuals with strong preferences for public services but also those with high incomes are willing to pay more for the production of public goods.

We view the present analysis as complementary to these contributions for several reasons. First, it is the first to analytically prove the emergence of sorting equilibria, and to relate their (non-)existence and their characteristics to the parameters of the model. Second, we consider taxes that are levied on income rather than on housing consumption. As mentioned in the Introduction, while income taxation is of less importance for communities in the U.S., it is a significant source of local revenue in Europe. A case in point is Switzerland, where income taxes are raised and decided upon locally both at the cantonal and the municipal level of government, and where considerable local income tax differentials can be observed. Third, while the analysis in Nechyba (1997) is in many way more general than ours, his work assumes a fixed community size, which effectively translates into a community entrance fee (the gross of tax housing price differential) that may be prohibitive for low-income households. While a sufficiently tight housing market is an alternative mechanism that can help to support local differences, its presence also blurs the potentially important role that exogenous taste differentials play in the sorting of households and the formation of distinct local policies. Also, the complete sorting results in Nechyba only apply for the case of homogeneous housing, where the property taxation ceases to be redistributive in nature and the phenomenon of low-income households migrating to wealthier communities does not arise.

4 The Model with Relocation

The model analyzed in the previous section presumed that policies are determined for a fixed population in every community. While this assumption has been employed by most of the multi-community literature with heterogeneous agents, it does not capture the potentially important aspect of jurisdictions competing to attract members. Let us therefore investigate our framework in light of what Caplin and Nalebuff (1997) call the 'position-based' approach and Epple and Romer (1991) call the 'sophisticated voter model', respectively. In this concept, agents again pick their preferred jurisdiction taking the vector of local policies as given. The difference to the previous model lies in how jurisdictions choose their policies: a local policy is selected according to the majority rule, taking the policies (positions) of other jurisdictions as fixed and anticipating correctly the migrational responses that will result. Thus, the feasibility of a (proposed) local policy in each jurisdiction depends on the migration that is induced by the policy, taking the policies elsewhere as given. This alternative concept has been applied by Epple and Romer (1991), Epple and Platt (1998), and Epple et al. (2001). As Caplin and Nalebuff (1997) themselves note, though, this equilibrium concept is questionable as it does not require budgets to balance out of equilibrium. Specifically, jurisdictions take both taxes *and* public good levels elsewhere as given when they select their own policy. Hence, they ignore the fact that changes in their own local policy and the resulting migration will make other jurisdictions' positions infeasible (and therefore no longer credible).[24]

Fortunately, there is a simple way to ensure budget balance in and out of equilibrium in this framework: instead of having jurisdictions select both taxes and public good levels, we assume that each jurisdiction selects its local tax rate t_j (by majority rule)

[24] This point is most transparent in the sequential model (see below) that may be used to rationalize the notion that jurisdictions recognize policy-induced migration.

only, taking as given the tax rate of the other jurisdiction. This approach has also been used in Hindriks (2001) and has the advantage that the set of feasible policies that jurisdictions decide upon is exogenous ($t_j \in X_j = [0,1]$) and does not depend on the policies implemented elsewhere. Public goods g_j are then residually determined through the local budget where y_j now varies according to the perceived migrational response, i.e., by having jurisdictions vary their public good provision with migration flows to maintain budget balance. Naturally, the anticipated policy-induced migration has to be correct in the sense that the migrational response itself must be a migration equilibrium for all tax rates (see also Caplin and Nalebuff, 1997). Thus, let $\tilde{f}_j(\gamma, w \,|\, t)$ be the population structure that jurisdiction j anticipates given a vector of tax policies $t = (t_A, t_B) \in [0,1]^2$ and recall from (4) that

$$v(t_j, y_j; \gamma, w) \equiv V\left(t_j, g_j = (t_j - \frac{1}{2}t_j^2)y_j, \gamma, w\right) = (1 - t_j)w + \gamma(t_j - \frac{1}{2}t_j^2)y_j \qquad (10)$$

is the utility of a (γ, w)-type individual when living in a jurisdiction with a tax rate of t_j and a per capita income of y_j. Migration responses $\tilde{f}_j(\gamma, w \,|\, t)$ with the corresponding per-capita incomes $\tilde{y}_j(t)$ then imply a local public good supply of $g_j(t) = (t_j - \frac{1}{2}t_j^2)\tilde{y}_j(t)$. For any vector of tax rates t, anticipated migration is consistent with a migration equilibrium if

$$\tilde{f}_j(\gamma, w \,|\, t) > 0 \quad \Rightarrow \quad v\left(t_j, \tilde{y}_j(t); \gamma, w\right) \geq v\left(t_k, \tilde{y}_k(t); \gamma, w\right), \ \forall j, k = A, B, \qquad (11)$$

where $\tilde{y}_j$ is the average income in j that corresponds to the population structure $\tilde{f}_j(\cdot)$. Condition (11) says that expectations with regard to the migrational responses are rational, i.e., not inconsistent with the preferences of individuals over jurisdictions when all budgets have to balance.

It remains to specify a consumer's preferences over tax policies. In contrast to the previous section, the majority-preferred tax rate now depends on the tax policy that is chosen in the other jurisdiction through two channels: first, when evaluating a policy, jurisdictions take into account the fiscal-policy induced migration pattern, which determines the composition of communities and therefore affects the local public good level. Secondly, jurisdictions also take into account that a resident's preferences over local taxes vary depending on whether or not she would move given the contemplated policy. In other words, if a consumer in, say, jurisdiction A prefers to move given tax rates (t_A, t_B), the relevant utility she nets from the local policy t_A (given t_B) must be her utility after *everybody including herself* has chosen her residence optimally.[25] Formally, the indirect utility of a (γ, w)-individual from a tax rate t_j, given the tax set in the other jurisdiction, $t_k, k \neq j$ is

$$\mathcal{V}(t_j, t_k; \gamma, w) = \max_{l=j,k} v\left(t_l, \tilde{y}_l(t); \gamma, w\right). \tag{12}$$

Given the tax rate in the other jurisdiction, t_k, a population structure $f_j(\gamma, w)$ and expected migration responses $\tilde{f}_j(\gamma, w|t)$, the majority rule outcome in jurisdiction j is thus a tax rate $t_j \in [0, 1]$ that is preferred to any other tax rate $t'_j \in [0, 1]$ according to (12) by a majority of the inhabitants in j.

Definition 2. Suppose jurisdictions anticipate policy-induced migration. An inter-jurisdictional equilibrium is then a vector of local policies $\{(t_j^*, g_j^*)\}_{j=A,B}$, a distribution of the population over jurisdictions $\{f_j^*(\gamma, w)\}_{j=A,B}$, and expectations over migrational responses $\{\tilde{f}_j(\gamma, w \,|\, t)\}_{j=A,B}$ such that, for all $j = A, B$

a) expectations over migration responses are rational, i.e., $\forall(\gamma, w)\ \forall t \in [0, 1]^2$

$$\tilde{f}_j(\gamma, w \,|\, t) > 0 \;\Rightarrow\; v\left(t_j, \tilde{y}_j(t); \gamma, w\right) \geq v\left(t_k, \tilde{y}_k(t); \gamma, w\right),\ k = A, B$$

b) the distribution of the population forms a migration equilibrium given (t_A^*, t_B^*), i.e., $\forall(\gamma, w)\ f_j^*(\gamma, w) = \tilde{f}_j(\gamma, w|t_A^*, t_B^*)$ and $\alpha_j^* > 0$,

c) given t_k^*,$f_j^*(\gamma, w)$ and $\tilde{f}_j(\gamma, w|t_j, t_k^*)$, policies form a political equilibrium, i.e., $t_j^* \in [0, 1]$,

$$\mathcal{V}(t_j^*, t_k^*; \gamma, w) \geq \mathcal{V}(t_j, t_k^*; \gamma, w), \forall\, t_j \in [0, 1]$$

for a majority of the residents in j and budgets balance, $g_j^* = (t_j^* - \frac{1}{2}t_j^{2*})y_j^*$.

Part a) ensures that equilibrium expectations are rational, that is, the expected responses form a migration equilibrium given any vector of tax rates. Part b) requires equilibrium residential choices to form a migration equilibrium. The majority rule application for the policy choice in each jurisdictions is covered by part c), which also

[25] This notion is in line with Hindriks (2001) but differs from Epple and Romer (1991), Epple and Platt (1998), and Kessler et al. (2002). In these models, resident-voters are 'sophisticated' enough to recognize that others will move, but are myopic with respect to their own residential decision. However, under the additional assumption on public good provision we impose below, it can be shown that the two concepts essentially coincide.

ensures budget balance. This equilibrium definition is very similar to the 'policy-based institutional equilibrium in taxes' as defined in Hindriks (2001), albeit in a different context.[26] The only essential difference is that Hindrik's Definition 2 (p. 102) does not formally distinguish between expectations over the division of the population across jurisdictions and actual (equilibrium) residential choices. This distinction is not necessary in his model because optimal migration decisions define a unique partition of the population. We will see below, however, that there may be more than one partition of individuals compatible with a migration equilibrium in our framework. In such a situation, the formal distinction between anticipated responses and actual equilibrium behavior must be drawn, if only because the two could be very different in principle.[27]

As we saw in the previous section, the approach where jurisdictions treat their local population as fixed can be rationalized in a sequential formulation. It thus seems natural to ask whether an analogous dynamic representation can be found for the approach in the present section as well. Let us therefore come back to the sequential formulation, to which we add a relocation stage.[28] More specifically, consider the following sequence of events. Again, individuals simultaneously decide on the jurisdiction to live in at date 0. At date 1, tax rates in each jurisdiction are determined by majority rule of the current residents; at date 2, all individuals simultaneously decide whether to relocate. Finally, taxes are collected, public goods provided, and individuals consume at date 3. It is now easy to see that an interjurisdictional equilibrium as defined above is also a perfect foresight equilibrium of this sequential model. Note first that bud-

[26]Hindriks (2001) analyzes a model of residential an political choice with the primary focus on tax competition rather than sorting. Confining the analysis to symmetric equilibria, his paper shows that greater mobility of low-income households may increase local redistribution and that taxation may be excessive (on the wrong side of the Laffer curve) in equilibrium.

[27]In equilibrium, however, they are required to be equal. Part b) of Definition 2 covers this case: it not only calls for the equilibrium population structure to form a migration equilibrium, but also requires it to be identical to the expected migrational response, given equilibrium tax rates.

[28]Adding the relocation stage is not only the most natural modification in light of what we seek to capture, namely, competition between jurisdictions. It is also the only one: the two dynamic formulations (with and without relocation) completely exhaust all possibilities. Since individuals are rational and perfectly foresee future developments, introducing finitely many additional voting and/or migration stages does not generate new equilibrium outcomes: from each individual's point of view, the only stage that matters is the last stage before consumption occurs, i.e., whether it is a voting or a migration stage (see also Caplin and Nalebuff, 1997). In the formulation with relocation, the pre-voting location stage 1 is only necessary to eliminate the possibility of arbitrary (path-dependent) outcomes through arbitrary initial assignments of the population.

gets will be balanced naturally ex post for all possible policies at the preceding stage. Now, the final date 2 residence decision of each person maximizes his utility, given the (simultaneous) residential decisions of all other individuals and any vector of local tax rates chosen at the previous stage.[29] This behavior is rational because - from the viewpoint of each individual - the residential choices of all other individuals fix the average income in each community and thus for given tax rates the level of the local public good g_j through the jurisdictions' budget constraints. These final residential choices induce a distribution of the population across jurisdictions, $\tilde{f}_j(\gamma, w \mid t)$, for any history summarized by the vector of local tax rates $t = (t_A, t_B)$ [part a) of Definition 2]. Given the subsequently optimal migration decisions, jurisdictions select their policy via majority rule at date 1. At this stage, the preferences of their residents are given by (12) because individuals perfectly foresee both the relocation decisions of themselves and of those of others [part c) of Definition 2]. If everybody rationally anticipates the policies selected at date 1 and the relocation decisions at date 2, moving to the most preferred community (and not subsequently relocating) forms a migration equilibrium at date 0 [part b) of Definition 2].[30]

This sequential interpretation has also been provided in Bolton and Roland (1996) who solve the model backward in search for an equilibrium. As will become clear shortly, however, using the approach in Definition 2 (allowing for relocation, respectively) gives rise to a conceptual difficulty that was not present previously. This problem stems from the fact that a migration equilibrium cannot generally be ensured for arbitrary combination of tax rates $t = (t_A, t_B)$ in both communities. In such a situation, what are the migration flows that jurisdictions (individuals) should expect to result from the tax policies that are locally selected? And if there do not exist consistent expectations (respectively, equilibria at the relocation stage) for a given vector of tax rates t, a comparison of *all* tax rates according to the majority voting criterion is obviously impossible: if one cannot infer the corresponding migration flows and the resulting public good supply, then a resident's utility from a given local tax rate is simply not

[29] Hence, final location choices are optimal for *any* vector of tax rates (t_A, t_B) chosen at a pre-stage (not just for the equilibrium values).

[30] Notice, though, that there may be additional equilibria in the sequential model where individuals do relocate in equilibrium, which are ruled out by part b) of our formalization in Definition 2. These additional equilibria would disappear if individuals incur some - positive but arbitrarily small - moving costs.

well defined.

To illustrate the problem, consider an example of pure redistribution, i.e. identical $\gamma = 1$ for all individuals (see also Caplin and Nalebuff, 1997). It is convenient to focus on pure redistribution because in this case, it is easy to see that no sorting equilibria exist if the jurisdictions take their membership as fixed (the model without relocation, respectively): if $(t_A, g_A) > (t_B, g_B)$ in any potential equilibrium with stratification according to income, the wealthiest resident of the poorer jurisdiction A, who is a net contributor to the public budget there, would always want to move to the wealthier jurisdiction B where he is the poorest citizen and a net recipient of public transfers. Hence, there is no boundary individual in any potential stratification equilibrium and, as a consequence, no migration equilibrium exists. Coming back to the present formulation with variable membership, consider for concreteness the sequential model with the relocation stage. Suppose asymmetric tax rates $t_A > t_B$ are the political outcome at date 1. By the above reasoning, the only *potential* equilibrium population structure at date 2 for $t_A > t_B$ is that *all* individuals eventually settle in B. No assignment of individuals into jurisdictions according to their hedonic preferences could ever make some boundary individual indifferent (since the net return from redistribution in A is always negative for the highest-income individuals, they optimally move to B where taxes are lower). But migration of the whole population to the low-tax community B cannot be a migration equilibrium at date 2 either because wealthy individuals in B then had an interest to resettle in A: for any $t_B > 0$, they are a net contributor to the system in B while they can avoid redistribution by moving to A and paying taxes only to themselves.[31] Our discussion thus suggests that the relocation stage has no equilibrium for asymmetric tax rates $t_A \neq t_B$. Likewise, there is no anticipated migrational response $\tilde{f}_j(\gamma, w \,|\, t)$ which is consistent, i.e., satisfies (11) for asymmetric and positive tax rates $t_A \neq t_B > 0$. As a consequence, tax rates cannot be ranked according to the majority-voting criterion and an overall equilibrium is not well defined. If symmetric tax rates are a necessary equilibrium condition in the game without relocation (as in the special case of redistribution) this conclusion is always valid. In our framework with heterogenous tastes, the same situation arises if it is impossible

[31]This reasoning holds if the tax differential between A and B is sufficiently small, i.e. the difference in distortionary losses is not too large. The same argument can be applied to show that the relocation stage does not even have a mixed strategy equilibrium if individuals are risk-neutral.

to find an individual who is indifferent between the communities for some $t_A \neq t_B$. The problem is obviously that in order to pin down rational expectations (respectively, ensure a migration equilibrium at date 2), we have to guarantee that for *all* admissible vectors of local tax rates $t = (t_A, t_B)$ there is a migration equilibrium on the basis of which consistent expectations can be formed.

This non-existence problem can be overcome by assuming that no individual can reside in a community alone, i.e. that her payoff is sufficiently low if she is the only inhabitant. Under this additional assumption that is often invoked in the literature and which we adopt here, no individual moves to A given that all other agents live in B, so that migration equilibria where one community is empty are supported.[32] As a result, there are now at least two expected migration responses which are consistent (date 2 migration equilibria, respectively) for any vector $t = (t_A, t_B)$: either the entire population resides in A or, alternatively, everybody lives in B. In view of the above line of reasoning, we will in what follows employ the allocation where everybody lives in the lowest tax jurisdiction as the most natural direction of policy-induced migration. We can now show that the equilibria of our previous analysis in the case where individuals differ in their intrinsic preferences γ for a public service ($\bar{\gamma} > \underline{\gamma} \geq 1$) prevail.

Proposition 3. *If a fiscal policy vector $\{(t_j^*, g_j^*)\}$ and the corresponding distribution of the population over jurisdictions $f_j^*(w, \gamma)$, $j = A, B$ is an equilibrium as characterized in Propositions 1 and 2, then the same policy vectors and the same population distributions form an equilibrium when jurisdictions correctly anticipate policy-induced migration (in the sequential model with relocation, respectively).*

Proof: We provide the proof for an equilibrium as described in Proposition 2. Consider parameter values $(\underline{\gamma}, \bar{\gamma})$ for which sorting equilibria exist under the membership-based approach (in the model without relocation, respectively). Pick any such equilibrium with taxes (t_A^*, t_B^*), public good levels (g_A^*, g_B^*) and a population distribution

[32] Epple et al.(1993), for instance, assume that there are small fixed costs associated with public spending. A community is then 'viable' only if it is inhabited by a positive mass of individuals. The authors use this assumption to prove existence of stratification equilibria in a framework where households differ only in their income and where relocation is not allowed for. Bolton and Roland (1996) also assume that equilibria where everyone settles in one community are supported. Note that this assumption does not invalidate existing equilibria in the model without relocation (Proposition 1 and 2).

$\{f_A^*(w,\gamma), f_B^*(w,\gamma)\}$. We show that the following is an equilibrium when jurisdictions do not treat their population as fixed (the formulation with relocation, respectively). First, agents' residential choices (at date 0) correspond to $\{f_j^*(\gamma,w)\}_{j=1,\ldots,J}$ so that individuals with small (large) hedonic incomes live in jurisdiction A (B). The local population structure relevant for the application of majority rule (at date 1) is therefore $\{f_j^*(\gamma,w)\}_{j=A,B}$. The expectations regarding policy induced migration $\tilde{f}_j(\gamma,w\,|\,t)$, (the migration equilibrium at date 2) are as follows. If the presumed equilibrium tax rates (t_A^*, t_B^*) are the outcome of the majority rule in both jurisdictions (at date 1), individuals are expected to locate according to $\{f_j^*(\gamma,w)\}_{j=A,B}$. For any other combination of tax rates $(t_A,t_B) \neq (t_A^*, t_B^*)$, all individuals locate in the community with lower tax rates.[33] Formally,

$$\begin{aligned}
\tilde{f}_j(\gamma,w\,|\,t) &= f_j^*(\gamma,w) \qquad\qquad \text{if } t=(t_A^*,t_B^*),\\
\tilde{f}_j(\gamma,w\,|\,t) &= \begin{cases} p(\gamma)f(w) & \text{for } t_j \leq t_k \\ 0 & \text{for } t_j > t_k \end{cases} \qquad \text{otherwise,}
\end{aligned} \tag{13}$$

where $p(\gamma)$ is the proportion of γ-type individuals in the global population. Note that these expectations are consistent in the sense of part a) of Definition 2 (the allocation forms a migration equilibrium at date 2): since $\{f_j^*(\gamma,w)\}_{j=A,B}$ is an equilibrium composition for given policies (t_j^*, g_j^*) according to Definition 1, the same composition is a rationally anticipated migration response given taxes t_j^* and the resulting public good levels g_j^* that balance the budget. Furthermore, a partition where all agents live in one community for any other vector of taxes forms a migration equilibrium because given that all other individuals reside in the low-tax community, each single individual i finds it in her best interest to live in the same region as well. The proof now proceeds in three steps:

i) We first argue that given t_B^*, $\{f_j^*(\gamma,w)\}_{j=A,B}$, and $\tilde{f}_j(\gamma,w\,|t)$ as described above, the majority-preferred tax rate in jurisdiction A is t_A^*. To see this, suppose t_B^* is the tax rate in B and recall that the optimal migration decision of each inhabitant of region A if $t_A \neq t_A^*$ is such that she either stays in A (if $t_A \leq t_B^*$) or moves to B (if $t_A > t_B^*$). For any $t_A \neq t_A^*$, the utility of a (γ,w)-type individual is thus $\mathcal{V}(t_A, t_B^*;\gamma,w) = v(\min\{t_A,t_B^*\}, y;\gamma,w)$ where y indicates the per capita income of the population as a whole. If the majority rule selects $t_A = t_A^*$, the utility is

[33] If tax rates in either region are the same, let agents coordinate on one community.

$\mathcal{V}(t_A^*, t_B^*; \gamma, w) = v(t_A^*, y_A^*; \gamma, w)$ and is identical to the utility this individual obtains in the corresponding sorting equilibrium of Proposition 2 (because no individual migrates and the population distribution $f_A^*(\gamma, w)$ is preserved). From our equilibrium considerations in Section 3, revealed preferences imply $\mathcal{V}(t_A^*, t_B^*; \gamma, w) \geq \mathcal{V}(t_A, t_B^*; \gamma, w), t_A \in [0, 1]$ for a majority of the population in A. To see this, note that for any tax rate $t_A > t_B^*$ and $t_A \neq t_A^*$, all individuals finally cluster in B, face a tax rate t_B^* and an average income of $y \leq y_B^*$. But by definition of $f_A^*(\gamma, w)$ and (t_A^*, t_B^*), $\mathcal{V}(t_A^*, t_B^*; \gamma, w) = v(t_A^*, y_A^*; \gamma, w) > v(t_B^*, y_B^*; \gamma, w) \geq v(t_B^*, y; \gamma, w) = \mathcal{V}(t_A, t_B^*; \gamma, w)$ for any resident of A. Hence, a tax rate t_A^* and staying in A gives each resident of A a strictly higher utility than a tax rate $t_A \neq t_A^*$ with $t_A > t_B^*$ and moving to B. Hence, no tax rate $t_A > t_B^*$ is majority-preferred to t_A^*. Next consider $t_A \leq t_B^* < t_A^*$. In this case, anticipated migration responses require everybody to move to A, so that average income there is equal to $y \geq y_A^*$. But for all individuals in A with $\omega \leq \omega_{mA}$, we then have $\mathcal{V}(t_A^*, t_B^*; \gamma, w) = v(t_A^*, y_A^*; \gamma, w) > v(t_B^*, y; \gamma, w) \geq v(t_A, y; \gamma, w) = \mathcal{V}(t_A, t_B^*; \gamma, w)$ for any $t_A \leq t_B^*$ by definition of $v(\cdot)$. Thus, at least half of the population in A also favors t_A^* over any tax rate $t_A \leq t_B^*$. It follows that t_A^* is the majority rule outcome in A. That g_A^* is the corresponding equilibrium level of public good provision follows from budget balance.

ii) For a given tax rate t_A^* in region A, t_B^* is the majority rule outcome in jurisdiction B. Recalling that $t_B^* \in \operatorname{argmax}_t v(t, y_B; \omega_{mB})$, any tax rate $t_B < t_A^*$, $t_B \neq t_B^*$ (with the resulting reduction in average income to y through everybody living in B) makes the median hedonic income resident ω_{mB} of B worse off. Obviously, the same is true for any other resident of B with $\omega_i < \omega_{mB}$, who prefers a larger tax rate than the median individual. Conversely, for $t_B \geq t_A^*$, everybody (including the median agent herself) locates in A where taxes are higher than t_B^* and average income is weakly lower than y_B. Clearly, this policy cannot be profitable for the median voter nor for any individual i in B with $\omega_i > \omega_{mB}$. Thus, we have $\mathcal{V}(t_A^*, t_B^*; \gamma, w) \geq \mathcal{V}(t_A^*, t_B; \gamma, w), t_B \in [0, 1]$ for at least half the population in B as required for the majority rule outcome. Again, g_B^* follows from budget balance.

iii) Combining steps i) and ii), we have shown that for residential decisions $f_j^*(\gamma, w)$ and anticipated migration responses $\tilde{f}_j(\gamma, w \,|\, t)$, which satisfy part a) of Definition 2, the tax rate vector (t_A^*, t_B^*) forms a political equilibrium according to part c) of Definition 2:

t_j^* is majority preferred to any other tax policy in community j, $j = A, B$, given the tax implemented in the other community and the rational migration responses $\tilde{f}_j(\gamma, w \,|\, t)$ from (13). That $\{f_j^*(\gamma, w)\}_{j=A,B}$ is a migration equilibrium follows directly from the fact that it constitutes an equilibrium composition for given policies (t_j^*, g_j^*) in the model where jurisdictions take their population as fixed (see Definition 1). Also note that $f_j^*(\gamma, w) = \tilde{f}_j(\gamma, w \,|\, t^*)$ by construction, so that $\{f_j^*(\gamma, w)\}_{j=A,B}$ satisfies part b) of the equilibrium definition. Accordingly, the allocation $\{f_j^*(w, \gamma), t_j^*, g_j^*\}_{j=A,B}$ forms an equilibrium which is equivalent to the corresponding equilibrium in Proposition 2. The proof for the symmetric equilibrium as in Proposition 1 is analogous. □

To our knowledge, Proposition 3 provides the first existence proof of sorting equilibria if jurisdictions correctly anticipate policy-induced migration (and budgets have to balance out of equilibrium) or, alternatively, in a model where individuals can resettle after policies have been determined. It shows that the set of equilibrium outcomes in the membership-based formulation (without relocation) is a subset of the equilibria in the position-based formulation (with relocation), provided only communities with a positive number of inhabitants are 'viable'. The existence of sorting equilibria thus does not hinge on the restrictive assumption that jurisdictions cannot compete for a mobile population because they take their membership as given, i.e., that individuals cannot resettle after policies have been implemented. The finding of Bolton and Roland (1996), according to which only symmetric equilibria with identical tax rates and per-capita incomes across jurisdictions can prevail in this framework (see Propositions 1 and 2 in their paper), is therefore incorrect.

Unfortunately, the set of equilibria when jurisdictions anticipate policy-induced migration (with relocation) is larger than in the model where they don't (if relocation is not allowed). An example illustrating that the anticipated migration responses (the relocation stage) also gives rise to equilibria that were not present before is provided in the Appendix. Intuitively, additional policies are now sustainable as majority rule outcomes due to the associated possibility of 'punishment for deviation' through anticipated mass migration after tax policies have been selected. Naturally,there may be consistent expectations based on migration equilibria (at the relocation stage) that involve sorting with both jurisdictions being populated for more than just the equilibrium tax rates in membership-based model (without relocation). If so, the local population structure may be a continuous function of the local tax rate for some subset of policies. As long as such migration equilibria do not exist for all possible tax combinations, however, there will always be policies such that all individuals eventually settle in one jurisdiction. As a result, the tax base is either zero or identical to the overall federal tax base, implying similar discontinuities as in the present model. These discontinuities can render a formal analysis difficult, if not impossible. Furthermore, the multiplicity of consistent expectations (continuation equilibria at the relocation stage) may give rise to additional equilibria at the policy selection stage. A full characterization of the entire set of equilibria is therefore unlikely to be feasible. Still, one important conclusion to be drawn from Proposition 3 remains valid. It formally shows that sorting equilibria are 'stable' even if jurisdictions can compete for a mobile population. Sorting thus remains a robust outcome if one extends the traditional Tiebout multi-community model to a more dynamic framework which allows individuals to migrate again after local policies have been determined.

5 Concluding Remarks

This paper has provided a positive analysis of residential and political choice in a multi-community model if individuals are heterogenous not only with respect to income but also with respect to their preference intensities for the public good. In addition to proving existence of equilibrium, we have delivered a characterization of sorting equilibria in which individuals with similar preferences cluster together in one community. In particular, there is perfect sorting of the population according to intrinsic preferences if the income of the poorest individual is above some minimum level. If low income households are sufficiently poor, however, they will always migrate into the community which offers a higher level of public spending, irrespective of their tastes. Nevertheless, sorting equilibria still exist for sufficiently large intrinsic preference differences across individuals. The smaller the taste differential, the stronger the motive for wealthy individuals to escape taxation and the larger the income differences between communities (income stratification). We have further demonstrated that sorting equilibria continue to exist if individuals need to take migrational responses into account when taking their voting decision, i.e., if each voter is allowed to relocate after tax policies have been determined. According to this possibly important result, the emergence of Tiebout-type equilibria need not be hampered by the possibility of tax competition. On the other hand, though, we argued that a comprehensive characterization of the set of all equilibria in a setting with relocation may well be infeasible.

We believe that our results on equilibrium characteristics bear empirical relevance. For example, evidence suggests that the sorting of households according to incomes is much less pronounced than one should expect from previous work on income stratification (see Epple and Platt, 1998, for a discussion of this point). In this regard, it would have been desirable to incorporate a housing market which plays an important role in smaller communities and metropolitan areas, albeit at the expense of analytical tractability. We should note, though, that housing availability may not pose significant restrictions on migration in the long run if one considers more spacious regions.[34] As a natural and perhaps promising avenue for future research, one could also allow tastes to vary with incomes which was beyond the scope of the present work. This extension may provide other interesting insights on how the local population structure depends on the nature and scope of local public services offered by a community.

[34]Also recall that we assume income rather than property taxation. While the latter is the primary source on the community level, the former is more important on higher levels of government (income and sales taxes are equivalent in our framework).

Appendix

The following example illustrates that the set of equilibria may be considerably larger if one employs the position-based approach as opposed to the membership-based approach (a model where relocation is possible, respectively). For ease of exposition, we focus on the sequential formulation. Consider an otherwise arbitrary tax vector $\{\hat{t}_j\}_{j=A,B}$ with $\hat{t}_A > \hat{t}_B > 0$ for which a partition of the population across communities $\{\hat{f}_j(w,\gamma)\}_{j=A,B}$ with the following properties exists: first, $\hat{f}_j(w,\gamma) > 0 \Rightarrow v(\hat{t}_j, \hat{y}_j; \gamma, w) \geq v(\hat{t}_k, \hat{y}_k; \gamma, w) \, \forall (\gamma, w)$ and $\hat{\alpha}_j > 0$, $j, k \in \{A, B\}$. Second, $\hat{f}_j(\underline{\gamma}, w) > 0$ and $\hat{f}_j(\overline{\gamma}, w) > 0$ for some $w \in [\underline{w}, \overline{w}]$ and some j. In words, there exists a date 2 migration equilibrium given $(\hat{t}_A, \hat{t}_B)$ in which both jurisdictions are populated with some taste heterogeneity in at least one jurisdiction.

Suppose that the date 0 composition of jurisdiction j is $\hat{f}_j(w,\gamma)$ and recall that $v(t_j, y_j; \gamma, w)$ is the indirect utility of a (γ, w)-type individual that lives in a jurisdiction with a tax rate t_j and average income y_j. Let ω_{mB} be the median hedonic income and y_B be the average income in jurisdiction B for the population structure $\hat{f}_B(w,\gamma)$. We first argue that $\{\hat{t}_j\}_{j=A,B}$ will be chosen under majority rule at date 1 if

$$v(\hat{t}_B, \hat{y}_B; \omega_{mB}) \geq v(t, y; \omega_{mB}) \quad \forall \, t \in [0, 1] \tag{14}$$

where y the overall average income. Observe that since the sorting is not fully revealing by assumption, $\hat{t}_A > \hat{t}_B$ implies $\hat{y}_B > y$. Hence, the above inequality can be satisfied even if t_B is not the median individual's most preferred feasible policy given $\hat{f}_j(w,\gamma)$ (respectively, $\hat{y}_B$). The condition (14) is therefore less restrictive than is at first glance suggested: it requires $\hat{t}_B$ to be 'not too far' from the median resident's ideal policy if no relocation is allowed. To support the equilibrium outcome $\{\hat{t}_j, \hat{g}_j, \hat{f}_j(w,\gamma)\}_{j=A,B}$, assume that everyone locates in jurisdiction B at date 2 if $(t_A, t_B) \neq (\hat{t}_A, \hat{t}_B)$ is selected at date 1. Condition (14) and continuity then implies that $\hat{t}_B$ is majority-preferred to any other feasible tax rate by the population in B and, hence, the majority rule outcome in jurisdiction B.

Next, the utility of (γ, w)-type individuals living in A at date 0 is $v(\hat{t}_A, y_A; \gamma, w)$ if $\hat{t}_A$ is selected at date 1 and $v(\hat{t}_B, y, \gamma, w)$ otherwise (in which case everybody locates in B at date 2). Since by construction, $\hat{f}_j(w,\gamma)$ is a migration equilibrium for tax rates $\{\hat{t}_j\}_{j=A,B}$, we have

$$v(\hat{t}_A, \hat{y}_A, \gamma, w) \geq v(\hat{t}_B, \hat{y}_B, \gamma, w) > v(\hat{t}_B, y, \gamma, w) \quad \forall \, (\gamma, w) \text{ with } \hat{f}_A(\gamma, w) > 0,$$

where the last inequality follows from $\hat{y}_B > y$. Hence, the date 0 population in A unanimously prefers t_A over any other tax rate (which would trigger date 2 migration to B). As a result, everybody locating initially according to $\{\hat{f}_j(w,\gamma)\}_{j=A,B}$ with the resulting taxes $\{\hat{t}_j\}_{j=A,B}$, no relocation and a public service supply $\{\hat{g}_j\}_{j=A,B}$ is an overall equilibrium. This is true although the policies $(\hat{t}_j, \hat{g}_j)$ need not constitute equilibrium policies in the formulation without relocation (note in particular that $\hat{t}_A$ could be chosen arbitrarily as long as both jurisdictions remain populated and sorting is not perfect).

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