RESEARCH ARTICLE

Institutions and Sorting in a Model of Metropolitan Fragmentation

ELIZABETH MAGGIE PENN
Department of Social and Decision Sciences, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213

Received July 2, 2003; revised May 21, 2004; accepted May 21, 2004

I construct a theoretical and computational model of municipal fragmentation and Tiebout competition and show that factors such as income heterogeneity, political institutions, and the discretionary power of municipalities to tax can substantially affect both where individuals choose to live and how cities form. Conclusions are drawn about the types of cities that form when secession is an option. These conclusions support the idea that increasing the range of choices available to municipalities and to individuals can actually leave a majority of residents worse-off. © *2004 Wiley Periodicals, Inc. Complexity 9: 62–70, 2004*

Key Words: municipal secession; Tiebout competition; residential choice; taxation; voting

1. INTRODUCTION

Over the last half-century municipal secession has become one of the most dominant expressions of class conflict in the United States. The process is played out as the affluent suburb seeks incorporation in an attempt to lower the property tax rates of its residents, whereas the central city seeks to keep levels of social services high by holding on to its suburban tax base. An example is Los Angeles County, where between the years of 1954 and 1991 the number of incorporated municipalities rose from 45 to 88. Through the sixties and seventies, cities like Arcadia decreased property tax rates, yet ultimately saw per capita property tax revenues rise as a result of increased property valuation brought about by a large influx of wealthy residents. Meanwhile, cities such as Compton maintained policies friendly to lower income classes and saw their tax bases deteriorate while their need for social services drastically increased. (See Miller [1] for an account of the fragmentation of Los Angeles County in general and these cities in particular.)

Today, secession remains a heated topic in Southern California, with recent separatist attempts coming from the San Fernando Valley, Hollywood, and the San Pedro Harbor area. In November 2002, Los Angeles voters overwhelmingly defeated a measure on San Fernando Valley cityhood, although the measure narrowly passed in the Valley. This article examines the issue of metropolitan fragmentation—specifically how political and economic institutions affect residential location decisions, how municipalities form and fragment, and the types of residents that benefit from municipal fragmentation.

In his seminal work "A Pure Theory of Local Public Goods," Charles Tiebout [2] countered one of the most important developments in economic theory of the day,

Correspondence to: Elizabeth Maggie Penn, E-mail: epenn@andrew.cmu.edu

"namely, that no 'market type' solution exists to determine the level of expenditures on public goods" ([2], p 416).[1] Tiebout argued that a "market type" solution could indeed exist and that the key to achieving such equilibrium in supply and demand for local expenditures is to increase the menu of residential location choices available to the "consumer-voter." In Tiebout's words, "[t]he greater the number of communities and the greater the variance among them, the closer the consumer will come to fully realizing his preference position." In Tiebout's model cities compete for residents by offering varying bundles of public goods. Residents then "vote with their feet" and relocate to the city that most closely matches their preferences.

In this article I examine Tiebout's hypothesis that more choices are better in a setting where cities are formed endogenously—namely, when the preferences of individuals dictate not only where they choose to reside and the level of public good provided by their city, but also affect the distribution of jurisdictions in a metropolitan area through the voting process. This question is complicated by the fact that individual preferences are not static. A person's demand for a public good can vary from jurisdiction to jurisdiction, depending on the distribution of types of other residents in each jurisdiction. If, for example, a poor citizen lives in a region with many wealthy residents, his ideally preferred level of public good may be higher than it would be if his neighbors were poorer than he. In the first instance his tax share is much lower than that of his neighbors; in the second instance it is higher. Thus, the system may create either incentives or disincentives for agents to mix with others of a different type.

One implication is that these conflicting micro-level incentives can often result in an aggregate in which individually improving relocation decisions actually reduce social welfare. Herein lies the social dilemma. Tiebout's model is clearly correct and appropriate if we consider the communities in which we reside to be a consumption good—certainly citizens should be able to choose to live wherever they are happiest and communities should be free to pursue the policies that make their residents happiest. The problem arises when these choices impose a negative externality on the residents of neighboring communities because communities do not exist in a static environment. Choices made by one community, with respect to rates of taxation or zoning laws for example, can have profound effects on the choices available to neighboring communities. In this sense, secessionist movements demonstrate the tension that can exist between the democratic ideals of majority rule and free will and the ideal of furthering the common good. In the model presented here, aggregate social welfare is virtually always lowered by secessionist movements because the political and economic institutions of majority rule and decentralized public goods provision do not require new communities to internalize the external effects of their secession.

The remainder of the article proceeds as follows. I first construct a simple theoretical model of residential location choice when the number of municipalities in a metropolitan area is exogenously set. This model is used to analyze the demand for, and allocation of, public goods across jurisdictions. Using the equilibrium predictions of this static model, I then construct a dynamic, computational model of secession in order to simulate city formation and residential location choice under varying tax schedules, political processes, and income and preference distributions. Clearly initial conditions, such as the locations of residents within a municipality, can substantially affect both the residential location choices individuals make and the final distribution of cities over time. Although analytic models would be intractable in this setting, a computational approach allows us to examine the kinds of cities that emerge over time as a function of these random factors. Furthermore, these computational simulations also allow us to look at the actual dynamics of city formation and individual movement.

2. RELATED WORK

In his classic article on local public goods, Tiebout [2] argues that the ability of individuals to move freely from one jurisdiction to another leads governments to achieve a Pareto optimal allocation of resources. Citizens choose to live in cities with the mix of taxes and public goods that they prefer, and local governments choose this mix so as to attract residents. Because individuals can relocate, increasing the number of municipalities in a geographical area can only help residents by, in Kenneth Arrow's words, "[increasing] the individual's area of choice" (quoted in Miller [1]). Although it has been generally recognized that Tiebout's notion of equilibrium holds only when very restrictive assumptions are made and that his idea does not lead to a general theory of local public goods provision, research on residential location choice rarely contradicts Tiebout's hypothesis (See Bewley [3] for a critique of Tiebout's theory.) Even less has been written about secession in particular—instances where the number of jurisdictions is endogenously determined. The following paragraphs give a brief overview of some of the literature to date.

Many theoretical articles written on residential location choice assume an exogenous number of jurisdictions and then demonstrate that individuals choose to sort, a la Tiebout, into the jurisdiction whose level of taxes and services most closely matches their own tastes. Bucovetsky [4] argues that because Tiebout-type sorting is so efficient, attempting to equalize any type of public spending across jurisdictions (even per-capita educational expenditure) can

[1] *Specifically Tiebout was referring to the work of Richard Musgrave and Paul Samuelson.*

be detrimental to low-income residents by inducing migration into their city, thus driving up housing prices. However, Epple and Romer [5] examine income redistribution when voters are aware of the migration effects of redistributive policies and show that significant income redistribution is feasible, even when out-migration occurs. Epple and Zelenitz [6] ask whether competition between jurisdictions leads to an efficient provision of public goods and find that it does not because land is immobile and governments can usurp some land rents.

In a series of articles, Haimanko et al. [7] study secessionist movements at the national level. They find that the key determinant of whether a country should fragment or whether transfers should be introduced is the degree of polarization of citizen preferences. Le Breton and Weber [8] prove that, under very general conditions, there exist income transfer instruments that prevent the threat of secession between all of a country's regions, while simultaneously providing no incentive for citizens to migrate.

Miller [1] examines the Tiebout hypothesis historically and empirically, with a fascinating account of the fragmentation of Los Angeles County from 45 municipalities in 1954 to 81 by 1981. The account focuses primarily on the incorporation of the "Lakewood Plan" cities in 1954, a group of municipalities designed to contract with the county for the provision of a minimal level of public services. Wealthy residents of Los Angeles county "voted with their feet" for lower levels of taxes and public services by moving to the Lakewood Plan cities. The creation of these municipalities was not, however, a universal good, because the presence of wealthy individuals had created a positive externality for the lower income classes in neighboring cities.

Miller argues that extending an individual's range of choice is not unambiguously beneficial and that in fact "the decision to broaden or limit the range of individual choice is … an institutional question that masks a substantive reallocation of benefits" ([1], p 166). In this sense, Tiebout's notion of economic efficiency misses a fundamental point ([1], p 168):

> [T]he politically relevant phenomenon is not some immutable preference position based on an intrinsic set of "tastes" for public goods, but the quantity of a public good demanded by an individual in a given jurisdiction. And if the quantity demanded of a public good varies from jurisdiction to jurisdiction, then the idea that the individual chooses his jurisdiction by minimizing conformity costs (measured as distance from some unvarying preference position) is not useful or correct… [A]n individual may actually prefer to live in one jurisdiction, enduring conformity costs rather than live in another jurisdiction where the preferences he or she expresses are identical to the levels of public goods provided.

Thus, it may not be correct to assume that residents favor residing in a city whose level of public good most closely matches their own needs. This is because an individual's taste for a public good is not static and depends on the other residents of the city in which he resides. A person may actually receive more utility from residing in a city whose level of public good differs greatly from what he demands than he receives from residing in a city whose level of public good exactly equals his demand. For this reason, it may be *politically* impossible to achieve an economically efficient allocation of individuals across cities.

By examining the differences between what is politically feasible and what is economically efficient, an important point can be drawn: when city lines are exogenously set, the political power of citizens in a metropolitan area may be unimportant when determining residential location choice—residents simply choose from a "menu" of cities to find the one whose levels of taxation and public services fit their preferences most closely. However, if we assume that residents themselves determine whether a city is to incorporate or not, the societal stratification that Tiebout predicts may not occur, and if it does occur, it may leave many residents worse off. This is because the presence of different types of residents in the initial jurisdiction becomes an important factor to be considered. In Tiebout's model, demand and supply for the public good equilibrate because society stratifies; because every resident of a city is of the same type, every resident demands the same level of public good. However, when city lines are drawn through secessionist movements, poor citizens may oppose secession because the presence of wealthy individuals in their jurisdiction is a positive externality, even if demand and supply for the public good is in disequilibrium.

Perhaps most related to this article is Calabrese et al.'s [9] article on metropolitan consolidation. The authors analyze metropolitan consolidation analytically, when there are numerous cities that levy both income and property taxes, and engage in both redistributive and public service expenditures. These levels of taxation and public expenditures are determined endogenously, by popular vote. The authors then develop a computational model to investigate the effect of fiscal consolidation on the welfare of the citizens in the metropolitan area. They find that although low-income residents are almost universally made better off through annexation, high-income residents are almost universally made worse off. The adverse effects of annexation are felt most strongly by the suburb being annexed, although there is a negative "domino effect" felt by *all* suburbs in the area. As a result, annexation efforts routinely fail when subjected to a vote by residents of the suburb targeted for annexation.

The model I study differs from this and prior models by allowing citizens to not only move between cities and endogenously set the level of public good provision, but also to vote on whether their city is to fragment or not. Thus, this article

not only looks at the fiscal effects of municipal fragmentation, but also examines the effects of political institutions on whether fragmentation does or does not occur. Using this information, we can directly link political institutions with economic outcomes. Most Tiebout models take institutions as fixed. The model presented here is more in keeping with Kollman et al. [10], in that it applies a mechanism design approach to the Tiebout hypothesis by comparing the performance of different political and economic institutions. However, this approach differs from theirs in that I do not assume citizen preferences are static or ideological. In this model, the preferences of individuals depend solely on their consumption of public and private goods. A consequence is that a person's welfare depends in large part on who his neighbors are, and whether he is able to free-ride off of other residents.

3. A MODEL OF CITY FORMATION

The analysis presented here consists of two parts. First, I construct a simple analytic model that determines how a given city with a fixed population sets its levels of taxation and expenditure so as to balance its budget. Using this model, individuals can then evaluate the fiscal effects of secession by calculating the levels of taxation and expenditure the new cities will set. I then present a computational model in which citizens are able to vote on secessionist proposals. In equilibrium, the budget of every city is balanced, and no secessionist movements are capable of succeeding.

3.1. The Analytic Model

The analytic model consists of a collection of households, I, differing in endowed income, $y_i \in [0, 1]$. At any given time, let J be the set of local jurisdictions. Each local government $j \in J$ provides some level of public good to its residents, P_j. The public good is financed by an income tax, $t_j = \{t_{ij}\}_{i \in j}$ on the income of the residents, where t_j is parameterized by s_j, the progressivity (or regressivity) of the tax. Thus, for household i with income y_i in jurisdiction j, the percentage of the public good borne by i equals

$$t_{ij} = \frac{y_i^{s_j}}{\sum_{l \in j} y_l^{s_j}}, \tag{1}$$

where $s_j \in \Re_+$.

In each jurisdiction, voting is conducted on the variables P_j and s_j, determining the level of public good provided and the progressivity of the tax.[2] Because individual types are one-dimensional, a majority rule equilibrium exists at the median-preferred levels of P_j and s_j.[3] Everyone with a different income than the median voter is "out of equilibrium," preferring either more or less of the public good.

Let N_j denote the number of individuals in jurisdiction j, and let $k \in [0, 1]$ be a crowding effect. Individuals derive utility from both consumption of a private good, c_i, and the level of public good provided by their jurisdiction. Thus, if individual i lives in jurisdiction j, he has the Cobb-Douglas utility function

$$u_i = c_i^{\alpha_i} \frac{P_j^{\beta_i}}{N_j^k}, \tag{2}$$

and faces budget constraint

$$y_i = c_i + t_{ij} P_j.$$

Again, t_{ij} is the percentage of the public good borne by i when living in jurisdiction j, and α_i and β_i represent the respective weights individual i places on private good consumption and public good consumption, respectively. It is assumed that $\alpha_i + \beta_i = 1$. Note that if $k = 0$ then P is a pure public good; it is nonexcludable and nonrival. When $k = 1$, each individual in jurisdiction j receives $1/N_j$ of the publicly provided good. With these assumptions, it follows that individual demand for the publicly provided good is

$$P_i^* = \left(\frac{\beta_i}{\alpha_i + \beta_i}\right)\left(\frac{y_i}{t_{ij}}\right).$$

If the tax rate is constrained to the interval $[\underline{s}, \bar{s}]$, individual i's optimal tax rate is $\underline{s}$ if his income is higher than the average in his community, and $\bar{s}$ otherwise. For example, if we assume a progressive, budget-balancing tax share with $s_j = 2$, then

$$t_{ij} = \frac{y_i^2}{\sum_{i \in j} y_i^2},$$

and the demand function represents a normal good for which demand increases with income. Note that the quantity of public good demanded by individual i, P_i^*, is a function of both income and tax share, but that tax share varies

[2] *It is assumed that all residents vote. Michael Alvarez has suggested that an interesting topic for future research is to allow the probability that an individual turns out to vote be a function of either income or taste for the publicly provided good.*

[3] *Although it is assumed that tax rates are set by popular vote, it could also be the case that cities set their own tax rates so as to maximize revenue. Under either assumption the same tax rate will be set; in this model, the median-preferred tax rate is also the rate that maximizes revenue.*

with jurisdiction. Thus, i will demand a level of P that is dependent on the jurisdiction he resides in.

A household wishes to locate in the community with the tax-expenditure policy for which it obtains the highest utility. Equilibrium in this model is an allocation of households across communities such that within each community:

- The government's budget is balanced.
- A majority rule equilibrium determines government policy, $\{P_j, s_j\}$.
- There is no possible "compact" division of the community that would make a majority of its residents better off (i.e. no separatist attempt could succeed).[4]

The above equilibrium conditions are similar to the *internal equilibrium* conditions outlined in Calabrese et al. [9]. However, I do not impose an equilibrium condition on housing location choice. Individuals relocate stickily; they observe the taxation and expenditure policies of the existing cities and calculate the utility they would receive if they lived in each different city. Then for every city $j \in J$, agents in city j are able to "switch" locations with agents outside of the city who would prefer the policies of city j to their own city's policies. It is costless to move, but individuals must first find a willing partner. This methodology is used in order to allow individuals to move between jurisdictions and to ensure that each jurisdiction is fully occupied. However, this approach is only a first step in computationally modeling city formation and location choice. A more sophisticated model would allow individuals to out-migrate to different metropolitan areas, and would establish an explicit housing market.

In the computational analysis that follows, equilibrium existence is established by verifying that the above conditions are met. When these conditions are met, no further secessionist movements are capable of succeeding, and we can then analyze the types of cities that have formed endogenously.

3.2. The Computational Model

I construct a simple model of municipal fragmentation. Initially, all agents (citizens) live in one large city, which is represented by a two-dimensional grid. Every agent is assigned a unique location within the city or square on the grid. Public policy (the level of public good supplied by the city and the rate of taxation) is determined by the preferences of the median voter. Next, a random division of the city is proposed, which divides the city into two separate, compact jurisdictions. This random proposal represents a separatist attempt.

Once new platforms (public good levels and tax rates) for the proposed and existing city are determined, citizens then vote on whether they approve or disapprove of the secession. A preference aggregation rule is used to determine whether the city splits or not. Then if a split occurs, agents are allowed to move freely between all existing cities by finding another agent to trade locations with. Agents will switch places if the switch is a Pareto improvement, and the switching process ends when there are no more Pareto improving switches possible. When deciding on whether to switch locations, agents take into account the effects of their own movements on existing, but not future, policy. Last, an existing city is randomly chosen and the process is reiterated. When no new cities can be created by a vote of the population of any existing city, and when no two agents wish to switch places, the process ends.

In Step 1 of the computational model, citizen types and locations are assigned. One hundred agents are each assigned a square on a 10×10 grid. The agents are also assigned a type, or income. Individual i receives income y_i, where y_i is uniformly drawn from the interval [0, 1]. It is assumed that all agents have the same utility function, so that for all i, $\alpha_i = \alpha$ and $\beta_i = \beta = (1 - \alpha)$. All citizens live within one large jurisdiction and the level of public good provided and tax rate are those demanded by the median voter, as in Section 3.1. Initial individual utility levels are calculated.

In Step 2 a random line is drawn through the initial city, splitting it into two new cities. This line can be parallel to either the x-axis or the y-axis, thus rendering both of the new cities rectangular. New utilities are calculated for each individual within a new city. Citizens then vote on whether they prefer to live in one large city versus two smaller ones, where preference is determined simply by comparing old and new utility levels. A preference aggregation rule, ν, is used to determine whether the city splits or not. The parameter ν represents the percentage of residents of a proposed city that prefer to secede. In all instances a majority of residents in the initial city to be split is needed for the secession to be ratified. However, a ν of 0.7 would imply that not only a majority of residents overall is needed, but a 70% supermajority of residents of one of the newly formed cities would also need to vote in favor of secession for it to be ratified. The city is then either split or not. If the split does not occur, a new line is drawn. Lines are redrawn until a split actually occurs or all possible splits have been considered.

In Step 3 the agents are allowed to move between cities. Every agent calculates his perceived benefit from switching to every other city. This is simply his utility from being a resident of the other city, given the current policies of that city, minus his current utility. Once these benefits are cal-

[4] *Geographically, compactness refers to connectedness, plus a shape resembling something convex. In the computational model I consider, divisions of a city must specifically be a rectangular subset of a two-dimensional grid.*

TABLE 1

Estimated Effects on Dependent Variables

	Social Welfare	(Log) Number of Cities	(Log) Std. Dev. In Income	(Log) Std. Dev. In Welfare
Discretion	−3.877** (0.299)	0.566** (0.025)	1.761** (0.079)	1.768** (0.079)
Crowding	0.985 (0.747)	1.365** (0.062)	4.057** (0.197)	3.603** (0.198)
α	4.954** (0.498)	0.058 (0.041)	−0.035 (0.131)	−0.579** (0.132)
Vote rule	4.620** (0.325)	−0.732** (0.027)	−2.282** (0.086)	−2.207** (0.086)
Constant	−4.779** (0.504)	−0.409** (0.042)	−10.148** (0.133)	−9.693** (0.134)

*Significant at 0.05 level.
**Significant at 0.01 level.

culated, the process moves iteratively through the players, matching each with the first unmatched other player who wishes to move into his city. The process continues until there are no more matches that are Pareto improving. Note that the process occurs as if agents move simultaneously—once an agent has been matched in a given round, he will not be matched again. Also note that the agents are myopic—they don't calculate how their switch will affect the outcome of future rounds.

In Step 4 of the computational model, an existing city is randomly selected and the process is repeated on this new city. The entire process is repeated until no city can be split any further. The Appendix provides an example of a simulated collection of cities generated by this process.

4. RESULTS

The computational model was run while varying four parameters as independent variables: the discretionary power of cities to tax, δ, the crowding effect on the public good, k, as defined in Equation 2, the relative preference of citizens for the private good over the public, α, as defined in Equation 2, and the preference aggregation rule, υ. Recall that β as defined in Equation 2 is simply $1 - \alpha$.

δ parameterizes the range in which city j's rate of taxation, s_j, as described in Equation 1, must lie. Thus, for a given $\delta \in \Re_+$, $s_j \in [1 - \delta, 1 + \delta]$. In the simulations that follow, $\delta \in \{0, 0.5, 1\}$. When $\delta = 0$, for example, cities have no discretion over the tax rate. When $\delta = 1$, $s_j \in [0, 2]$, and thus cities are capable of imposing either a very regressive or progressive tax on the incomes of their residents. The crowding effect k takes values in the set $\{0.3, 0.5, 0.7\}$. Thus, for a given k, individuals receive $1/N^k$ of the publicly provided good. The parameter $\alpha \in \{0.2, 0.5, 0.8\}$. When $\alpha = 0.2$, for example, agents prefer more of the public good to the private, and when $\alpha = 0.5$, agents are indifferent between the two. The parameter υ assumes values in the set $\{0, 0.75\}$, representing the supermajority of residents in a particular city needed to ratify a secession. When $\upsilon = 0$, no supermajority is needed; when $\upsilon = 0.75$, a supermajority of 75% is needed in one of the newly formed cities to ratify the secession attempt. This could represent an instance in which a small but extremely determined segment of society wishes to secede from the whole.

In the following structural equations, the parameter δ will be referred to as *discretion*, k will be referred to as *crowding*, and υ will be referred to as *vote rule*, for the sake of readability. For all runs of the model I let N, the number of agents, equal 100. The four parameters were varied across each of their values listed above, yielding $3 \times 3 \times 3 \times 2 = 54$ parameter value combinations. Each of these cases was run 100 times, for a total of 5400 runs of the model. Note that this dataset is quite large and that there is zero correlation between the independent variables. Thus, the standard errors in the Table 1 are very small, a consequence of the fact that a computational approach yields data that is manufactured.

The four dependent variables examined are social welfare, number of cities, and the standard deviation of average income and social surplus across cities. Social welfare is calculated as the ending sum of all individual utilities minus the starting sum of all individual utilities. The number of cities is simply the final number of cities formed by the entire computational process. The standard deviation in average income across cities reflects the heterogeneity of income across the newly formed cities. Last, the standard deviation in per capita social welfare across cities reflects the difference in individuals' welfare across the newly formed cities. The last three dependent variables always take on positive values, and so the logs of these variables are used in the regression.

In Table 1, I regress each of these dependent variables on the four independent variables.

I will discuss each of the independent variables in order. *Discretion* has a significant effect on all of the dependent variables, with the effect being negative on social welfare and positive on the number of cities formed and the stan-

dard deviation in average income and social welfare across cities. Thus, as cities are given more discretion over their tax rates, secession is increasingly appealing to residents, and newly formed cities are increasingly heterogeneous. Overall, however, this income heterogeneity across cities hurts the average resident.

The crowding effect, *crowding*, has a significant and positive effect on the number of cities formed and on the standard deviation in average income and per capita welfare across cities. This makes sense; when the public good is more susceptible to overcrowding, cities will be smaller in equilibrium. Furthermore, more cities provide residents with more opportunities to relocate and self-sort, and so type heterogeneity, and thus heterogeneity in individual welfare, across cities is increased.

The parameter α, reflecting the agents' relative preference for the private good over the public, has a significant and positive effect on social welfare, a positive but insignificant effect on the number of cities formed, and a significant and negative effect on the standard deviation in per capita social welfare across cities. This is because as α increases, the public good is less important to residents, and so the benefit of being in a large city, in terms of being able to procure more of the public good, is diminished and smaller cities break off. The effect of α on social welfare is positive because, even though more cities are being formed, poor residents are hurt less because the presence of wealthy residents is less of a positive externality as the publicly provided good is less important. This is also why the standard deviation in per capita social welfare across cities decreases in α.

Finally, *vote rule* has a significant positive effect on social welfare and a significant negative effect on the number of cities formed and the standard deviation in average income and per capita welfare across cities. This is because when *vote rule* is high, it is more difficult for secessionist movements to succeed, and it is easier for low-income residents to "hold on" to their wealthy neighbors. Thus, the number of cities formed and type heterogeneity across cities decreases. This leaves the average resident better off.

Table 2 shows data from the same simulation by city. I regressed per capita social welfare by city on the city's tax rate, *city tax* and average income by city, *city income*. Then I added a dummy variable, *split*, to the regression, which equaled one if a secession occurred during the simulation, and zero otherwise.

The negative coefficient on *city tax* tells us that on average, residents in cities with more progressive tax schedules are left worse off by the process of municipal secession than those in cities with less progressive tax schedules. Furthermore, residents of cities with higher average incomes are left better off by the process of secession, as we can see by the coefficient on *city income*. And the effect of secession, *split*, is to reduce per capita social welfare, by city.

TABLE 2

Estimated Effects on Per Capita Social Welfare, by City

	Per capita social welfare	
City tax	−0.021** (0.005)	−0.023** (0.005)
City income	0.458** (0.012)	0.385** (0.012)
Constant	−0.296** (0.011)	−0.160** (0.012)
Split		−0.148** (0.005)

*Significant at 0.05 level.
**Significant at 0.01 level.

5. CONCLUSIONS

Extending the range of choices available to a decision maker is neither a neutral process, nor is it unambiguously beneficial. When the choices are political in nature, then the process will likely be one in which there are both winners and losers. This article makes the point with a computational model of secession, taxation, and expenditure. Using this model, I compute the effects of extending the range of choices available to both municipalities and to individuals; specifically, the range of discretion a municipality has in setting its tax rate and the range of discretion a population has in determining the boundaries of its cities, through the vote.

In the simulations presented in Section 4, I find that increasing the range of choice a municipality has over its tax rate increases the number of cities formed in a metropolitan area and increases the heterogeneity of the cities formed, both in terms of the average income in each city and per capita social welfare. Easing the ability of secessionist movements to succeed, by reducing the plurality needed to ratify a secession, has a similar effect on the number of cities formed and the heterogeneity of populations across cities. In these instances, extending the range of choice provided to municipalities and to populations lowers overall social welfare and furthers the creation of distinctly rich and poor communities. The data from these computational simulations also suggest that secession makes wealthy citizens better off and poor citizens worse off and that more progressive tax schedules negatively affect the poor by inducing the wealthy to out-migrate. Although the results are not surprising, they have important policy implications.

To refer back to Miller's example of Compton, problems developed because its policies were friendly to lower income groups. Although these policies posed no problem when Compton's tax levels were not significantly higher than those of other cities within Los Angeles County, the creation of the Lakewood Plan cities dramatically changed Compton's relative standing. Between 1950 and 1970, the percentage of poor residents in Compton rose from 5.7% to 19.1% . By the mid-1970s, the effects of this out-migration were so bad that Compton was driven to imitating the

policies of its Lakewood Plan neighbors. High property tax rates actually hurt low-income renters, by raising the incentives of homeowners to relocate. Furthermore, the creation of the Lakewood Plan cities was not neutral, in that it did not affect all residents similarly. The creation of these cities gave wealthy homeowners a place to relocate to ([1], pp 176–183). It is not surprising that secessionist movements, such as those seen recently in Southern California, routinely fail when subjected to a vote by the population of the entire metropolitan area. For exactly the same reasons, annexation efforts routinely fail when subjected to a vote by residents of the suburb targeted for annexation.

Both secessionist and annexation movements demonstrate the tension that often exists between the democratic ideal of majority rule and the ideal of maximizing the common good. These concepts do not necessarily go hand-in-hand, and it is clear that determining city lines by popular vote is an imperfect way of achieving the best common good. In this model, social welfare is virtually always lowered by secession because it is not in the best interest of any of the actors involved (either municipalities or residents) to increase social welfare across the metropolitan area. If we consider aggregate social welfare to be an important concept worth maximizing, then perhaps our political institutions should grant discretionary power over such issues to an actor in whose best interest it is to maximize social welfare.

In the simulations presented here, it is not the number of cities *per se* that lowers social welfare. Rather, it is the discretionary power of cities to compete with each other and to differentiate themselves by means of their policies that incites a race to the bottom. Orfield [11] argues that the fragmentation of a metropolitan area into numerous small jurisdictions is not only inefficient, because of the duplication of many public services and of infrastructure, but that it also causes fiscal disparities and social segregation. His solution is to take much of the authority to make land use and infrastructure decisions away from local jurisdictions and place it in the hands of regional governing bodies. Similarly, the results of this model suggest that policy coordination at the regional level could benefit many communities.

ACKNOWLEDGMENT

I thank Mike Alvarez, Jeff Dubin, Bill Keech, John Miller, Scott Page, John Patty, and a helpful referee. I gratefully acknowledge the support of the Santa Fe Institute graduate workshop in computational economics.

REFERENCES

1. Miller, G. Cities by Contract: The Politics of Municipal Incorporation; MIT Press: Cambridge, MA, 1981.
2. Tiebout, C.M. A pure theory of local public expenditures. J Polit Econ 1956, 64(3), 416–424.
3. Bewley, T.F. A critique of Tiebout's theory of local public expenditures. Econometrica 1981, 49(3), 713–740.
4. Bucovetsky, S. Inequality in the local public sector. J Polit Economy 1982, 90(1), 128–145.

FIGURE 1

.31	.33	.39	.30	.36	.69	.57	.68	.12	.83
.22	.96	.92	.30	.27	.55	.70	.64	.10	.18
.20	.12	.42	.32	.97	.13	.19	.20	.07	.07
.41	.34	.14	.95	.34	.02	.25	.71	.99	.70
.16	.20	.97	.08	.28	.85	.07	.15	.84	.84
.14	.30	.30	.36	.37	.82	.89	.98	.73	1.00
.38	.23	.29	.91	.16	.96	.92	.98	.99	.63
.42	.47	.50	.54	.52	.90	.97	.83	.86	.77
.29	.49	.46	.51	.56	.98	.91	.82	.71	.93
.54	.54	.75	.77	.66	.55	.96	.82	.97	.70

Incomes and equilibrium of citizens.

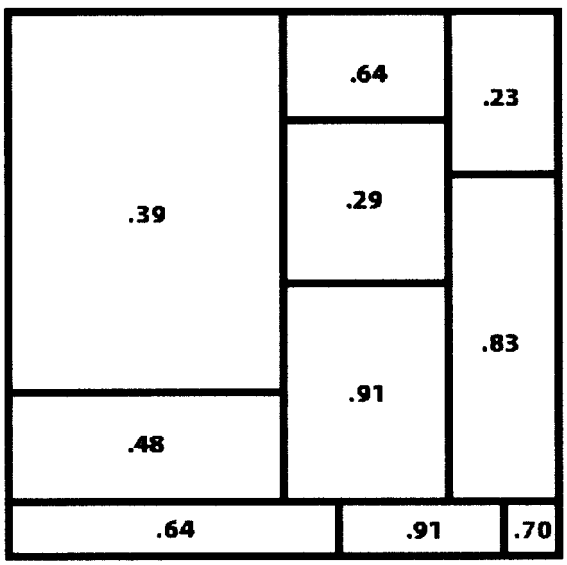
5. Epple, D.; Romer, T. Mobility and redistribution. J Polit Economy 1991, 99(4), 828–858.
6. Epple, D.; Zelenitz, A. The implications of competition among jurisdictions: Does Tiebout need politics? J Polit Economy 1981, 89(6), 1197–1217.
7. Haimanko, O.; Le Breton, M.; Weber, S. Transfers in a polarized country: Bridging the gap between efficiency and stability. J Publ Econ 2004, forthcoming.
8. Le Breton, M.; Weber, S. The art of making everybody happy: How to prevent a secession. IMF, Staff papers, WP No., 01/176; November 2001.
9. Calabrese, S.; Cassidy, G.; Epple, D. Local government fiscal structure and metropolitan consolidation. Written for the 3rd Brookings-Wharton Conference on Urban Affairs, 2000.
10. Kollman, K.; Miller, J.; Page, S. Political institutions and sorting in a Tiebout model. Am Econ Rev 1997, 87(5), 977–992.
11. Orfield, M. American Metropolitics: The New Suburban Reality; Brookings Institution Press, 2002.

APPENDIX

What follows is an example of a map depicting agents and cities produced by the computational secession model described in Section 3.2 for the following parameters: $\delta = 0.5$, $\nu = 0$, $k = 0.7$, and $\alpha = 0.2$. In this particular simulation, 10 cities were formed in equilibrium. Figures A1–A5 depict the cities that were formed and their residents, and the average income, social surplus, level of public goods provision, and tax rate by city.[5]

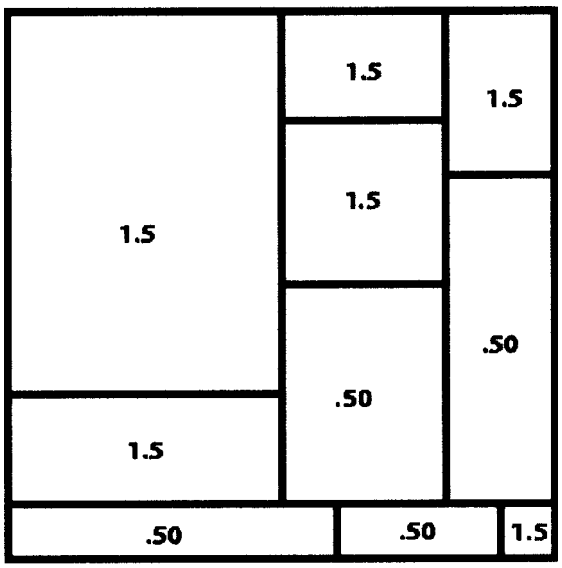
[5]*Note that only the composition of residents within the cities pictured was generated by the simulation; not the specific configuration of cities within the geographical area, or the specific configuration of agents within cities.*

FIGURE 2



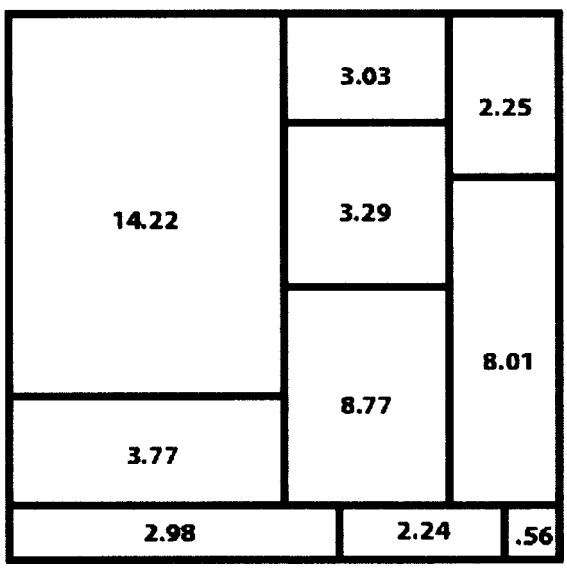
Average income by city.

FIGURE 3



Tax rate by city.

FIGURE 4



Level of public goods provision by city.

FIGURE 5

Per capita social surplus by city.