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ABSTRACT

Locational choice is one of the fundamental exercises of consumer sovereignty. When regions (or localities within regions) specify different tax rates or supply different amounts of public goods, they distort individuals' location choices.

This paper models and measures for the U.S. and New England the location distortion arising from inter regional differences in taxation and supplies of public goods. In our overlapping generations model agents, at each point in their lifespan, choose where to locate taking into account their locational preferences, each region's wage, consumption, and personal capital income taxes, and each region's supply of public goods.

The findings suggest that regional fiscal differences play an important role in the location choices of three to four percent of Americans. For these Americans the distortion of location choice is equivalent to roughly a half of a percent of their lifetime consumption. Across all Americans, however, the location distortion induced by U.S. regional fiscal differences is quite small, simply because the differences in tax rates and per capita levels of public goods expenditures across regions are not sufficiently large to induce most Americans to change location. Our analysis indicates, however, that location distortions are an increasing function of regional differences in tax rates and levels of public goods expenditure. Indeed, a doubling of the scale of public finances across all U.S. states would lead to roughly a quadrupling of the location distortion.

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This paper models and estimates for the U.S. in its entirety and for New England the distortion in choice of location (the decision of where to live) arising from regional differences in taxation and the supply of public goods. The model assumes that agents have preferences concerning the region (or country in an international context) in which they wish to live. Differences across regions in wage, consumption, and capital income taxes as well as in the supplies of public goods induce those agents who care less about the region in which they live to move to a region with lower taxes and/or more public goods. The evaluation of the advantages to moving depend on one's age. For example, elderly retirees will be particularly concerned about their chosen region's consumption and capital income taxes, while young workers will focus to a greater extent on wage taxes. The model accommodates this life cycle aspect of location decisions by positing agents who work full time for two periods followed by a final period of retirement. At the beginning of each period the agent decides in which of five regions to live.

Production in each region is governed by identical constant returns to scale functions of capital and labor. While capital mobility is perfect, labor moves between regions up to the point that the marginal agents who exit or enter specific regions are just indifferent between moving and not moving. With these assumptions and our assumption that all capital income taxes are personal, pre-tax factor prices in each region are identical and there are no production distortions. While production distortions arising from regional differences in fiscal policy are likely to be important, production distortions have already been studied extensively in the literature (e.g., Bradford, 1978).

Another distortion with which we are not concerned here is the distortion in intertemporal choices arising from capital income taxes and time-varying consumption taxes. Although our life cycle model features intertemporal utility maximization, to ensure zero intertemporal distortion we assume Leontief preferences over private goods at different dates.

Given our assumptions about production and preferences, the sole distortion in the model is the location distortion arising from regional tax differences. In addition to focusing attention solely on location distortions, our production and preference assumptions are convenient in that they help rule out general equilibrium effects. These assumptions, together with a) our method of compensating regional taxes and b) our method of financing regional public goods, imply a policy-invariant aggregate (across all regions) supply of capital. Since the aggregate supply of labor is fixed by assumption, changes in regional taxes and/or supplies of public goods entail no general equilibrium changes in factor prices; i.e., regional tax differences do not perturb the economy's steady state capital stock, labor supply, or factor prices. Hence, welfare changes in our model are due solely to regional differences in taxes and in the supply of public goods.

Our approach appears to augment the existing literature by addressing the life cycle aspect of locational choice. In addition, we are unaware of other location models in which agents have preferences about the region in which they wish to live. Tiebout models (e.g., Tiebout, 1956 and Stiglitz, 1983) assume that agents care about the type of community in which they live (i.e., its public goods and its taxes), but are indifferent with respect to its location. Indeed, our model delivers, as a limiting case, the Tiebout result that perfect location mobility eliminates distortions. This limiting case arises in our model when agents are indifferent with respect to the region in which they live.

Since our focus is on the distortion caused by regional tax differences, rather than why such tax differences arise, our model does not seek to explain the level of regional taxation. Whether regional fiscal differences reflect the type of political-economic theory offered by Persson and Tabellini (1990) and others or are the outcome of competition as in Gordon (1983), Zodrow and Mieszkowski (1986), Wilson (1987), and Wildasin (1988), regional fiscal differences will still entail location distortions.

The findings suggest that fiscal differences may play an important role in the location choices of three to five percent of Americans. For these Americans the distortion of location choice is equivalent to roughly a half of one percent of their lifetime consumption. Across all Americans, however, the location distortion induced by U.S. regional fiscal differences is quite small, simply because the differences in tax rates and per capita levels of public goods expenditures across regions are not sufficiently large to induce most Americans to change location. Our analysis indicates, however, that location distortions are an increasing function of regional differences in tax rates and levels of public goods expenditure. Indeed, a doubling of the scale of public finances across all U.S. states would lead to roughly a quadrupling of the location distortion.

The paper continues in Section I with a presentation of the model. Section II shows how the model's key parameters can be estimated by simulating the likelihood of particular location decisions. Section III discusses the use of U.S. Census and state tax and expenditure data to estimate the model for both a five region subdivision of the 50 U.S. states as well as a five region subdivision of the six states of New England. Section IV presents estimates for the U.S. and New England of the location distortion arising from inter regional tax and public goods differences, and Section V summarizes the paper's findings.

I. A Multi-Period Multi-Regional Model of Locational Choice

A. Preferences

Our model assumes that a set of compensated regional taxes is introduced at time t. We first discuss preferences for members of generation s≥t and then discuss preferences for members of generations t-1 and t-2. The statement that an agent is a member of generation h means that he was young at time h. Equation (1) specifies the lifetime utility $U_{i,s}$ of the ith agent of generation s≥t.

$$(1)\quad U_{i,s} = Z^{y}_{i,s} + Z^{m}_{i,s} + Z^{o}_{i,s} + \alpha \text{Min}[C^{y}_{i,s}; \rho C^{m}_{i,s}; \rho^{2} C^{o}_{i,s}] + \beta [G^{y}_{i,s} + \rho G^{m}_{i,s} + \rho^{2} G^{o}_{i,s}]$$

There are three components to lifetime utility. The first component, represented by the first three terms on the right hand side of (1), indicates the agent's utility from his choice of location when young, middle age, and old. The second component, involving the minimum function, specifies the agent's utility from consumption when young, middle age, and old. The third component, represented by the last three right hand side terms, determines the utility from consuming public goods when young, middle age, and old. There are N regions in which the agent can reside in a given period. The terms $Z^{y}_{i,s}$, $Z^{m}_{i,s}$, and $Z^{o}_{i,s}$ in (1) denote, respectively, the locational utility the ith member of generation s enjoys when young, middle age, and old. The value of these terms depend, respectively, on the region of residence when young, middle age, and old.

Turning to the second utility component, the terms $C^y{}_{i,s}$, $C^m{}_{i,s}$, and $C^o{}_{i,s}$ stand, respectively, for the ith member of generation s'consumption when young, middle age, and old. The parameter ρ is the time preference factor determining the shape of the age-consumption profile, and the parameter α scales preferences for goods versus preferences for locations. Finally, the terms $G^y{}_{i,s}$, $G^m{}_{i,s}$, $G^o{}_{i,s}$ stand for the region-specific public goods per capita (divided by the region's population) enjoyed by the ith member of generation s when young, middle age, and old, respectively. While each agent living in a specific region enjoys the same public goods per capita, we index $G^y{}_{i,s}$, $G^m{}_{i,s}$, $G^o{}_{i,s}$ by i to indicate that the amount of regional per capita public goods enjoyed by agent i depends on agent i's location decisions when young, middle age, and old. The term β scales preferences for regional public goods relative to location preferences and preferences for goods. By specifying that a region's per capita public goods rather than its absolute quantity of public goods enters utility we are incorporating the assumption that regional public goods are subject to congestion.

The utility of the ith member of generation t-1, who is middle age at time t when the regional taxes are introduced is given by

(2) $$U_{i,t-1} = Z^m_{i,t-1} + Z^o_{i,t-1} + \alpha \mathrm{Min}[C^m_{i,t-1}; \rho C^o_{i,t-1}] + \beta [G^m_{i,t-1} + \rho G^o_{i,t-1}];$$

and the utility of the ith member of generation t-2, who is old at the time t, is

(3) $$U_{i,t-2} = Z^o_{i,t-2} + \alpha C^o_{i,t-2} + \beta G^o_{i,t-2}.$$

In equations (2) and (3) we assume that, for the initial old and middle age generations alive when the compensated regional taxes and public goods are introduced, their utility function is of the form given in (1), but restricted to their remaining years of life; e.g., for the t-1 generation their utility from consumption of private goods is Leontief only in consumption when middle age and when old.[1]

B. Budget Constraints

If the ith member of generation s chooses to live in region j when young, k when middle age, and l when old, he faces the present value budget constraint

$$(4)\qquad (1+\tau_j)C^y_{i,s} + \frac{(1+\tau_k)C^m_{i,s}}{1+r(1-\theta_k)} + \frac{(1+\tau_l)C^o_{i,s}}{[1+r(1-\theta_k)][1+r(1-\theta_l)]}$$

$$= (1-\upsilon_j)W + T^y_s - Q^y_s + \frac{(1-\upsilon_k)W + T^m_s - Q^m_s}{1+r(1-\theta_k)} + \frac{T^o_s - Q^o_s}{[1+r(1-\theta_k)][1+r(1-\theta_l)]},$$

where the symbols τ_f, θ_f, and υ_f stand, respectively, for the consumption, capital income, and wage tax rates in region $f \in \{j,k,l\}$. The terms W and r stand, respectively, for the pre-tax wage and interest rates. Since, as described below, W and r are identical in all regions, we do not index these variables by region. The terms $T^y{}_s$, $T^m{}_s$, and $T^o{}_s$ stand, respectively, for the lump-sum rebate of taxes when young, middle age, and old to members of generation s. The rebates are given in equal amounts to all members of generation s regardless of where they choose to locate. Finally, the terms $Q^y{}_s$, $Q^m{}_s$, and $Q^o{}_s$ stand for the lump-sum taxes assessed equally on all members of generation s when young, middle age, and old to pay for regional public goods. The budget constraint reflects our assumption that agents work full time when young and middle age and are fully retired when old.

The time t budget constraint for the ith member of generation t-1 who chooses to live in region k when middle age and region l when old is

$$(5) \quad (1+\tau_m)C^m_{i,t-1} + \frac{(1+\tau_l)C^o_{i,t-1}}{1+r(1-\theta_l)} = (1-\nu_k)W + T^m_{t-1} - Q^m_{t-1} + \frac{T^o_{t-1} - Q^o_{t-1}}{1+r(1-\theta_l)} + A^m_{i,t-1}[1+r(1-\theta_k)],$$

where $A^m_{i,t-1}$ stands for the net wealth of the ith member of generation t-1 at the beginning of his second (middle age) period of life.

For the ith member of generation t-2, if he elects to live in region l in his last period of life (time t), his budget constraint is

$$(6) \quad (1+\tau_l)C^o_{i,t-2} = T^o_{t-2} - Q^o_{t-2} + A^o_{i,t-2}[1+r(1-\theta_l)],$$

where $A^o_{i,t-2}$ stands for the net wealth of the ith member of generation t-2 at the beginning of his last (old age) period of life.

C. <u>Utility Maximization</u>

Maximization by the ith member of generation s (s≥t) of (1) subject to (4) implies the first order conditions

$$(7) \quad C^y_{i,s} = \rho C^m_{i,s} = \rho^2 C^o_{i,s}.$$

These equations plus (4) can be used to solve for the ith member of generation s' indirect utility conditional on the location sequence {j,k,l}. Let

$V_{i,s}(j,k,l)$ denote this indirect utility. The optimal lifetime location sequence $j=j^*$, $k=k^*$, and $l=l^*$ satisfies

$$(8) \qquad V_{i,s}(j^*,k^*,l^*) = \max_{j,k,l} \{V_{i,s}(j,k,l)\},$$
$$\text{s.t. } j\in\{1,\ldots,N\};\ k\in\{1,\ldots,N\};\ \text{and } l\in\{1,\ldots,N\}.$$

Equation (8) indicates that the ith member of generation s ($s\geq t$) chooses that sequence of locations which, in conjunction with its implied lifetime budget constraint, yields the highest level of lifetime utility.

The ith member of generation t-1's utility maximization is directly analogous. His first order condition is

$$(9) \qquad C^m_{i,t-1} = \rho C^o_{i,t-1}.$$

Equations (9) and (5) determine the demand functions for consumption when middle age and old for the ith member of generation t-1 conditional on the location sequence k,l. Let $V_{i,t-1}(k,l)$ denote the ith member of generation t-1's indirect utility condition on the location sequence k,l. Then the optimal location sequence k^*,l^* satisfies

$$(10) \qquad V_{i,t-1}(k^*,l^*) = \max_{k,l} \{V_{i,t-1}(k,l)\},\ \text{s.t. } k\in\{1,\ldots,N\} \text{ and } l\in\{1,\ldots,N\}.$$

For the ith member of generation t-2 the level of old age consumption conditional on location choice l is implicitly defined in equation (6). Denote by $V_{i,t-2}(l)$ the indirect utility of this agent. Then the optimal old age location choice l^* selected by this agent is defined by

$$(11) \qquad V_{i,t-2}(l^*) = \max_{l} \{V_{i,t-1}(l)\},\quad \text{s.t. } l \in \{1,\ldots,N\}.$$

D. The Tax Compensation Scheme

This subsection describes our method of compensating the region-specific taxes paid by different cohorts. The following subsection describes our method of financing region-specific public goods expenditures. To focus attention on the location distortion arising from regional differences in tax policy we assume a central government receives the regional tax revenues and returns them to agents in a lump-sum manner independent of their locational choice. To avoid intergenerational redistribution which would have its own welfare effects, the central government's compensation is cohort-specific; i.e., the wage, capital income, and consumption taxes paid by each generation in each period of its life are rebated equally to all members of the generation in a lump-sum in the same period that the taxes are paid. Thus all taxes paid by the young (respectively, middle age and old) in each period across all regions are used to finance a lump-sum rebate to the young (respectively, middle age, old) in the same period.

This paradigm of a central government imposing region-specific taxes, but rebating these taxes to all agents regardless of where they live clarifies the distortive nature of region-specific taxes. Since these taxes are not used to finance specific government programs, they serve only to alter locational choices. If agents didn't care about the region in which they lived the government's action would not alter any agent's welfare. In this case all agents in a cohort would choose the same j^* location when young, the same location k^* (not necessarily equal to j^*) when middle age, and the same location l^* (not necessarily equal to j^* or k^*) when old. Since taxes are rebated they would face the same lifetime budget as without the tax. While they would potentially face capital income and consumption taxes that differ across their three periods of life, these compensated taxes would cause no reduction in utility through an intertemporal distortion because of our assumption of Leontief intertemporal preferences.

In the situation of interest in which agents care about where they live and do not all choose the same location sequence, the compensated region-specific taxes serve to redistribute between those members of a cohort that choose different location sequences. But, as indicated in the Subsection G, in the formula for excess burden this redistribution nets out.

Equations (12)-(14) define, respectively, the taxes paid by the ith member of generation s (s≥t) when young, $T^{y}_{i,s}$, middle age, $T^{m}_{i,s}$, and old, $T^{o}_{i,s}$. The value of these taxes and the consumption and asset holdings on which they are based are functions of the optimal location sequence j^*,k^*,l^* chosen by the ith agent of generation s. We suppress this functional dependence in the notation to limit the amount of notation. We could also subscript j^*,k^*,l^* by the agent i to which they refer, but we trust this dependence is obvious.

(12) $$T^{y}_{i,s} = \upsilon_{j^*}W + \tau_{j^*}C^{y}_{i,s}$$

(13) $$T^{m}_{i,s} = \upsilon_{k^*}W + \tau_{k^*}C^{m}_{i,s} + r\theta_{k^*}A^{m}_{i,s}$$

(14) $$T^{o}_{i,s} = \tau_{l^*}C^{o}_{i,s} + r\theta_{l^*}A^{o}_{i,s}$$

The taxes paid by the ith member of generation t-1 when middle age and old, $T^{m}_{i,t-1}$ and $T^{o}_{i,t-2}$, are defined in equations (15) and (16).

(15) $$T^{m}_{i,t-1} = \upsilon_{k^*}W + \tau_{k^*}C^{m}_{i,t-1} + r\theta_{k^*}A^{m}_{i,t-1}$$

(16) $$T^{o}_{i,t-1} = \tau_{1^*}C^{o}_{i,t-1} + r\theta_{1^*}A^{o}_{i,t-1}$$

Finally, equation (17) defines the taxes paid by the ith member of generation t-2 in his old age.

(17) $$T^{o}_{i,t-2} = \tau_{1^*}C^{o}_{i,t-2} + r\theta_{1^*}A^{o}_{i,t-2}$$

We assume zero population growth and denote by I the number of members of each cohort. The per-cohort member lump-sum compensation terms appearing in equations (4) through (6) can now be defined:

(18) $$T^{y}_{s} = \sum_{i=1}^{I} T^{y}_{i,s} /I$$

(19) $$T^{m}_{s} = \sum_{i=1}^{I} T^{m}_{i,s} /I$$

(20) $$T^{o}_{s} = \sum_{i=1}^{I} T^{o}_{i,s}/I$$

(21) $$T^{m}_{t-1} = \sum_{i=1}^{I} T^{m}_{i,t-1}/I$$

(22) $$T^{o}_{t-1} = \sum_{i=1}^{I} T^{o}_{i,t-1}/I$$

(23) $$T^{o}_{t-2} = \sum_{i=1}^{I} T^{o}_{i,t-2}/I$$

E. The Non-Distortionary Finance of Region-Specific Public Goods

We assume that private and public goods are the same commodity (are produced with identical production functions) and, hence, can be transformed from one into the other at a point in time at no cost. To focus attention on the location distortion associated with regional differences in per capita public goods expenditures we assume that regional public goods are financed by age-specific lump-sum taxes levied on cohort members. These lump-sum taxes at a given age have the same value for each cohort member no matter where he or she chooses to live. Let J stand for the economy's aggregate expenditure (across all regions) on public goods, where

$$(24) \qquad J = \sum_{i=1}^{I} G^{y}_{i,s} + \sum_{i=1}^{I} G^{m}_{i,s-1} + \sum_{i=1}^{I} G^{o}_{i,s-2} \qquad \text{for } s \geq t.$$

Equation (24) states that at any point in time total expenditure across the economy on region-specific public goods equals the sum across all individuals - the young, middle age, and old - of the per capita expenditure they enjoy in their region of choice at that point in time.[2]

At any time $s \geq t$ aggregate public goods expenditures are financed by the sum of lump-sum taxes, i.e.,

$$(25) \qquad J = [Q^{y}_{s} + Q^{m}_{s-1} + Q^{o}_{s-2}]I.$$

While equation (25) states that total taxes equals total expenditures, it leaves open the question of how these taxes are distributed across different contemporaneous generations. We assume that the burden of paying for public goods expenditures is spread across the different contemporaneous generations such that for any $s \geq t$

$$(26) \qquad Q^y_s = \rho Q^m_{s-1} = \rho^2 Q^o_{s-2}.$$

The substitution of equation (26) into equation (25) indicates that each generation's members face the same age-specific taxes; i.e., the solutions for $Q^y{}_s$, $Q^m{}_s$, and $Q^o{}_s$ satisfy, for all s: $Q^y{}_s = \rho^2 J/(1+\rho+\rho^2)I$; $Q^m{}_s = \rho J/(1+\rho+\rho^2)I$; and $Q^o{}_s = J/(1+\rho+\rho^2)I$.

F. Why the Compensated Taxes and lump-sum Tax-Financed Public Goods Have No Effect on Aggregate Savings

Before describing our calculation of excess burden, we demonstrate that the aggregate economy's total (private plus government) consumption at each point in time is unaltered by the introduction of the compensated regional taxes and the lump-sum tax-financed expenditures on regional public goods. In equations (4')-(6') we rewrite the budget constraints (4)-(6) in terms of the individual and per cohort-member rebate terms defined in equations (12)-(23) and the age-specific lump-sum taxes that finance the public goods.

$$(4') \qquad C^y_{i,s} + \frac{C^m_{i,s}}{1+r} + \frac{C^o_{i,s}}{(1+r)^2} = W + T^y_s - T^y_{i,s} - Q^y_s + \frac{W + T^m_s - T^m_{i,s} - Q^m_s}{1+r} + \frac{T^o_s - T^o_{i,s} - Q^o_s}{(1+r)^2}$$

$$(5') \qquad C^m_{i,t-1} + \frac{C^o_{i,t-1}}{1+r} = W + T^m_{t-1} - T^m_{i,t-1} - Q^m_{t-1} + \frac{T^o_{t-1} - T^o_{i,t-1} - Q^o_{t-1}}{1+r} + A^m_{i,t-1}(1+r)$$

$$(6') \qquad C^o_{i,t-2} = T^o_{t-2} - T^o_{i,t-2} - Q^o_{t-1} + A^o_{i,t-2}(1+r)$$

One can easily check that given the definition of the tax and rebate terms, (6') is equivalent to (6). A little more manipulation is required to show that (5') is equivalent to (5) and that (4') is equivalent to (4).

To see why the economy's aggregate consumption is unaffected by the introduction of the compensated taxes and lump-sum financed public goods, first consider the case that there are no public goods, i.e., assume that Q^y_s, Q^m_s, and Q^o_s are all zero for all s≥t. Next consider the summation of equation (6') over i. This summation leads to a cancellation of the tax and rebate terms and the result that the aggregate consumption of the initial elderly at time t simply equals principal plus interest on their period t assets. But this is just their aggregate consumption in the absence of the compensated taxes. To prove that generations t-1's aggregate consumption is unchanged at each age one need only use equation (9) and (6') to solve for the values of $C^m_{i,t-1}$ and $C^o_{i,t-1}$. The solutions are linear in the difference $T^o_{t-1} - T^o_{i,t-1}$; hence, the tax and rebate terms cancel in the summation of $C^o_{i,t-1}$ over the I members of cohort t-1, yielding the same aggregate consumption for this cohort at each age as occurs with no regional taxes. Similarly, one can use equations (7) and (5') to show that cohort s's (s≥t) consumption at each age is unaffected by the compensated regional taxes.

Now consider the case that there are region-specific public goods, meaning that the Q^y_s, Q^m_s, and Q^o_s are not zero. Since aggregate government public goods consumption expenditure is J, we need to show that the financing of this expenditure reduces aggregate private consumption by J. From (6') and the fact that Q^o_{t-1}-$J/(1+\rho+\rho^2)I$, it's immediate that aggregate consumption of the elderly at time t declines by $J/(1+\rho+\rho^2)$. Similarly using the relationships $Q^m_s = \rho J/(1+\rho+\rho^2)I$ and $Q^y_s = \rho^2 J/(1+\rho+\rho^2)I$, the first order conditions (7) and (9), and summing (4') and (5') over all cohort members, one can easily show that the aggregate consumption of the middle age and young generations at time t decline by the respective amounts $\rho J/(1+\rho+\rho^2)$ and $\rho^2 J/(1+\rho+\rho^2)$. Adding together the reduction in the time t consumption of the young, middle age, and old gives J as the total reduction in private consumption arising from public goods consumption spending of J. It is also easy to see that in each period after time t the reduction in total private consumption due to the financing for region-specific public goods will also equal J. Indeed, the reduction in consumption at each age for each cohort is constant through time. For example, according to (5′) and equation (7), the old at time t+1 experience, in the aggregate, a reduction in their consumption equal to $J/(1+\rho+\rho^2)$, which is the same reduction experienced by the old at time t.

G. <u>Calculating the Excess Burden from Regional Tax Distortions</u>

Our calculation of excess burden can be explained by defining for each agent in each cohort the amount of lump-sum recompense required to raise or lower his utility in the initial no-tax steady state to the utility level he obtains with compensated regional taxes. Let $D_{i,t-2}$, $D_{i,t-1}$, and $D_{i,s}$ stand, respectively, for the recompense to the ith agent of generation born at t-2, t-1, and s≥t. These terms are defined by

(27)

$$D_{i,s} = 3\left[\frac{1}{\alpha}\,[Z^y_{i,s}(\overset{*}{j}) + Z^m_{i,s}(\overset{*}{k}) + Z^o_{i,s}(\overset{*}{i})] + \overset{*}{C}{}^y_{i,s} + \frac{\beta}{\alpha}\,[G^y_{i,s}(\overset{*}{j}) + \rho G^m_{i,s}(\overset{*}{k}) + \rho^2 G^o_{i,s}(\overset{*}{i})]\right]$$

$$-3\left[\frac{1}{\alpha}\,[Z^y_{i,s}(\hat{j}) + Z^m_{i,s}(\hat{k}) + Z^o_{i,s}(\hat{i})] + \hat{C}^y_{i,s} + \frac{\beta}{\alpha}\,[G^y_{i,s}(\hat{j}) + \rho G^m_{i,s}(\hat{k}) + \rho^2 G^o_{i,s}(\hat{i})]\right] \quad s \geq t,$$

$$(28)\ D_{i,t-1} = 2\left[\frac{1}{\alpha}\ [Z^{m}_{i,t-1}(\overset{*}{k}) + Z^{o}_{i,t-1}(\overset{*}{l})] + \overset{*m}{C}_{i,t-1} + \frac{\beta}{\alpha}\ [G^{m}_{i,t-1}(\overset{*}{k}) + \rho G^{o}_{i,t-1}(\overset{*}{l})]\right]$$

$$- 2\left[\frac{1}{\alpha}\ [Z^{m}_{i,t-1}(\hat{k}) + Z^{o}_{i,t-1}(\hat{l})] + \hat{C}^{m}_{i,t-1} + \frac{\beta}{\alpha}\ [G^{m}_{i,t-1}(\hat{k}) + \rho G^{o}_{i,t-1}(\hat{l})]\right],$$

and

$$(29)D_{i,t-2} = \left[\frac{1}{\alpha}Z^{o}_{i,t-2}(l^{*}) + C^{*o}_{i,t-2} + \frac{\beta}{\alpha}\ G^{o}_{i,t-2}(l^{*})\right] - \left[\frac{1}{\alpha}Z^{o}_{i,t-2}(\hat{l}) + \hat{C}^{o}_{i,t-2} + \frac{\beta}{\alpha}\ G^{o}_{i,t-2}(\hat{l})\right].$$

In equations (5)-(7) the superscript ^ denotes location and consumption choices in the initial steady state, and the superscript * denotes these choices in the transition induced by the compensated regional taxes and changes in the regional allocation of total public goods expenditure J. The numbers 3, 2, and 1 multiplying the utility from location and public goods in equations (27), (28), and (29), respectively, reflect the Leontief nature of preferences for private consumption. Consider, for example, $D_{i,s}$ for $s \geq t$ which stands for the amount of additional resources member i of cohort s needs in the initial steady state to attain the post-policy level of utility. If we left out the number 3 in equation (27) we would have an expression for the amount of additional consumption when young required in the initial steady state by member i of cohort s to attain the post-policy level of utility. But since each new cohort spends a third of its total present value of after-tax resources on consumption when young, one needs to multiply the required addition in consumption when young by three to obtain the required addition in resources. In the case of initial middle age and initial old generations the corresponding adjustment factors are two and one.

The present value of the economy's excess burden, E, along its transition path arising from implementing compensated regional taxes and\or changing the regional allocations of spending J equals the sum across all cohort members of the $D_{i,t-2}$'s, the $D_{i,t-1}$'s, and the present discounted value of the $D_{i,s}$'s ($s \geq t$). The formula for E is given by

$$(30) \qquad E = - \sum_{i=1}^{I} \left[D_{i,t-2} + D_{i,t-1} + \sum_{s=t}^{\infty} \frac{D_{i,s}}{(1+r)^{s-t}} \right],$$

where the minus sign corrects for the fact that the sums of the $D_{i,j}$'s $j \geq t-2$ are negative.

Consider first the formula for excess burden in the case of zero region-specific public goods. As discussed above, because of the Leontief preference structure each cohort's total consumption at each point in time is unaltered by the introduction of the compensated regional taxes. Since consumption drops out of equation (30)'s cohort summations of the $D_{i,t-2}$'s, $D_{i,t-1}$'s, and $D_{i,s}$'s ($s \geq t$), the formula for excess burden E involves only tax-induced changes in the utility from locational choice (changes in the $Z^y{}_{i,s}$'s, $Z^m{}_{i,s}$'s, and $Z^o{}_{i,s}$'s ($s \geq t$), changes in the $Z^m{}_{i,t-1}$'s and $Z^o{}_{i,t-1}$'s, and changes in the $Z^o{}_{i,t-2}$'s); i.e., there is no excess burden associated with the utility from consumption. Rather the model's excess burden arises solely from distortions in locational choice.[3]

Next consider the formula for excess burden when there are region-specific public goods as well as compensated region-specific taxes. To measure the inefficiency of regional allocations of public goods, we need first to specify an efficient regional allocation of public goods and measure, as excess burden, the departure from that standard. We take as our efficient allocation (the ^ values in equations (27)-(29)) an initial steady state with two characteristics. First, no region-specific taxes and second, a division across regions of total public goods spending J that is proportional to the division of the economy's entire population across the regions that would arise in the absence of region-specific public goods. Since the utility from public goods depends on public goods per capita, which, by construction, is the same in each region, this ^ allocation provides agents with no incentive to change location compared with the case of zero public goods. In addition, since the lump-sum taxes used to finance the public goods are not region-specific, the financing of the ^ allocation of public goods does not distort location choices.

One additional condition is required for the ^ public goods allocation to be efficient.[4] This condition is that $\rho=1/(1+r)$, i.e., that the intertemporal marginal rate of substitution between public goods equals the economy's intertemporal marginal rate of transformation. Suppose, to the contrary that $\rho<1/(1+r)$ ($\rho>1/(1+r)$) and consider a reallocation of public goods across regions that raises (lowers) some agents' public goods consumption when young and lowers it when old, but maintains fixed the present value of the agent's public goods consumption. This reallocation will raise (lower) the agent's welfare, and positive (negative) applications of this policy can produce a Pareto efficiency gain.[5]

With the assumption $\rho=1/(1+r)$ we can now show that the excess burden formula (30) arising from allocations of aggregate public goods expenditures that differ from the ^ allocation and\or region-specific taxes involves neither changes in the utility from private or government consumption; i.e., E depends only on changes in the direct utility from locational choice (changes in the $Z^y_{i,s}$'s, $Z^m_{i,s}$'s, and $Z^o_{i,s}$'s (s≥t), changes in the $Z^m_{i,t-1}$'s and $Z^o_{i,t-1}$'s, and changes in the $Z^o_{i,t-2}$'s).

To understand why changes in the utility from private consumption do not enter the formula for E note that each cohort's total consumption at each point in time is unaltered by changes in the regional allocation of public goods spending J. To see this recall that reallocating J across different regions does not affect the lump-sum taxes financing J and, therefore, does not directly affect any agent's private budget constraint. The budget constraints of particular agents will, however, be affected because the new pattern of regional public goods spending may induce some agents to change their location choices. Such changes in location choices will, in general, eventuate in the agents paying different taxes. While the budget constraints of particular agents within a generation may be altered by changing the pattern of public goods spending, because all taxes (other than those financing J) paid by a cohort are rebated to the cohort, the budget opportunities for each cohort as a whole and, therefore, its total consumption at each point in time will be unaffected by regional reallocations of J. This point follows from summing equations (4'), (5'), and (6') over their respective cohort members. It is also easy to show that the formula for E does not involve welfare changes arising from changes in the levels of per capita public goods expenditure enjoyed by different agents. Given that $\rho=1/(1+r)$ one can use equations (24) and (27)-(29) to show that all terms involving government consumption drop out of the formula for E.

To summarize, excess burden E is simply the present value sum across all current and future agents of the differences (measured in units of consumption) between their base case (no compensated taxes and the ^ regional distribution of public goods expenditure) location component of utility and their location component of utility with compensated regional taxes and distributions of public goods expenditure that differ from the ^ distribution. Since in the ^ allocation there is no economic incentive for an agent to live in one region versus another, location choice is maximized by each agent. In contrast, in the * allocation location choices are influenced by economic variables, and hence the location component of utility in the * allocation is not maximized. Since measured excess burden depends only on the difference between the location components of utility in the ^ and * allocations, and the utility from location is maximized in the ^ allocation, moving from the ^ to the * allocation will entail a positive excess burden.

One remaining point remains to be made about the calculation of excess burden. The reason we assume that regional taxes are compensated back to the agents paying these taxes (regardless of where they live) and that region-specific public goods are financed by lump-sum taxes on agents (regardless of where they live) is to neutralize the income effects arising from regional fiscal policies. Such neutralization of income effects is not special to this model; all excess burden calculations control in some manner for income effects arising from the policy in question (e.g., see Diamond and McFadden, 1972). In controlling for income effects in our model we do not mean to suggest that compensation for regional taxes and lump-sum financing of regional public goods necessarily arise in the real world, at least not explicitly. The point, however, is that any regional tax and public goods expenditure policies that do not involve compensation and lump-sum finance can be described as policies that do involve these features plus additional lump-sum transfers (taxes) across agents. These additional lump-sum transfers (taxes) give rise to pure income effects. Once one controls for such additional income effects in calculating welfare changes, one is left with the excess burden that we measure here.

F. Comparing the Location Distortion with the Present Value of Consumption

In reporting our results we express the excess burden E as a percentage of the present value (as of time t) of private consumption of all generations either alive at time t or arriving in the future. We also consider the excess burden as a fraction of the present value of consumption of those current and future agents whose location choices are altered. While those agents who are induced to move may end up better off as a result of the lump-sum rebate of tax revenues, one could add to our model agent-specific lump-sum taxes and transfers that would offset all the income effects of the fiscal policies as well as the utility changes arising from changes in public goods expenditures. The addition of these agent-specific taxes and transfers would a) not influence any agent's location choice, b) leave the utility of all agents who were not induced to move unchanged, c) produce a change in utility of those who are induced to move equal to simply the change in their utility from location choice, and d) leave unchanged the total location distortion. The total loss in welfare (excess burden) in this case would be visited only on those agents who were induced to move, so it seems useful to compare the consumption-equivalent size of their welfare loss with the present value of their consumption.

Using agent-specific lump-sum redistribution to ensure that only those agents with induced location changes experience a welfare loss is also useful for understanding the magnitude of the excess burden relative to the present value of consumption. Consider a young agent who is induced by say a 1 percent lower consumption tax rate to move from his region of birth to another region. Suppose the government levies lump-sum taxes or transfers on this agent such that his utility change reflects only his change in locations throughout his lifetime. Let us assume this agent remains in this new region for his entire life. For such an agent the present value consumption-equivalent change in the utility from location measured as a percent of his present value of consumption will be 1 percent or smaller. If it was larger than 1 percent the agent would not have been induced to move. Hence, the percentage difference in the present value of lifetime consumption afforded by different lifetime location decisions provides an upper bound on the location distortion measured as a percentage of the present value of consumption of agents experiencing the distortion.

This example helps explain why the location distortion measured relative to the present value of consumption is likely to rise at an increasing rate with the extent of the distortion. If tax differences across locations are on the order of two percent of lifetime consumption, rather than one percent, all those whose location utility differences are two percent or smaller will be induced to move. If the distribution of agents with respect to their location utility differences has increasing mass with the size of the utility differences, which seems quite likely, increasing the tax incentive to move from one to two percent will more than double the number of agents induced to relocate and, thus, more than double the excess burden. Even if the number of agents induced to relocate only doubles, excess burden will more than double because there is a larger distortion for those induced at the margin to move.

G. The Production Sector

Each of the model's N regions has an identical constant returns to scale production function given by

(31) $Y_n = F(K_n, L_n), \quad n=1,\ldots,N,$

where Y_n, K_n, and L_n stand, respectively, for output, capital, and labor in region n. As mentioned, capital is assumed to be fully mobile across countries; hence, the pre-tax interest rate is identical in all regions. Given the constant returns technology this implies identical capital-labor ratios (equal to the aggregate economy's capital labor ratio) in each region which, in turn, implies identical pre-tax wage rates in each country. Letting W and r stand, respectively, for the pre-tax wage and pre-tax interest rate, we have

(32) $W = \delta F/\delta L_n, \quad n=1,\ldots,N,$

and

(33) $r = \delta F/\delta K_n, \quad n=1,\ldots,N.$

H. The Economic Transition with Compensated Taxes

Let $\bar{K}$ denote the aggregate (economy-wide) initial steady state capital stock. As demonstrated above, given the economy's pre-tax factor prices, aggregate consumption is unchanged by the compensated regional taxes and lump-sum tax-financed regional public goods expenditures. At time t when the compensated taxes are introduced and the regional reallocation of aggregate public goods occurs, the pre-tax factor prices are determined by the aggregate economy's capital-labor ratio, which equals $\bar{K}$ divided by 2I, the number of young and middle age agents (all of whom work full time). Hence, at time t pre-tax factor prices, W and r, equal their initial steady state values. Since time t aggregate income and aggregate consumption have the same values as in the initial steady state, time t aggregate saving is the same as in the initial steady state. This implies that the aggregate capital stock at time t+1 remains equal to $\bar{K}$. The same logic implies that aggregate capital after t+1 is also equal to $\bar{K}$. Thus the economic transition with compensated taxes involves no change in the economy-wide capital stock or factor prices through time.[6]

We assume that the distributions of the $Z^y{}_i$'s, $Z^m{}_i$'s, and $Z^o{}_i$'s are stationary, i.e., these distributions are the same for each generation. This assumption and the assumption that I is large implies that the economy reaches a steady state (with respect to the distribution of locational choices). Indeed, the economy reaches its new steady state at time t+2, i.e., in the third period after the taxes are imposed. During periods t and t+1 the distribution of location decisions of the initial middle age and old generations will differ from those of middle age and old generations after t+2 because the initial middle age and old generations did not anticipate facing regional taxes later in life when they made their location decisions when young, in the case of the initial middle age, and when young and middle age, in the case of the initial old.

II. *Distribution Assumptions and Estimation Strategy*

Since the distributions of the $Z^y{}_i$'s, $Z^m{}_i$'s, and $Z^o{}_i$'s are the same for each generation, we drop the generation subscript in our subsequent notation. Equation (34) expresses our normalization of location preferences. The location index b in this equation stands for individual i's region of birth. The normalization is that the preference for one's region of birth equals unity when young, middle age, and old.

(34) $$Z_i^y(b) = Z_i^m(b) = Z_i^o(b) = 1$$

Equation (35) indicates that for the ith agent on any generation the utility of living in region $j \neq b$ when young, $Z^y{}_i(j)$, is distributed according to the function, G( ), which we assume is Gamma.

$$(35) \qquad Z_i^y(j) \sim G(\psi_{b,j}), \quad \text{for } j \neq b$$

The Gamma distribution is determined by a single parameter, $\psi_{b,j}$. By indexing the Gamma distribution parameter by the region of birth, b, as well as the region of location j, we permit agents born in different regions to have, on average, different locational preferences. Since the parameter $\psi_{b,j}$ also determines the variance of the Gamma distribution, the variance of the distribution of preferences of agents born in different regions can also differ.[7]

Equations (36) and (37) indicate that agent i's utility for region j ($j \neq b$) as he ages evolves as a random walk, where the terms $\epsilon^m{}_i(j)$ and $\epsilon^o{}_i(j)$ are normal variates with mean zero and variance equal to σ^2.

$$(36) \qquad Z_i^m(j) = Z_i^y(j) + \epsilon_i^m(j), \quad j \neq b$$

$$(37) \qquad Z_i^o(j) = Z_i^m(j) + \epsilon_i^o(j), \quad j \neq b$$

To illustrate the import of equations (34)-(37), consider the determination of locational preferences of the ith agent as he ages. First, equation (34) indicates that this agent has, at each age, location utility equal to one if he lives in his region of birth. Second, equation (35) indicates that the utility of the agent when young from living in each region

$j \neq b$ is determined by taking a draw from each of the (assumed independent) N-1 distributions $G(\psi_{b,j})$ $j \neq b$ for the N regions not including region b. Third, equations (36) and (37) indicate how agent i's preferences for living in region j in middle and old age evolve given his preferences for living in region j when young. Equations (36) and (37) permit the individual's preferences with respect to living in a particular region to change as he ages. Since these changes in preferences are not systematic, an agent's locational preferences at each age are correlated. Also note that there is no requirement that agent i prefer his region of birth to living in other regions. The values of $Z^y{}_i(j)$, $Z^m{}_i(j)$, and $Z^o{}_i(j)$ can exceed unity.

There are 21 parameters associated with these distribution assumptions: 4 values of $\psi_{b,j}$ ($j \neq b$) for each of the five possible values of b, the region of birth, plus σ^2. In addition to these parameter values, the calculation of excess burden requires knowledge of the scaling parameters α and β and the time preference rate ρ. We estimate α and β together with the 21 distribution parameters. The time preference rate is assumed to equal the interest rate which is, in turn, determined by the marginal product of capital. Specifically, we assume that production functions in each region are identical Cobb-Douglas functions with capital income share equal to .25. In using the model to calculate excess burdens, we normalize W to 1, and solve our model for its equilibrium capital-labor ratio, and, thus its marginal product of capital.

To estimate the 21 distribution parameters plus α and β we fit modified versions of our model to U.S. and New England regional data. We assume that the U.S. and New England are in locational steady states and fit the age-specific location choices observed in the 1980 U.S. Census to the steady state versions of our modified model. In the modified models we take factor prices as given, i.e., we do not attempt to estimate the capital income share parameter of the Cobb-Douglas production function. Specifically, we normalize the wage to 1 and assume an interest rate of 51.82, which corresponds to an annual real interest rate of 1.4 percent.[8] We also use the average tax rates and per capita public goods expenditure observed in 1980 as reported in Significant Features of Fiscal Federalism for 1981-83. Since we are estimating only demand side parameters, there is no need to trace through issues of government budget balance. Hence, our modified models do not assume either that regional taxes are compensated or that regional public goods expenditure is financed through lump-sum taxation.

Ideally, one would like to have panel data that followed individuals as they changed or didn't change their location over their lifetimes. Since, for our purposes, the sample sizes of the available panel data are quite small, we decided to use the Census data. The 1980 U.S. Census recorded its respondents' states of birth and their current state of residence. With these data one can identify all agents within a specific age group (young, middle age, and old) who were born in a specific region. One can then determine the distribution of these agents across the regional locations at the time of the Census. These location decisions are then matched up against the location decisions predicted by our modified model.

To be more specific about our estimation procedure, let us define $P^y_{b,j}(\omega)$, $P^m_{b,j}(\omega)$, and $P^o_{b,j}(\omega)$ as the probabilities that an agent born in region b lives in region j when young, middle age, and old, respectively. The term ω stands for the vector of parameters entering our model. It contains the values of the parameters of the gamma distributions, the 20 $\psi_{b,j}$'s $(j \neq b)$, the variance of the normal distribution, σ^2, and the values of α and β. Next, let $M^y_{b,j}$, $M^m_{b,j}$, and $M^o_{b,j}$ stand, respectively, for the number of young, middle age, and old agents who, according to the Census data, were born in region b and live (in 1980) in region j. Then the likelihood $L(\omega)$ of observing the Census data is

$$(38) \qquad L(\omega) = \prod_{b=1}^{I} \prod_{j=1}^{I} \left[P^{y}_{b,j}(\omega)\right]^{M^{y}_{b,j}} \left[P^{m}_{b,j}(\omega)\right]^{M^{m}_{b,j}} \left[P^{o}_{b,j}(\omega)\right]^{M^{o}_{b,j}}.$$

While each individual in the Census has his or her specific location preferences, these preferences are unobservable. Hence, from an econometric perspective, each individual born in a particular region has the same age-specific probabilities of living in his region of birth or in other regions. This explains why the likelihood function treats uniformly all individuals with the same b,j combination at a particular age.

Estimation of the likelihood function given in (38) requires values for $P^{y}_{b,j}(\omega)$, $P^{m}_{b,j}(\omega)$, and $P^{o}_{b,j}(\omega)$. While one can write down analytical expressions for these functions, they are highly complex and involve multidimensional integration. As an alternative to determining these probabilities with an analytical formula (whose evaluation would require numerical techniques), we use our model to simulate the probabilities. (This is the Lerman and Manski 1981 simulation estimator; see Pakes 1986 for a similar application of this estimator). Specifically, for a given choice of the estimable parameters ω, we determine from the model the age-specific marginal location densities for 3,000 hypothetical agents born in each region. Computation with more than 3,000 hypothetical agents born per region was not feasible, but 3,000 appears to be large enough, since the parameter estimates do not appear to be materially different based on only 1000 hypothetical agents. For each of the 3000 agents we draw at random their location preferences (their values of $Z^y{}_i$, $Z^m{}_i$, and $Z^o{}_i$) based on the assumed Gamma and Normal distributions. Next we determine for each agent his optimal location sequence. This optimization is done by evaluating separately the lifetime utility of each of the possible location sequences and choosing the maximum. (While this step could also be done by dynamic programming, the numerical approximations introduced by dynamic programming would add an additional approximation error to our estimates.) Given these choices we form the fraction of the 3,000 hypothetical agents born in region b who choose to live in region j when young, middle age, and old. Thus our computer model represents a numerical function determining the marginal location probabilities. It can, obviously, also determine numerically the derivatives used in the maximization of the likelihood function.

III. Data, Sample Selection, and Parameter Estimates

A. Regional Divisions and Census Data

Computation limitations restricted our analysis to at most five regions. The reason is that the number of parameters as well as locational choices which must be evaluated increases exponentially with the number of regions. Our division of the U.S. into five regions is given in Table 1. The New England states are also divided into five regions by combining Massachusetts and Rhode Island into one single region. The other four New England regions correspond to Vermont, New Hampshire, Maine, and Connecticut.

The 1980 Census reports for each adult who was born in the U.S. his or her current state of residence as well as his or her state of birth. In our five percent Census sub sample there are 136,328 such adults. In our analysis of locational choice among the five U.S. regions we grouped these 136,328 observations according to region of birth as well as age category. Our three age categories are 20-39, 40-59, and 60+. We then determined the locational choices of those adults in each age category who were born in a particular region. For example, according to our Census sub sample data, there are 3060 adults age 40-59 who were born in the West. Of these 2,671 chose to live in the West, 53 chose to live in the Northeast, 79 chose to live in the Great Lakes, 109 chose to live in the Plains, and 148 chose to live in the South. These values (2,671, 53, 79, 109, and 148) represent the $M^m_{b,j}$'s used in the estimation of our model for the U.S.

In the case of our estimation of location choice in New England we considered only those 5,894 adults in the Census sub sample who were both born in New England and lived in New England in 1980; i.e., we ignored cases of out migration from New England. We grouped these 5,894 adults by region of birth within New England and age category and formed the values of the $M^y_{b,j}$'s, $M^m_{b,j}$'s, and $M^o_{b,j}$'s used in the New England estimation. Tables 2 and 2a present the 1980 Census location choice data (the $M^y_{b,j}$'s, $M^m_{b,j}$'s, and $M^o_{b,j}$'s) used in the two estimations of our model - one for the five regions of the U.S. and one for the five regions of New England.

As Table 2 indicates, most Americans (roughly three quarters) born in a particular region are living in that region at a point in time. For example, of 16,805 young (age 20-39) Census respondents who reported they were born in the Northeast, 78.32 percent were still living in the Northeast in 1980. The location that attracted the most young Northeasterners was the South; the South was the location choice for 10.14 percent of these respondents. An even larger percentage (12.26 percent) of elderly Northesterners chose to live in the South.

Those born in what we call the Plains are most likely to relocate. Across the life cycle only about half of those born in the Plains choose to live in the Plains. In contrast, those born in the West are the least likely to relocate to a different region of the U.S. Roughly 85 percent of Westerners live in the West at a point in time.

If we focus in Table 2a on those New Englanders who chose to remain in New England, we find an even greater tendency to remain in one's region of birth. For example, about 90 percent of those New Englanders born in either Connecticut or Massachusetts/Rhode Island who remain in New England chose to live in their home state in 1980.

B. Tax Rates and Expenditures on Public Goods

Average tax rates are calculated for each of the 50 U.S. states plus Washington D.C. and, where necessary, aggregated to regional averages base on 1980 state population weights. Each state's average income tax rates are derived by simply dividing the state and local income tax revenue by state personal income. Since the data do not permit one to calculate separate wage and capital income tax rates, we assume, in estimating our models, that both of these tax rates in a given region equal the region's average income tax rate.

State average consumption tax rates were calculated by dividing state and local sales tax revenue by our estimate of the state's consumption expenditure. Our estimate of each state's consumption expenditure is based on the assumption that its share of national consumption expenditure equals its share of national personal income.

In determining each state's per capita public goods expenditure we divided the state's population into the sum of its total (including local government) expenditures on education, highways, health, hospitals, police, fire, sewerage and sanitation. These per capita expenditures were used to form regional averages (again using population weights), and these regional averages were used in the estimation of the U.S. and New England models.

Tables 3 and 3a report for the different regions in the U.S. and New England, respectively, the 1980 average income and consumption tax rates as well as per capita public goods expenditure. In the case of the five U.S. regions average income tax rates range from 1.6 percent in the South to 4 percent in the Northeast. There is less dispersion in consumption tax rates; the lowest consumption tax rate is 2.9 percent in the Plains and the highest is 4.1 percent in the West. Table 3 indicates a considerable disparity across regions in per capita public goods expenditure in 1980. The West, which had the largest per capita spending, had 43.0 percent larger spending than the South, which had the smallest per capita spending.

Turning to Table 3a, we see that income tax rates in New England range from 1 percent in New Hampshire to 4.4 percent in Massachusetts/Rhode Island and consumption tax rates range from zero percent in New Hampshire to 3.6 percent in Maine. The disparity in per capita public goods expenditure in New England regions is somewhat smaller. Mass./R.I., whose per capita expenditure is largest of the New England regions, has 21.6 percent larger per capita expenditure than does Maine, which has the lowest per capita public goods spending of the New England regions. It may also be worth pointing out that per capita public goods expenditure in New England in 1980 was 13.1 percent smaller than the corresponding national figure.

C. Parameter Estimates

Tables 4 and 4a present parameter estimates for the U.S. and New England models, respectively.[9] They are based on a wage scaled to 1 and appropriately scaled regional per capita expenditures. Standard errors appear in parenthesis beneath every coefficient. Each table begins with a presentation of the $\psi_{b,j}$'s - the parameters of the location preference density functions. These estimates are followed by estimates of σ (the standard deviation of the $\epsilon^m{}_i$'s and $\epsilon^o{}_i$'s) the parameter α that scales utility of private consumption relative to utility from location, and the parameter β that scales utility of per capita public goods expenditure relative to utility from location. With the exception of σ all parameter estimates are highly significant.

In considering estimates of the $\psi_{b,j}$'s one should bear in mind that the mean of the gamma distribution $G(\psi_{b,j})$ is simply $1/\psi_{b,j}$, that the variance is $1/\psi_{b,j}{}^2$, and that the location preference for living in one's region of birth has been normalized to unity. All of the $\psi_{b,j}$ values in Tables 4 and 4a exceed unity, indicating that the average location preference for living in other regions ($1/\psi_{b,j}$) is smaller than that of living in one's region of birth. As one would expect from the location choices documented in Table 2, those born in the Plains have the smallest values of $\psi_{b,j}$'s and thus the largest values of the $1/\psi_{b,j}$'s. For example, the reciprocal of the ψ of those born in the Plains with respect to living in the West is .81; in contrast, the reciprocal of the ψ of those born in the Northeast with respect to living in the West is only .38. These figures mean, roughly speaking, that those born in the Plains view living in the West as worth twice as much (measured in units of consumption) as those born in the Northeast. If those born in the Plains are the least attached to their origins, those born in the West and the Northeast are most attached to their origins; i.e., they typically have the smallest values of the $1/\psi_{b,j}$'s. The estimated $\psi_{b,j}$'s also indicate a general antipathy for living in the Plains of those born outside the Plains. The column average of $1/\psi_{b,j}$ (which equals .25) for the Plains in Table 4 is the smallest of the five column averages.

The $\psi_{b,j}$ estimates in Table 4a indicate that, on average, those born in Connecticut are, other things equal, the least likely to move to another region of New England. The average row value of the $1/\psi_{b,j}$'s for Connecticut is smaller than the corresponding average row values for the other regions. The largest column average of the $1/\psi_{b,j}$'s is for Massachusetts/Rhode Island, indicating that New Englanders find moving to Massachusetts/Rhode Island more desirable, on average, than moving to other parts of New England.

Turning to the other parameter values, there are two points to stress. First, the estimates of σ are very small, indicating only minor changes over the life cycle in individual preferences concerning location. Second, while the estimates of β are smaller than the estimates of α, given the difference in the utility function from consuming private and public goods one needs to multiply the estimates of β by 3 to properly compare the estimates.[10]

In the case of the U.S. model, the estimate of α of 18.1 is substantially larger than 3 times the estimate of β, namely 3.3. In the case of the New England model, the estimate of α of 11.6 is considerably smaller than 3 times the estimate of β, namely 19.4. As a consequence of these differences in relative valuation of public goods, the estimated distortion for New England arising from regional differences in per capita public goods spending is larger than that for the U.S.

IV. *Estimates of the Location Distortion in the U.S.*

A. <u>Methodology</u>

Based on the parameter estimates of Tables 4 and 4a we next considered the base case equilibria for both the U.S. and New England models. Recall that our base case involves zero region-specific compensated taxes and equal per capita public goods expenditure. We determine total public goods expenditure in our model of locational choice in the U.S. (New England) by multiplying our model's net national product by the ratio of total U.S. (New England) state and local public goods expenditure to U.S. (New England) NNP. In the case of our New England model we determine New England net national product by assuming that New England's share of total U.S. net national product equals its share of total U.S. gross national product.

In allocating the total public goods expenditure across regions in our base case we first determined the number of agents who would live in each region in the absence of any government public goods spending and then allocated total public goods expenditure in proportion to this regional population distribution. Since this method of allocating total public goods expenditure leads to equal per capita public goods expenditure across all regions if no one is induced to relocate and since equal per capita expenditures induces no one to relocate, the base case choice of locations are those that would arise in the complete absence of government policy.

Our analysis of the U.S. and New England models are both based on 45,000 agents alive at a point in time; i.e., 15,000 agents per cohort. The distribution of regions of birth of these 45,000 agents is set equal to the distribution of regions of birth of our 136,328 Census observations. Thus our analyses of the base case as well as policy alternatives to the base case are each based on a representative (by region of birth) regional distribution of the model's agents. In the case of the U.S. model, 3,923 of the 15,000 agents in each cohort are born in the Northeast, 3,919 are born in the Great Lakes, 830 are born in the Plains, 1,367 are born in the West, and 4,961 are born in the South. In the case of the New England model, 3,059 of the 15,000 agents in each cohort are born in Connecticut, 1,641 are born in Maine, 8,811 are born in Massachusetts/Rhode Island, 840 are born in New Hampshire, and 649 are born in Vermont.

Tables 5 and 5a report for the U.S. and New England, respectively, the location distortion arising from four different policy alternatives that deviate from the base case. Excess burden is measured relative to a) the economy's aggregate present value of private consumption and b) the present value of consumption of those agent's whose location choices have been distorted. These tables also report the steady state fraction of the 15,000 members of each cohort who are induced to relocate at least once in their three periods of life by the different policies. Tables 6 and 6a report for the U.S. and New England the steady state location choices at a point in time of the 45,000 agents alive at any time for the base case as well as the four policy alternatives. These tables also report the 1980 Census populations by region scaled to the 45,000 aggregate.

B. The Distortion from Different Per Capita Public Goods Expenditures

Case 1 considers the distortion arising simply from differences in levels of per capita public goods expenditures. In this alternative to the base case, we do not introduce any region-specific taxes, but we do reallocate the total (U.S. or New England) public goods expenditure assumed in the base case to the different U.S. or New England regions according to the actual U.S. or New England regional distribution of absolute expenditure. The regional allocation of public goods expenditures are derived from data reported in Significant Features of Fiscal Federalism.

In contrast to the base case in which the same absolute total expenditure is allocated according to the population distribution that would arise in the absence of government, the Case 1 allocation leads to differences in per capita expenditures across regions and induces some agents to relocate. In the case of the new U.S. steady state 1.06 percent of the 15,000 members of each cohort are induced to relocate at least once in their lives. The comparable figure for the New England is 2.68 percent. This difference reflects the larger value of β relative to α estimated for New England compared to the U.S.

For the U.S. the excess burden in Case 1 is .14 percent of the present value of consumption of those who relocate (including agents alive during the transition path as well as in the new steady state). The comparable figure for New England is 1.11 percent. Since such small fractions of the total populations in the two model are induced to relocate, the excess burden in Case 1 measured as a fraction of the present value of all initial and future agents' consumption is quite small; it is .002 percent for the U.S. and .030 percent for New England.

C. The Distortion from Introducing Region-Specific Taxes to the Base Case

Case 2 considers how introducing the region-specific taxes of Tables 3 and 3a to the base cases of the two models distorts location choice. In this policy simulation the absolute allocation of total (U.S. or New England) public goods expenditures corresponds to that in the base case. While the allocation of public goods expenditures doesn't change, location choices in Case 2 are distorted not only because of the region-specific taxes, but also because of differences in per capita public goods expenditures. Per capita public goods expenditures differ across regions in this case because region-specific taxes induce a relocation of some agents across regions, which alters the levels of per capita expenditures (by altering the total number of agents relative to the fixed amount of expenditures in the different regions).

The excess burdens for Case 2 for the U.S. and New England are, respectively, .58 percent and .94 percent of the present value of consumption of those whose location choices are altered. The percentages of agents induced to move are 3.69 percent for the U.S. and 2.72 percent for New England. Tables 6 and 6a indicate that the region-specific taxes can make a major difference to the population totals in specific regions. Consider, for example, the New England results. Compared with the base case New Hampshire's (a very low tax state) Case 2 population is 12.4 percent larger and Massachusetts' (a high tax state) population is 2.3 percent smaller.

D. <u>The Excess Burden from Introducing Only Region-Specific Taxes</u>

As mentioned, in Case 2 the population shifts induced by region-specific taxes alter the levels of per capita public goods expenditures. Regions which set high tax rates lose inhabitants, but this raises their per capita public goods expenditure which mitigates the outmigration. In Case 3 we again switch on the region-specific taxes, but this time we endogenously adjust the allocation of public goods expenditure to maintain an equal per capita level of public goods expenditures in each region. Hence, Case 3 reveals the excess burden arising purely from regional differences in taxes. In endogenously adjusting the allocation of public goods expenditure, we use a Gauss-Seidel iteration in which the regional allocation of total public goods expenditure in each iteration is set equal to the regional population distribution in that iteration.

As one would expect, the excess burden arising in Case 3 exceeds that in Case 2. Now the excess burden is .64 percent of the present value of consumption of relocators in the U.S. model and 1.62 percent in the New

England model. In the case of the U.S. 4.04 percent of steady state agents are induced to relocate, while for New England the figure is 4.23 percent.

E. The Excess Burden from Actual Region-Specific Taxes and Public Goods Expenditures

Case 4 considers the excess burden arising from actual U.S. and New England tax rates and regional allocations of total public goods expenditures. As a percentage of the present value of consumption of relocators, the excess burden is .49 percent for the U.S. and 1.70 percent for New England. Dividing the excess burden by the present value of consumption of all agents, the excess burden is .017 percent for the U.S. and .083 percent for New England.

A comparison of location choices for Case 4 in Tables 6 and 6a with the scaled Census data indicates that our models do quite a good job in reproducing actual U.S. and New England location choices. In the case of the U.S. our model's predicted regional populations are each within 3 percent of the corresponding Census numbers. And for New England, the model's regional populations are each within 7 percent of the Census numbers.

F. Sensitivity Analysis

Tables 7 and 7a report the results of some sensitivity analysis. The first set of results in these tables are for Case 3, which deviates from the base case only in terms of region-specific taxes. Our first Case 3 exercise involves doubling all tax rates. For both the U.S. and New England this leads, roughly speaking, to a doubling of the excess burden per agent affected as well as a doubling of the fraction of agents who relocate. As a result, excess burden, measured as a fraction of the present value of all agents' consumption, rises by roughly a factor of 4 (the factors are 3.69 for the U.S. and 4.45 for New England).

Clearly, the location distortion arising from regional tax differences depends on the size of tax differences rather than the level of taxes per se. To consider further the importance of differences in tax rates, the next three Case 3 exercises in the two tables double specific tax rates only in specific regions. For example, the second row in Table 7 considers a doubling of the New England income tax rate in the U.S. model. This policy leads to an over seven-fold increase in total excess burden (.188 versus .026 (see Table 5)). For those agents whose location choices are altered, excess burden now averages almost two percent of the present value of consumption.

Another example is the fourth row in Table 7a. Here we double the income tax in Mass./R.I. (which has the highest income tax in New England) and also double the consumption tax in Maine (which has the highest consumption tax in New England). This policy leads to a quite significant excess burden for those induced to move – equivalent, on average, to their losing 3.3 percent of their consumption in present value.

The second sets of results in Tables 7 and 7a are for Case 4, which incorporates actual U.S. and New England regional tax and expenditure policy. Here we consider how measured location distortions for the U.S. and New England depend on our estimated parameter values. Consider first the simulation referenced in the sixth row of Table 7. In this simulation we set the value of α in the U.S. model equal to the estimated value of β, which is substantially smaller. As one would expect, since the utility of consumption is now less important relative to the utility of location, there are fewer agents induced to move because of regional differences in taxes. Now only .99 percent of steady state agents relocate compared with the 3.37 percent figure reported in Table 5. Despite the fact that fewer agents relocate, the excess burden reported in the sixth row of Table 7 is larger than that reported for Case 4 in Table 5. The reason is that the consumption-equivalent value of the location distortion for those induced to relocate is larger the smaller is α. This can be seen by reconsidering equations (27)-(30). Thus, while fewer agents in this simulation have their location choice distorted, for those agents induced to move, the distortion is larger (measured in units of consumption).

The next row in Table 7, row seven, indicates how raising the value of β to .75 times the estimated value of α affects measured location distortion for the U.S. Since the value of β does not influence how much agents value consumption relative to location, a higher value of β serves only to magnify the importance of any regional differences in per capita public goods expenditure. In this case the U.S. excess burden, measured relative to the economy's present value of consumption, more than doubles.

Rows eight and nine in Table 7 consider how raising or lowering α and β by the same factor alters the calculated excess burden. The results here are not much different from the Case 4 simulation in Table 5. Finally, row nine examines the impact on the excess burden estimates of doubling the value of σ. A higher value of σ spreads out the distributions of the location preferences and, not surprisingly, implies that more agents will be induced to relocate. On the other hand, those agents who are induced to relocate experience, on average, roughly the same excess burden compared to the case in which σ is not increased.

While the last five simulations of Table 7a differ somewhat from the last five simulations of Table 7, the basic message is quite similar, namely that the magnitude of the economy's excess burden, measured relative to the present value of its consumption, is not tremendously sensitive to parameter values.

V. Summary and Conclusion

This paper has considered an issue which appears to have been overlooked in the literature on harmonization of regional fiscal policies. The lack of attention paid to location distortions may reflect the sense that few individuals actually move to different states or countries because of differences in fiscal policies. This study confirms this view for the U.S.; for the U.S. economy as a whole the distortion of location choice appears to be small. However, for the four percent or so of Americans induced, by regional differences in fiscal policy, to relocate, the location distortion may range from .5 to 1.5 percent of the present value of their lifetime consumption – which is not small. In addition, the results suggest that location distortions rise geometrically with the size of regional fiscal differences. Hence, if the process in the U.S. of shifting fiscal burdens onto the states continues, the associated U.S. location distortion could dramatically increase.

Our model is highly stylized, and its results should be viewed as suggestive, not definitive. Our analysis ignores a number of aspects of location choices, such as family connections, job opportunities, and regional differences in real wages, that are surely at least as important as fiscal variables in the location choices of any particular individual. We chose to focus in our model and empirical analysis on regional fiscal differences and to subsume, as part of location preferences, all other reasons for location choice. Whether this modeling decision biases our estimates of location distortions remains to be seen in our own and hopefully others' future research.

Notes

1. Since the utility function (1) is not time-separable, this assumption is need to preclude the possibility of some members of the initial old and middle age generations choosing, in the switch to compensated regional taxes and regional public goods, to consume less than their remaining lifetime resources, because consuming more than what they consumed when young would yield no additional utility. An alternative time-separable utility function that would yield our assumptions about utility for initial and subsequent generations is an additive isoelastic function with an intertemporal elasticity of substitution very close to zero. The assumption of a very small intertemporal elasticity of substitution is consistent with much of the recent empirical evidence (e.g., Hall 1988).

2. Note that we can also express economy-wide spending on region-specific public goods as the per capita expenditure on public goods in each of the five regions multiplied by the number of young, middle age, and old agents choosing to live in each region.

3. The fact that the measure of excess burden does not involve changes in utility arising from changes in consumption is indicative of the statement made in Subsection IB that intragenerational redistribution associated with the compensated regional taxes cancels in our calculation of the economy's excess burden.

4. By an efficient allocation of total public goods expenditures we mean only that changes in the distribution of total public goods expenditures across regions coupled with lump-sum redistribution across agents can not produce a Pareto improvement. This is not to say that the level of total public goods expenditures is necessarily efficient.

5. The condition $\rho=1/(1+r)$ can be thought of as an intertemporal Samuelson condition. The term $1/(1+r)$ is the marginal rate of transformation between private goods today and public goods tomorrow, while ρ is the sum (after taking account that utility is based on per capita public goods) of marginal rates of substitution between public goods today and public goods tomorrow.

6. While regional fiscal policies in our model have no general equilibrium affects, this does not imply that our's is a partial equilibrium model. If our model did generate general equilibrium effects (it doesn't) and we were to ignore them by invoking the assumption of partial equilibrium, we would end up mismeasuring the excess burden from regional fiscal policies; i.e., general equilibrium effects influence excess burdens and one must account for these effects by modeling the general equilibrium. In our particular model general equilibrium effects turn out to be zero, but this is a result, not an assumption.

7. As indicated, the assumption that the Gamma distributions for each location $j\neq b$ depend on the region of birth permits agents born in a particular region to have location preferences that differ, on average, from those born in different regions. But the assumption that the Gamma distributions are independent means that two agents, h and i, born in the same region, will be

equally likely to like or dislike living in region j (have a large or small value of $Z^y(j)$) regardless of differences in their preferences about region m, where $m \neq j$ and $m \neq b$. We make the assumption of independent Gamma distributions to limit the number of parameters that need to be estimated. While one would expect a Californian's preferences for living in Massachusetts to be correlated with his preferences for living in New York, our model considers five very large regions within the U.S. over which preferences may be less correlated. Another feature of the Gamma distribution is that it is left skewed, which in our context means a large fraction of agents with relatively little interest in other locations and a small fraction of agents with considerable interest in other locations. Such skewness seems quite plausible for the issue of location preferences, but we must confess that we chose the Gamma distribution primarily to minimize the number of parameters that needed to be estimated.

8. This is the interest rate we derive in our general equilibrium model. Note that the unit of the scaling parameter α is inversely related to the unit of consumption and the wage; hence, a different normalization of the wage would lead to a proportionally different estimate of α, but would not alter our calculation of locational excess burden measured as a percent of the economy's present value of consumption.

9. Our maximization of the likelihood functions uses the BHHH (Berndt, Hall, Hall, and Hausman 1974) algorithm.

10. To see this consider increasing, for a young agent at time s, his lifetime income by a dollar and decreasing spending on public goods at time s by a dollar. Since the agent will spend only one third of the dollar on additional consumption when young, his lifetime utility from private consumption will rise by $\alpha/3$. In contrast, his lifetime utility from consuming public goods will fall by β. Hence, the utility gain or loss from this policy depends on the difference between α and 3β.

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Table 1

Regional Aggregation of the United States

<u>Northeast</u>
Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont
Delaware
Washington D.C.
Maryland
New Jersey
New York
Pennsylvania

<u>Great Lakes</u>

Illinois
Indiana
Iowa
Michigan
Minnesota
Missouri
Ohio
Wisconsin

<u>Plains</u>
Colorado
Idaho
Kansas
Montana
Nebraska
North Dakota
South Dakota
Wyoming

<u>West</u>
Arizona
Alaska
California
Hawaii
Nevada
New Mexico
Oregon
Utah
Washington

<u>South</u>
Alabama
Arkansas
Georgia
Kentucky
Louisiana
Mississippi
North Carolina
Oklahoma
South Carolina
Tennessee
Texas
Virginia
West Virginia

Table 2

U.S. Location Distributions

Distribution of Those Born in the Northeast Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Northeast	13,162	78.32	8,827	79.35	5,976	77.54
Great Lakes	631	3.75	478	4.30	276	3.58
Plains	208	1.24	75	0.67	37	0.48
West	1,101	6.55	724	6.51	473	6.14
South	1,704	10.14	1,020	9.17	945	12.26
Total	16,806	100.00	11,124	100.00	7,707	100.00

Distribution of Those Born on the Great Lakes at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Northeast	506	2.92	320	2.93	171	2.31
G. Lakes	13,365	77.13	7,985	73.15	5,398	73.00
Plains	480	2.77	300	2.75	216	2.92
West	1,425	8.22	1,354	12.40	905	12.24
South	1,552	8.96	957	8.77	705	9.53
Total	17,328	100.00	10,916	100.00	7,395	100.00

Distribution of Those Born in the Plains at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Northeast	69	2.10	52	2.12	45	2.49
G. Lakes	330	10.04	225	9.18	205	11.36
Plains	1,934	58.86	1,263	51.53	856	47.42
West	650	19.78	716	29.21	566	31.36
South	303	9.22	195	7.96	133	7.37
Total	3,286	100.00	2,451	100.00	1,805	100.00

Table 2 Continued

Distribution of Those Born in the West at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Northeast	194	2.43	53	1.73	29	2.10
G. Lakes	261	3.27	79	2.58	35	2.54
Plains	317	3.97	109	3.56	60	4.35
West	6,654	83.30	2,671	87.29	1,208	87.60
South	562	7.04	148	4.84	47	3.41
Total	7,988	100.00	3,060	100.00	1,379	100.00

Distribution of Those Born in the South at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Northeast	1,090	5.17	931	6.37	531	5.66
G. Lakes	1,453	6.89	1,530	10.46	742	7.91
Plains	277	1.31	181	1.24	101	1.08
West	1,246	5.91	1,205	8.24	724	7.71
South	17,008	80.71	10,776	73.69	7,288	77.65
Total	21,074	100.00	14,623	100.00	9,386	100.00

Source: US Department of Commerce; Bureau of the Census: 1980 Census of Population and Housing, 5 percent sample.

Table 2a

New England Location Distributions

Distribution of Those Born in Maine at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Maine	207	77.82	176	75.54	124	84.93
Conn.	16	6.02	18	7.73	3	2.05
New Hampsh.	15	5.64	9	3.86	2	1.37
Vermont	1	0.38	1	0.43	1	0.68
Mass./R.I.	27	10.15	29	12.45	16	10.96
Total	266	100.00	233	100.00	146	100.00

Distribution of Those Born in Connecticut at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Maine	5	0.83	1	0.28	1	0.41
Conn.	536	88.89	332	93.00	219	90.50
New Hampsh.	4	0.66	1	0.28	1	0.41
Vermont	9	1.49	2	0.56	0	0.00
Mass./R.I.	49	8.13	21	5.88	21	8.68
Total	603	100.00	357	100.00	242	100.00

Distribution of Those Born in New Hampshire at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Maine	9	5.52	4	4.17	4	5.63
Conn.	8	4.91	6	6.25	8	11.27
New Hampsh.	123	75.46	73	76.04	47	66.20
Vermont	7	4.29	4	4.17	0	0.00
Mass./R.I.	16	9.82	9	9.38	12	16.90
Total	163	100.00	96	100.00	71	100.00

Table 2a Continued

Distribution of Those Born in Vermont at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Maine	6	4.80	0	0.00	1	1.96
Conn.	6	4.80	7	8.86	6	11.76
New Hampsh.	6	4.80	7	8.86	7	13.73
Vermont	99	79.20	53	67.09	30	58.82
Mass./R.I.	8	6.44	12	15.19	7	13.73
Total	125	100.00	79	100.00	51	100.00

Distribution of Those Born in Mass./R.I. at Age:

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Maine	29	1.82	14	1.28	9	1.17
Conn.	47	2.94	44	4.02	30	3.89
New Hampsh.	70	4.38	46	4.20	32	4.15
Vermont	19	1.19	5	0.46	8	1.04
Mass./R.I.	1,432	89.67	985	90.04	692	89.75
Total	1,597	100.00	1,094	100.00	771	100.00

Source: US Department of Commerce; Bureau of the Census: 1980 Census of Population and Housing, 5 percent sample.

Table 3

1980 Population, Average Tax Rates and Per Capita Public Goods Expenditure by U.S. Region

Region	Population	Income Tax	Consumption Tax	Per Capita Public Goods
Northeast	54.6	4.0	3.0	$1129
Great Lakes	53.6	2.9	2.9	$1121
Plains	10.4	2.0	3.3	$1204
West	38.1	3.3	4.1	$1466
South	69.9	1.6	3.7	$1025
US	226.5	2.7	3.4	$1155

Source: Significant Features of Fiscal Federalism, 1981-83 Editions and The Economic Report of the President 1990.
Note: per capita public goods expenditure is in 1980 dollars.

Table 3a

1980 Population, Average Tax Rates and Per Capita Public Goods Expenditure by New England Region

Region	Population	Income Tax	Consumption Tax	Per Capita Public Goods
Connecticut	3.1	1.1	3.3	$ 993
Maine	1.1	2.4	3.6	$ 877
Mass./R.I.	6.7	4.4	2.1	$1066
New Hampshire	0.9	1.0	0.0	$ 954
Vermont	0.5	2.9	1.4	$1058
New England	12.3	3.1	2.3	$1022

Source: Significant Features of Fiscal Federalism, 1981-83 Editions and The Economic Report of the President 1990.
Note: per capita public goods expenditure is in 1980 dollars.

Table 4

Parameter Estimates of the U.S. Model

Gamma Parameters

Region of Birth	Region of Potential Location: Northeast	Gr. Lakes	Plains	West	South
Northeast	–	3.2652 (0.0267)	4.9978 (0.1180)	2.6061 (0.0221)	2.3251 (0.0169)
Great Lakes	3.2869 (0.0371)	–	3.2377 (0.0377)	2.0619 (0.0137)	2.4108 (0.0205)
Plains	3.1372 (0.0833)	2.0165 (0.0252)	–	1.2364 (.0186)	2.0276 (0.0252)
West	3.6588 (0.1152)	3.5594 (0.0603)	3.5429 (0.0525)	–	2.9135 (0.0464)
South	2.5030 (0.0180)	2.2798 (0.0136)	4.3119 (0.0292)	2.4972 (0.0248)	–

Other Parameters

σ	α	β
0.0740 (0.0257)	18.1079 (0.1912)	1.0975 (0.1581)

Standard errors are in parentheses.

Table 4a

Parameter Estimates for the New England Model

Gamma Parameters

Region of Birth	Region of Potential Location				
	Maine	Conn.	New Hampsh.	Vermont	Mass./R.I.
Maine	–	2.9176 (0.2087)	3.5973 (0.2798)	5.9527 (0.5064)	2.2436 (0.1324)
Conn.	4.8880 (0.1173)	–	5.3663 (0.2614)	4.4888 (0.3851)	2.5627 (0.1181)
New Hampsh.	2.4549 (0.1939)	2.4408 (0.3014)	–	3.2948 (0.4345)	1.8537 (0.1610)
Vermont	3.3444 (0.4535)	2.4956 (0.1524)	2.5077 (0.1891)	–	1.8873 (0.1447)
Mass./R.I.	3.7769 (0.0639)	3.2013 (0.0875)	3.4684 (0.1493)	4.7118 (0.0785)	–

Other Parameters

σ: 0.0001 (0.5622)	α: 11.6247 (1.3491)	β: 6.4747 (1.5538)

Standard errors are in parentheses.

Table 5

Estimates of Location Distortions for the U.S

Case	Compensated Regional Taxes	Public Goods Allocation	Excess Burden: Percent of Total PVC[a]	Excess Burden: Percent of PVC[a] of Relocators	Steady State Percentage Relocating
1	No	U.S. Regional Allocation	.002	.139	1.06
2	Yes	Base Case Allocation	.022	.585	3.69
3	Yes	Endogenous Allocation	.026	.636	4.04
4	Yes	U.S. Regional Allocation	.017	.489	3.37

a PVC stands for present value of consumption

Table 5a

Estimates of Location Distortions for New England

Case	Compensated Regional Taxes	Public Goods Allocation	Excess Burden: Percent of Total PVC[a]	Excess Burden: Percent of PVC[a] of Relocators	Steady State Percentage Relocating
1	No	N.E. Regional Allocation	.030	1.113	2.68
2	Yes	Base Case Allocation	.026	.948	2.72
3	Yes	Endogenous Allocation	.071	1.624	4.23
4	Yes	N.E. Regional Allocation	.083	1.699	4.80

a PVC stands for present value of consumption

Table 6

Location Choices in the U.S. Model

Case	Northeast	Great Lakes	Plains	West	South
			Region		
Base Case	11,060	10,764	2,048	7,557	13,571
1	11,011	10,695	2,043	7,781	13,470
2	10,640	10,858	2,195	7,125	14,182
3	10,598	10,862	2,220	7,076	14,244
4	10,598	10,797	2,204	7,340	14,061
Scaled Census Data	10,548	10,891	2,117	7,137	14,307

Table 6a

Location Choices in the New England Model

Case	Maine	Conn.	New Hampsh.	Vermont	Mass./R.I.
			Region		
Base Case	4,938	9,870	2,763	1,773	25,656
1	4,473	10,207	2,943	1,820	25,557
2	4,924	10,101	3,106	1,804	25,065
3	4,889	10,182	3,482	1,823	24,624
4	4,427	10,460	3,314	1,859	24,940
Scaled Census Data	4,505	9,818	3,382	1,825	25,470

Table 7

Sensitivity Analysis for the U.S.

Case 3	Excess Burden: Percent of Total PVC[a]	Excess Burden: Percent of PVC of Relocators	Steady State Percentage Relocating
Doubling all Taxes	.096	1.223	7.71
Doubling Income Tax in the Northeast	.188	1.959	9.53
Doubling Consumption Tax in the West	.1011	1.580	6.35
Doubling Consumption Tax in the West and the Income Tax in the East	.238	2.135	11.02
Doubling Total Public Goods Expenditures	.029	.715	4.07
Case 4			
Setting α equal to β	.019	1.936	.99
Setting β equal to $.75\alpha$	.035	.656	5.37
Multiplying α and β by 1.5	.022	.468	4.75
Multiplying α and β by .5	.010	.489	1.93
Doubling σ	.017	.414	4.07

[a] PVC stands for present value of consumption

Table 7a

Sensitivity Analysis for New England

Case 3	Excess Burden: Percent of Total PVC[a]	Excess Burden: Percent of PVC of Relocators	Steady State Percentage Relocating
Doubling all Taxes	.316	3.247	9.29
Doubling Income Tax in Mass./R.I.	.378	3.369	10.82
Doubling Consumption Tax in Maine	.088	1.852	4.63
Doubling Consumption Tax in Maine and the Income Tax in Mass./R.I.	.373	3.300	10.87
Doubling Total Public Goods Expenditures	.076	1.756	4.23
Case 4			
Setting α equal to β	.091	2.410	3.73
Setting β equal to α	.108	1.950	5.43
Multiplying α and β by 1.5	.094	1.491	6.19
Multiplying α and β by .5	.057	2.035	2.77
Setting σ equal to .2	.080	1.279	6.17

[a] PVC stands for present value of consumption