



How regional differences in taxes and public goods distort life cycle location choices*

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Abstract

This paper has considered an issue which only a few considered 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.

Keywords: Life cycle location choices, regional tax distortions, regional public goods

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1. Introduction

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

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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.

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), Feld and Kirchgässner (2001) or Binet (2008)). 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. 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.¹

When we published a first draft of this model in the early 1990s, we thought that our model covered a unique question of public finance research at that time Tiebout models were very popular. Tiebout models or Tiebout like models [e.g., Tiebout (1956), Stiglitz (1983), Brueckner (2006)], however, assume that agents care about the type of community in which they live (i.e., its public goods 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 regions in which they live. In the meanwhile, attachment to communities has become a standard enlargement of Tiebout models, see for example Mansoorian and Myers (1993). Liebig and Sousa-Poza (2006) look at the internal migration in Switzerland where there exists a significant tax competition between cantons (states). They find that migration decisions are not affected by taxes than rather by accommodation-related factors. For Canada, Conway and Houtenville (1998) find out that the public sector affects migration of the elderly between Canadian states, however, decisions to move are not as clear cut as theoretical models would predict. Day and Winer (2006) analyses also for Canada how differences in states' unemployment policies affect internal migration. They come to the conclusion that they are effects which however are rather small. Jones and Whalley (1988) on the other hand find significant effects of regional taxes for the migration pattern in Canada. Although there has been a certain amount of research addressing these questions (and our little survey is far from being plenary), our model provides still the feature of the life-cycle aspects of tax induced regional distortions which we think is still important and interesting.

The paper continues in Section 2 with a presentation of the model. Section 3 shows how the model's key parameters can be estimated by simulating the likelihood of particular location decisions. Section 4 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 5 presents estimates for the U.S. and New England of the location distortion arising from inter-regional tax and public goods differences while Section 6 summarizes the our findings.

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

2.1. Preferences

Our model assumes that a set of compensated regional taxes is introduced at time t . Equation (1) specifies the lifetime utility $U_{i,s}$ of the i -th agent of generation $s \geq t$. The statement that an agent is a member of generation h means that he was young at time h :

$$U_{i,s} = Z_{i,s}^y + Z_{i,s}^m + Z_{i,s}^o + \alpha \text{Min}[c_{i,s}^y; \rho c_{i,s}^m; \rho^2 c_{i,s}^o] + \beta [G_{i,s}^y + \rho G_{i,s}^m + \rho^2 G_{i,s}^o] \quad (1)$$

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 (y), middle age (m) and old (o). 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 $Z_{i,s}^y, Z_{i,s}^m$ and $Z_{i,s}^o$ in (1) denote, respectively, the locational utility the i -th member of generation s enjoys when young, middle age, and old. The value of the terms depend, respectively, on the region of residence.

Turning to the second utility component, the terms $c_{i,s}^y, c_{i,s}^m$ and $c_{i,s}^o$, respectively, for the i -th member of generations' consumption. 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 $G_{i,s}^y, G_{i,s}^m$ and $G_{i,s}^o$ stand for the region-specific public goods per capita (divided by the region's population) enjoyed by the i -th member of generation s . While each agent living in a specific region enjoys the same public goods per capita, we index $G_{i,s}^y, G_{i,s}^m$ and $G_{i,s}^o$ by i to indicate that the amount of regional per capita public goods enjoyed by agent i depends on agent i 's location decisions.² The term β scales preferences for regional public goods relative to location and private goods.

The utility of the i -th member of generation $t-l$, who is middle age at time t when the regional taxes are introduced is given by:

$$U_{i,t-1} = Z_{i,t-1}^m + Z_{i,t-1}^o + \alpha \text{Min} \left[c_{i,t-1}^m; \rho c_{i,t-1}^o \right] + \beta \left[G_{i,t-1}^m + \rho G_{i,t-1}^o \right] \quad (2)$$

and the utility of the i -th member of generation $t-2$, who is old at the time t , is

$$U_{i,t-2} = Z_{i,t-2}^o + \alpha c_{i,t-2}^o + \beta G_{i,t-2}^o \quad (3)$$

In equations (2) and (3) we assume that, for the initial old and middle age generations the utility function is of the form given in (1), but restricted to their remaining years of life.³

In the following we will make strong assumptions about the fiscal and production sector which recent research (e.g. Feldstein and Wrobel (1998) and Morgan, Mutti and Partridge (1998)) has shown probably unrealistic. However, as we want to focus solely on the distortions of local taxes on location choices, these assumptions are unfortunately necessary.

2.2. Budget Constraints

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

$$\begin{aligned} & (1 + \tau_j) c_{i,s}^y + \frac{(1 + \tau_k) c_{i,s}^m}{1 + r(1 - \theta_k)} + \frac{(1 + \tau_l) c_{i,s}^o}{[1 + r(1 - \theta)] [1 + r(1 - \theta_l)]} = \\ & = (1 - \nu_j) w + T_s^y - Q_s^y + \frac{(1 - \nu_k) w + T_s^m - Q_s^m}{1 + r(1 - \theta_k)} + \frac{T_s^o - Q_s^o}{[1 + r(1 - \theta_k)] [1 + r(1 - \theta_l)]} \end{aligned} \quad (4)$$

where the symbols τ_f , θ_f and ν_f stand, respectively, for the consumption, capital income and wage tax rates in region $f \in \{j, k, l\}$ while the terms w and r stand for the pre-tax wage and interest rates. Since, as described below, w and r are identical in all regions, they have no regional index. The terms T_s^y , T_s^m and T_s^o stand, respectively, for the lump-sum rebate of taxes. The rebates are given in equal amounts to all members of generation s regardless of where they choose to locate. Finally, the terms Q_s^y , Q_s^m and Q_s^o stand for the lump-sum taxes assessed equally on all members of generation s to pay for regional public goods again regardless of where they choose to locate. The time t budget constraint for the i -th member of generation $t-1$ who chooses to live in region k when middle aged and region l when old is:

$$\begin{aligned} & (1 + \tau_m) c_{i,t-1}^m + \frac{(1 + \tau_l) c_{i,t-1}^o}{1 + r(1 - \theta_l)} = (1 - \nu_k) w + T_{t-1}^m - \\ & - Q_{t-1}^m + \frac{T_{t-1}^o - Q_{t-1}^o}{1 + r(1 - \theta_l)} + A_{i,t-1}^m [1 + r(1 - \theta_k)] \end{aligned} \quad (5)$$

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

For the i -th 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

$$(1 - \tau_1)c_{i,t-2}^o = T_{t-2}^o - Q_{t-2}^o + A_{i,t-2}^o [1 + r(1 - \theta_1)] \quad (6)$$

where $A_{i,t-2}^o$ stands for the net wealth at the beginning of the agents $t-2$ last period of life.

2.3. Utility Maximization

Maximization by the i -th member of generation s ($s \geq t$) of (1) subject to (4) implies the first order conditions:

$$c_{i,s}^y = \rho c_{i,s}^m = \rho^2 c_{i,s}^o \quad (7)$$

These equations plus (4) can be used to solve for the i -th member of generation s ' indirect utility $V_{i,s}(j, k, l)$ conditional on the location sequence. The optimal lifetime location sequence $j-j^*$, $k-k^*$, and $l-l^*$ satisfies

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

The i -th member of generation $t-1$'s utility maximization is directly analogous:

$$c_{i,t-1}^m = \rho c_{i,t-1}^o \quad (9)$$

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

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

For the i -th member of generation $t-2$ the level of old age consumption conditional on location choice l is implicitly defined in equation (6). Let $V_{i,t-2}(l)$ be the indirect utility of this agent:

$$V_{i,t-2}(l^*) = \max_l [V_{i,t-2}(l)], \text{ s.t. } l \in (1, \dots, N) \quad (11)$$

2.4. The Tax Compensation Scheme

This subsection describes our method of compensating the region-specific taxes paid by different cohorts and 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, the central government's compensation is cohort-specific. 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 aged, 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 taxes. 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. However, as indicated in subsection 2.6, this redistribution causes no excess burden.

Equations (12)-(14) define, respectively, the taxes paid by the i -th member of generation s ($s \geq t$) when young, $Tax_{i,s}^y$, middle age, $Tax_{i,s}^m$, and old, $Tax_{i,s}^o$. 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 i -th 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.

$$Tax_{i,s}^y = v_{j^*} w + \tau_{j^*} c_{i,s}^y \quad (12)$$

$$Tax_{i,s}^m = v_{k^*} w + \tau_{k^*} c_{i,s}^m + r\theta_{k^*} A_{i,s}^m \quad (13)$$

$$Tax_{i,s}^o = \tau_{l^*} c_{i,s}^o + r\theta_{l^*} A_{i,s}^o \quad (14)$$

The taxes paid by the i -th member of generation $t-1$ when middle aged and old, $Tax_{i,t-1}^m$ and $Tax_{i,t-1}^o$, are defined in equations (15) and (16):

$$Tax_{i,t-1}^m = v_{k^*} w + \tau_{k^*} c_{i,t-1}^m + r\theta_{k^*} A_{i,t-1}^m \quad (15)$$

$$Tax_{i,t-1}^o = \tau_{l^*} c_{i,t-1}^o + r\theta_{l^*} A_{i,t-1}^o \quad (16)$$

Finally, equation (17) defines the taxes paid by the i -th member of generation $t-2$:

$$\text{Tax}_{i,t-2}^o = \tau_1^* c_{i,t-2}^o + r\theta_1^* A_{i,t-2}^o \quad (17)$$

We assume zero population growth and denote by I the number of members of each cohort. The per-cohort member lump-sum compensation out of equations (4) to (6) are defined as:

$$\text{Tax}_{\text{gen}}^{\text{age}} = \sum_{i=1}^I \text{Tax}_{i,\text{gen}}^{\text{age}} / I \quad \text{with } \text{age} \in (y, m, o) \quad \text{and } \text{gen} \in (t-2, t-1, s) \quad (18)$$

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

We assume that private and public goods are the same commodity (produced with identical production functions). 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 she chooses to live. Let J stand for the economy's aggregate expenditure on public goods, where:

$$J = \sum_{i=1}^I G_{i,s}^y + \sum_{i=1}^I G_{i,s-1}^m + \sum_{i=1}^I G_{i,s-2}^o \quad \text{for } s \geq t \quad (19)$$

Equation (19) 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. At any time $s \geq t$ aggregate public goods expenditures are financed by the sum of lump-sum taxes, i.e.,

$$J = [Q_s^y + Q_{s-1}^m + Q_{s-2}^o] I \quad (20)$$

While equation (20) 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 $s \geq t$

$$Q_s^y = \rho Q_{s-1}^m = \rho^2 Q_{s-2}^o \quad (21)$$

The substitution of equation (21) into equation (20) indicates that each generation's members face the same age-specific taxes; i.e., the solutions for Q_s^y , Q_s^m , and Q_s^o satisfy, for all s : $Q_s^y = \rho^2 J / (1 + \rho + \rho^2) I$; $Q_s^m = \rho J / (1 + \rho + \rho^2) I$ and $Q_s^o = J / (1 + \rho + \rho^2) I$. Given the presented regime, one can 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.

2.6. Calculating the Excess Burden from Regional Tax Distortions

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 i -th agent of generation born at $t-2$, $t-1$, and $s \geq t$. These terms are defined by

$$D_{i,s} = 3 \left[\frac{1}{\alpha} \left[Z_{i,s}^y(j^*) + Z_{i,s}^m(k^*) + Z_{i,s}^o(I^*) \right] + c_{i,s}^{*y} + \frac{\beta}{\alpha} \left[G_{i,s}^y(j^*) + \rho G_{i,s}^m(k^*) + \rho^2 G_{i,s}^o(I^*) \right] \right] - \left[\frac{1}{\alpha} \left[Z_{i,s}^y(\hat{j}) + Z_{i,s}^m(\hat{k}) + Z_{i,s}^o(\hat{I}) \right] + \hat{c}_{i,s}^y + \frac{\beta}{\alpha} \left[G_{i,s}^y(\hat{j}) + \rho G_{i,s}^m(\hat{k}) + \rho^2 G_{i,s}^o(\hat{I}) \right] \right] \quad s \geq t \quad (22)$$

$$D_{i,t-1} = 2 \left[\frac{1}{\alpha} \left[Z_{i,t-1}^m(k^*) + Z_{i,t-1}^o(I^*) \right] + c_{i,t-1}^{*m} + \frac{\beta}{\alpha} \left[G_{i,t-1}^m(k^*) + \rho G_{i,t-1}^o(I^*) \right] \right] - \left[\frac{1}{\alpha} \left[Z_{i,t-1}^m(\hat{k}) + Z_{i,t-1}^o(\hat{I}) \right] + \hat{c}_{i,t-1}^m + \frac{\beta}{\alpha} \left[G_{i,t-1}^m(\hat{k}) + \rho G_{i,t-1}^o(\hat{I}) \right] \right] \quad , \text{ and} \quad (23)$$

$$D_{i,t-2} = \left[\frac{1}{\alpha} Z_{i,t-2}^o(I^*) + c_{i,t-2}^{*o} + \frac{\beta}{\alpha} G_{i,t-2}^o(I^*) \right] - \left[\frac{1}{\alpha} Z_{i,t-2}^o(\hat{I}) + \hat{c}_{i,t-2}^o + \frac{\beta}{\alpha} G_{i,t-2}^o(\hat{I}) \right] \quad (24)$$

In equations (22)-(24) the superscript $\hat{\cdot}$ 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 (22)-(24), 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 (22) 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

$$E = - \sum_{i=1}^I \left[D_{i,t-2} + D_{i,t-1} + \sum_{s=t}^{\infty} \frac{D_{i,s}}{(1+r)^{s-t}} \right] \quad (25)$$

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 (25)'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 $Z_{i,s}^y$'s, $Z_{i,s}^m$'s, and $Z_{i,s}^o$'s ($s \geq t$), changes in the $Z_{i,t-1}^m$'s and $Z_{i,t-1}^o$'s, and changes in the $Z_{i,t-2}$'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.⁴

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 $\hat{\cdot}$ values in equations (22)-(24)] 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 location choices.

One additional condition is required for the $\hat{\cdot}$ public goods allocation to be efficient. 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.

With the assumption $\rho=1/(1+r)$ we can show that the excess burden E depends only on changes in the direct utility from locational choice (changes in the $Z_{i,s}^y$'s, $Z_{i,s}^m$'s, and $Z_{i,s}^o$'s, ($s \geq t$), changes in the $Z_{i,t-1}^m$'s and $Z_{i,t-1}^o$'s, and changes in the $Z_{i,t-2}^o$'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 (19) and (22)-(24) to show that all terms involving government consumption drop out of the formula for E .

To summarize, the excess burden E is simply the present value sum across all current and future agents of the differences between their base case 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 $\hat{\cdot}$ 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, the \ast allocation location choices are influenced by economic variables, and hence the location component of utility in the \ast allocation is not maximized. Since measured excess burden depends only on the difference between the location components of utility in the $\hat{\cdot}$ and \ast allocations, and the utility from location is maximized in the $\hat{\cdot}$ allocation, moving from the $\hat{\cdot}$ to the \ast allocation will entail a positive excess burden. One 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 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 re-

gional tax and public goods expenditure policies that do not involve compensation and lump-sum finance can be described as policies without these features plus additional lump-sum transfers (taxes) across agents. These additional lump-sum transfers (taxes) induce pure income effects. Once one controls for such additional income effects in calculating welfare changes, one is left with our measurement of excess burden.

2.7. The Production Sector

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

$$Y_n = F(K_n, L_n), \quad n = 1, \dots, N, \quad (26)$$

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

$$w = \delta F / \delta L_n, \quad n = 1, \dots, N, \quad (27)$$

$$r = \delta F / \delta K_n, \quad n = 1, \dots, N, \quad (28)$$

2.8. 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. 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 $t+I$ remains equal to \bar{K} . The same logic implies that aggregate capital after $t+I$ 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.⁵ We assume that the distributions of Z_i^y 's, Z_i^m 's, and Z_i^o 's are stationary. 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.

3. Distribution Assumptions and Estimation Strategy

Since the distributions of the Z_i^y 's, Z_i^m 's, and Z_i^o 's are the same for each generation, we drop the generation subscript in our subsequent notation. Equation (29) 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.

$$Z_i^y(b) = Z_i^m(b) = Z_i^o(b) = 1 \quad (29)$$

Equation (30) indicates that for the i -th agent of any generation the utility of living in region $j \neq b$ when young, $Z_i^y(j)$, is distributed according to the function, $G(\cdot)$, which we assume is Gamma.

$$Z_i^y(j) = G(\psi_{b,j}), \quad \text{for } j \neq b \quad (30)$$

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.⁶

Equations (31) and (32) indicate that agent i 's utility for region j ($j \neq b$) as she ages evolves as a random walk, where the terms $e_i^m(j)$ and $e_i^o(j)$ are normal variants with mean zero and variance equal to s^2 .

$$Z_i^m(j) = Z_i^y(j) + e_i^m(j) \quad \text{for } j \neq b \quad (31)$$

$$Z_i^o(j) = Z_i^m(j) + e_i^o(j) \quad \text{for } j \neq b \quad (32)$$

To illustrate the import of equations (29)-(32), consider the determination of locational preferences of the i -th agent as he ages. First, equation (29) indicates that this agent

has, at each age, location utility equal to one if he lives in his region of birth. Second, equation (30) 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 (31) and (32) 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 (31) and (32) 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 $Z_i^y(j)$, $Z_i^m(j)$, and $Z_i^o(j)$ can exceed unity.

There are 21 parameters associated with these distribution assumptions: four values of $\psi_{b,j}(j \neq b)$ for each of the five possible values of b , the region of birth, plus s^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 0.25. 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 annual real interest rate of 1.4 percent.⁷ We also use the average tax rates and per capita public goods expenditure observed in 1980 as reported in Advisory Commission on Intergovernmental Relations (1981, 1982 and 1983) for 1981-83. Since we are estimating only demand side parameters, there is no need to ask for government budget balance. Hence, our modified models do not assume 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 needed 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 specified 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 $P_{b,j}^y(x)$, $P_{b,j}^m(x)$ and $P_{b,j}^o(x)$ as the probabilities that an agent born in region b lives in region j when young, middle age, and old, respectively. The term x 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 ($j \sim b$), the variance of the normal distribution, r^2 , and the values of α and β . Next, let $M_{b,j}^y$, $M_{b,j}^m$ and $M_{b,j}^o$ 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 $L(w)$ of observing the Census data is

$$L(w) = \prod_{b=1}^I \prod_{j=1}^I [P_{b,j}^y(x)]^{M_{b,j}^y} [P_{b,j}^m(x)]^{M_{b,j}^m} [P_{b,j}^o(x)]^{M_{b,j}^o} \quad (33)$$

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 (33) requires values for $P_{b,j}^y(x)$, $P_{b,j}^m(x)$ and $P_{b,j}^o(x)$. 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 w , 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 1,000 hypothetical agents. For each of the 3,000 agents we draw at random their location preferences (their values of Z_i^y , Z_i^m and Z_i^o) 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. 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.

4. Data, Sample Selection, and Parameter Estimates

4.1. 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 adults in each age category who were born in a particular region. For example, according to our Census 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_{bj}^m '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_{bj}^y 's, M_{bj}^m 's, and M_{bj}^o 's used in the New England estimation. Tables 2 and 2a present the 1980 Census location choice data (the M_{bj}^y 's, M_{bj}^m 's, and M_{bj}^o '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 Northeasterners 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 1980.⁸

4.2. 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 noticing that per capita public goods expenditure in New England in 1980 was 13.1 percent smaller than the national figure.

4.3. 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 e_i^m 's and

e_i^o '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 u 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 α are very small, indicating only minor changes over the life cycle in individual preferences concerning location. Second, while the estimates of α are smaller than the estimates of β , given the difference in the utility function from consuming private and public goods one needs to multiply the estimates of α 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 three times the estimate of β (3.3). In the case of the New England model, the estimate of α of 11.6 is considerably smaller than three times the estimate of β (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.

5. Estimates of the Location Distortion in the U.S.

5.1. Methodology

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 birth regions 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 regional distribution of the model's agents. 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.

5.2. 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 Advisory Commission on Intergovernmental Relations (1981, 1982 and 1983). 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 and 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.

5.3. 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. For example, the New England results compared with the base case of New Hampshire (a very low tax state) the population is 12.4 percent larger and Massachusetts' (a high tax state) population is 2.3 percent smaller.

5.4. The Excess Burden from Introducing Only Region-Specific Taxes

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.

5.5. The Excess Burden of 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 relocates, 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 three percent of the corresponding Census numbers. And for New England, the model's regional populations are each within seven percent of the Census numbers.

5.6. 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 four.

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 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. (highest income tax in New England) and also double the consumption tax in Maine (highest consumption tax in New England). This policy leads to a significant excess burden for those moving (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 a 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 α to β .75 times the estimated value of α affects measured location distortion for the U.S. Since the value of α 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 7 and Table 7a differ quantitatively, the basic outcome is quite similar qualitatively, 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.

6. Summary and Conclusion

In this paper we develop a model to analyze location distortions due to differences in fiscal policies (i.e. regional taxes). We stylize this model in the way that only the distortion effect of taxes is the driver of the model. After explaining our theoretical framework, we estimate our model for the U.S. in its entirety and for the New England states.

Most studies in this area focus on the question of international mobility where taxes and employment opportunities could be major drivers (e.g. Hafner (2005) or Rasmussen (2004)). Only a few have studied this question in a fiscal federalism context which probably reflects

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. As our database is from 1980 (Census 1980), it is interesting to see that a very recent study by Coomes and Hoyt (2008) seems to confirm our findings at least in qualitative terms i.e. that only large differences in state taxes have a profound effect on migration between states in the U.S. They use Census data from 2000 which backs our claim that the randomness of our data sample outweighs the actual point in time from which it were taken.

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. However, as Conway and Rork (2006) point out, it is an interesting question if tax differences induce location distortions or if tax differences are induced by location decisions.
2. 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.
3. Since the utility function (1) is not time-separable, the assumption is needed to preclude the possibility of some members of the initial old and middle aged generations choosing, to compensate the 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 iso-elastic function with an intertemporal elasticity of substitution close to zero. The assumption of a very small intertemporal elasticity of substitution is consistent with empirical evidence (e.g., Hall (1988)).
4. 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 2.2 that intergenerational redistribution associated with the compensated regional taxes cancels in our calculation of the economy's excess burden.
5. While regional fiscal policies in our model have no general equilibrium effects, it does not imply a partial equilibrium model. If our model generates general equilibrium effects (it doesn't) and we ignore them by invoking the assumption of partial equilibrium, we would end up miss-measuring the excess burden from regional fiscal policies. In our particular model general equilibrium effects turn out to be zero as a result, not an assumption.

6. 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. However, the assumption that the Gamma distributions are independent means that two agents, hand i , born in the same region, will be equally likely to like or dislike living in region j . 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.
7. 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.
8. We are aware of the fact that our data sample from 1980 seems outdated to the distinguished reader. However, as it is a random selection of one wave of data, we think that the conclusions of our simulation would still hold with more recent data (see also Cooms and Hoyt (2008)). Updating and expanding the model remains a job for future research.
9. Our maximization of the likelihood functions uses the Berndt, Hall, Hall, and Hausman (1974) algorithm.
10. To see this consider a young agent at time s increases his lifetime income by a dollar while spending on public goods at time s are decreased 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 three β .
11. Per capita public goods expenditure is in 1980 dollars.
12. Per capita public goods expenditure is in 1980 dollars.

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Resumen

Este trabajo ha considerado algo que pocos trabajos en la literatura han hecho en el análisis de la armonización de las políticas fiscales: el efecto de las distorsiones territoriales, cuyo impacto puede dar sentido al hecho de que muy pocos individuos se muevan a diferentes estados o países por diferencias en la política fiscal. Este trabajo lo confirma para Estados Unidos. Para la economía norteamericana la distorsión generada por la elección de un determinado lugar de residencia parece pequeña. En todo caso, un cuatro por ciento de americanos habrían sido inducidos a mover su residencia por diferencias regionales en la política fiscal mientras que la distorsión territorial estaría entre el 0,5 y el 1,5 por ciento del valor presente de su consumo vital - valor que no es pequeño. Además, los resultados sugieren que las distorsiones aumentan geométricamente con la dimensión de las diferencias fiscales regionales.

Palabras clave: elección de ciclo vital, distorsiones fiscales regionales, bienes públicos regionales.

Clasificación JEL: H73, H71, H72.

APPENDIX

Table 1
REGIONAL AGGREGATION OF THE UNITED STATES

Northeast	Great Lakes	Plains	South	West
Connecticut	Illinois	Colorado	Alabama	Arizona
Maine	Indiana	Idaho	Arkansas	Alaska
Massachusetts	Iowa	Kansas	Georgia	California
New Hampshire	Michigan	Montana	Kentucky	Hawaii
Rhode Island	Minnesota	Nebraska	Louisiana	Nevada
Vermont	Missouri	North Dakota	Mississippi	New Mexico
Delaware	Ohio	South Dakota	North Carolina	Oregon
Washington D.C.	Wisconsin	Wyoming	Oklahoma	Utah
Maryland			South Carolina	Washington
New Jersey			Tennessee	
New York			Texas	
Pennsylvania			Virginia	
			West Virginia	

Table 2
U.S. LOCATION DISTRIBUTIONS.
DISTRIBUTION OF THOSE BORN IN 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	11,124	100	7,707	100

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
Great Lakes	13,365	77.13	7,985	73.15	5,398	73
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	10,916	100	7,395	100

Table 2 (continuación)
U.S. LOCATION DISTRIBUTIONS.
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
Great 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	2,451	100	1,805	100

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
Great 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	3,060	100	1,379	100

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
Great Lakes	1,453	6.89	1,530	10.46	742	7.91
Plains	277	1.13	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	14,623	100	9,386	100

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
Connecticut	16	6.02	18	7.73	3	2.05
New Hampshire	15	5.64	9	3.86	2	1.37
Vermont	1	0.38	1	0.43	1	0.68
Massachusetts/Rhode Island	27	10.15	29	12.45	16	10.96
Total	266	100	233	100	146	100

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
Connecticut	536	88.89	332	93	219	90.50
New Hampshire	4	0.66	1	0.28	1	0.41
Vermont	9	1.49	2	0.56	0	0
Massachusetts/Rhode Island	49	8.13	21	5.88	21	8.68
Total	603	100	357	100	242	100

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
Connecticut	8	4.91	6	6.25	8	11.27
New Hampshire	123	75.46	73	76.04	47	66.20
Vermont	7	4.29	4	4.17	0	0
Massachusetts/Rhode Island	16	9.82	9	9.38	12	16.90
Total	163	100	96	100	71	100

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	1	1.96
Connecticut	6	4.80	7	8.86	6	11.76
New Hampshire	6	4.80	7	8.86	7	13.73
Vermont	99	79.20	53	67.09	30	58.82
Massachusetts/Rhode Island	8	6.44	12	15.19	7	13.73
Total	125	100	79	100	51	100

Table 2a (continuación)
NEW ENGLAND LOCATION DISTRIBUTIONS.
DISTRIBUTION OF THOSE BORN IN MASSACHUSETTS/RHODE ISLAND AT AGE

	20-39		40-59		60-79	
	Number	Percent	Number	Percent	Number	Percent
Maine	29	1.82	14	1.28	9	1.17
Connecticut	47	2.94	44	4.02	30	3.89
New Hampshire	70	4.38	46	4.20	32	4.15
Vermont	19	1.19	5	0.46	8	1.04
Massachusetts/Rhode Island	1,432	89.67	985	90.04	692	89.75
Total	1,597	100	1,094	100	771	100

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. REGION¹¹

	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
U.S.	226.5	2.7	3.4	\$1155

1980 POPULATION, AVERAGE TAX RATES AND PER CAPITA PUBLIC GOODS
EXPENDITURE BY NEW ENGLAND REGION¹²

	Population	Income Tax	Consumption Tax	Per Capita Public Goods
Northeast	3.1	1.1	3.3	\$993
Great Lakes	1.1	2.4	3.6	\$877
Plains	6.7	4.4	2.1	\$1066
West	0.9	1.0	0.0	\$954
South	0.5	2.9	1.4	\$1058
U.S.	12.3	3.1	2.3	\$1022

Source: Advisory Commission on Intergovernmental Relations (1981, 1982 and 1983) and Chairman of the Council of Economic Advisors (1990)

Table 4
PARAMETER ESTIMATES OF THE U.S. MODEL
GAMMA PARAMETERS. REGION OF POTENTIAL LOCATION

Region of Birth	Northeast	Great 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 (0.0186)	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	
	0.7040 (0.0257)	18.1079 (0.1912)		1.0975 (0.1581)	

Standard errors are in parentheses

Table 4a
PARAMETER ESTIMATES OF THE NEW ENGLAND MODEL
GAMMA PARAMETERS. REGION OF POTENTIAL LOCATION

Region of Birth	Maine	Connecticut	New Hampshire	Vermont	Massachusetts/ Rhode Islans
Maine		2.9176 (0.2087)	3.5973 (0.2798)	5.9527 (0.5064)	2.2436 (0.1324)
Connecticut	4.8880 (0.1173)		5.3663 (0.2614)	4.4888 (0.3851)	2.5627 (0.1181)
New Hampshire	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)
Massachusetts/ Rhode Islans	3.7769 (0.0639)	3.2013 (0.0875)	3.4684 (0.1493)	4.7118 (0.0785)	
Other Parameters					
	σ	α		β	
	0.0001 (0.5622)	11.6247 (1.3491)		6.4747 (1.5538)	

Standard errors are in parentheses

Table 5
ESTIMATES OF LACATION DISTORTIONS FOR THE U.S.

Case	Compensated Regional Taxes	Public Goods Allocation	Percent of Total PVC*	Percent of PVC* of Recolocators	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

*: PVC stands for present of consumption

Table 5a
ESTIMATES OF LACATION DISTORTIONS FOR THE NEW ENGLAND.

Case	Compensated Regional Taxes	Public Goods Allocation	Percent of Total PVC*	Percent of PVC* of Recolocators	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

*: PVC stands for present of consumption

Table 6
LOCATION CHOICE IN THE U.S. MODEL

Case	Northeast	Great Lakes	Plains	West	South
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	13,307

Table 6a
LOCATION CHOICE IN THE NEW ENGLAND MODEL

Case	Maine	Connecticut	New Hampshire	Vermont	Massachusetts/ Rhode Islans
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.
EXCESS BURDEN

Case 3	Percent of Total PVC ^a	Percent of PVC ^a 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 Expenditure	.029	.715	4.07
Case 4	Percent of Total PVC ^a	Percent of PVC ^a of Relocators	Steady State Percentage Relocating
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 of consumption

Table 7a
SENSITIVITY ANALYSIS FOR NEW ENGLAND
EXCESS BURDEN

Case 3	Percent of Total PVC ^a	Percent of PVC ^a of Relocators	Steady State Percentage Relocating
Doubling all Taxes	.316	3.247	9.29
Doubling Income Tax in the 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.	.076	1.756	4.23
Doubling Total Public Goods Expenditure	.029	.715	4.07
Case 4	Percent of Total PVC ^a	Percent of PVC ^a of Relocators	Steady State Percentage Relocating
Setting α equal to β	.091	2.410	3.73
Setting β equal to $.75\alpha$.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
Doubling σ	.080	1.279	6.17

^a: PVC stands for present of consumption

