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ON THE POLITICAL ECONOMY OF IMMIGRATION AND INCOME REDISTRIBUTION*

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In this article, we analyze an economy in which agents vote over immigration policy and redistributive tax policy. We show that natives' preferences over immigration are influenced by the prospect that immigrants will be voting over future tax policy. We also show that changes in the degree of international capital mobility, the distribution of initial capital among natives, the wealth or poverty of the immigrant pool, and the future voting rights and entitlements of immigrants can have dramatic effects on equilibrium immigration and tax policies. Finally, we provide some empirical support for the model's predictions.

1. INTRODUCTION

In this article, we study several general equilibrium models in which the agents in an economy must decide on the appropriate level of immigration into the country. Immigration does not enter directly into the native agents' utility functions, and natives have identical preferences over consumption goods. However, natives may be endowed with different amounts of capital, which alone gives rise to alternative levels of desired immigration. We show that the natives' preferences over desired levels of immigration are influenced by the prospect that new immigrants will be voting in the future, which may lead to higher taxation to finance government spending from which they will benefit. We also show that changes in the degree of international capital mobility, the distribution of initial capital among natives, the wealth or poverty of the immigrant pool, and the future voting rights and entitlements of immigrants can all have a dramatic effect on the equilibrium immigration and taxation policies.

Our analysis is novel in several respects. First and most important, the analysis integrates the political economy of immigration and the political economy of taxation and government spending, both of which have been examined separately but not, to our knowledge, jointly. In many countries, discussions of the impact of immigration focus almost exclusively on immigrants' consumption of publicly provided goods and services. One surprising result in our analysis is that the addition of immigrants who are both poorer than the native population and permitted

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to vote over redistribution does not necessarily result in higher taxes and transfers. If initial wealth inequality in the economy is low, the tax rate may actually *fall* as immigrants are admitted.

Second, our analysis examines the effect of immigration from the perspective of natives' utility levels, instead of income. In so doing, we also document why measures of the impact of immigration that focus solely on natives' income may be inappropriate. Such measures may be misleading because they ignore the effects that the change in factor prices engendered by immigration can have on natives' allocation of resources over time. Depending on the period sampled, natives' incomes may be increasing in the level of immigration, whereas their lifetime utilities are in fact falling as they are making intertemporal trade-offs that they would otherwise not. In this respect, the dynamic nature of our analysis is crucial.

Third, we study how the degree of international capital mobility affects natives' preferences over the immigration and taxation issues. This turns out to be important—if inflows of labor are accompanied by substantial inflows of physical capital, the effect of immigration on factor prices and, ultimately, natives' utilities, is likely to be small. We show that in the extreme, albeit unrealistic, case of perfect capital mobility, natives are in fact indifferent with respect to the level of immigration. In a world of less-than-perfect capital mobility, however, general equilibrium price effects and the effects of immigration on domestic fiscal policy combine to give sharp native preferences over the level of immigration.

Finally, in addition to studying capital mobility, the analysis below will illustrate how various other features of the economy can influence agents' preferences over various levels of immigration. For example, it is shown that support for increased immigration may be strengthened by inhibiting (or postponing) the ability of immigrants to subsequently obtain the franchise to vote, or curtailing the government transfers that immigrants can receive. Similarly, agent's preferences for immigration can significantly depend upon the wealth levels held these by immigrants.

The importance of immigration in the world economy is often underappreciated. According to the United Nations data, in 2000 there were 175 million migrants living in 228 countries.[2] This amounts to 3% of the world's population, or a population that is roughly the size of France, Italy, and the United Kingdom combined. This percentage of the world population has stayed roughly constant at least since 1965.[3] Immigration patterns differ radically across countries: The fraction of the population that is "foreign born" ranges from essentially zero in Vietnam to between 70% and 80% in Qatar, the United Arab Emirates, and Andorra. Australia, Canada, and the United States, which account for only 5% of the world population, have received three quarters of the world's immigrants in the 1990s. Immigration accounts for 40% of the U.S. population growth rate.

There is also evidence that immigration is likely to become a much more important issue in the future. One reason is the secular decline in transportation costs

[2] See United Nations (2003).

[3] See Martin (1996) for a comprehensive analysis of immigration patterns. There is also a monthly internet newsletter titled the "Migration News" that reports on worldwide immigration issues. It is available at http://migration.ucdavis.edu/.

that has permitted even unskilled workers to move great distances. But additionally, the fall in fertility rates of industrialized countries implies that the population of many of these economies may become *smaller* in the absence of immigration. For example, there is currently not a single country in Europe that has a fertility rate sufficient to maintain its current population in the long run, in the absence of immigration. Given the aging of the population of industrial countries, this has dire implications for the ability of these countries to maintain their current generous levels of government-funded social and retirement programs. As Canada has already learned, increased immigration is one way to alleviate this financial exigency.[4]

The intent of this article is to shed some light on the *economic* factors that may influence the voting patterns of domestic citizens on the issue of immigration. Additionally, we emphasize the *dynamic* aspects of this question, which would appear to be important. Altering immigration policy in one period will influence the quantity of the factors of production, factor prices, and the distribution of income in future periods. If citizens then make subsequent policy decisions, those *future* decisions will be affected as well by *current* immigration policy. If agents are forward looking, then they should take these future consequences into account when formulating preferences over the number of immigrants to admit today.

There is some recent work that is related to the approach adopted below. Storesletten (2000) constructs a model that enables him to study whether immigration can help finance the projected U.S. federal government spending policies. This is an interesting exercise because it sheds insight on whether immigration can substitute for taxation, in financing the government's social programs. Ben-Gad (1997) examines the consequences of exogenously determined immigration in an infinite-horizon capital accumulation model. Although Ben-Gad studies quite a different environment than the framework of this article, what is common to both papers is the finding that it is important to study the dynamic general equilibrium effects of immigration. Benhabib (1996) studies a simple model in which agents' motives are determined by purely economic considerations over alternative economic policies, though the analysis does not contain many of the details studied in the model in this article. A more detailed comparison of the present framework and that studied by Benhabib will be presented later in this article. Razin et al. (2002) study a model in which there is redistribution as well as migration. Unlike the approach adopted in this article, their model lacks a dynamic structure, and agents do not vote over the level of immigration. They find that there is likely to be less domestic appetite for immigration if this results in the immigrants draining the fiscal benefits away from the natives. Cukierman et al. (1997) also study immigration, but they look at an environment in which the potential migrants must make optimal decisions in considering whether or not to move. Neither of these papers consider the potential effect, over several periods, on the quantities of both capital and labor, together with the changes in their factor prices, that result from

[4] Eberstadt (1997) describes these data. For example, in the postunification Eastern Germany, the fertility rate is less than one birth per woman *per lifetime*. Similarly, Japan has had subreplacement fertility for over 40 years.

the endogenous determination of the level of immigration, nor do they study how immigration can influence the future levels of government spending or taxation through the outcome of the voting mechanism.

There is also a substantial body of empirical work that seeks to measure the costs or benefits of immigration into the United States. Borjas (1994, 1995, 1999) provides good references for this literature, while appearing to conclude that the benefits of immigration are at best minimal, and in fact the costs to residents can be large.

The remainder of this article is organized as follows. In the next section, we describe the economic environment in terms of the consumption and savings choices facing natives and immigrants, the determination of the supply of foreign-owned capital and the economy's aggregate production possibilities. In Section 3, we turn to the political decisions that agents in the economy face, describing the nature and timing of these decisions and the method by which we construct the economy's equilibrium. In Section 4, we analyze the behavior of the economy numerically under alternative assumptions about the degree of inequality in natives' initial endowments of capital, the degree of international capital mobility, the voting rights and entitlements of immigrants, and the relative wealth or poverty of the immigrant pool. The empirical support for the model is summarized in Section 5. We offer some concluding remarks in Section 6. An Appendix contains a proof of a proposition given in Section 4 and an analysis of the case in which the tax rate and the level of immigration are determined simultaneously by native voters at the outset, instead of sequentially.

2. THE ECONOMIC ENVIRONMENT

We analyze an economy that lasts for three periods. There is no uncertainty, and agents are assumed to have perfect foresight. We do not model immigrants' incentives to emigrate; rather, we assume that there is an unlimited supply of identical potential immigrants, relative to the initial size of the economy under consideration. Immigrants, if admitted, arrive in the second period. They then must make optimal employment and saving decisions. In the second period, all agents in the economy who are enfranchised will vote over the level of income taxation, and resulting redistribution, which will take place in the last period. In our benchmark case, immigrants arrive with only labor to supply and are enfranchised for voting in the second period. We also consider the cases where immigrants arrive with substantial capital, are not permitted to vote once admitted, and are not entitled to transfers.

A novel feature of this model is that the policy adopted in period 1, determining the amount of immigration, will influence the future distribution of income and therefore the preferences of agents for future income taxation, which will be determined in the subsequent period. There is a sequential nature to the voting scheme and if there is immigration, the median voter in one period will not, in general, be the median voter in a subsequent period. That is, agents in period 1—the economy's natives—must consider how their decision to admit immigrants will influence who will be the median voter over tax policy in period 2. This is an important ingredient that will enhance our understanding of the political mechanism that determines these policy parameters.

2.1. *The Decision Problem of Initial Residents.* We assume that there is a continuum of initial residents, or "natives," and the size of this population is normalized to unity. Natives in this economy face the most interesting decision problem. Each native is endowed with some amount of capital, k_1, in the first period. The native divides this capital, an all-purpose good, into consumption in the first period and savings for the second period. In the second period, the native receives his or her income from savings and from labor services, which the native supplies inelastically. The labor endowments of all agents, both natives and immigrants, are normalized to one. Income in period 2 is again divided between consumption and savings for period 3. Also in period 2, the agents vote on the level of taxation and transfers that are to be imposed in the following period. In the third and final period, agents simply consume their income, after any taxes and transfers have been completed.

For computational purposes, we assume that a native agent's utility over consumption in the three periods is described by the time-separable, logarithmic utility function

$$\log(c_1) + \beta \log(c_2) + \beta^2 \log(c_3) \tag{1}$$

All natives have the same preferences over the three consumption goods. A native endowed initially with k_1 units of capital faces the following budget constraints for consumption in the three periods:

$$c_1 + s_2 = k_1$$
$$c_2 + s_3 = r_2 s_2 + w_2$$

and

$$c_3 = (1 - \theta)(r_3 s_3 + w_3) + \tau$$

where s_{i+1} denotes savings in period i, and w_i and r_i denote the period-i real wage rate and rental rate of capital, respectively. θ is the income tax rate in period 3. We assume that the revenue that the government collects is rebated to agents in the economy in the form of a lump-sum transfer, τ, which is identical across agents. The transfer τ might also be viewed as representing some sort of public good or a transfer in kind that substitutes for private consumption.[5] We will say more below about the determination of the level of θ and τ.

[5] What we have in mind is that governments appear obligated to offer a certain amount of public services, even to newly arrived immigrants. These could take the form of welfare or income–subsidy payments, but also subsidies for education or health care, or nonexcludable goods such as roads or parks. This certainly seemed to be a pertinent area of concern for many people in California as attested to by the success of Proposition 187.

2.2. *The Decision Problem of Immigrants.* Immigrants are assumed to arrive at the beginning of period 2. For convenience, we denote the size of the immigrant population as M. Since the size of the initial resident population is unity, the size of the total population during periods 2 and 3 is then $1 + M \equiv L$. As a benchmark, it is assumed that these agents have no capital, but have a single unit of labor.[6] The preferences of immigrants are similar to those of residents over consumption in periods 2 and 3, and are given by

$$\log(c_2) + \beta \log(c_3)$$

Immigrants must maximize utility subject to the following budget constraints:

$$c_2 + s_3 = y_2$$

and

$$c_3 = (1 - \theta)(r_3 s_3 + w_3) + \tau$$

In the benchmark case where immigrants arrive with only a unit of labor to supply, an immigrant's income in period 2 consists solely of wage income—i.e., $y_2 = w_2$. If immigrants also have some amount of capital k^M, then $y_2 = w_2 + r_2 k^M$.

2.3. *Foreign Capital.* Not only can immigrants enter this economy, but there may be international movements of physical capital as well—that is, inflows of immigrants may be accompanied by inflows (or outflows) of physical capital from abroad. This is what one would expect, if physical capital were perfectly mobile across countries and if capital and labor are complements in the domestic country.[7] If the rates of return on physical capital are initially equal across countries, then a movement of labor into the domestic economy, other things equal, will raise the return to capital there relative to other countries.

To make this aspect of the model as simple as possible, we assume that foreign agents are risk-neutral investors who face a cost of adjusting their capital holdings in the domestic economy. Precisely, foreign agents have linear utility over consumption in all three periods, with a discount factor β. Given some initial amount of capital located in the domestic economy, call it K_1^F, they choose values of K_2^F and K_3^F to maximize

$$c_1 + \beta c_2 + \beta^2 c_3$$

[6] That the immigrants are relatively poor is a very plausible benchmark. Martin (1996) describes the "typical" immigrant around the world as someone who is young, at or near the bottom of the emigration country's job ladder, and often from rural areas. We will consider below the case where immigrants are relatively rich.

[7] Wellisch and Wildasin (1996) also incorporate capital mobility in a study of labor migration. However, they study quite different issues from those analyzed here.

subject to $c_i = \tilde{r}_i K_i^F - K_{i+1}^F - \gamma(K_{i+1}^F)$.[8] There is no restriction imposed that forces K_i^F to be positive, so that domestic capital held by natives may leave the country.[9] Here, $\tilde{r}_i$ represents the period-i return to capital located in the domestic economy, net of any taxes—in particular, $\tilde{r}_2 = r_2$ and $\tilde{r}_3 = (1-\theta)r_3$. Note that the return to foreign capital invested in the domestic economy in the third period is also taxed at the rate θ. The cost of adjustment is captured by $\gamma(K_{i+1}^F)$, which we assume to have the quadratic form[10]

$$\gamma\left(K_{i+1}^F\right) = \frac{\lambda}{2}\left(K_{i+1}^F\right)^2 \tag{2}$$

Utility maximization by foreign agents gives rise to the following simple rule governing the evolution of foreign-owned capital located in the domestic economy:

$$K_{i+1}^F = \frac{1}{\lambda}\left(\beta\tilde{r}_{i+1} - 1\right) \tag{3}$$

for $i = 1, 2$.

This decision rule implies that the higher is the net-of-tax domestic rate of return to capital, relative to $1/\beta$, the larger will be the inflow of foreign capital. Here, $\lambda \geq 0$ represents an adjustment cost parameter that influences the desired change in the capital stock; the smaller λ is, the larger will be the response in foreign capital to a change in the domestic net rate of return to capital. At one extreme, if $\lambda = 0$, then there are no adjustment costs, which implies that there is perfect capital mobility between economies. In this case, equilibrium requires that the after-tax domestic returns to capital in each period obey $\tilde{r}_{i+1} = 1/\beta$. At the other extreme, if $\lambda = +\infty$, then $K_2^F = K_3^F = 0$, then we are back to the closed-economy case.[11]

[8] This utility function has the property that the after-tax return to world capital is determined by the discount factor β, which captures the notion that the domestic economy is small relative to the rest of the world. The fact that the foreigners appear to be risk neutral is immaterial, since there is no uncertainty in the model.

[9] This budget constraint for the foreign consumers only contains terms that influence the decision to hold capital, which is all that is necessary for the study of the issue at hand. Obviously, a more complete description of their environment would include other sources of income, such as wage income, and capital income in their own country. This could then imply that $c_i > 0$, even if $K_i^F < 0$.

[10] We are considering this form of the adjustment cost, instead of the alternative $\frac{\lambda}{2}\left(K_i^F - K_{i+1}^F\right)^2$, because implicit in this latter formulation is that capital does not depreciate. However, writing adjustment costs as in Equation (2) implies that the depreciation rate is unity in both the foreign and domestic economies. It may be appropriate to think of a period as being long in this case, and so a higher depreciation rate is therefore appropriate.

[11] It is not clear how one is to measure the degree of capital mobility. It is fairly clear that "financial capital," in the form of deposits in financial institutions, is very mobile. On the other hand, physical capital, which is tangible capital used in the production of other goods, is clearly less mobile. Since the relevant concept here is the latter, we feel it is important to study economies where there is less-than-perfect capital mobility. Furthermore, recent empirical studies indicate that models in which there are no adjustment costs for capital have a great deal of difficulty accounting for observed flows in international capital (see Mendoza, 1991; Baxter and Crucini, 1993; Mendoza and Tesar, 1998). There is other research that adopts a slightly different approach from our adjustment cost setup—for

2.4. *Production Technology.* Production, which takes place only in periods 2 and 3, is undertaken by competitive firms with access to a constant-returns-to-scale Cobb–Douglas production technology, using capital and labor as inputs—that is, $F(K_i, L_i) = AK_i^{\alpha} L_i^{1-\alpha}$, for $i = 2, 3$. Obviously, K_i and L_i represent the aggregate stocks of capital and labor employed in period i, respectively. When foreign capital is present, aggregate capital K_i is the sum of aggregate domestic savings for period i—call it K_i^D—and foreign capital employed in the domestic economy in period i, so

$$K_i = K_i^D + K_i^F$$

is the aggregate stock of capital employed in period i.[12] As both natives and immigrants inelastically supply one unit of labor per person, the aggregate labor input in periods 2 and 3 is simply $L_i = 1 + M$.

In equilibrium, the factor prices r_i and w_i will obey the marginal conditions

$$r_i = F_1(K_i, L_i) = \alpha A(K_i/L_i)^{\alpha-1} \tag{4}$$

and

$$w_i = F_2(K_i, L_i) = (1-\alpha) A(K_i/L_i)^{\alpha} \tag{5}$$

3. IMMIGRATION AND TAXATION POLICIES

3.1. *The Timing of Decisions.* Immigration policy, which is here simply the number M of immigrants to admit, is decided in the first period, prior to the native residents' consumption–savings decision. Redistributive fiscal policy, summarized by the tax parameter θ, is determined in the second period, also prior to agents' consumption–savings decisions. To describe the political equilibrium, we use the standard model of two-party competition, though in this case there is a sequence of elections, each over a single issue.

Our choice of a sequential framework is primarily motivated by our interest in what happens when, through immigration, the size of the voting population and the distribution of income among voters change. It would be inappropriate to study this in a framework with a single first-period election over both M and θ, in which, necessarily, only natives would participate. By the same token, a *sequence* of elections in which *both* of the issues are decided—say, for example, if natives vote on a level immigration and taxation to be implemented in period 2, and then natives and newly arrived immigrants vote over further immigration and taxation

example, Backus et al. (1994) use a "time-to-build" structure whereas Backus et al. (1992) use an Armington aggregator. In both cases, the effects of these modifications are similar to the effect of adjustment costs, in that cross-country movements of physical capital are slowed in order to bring the models in line with observed movements of physical capital.

[12] In our experiments below, we consider a case where immigrants arrive in period 2 bringing a quantity of capital K_2^M, in which case aggregate capital in period 2 becomes $K_2 = K_2^D + K_2^F + K_2^M$.

for period 3—would seem to detract from the main mechanisms at work, as well as rendering the analysis hopelessly complicated.

Still, one might usefully compare the results of a single, first-period election over both θ and M with our results in Section 4.3.1, where we examine the case in which immigrants are not permitted to vote; we undertake such a comparison—and in the process prove the existence of a local majority-rule equilibrium under simultaneous voting—in the Appendix.

The issue in the first round of voting is the number of immigrants to admit. We will consider the case where the issue space is a closed interval from zero to some maximum number of immigrants. Even though natives have identical preferences over consumption goods, if they differ in their initial capital holdings they will in general not have identical preferences over the number of immigrants to admit. We let μ_1 denote the distribution of initial capital in the native population with support over some set $\mathcal{K} \subset R_+$. The size of the resident population is normalized to one, so that $\int_{\mathcal{K}} \mu_1 (dk_1) = 1$.

Once the number of immigrants to be admitted has been decided, natives make their consumption and saving decisions. In the second period, the immigrants arrive, production takes place, and agents receive their second-period incomes, which they will divide between second-period consumption and savings for the third period.

Prior to this second consumption–savings decision, however, agents vote on the size of the income tax rate θ to be implemented in the subsequent period.[13] Given government budget balance and equilibrium considerations, the choice of θ implies a choice of transfer τ. If immigrants are enfranchised, then the set of participants in this second round of voting consists of all $1 + M$ agents in the economy; otherwise, the set of participants is the same as in the first round of voting—i.e., the native population. Since there is no uncertainty the values of τ and θ are known at the beginning of period 2. As will be seen, these parameters are endogenously determined as functions of other structural features of the economy, in a manner that we describe in the next section.

It is also worth pointing out that, even if one wished to consider alternative political mechanisms by which policies are set, we believe that much of our analysis is still useful. Clearly, an essential *datum* to any politico-economic analysis of immigration policy is a description of natives' preferences over immigration. A large part of the analysis below is simply an attempt to understand, from general equilibrium considerations, where natives' preferences over immigration come from.

3.2. *The Model from Period 2 on.* In order to describe the economy's equilibrium, we work backward from the final period to the first. Because of the economy's recursive structure, we are able to solve for the equilibrium outcome in the

[13] More precisely, in terms of the underlying two-party competition, there is a second round of elections in which the candidates espouse platforms with respect to θ. A more complete description of the underlying two-party competition is given in the technical appendix, which is available on request from the authors.

last period—in terms of prices, quantities, and fiscal policy variables—conditional on a value of M and a distribution of income at the start of the second period. Full equilibrium for a given value of M—described in the subsequent section—is then had by stepping back to period 1 to consider the economic decisions that determine the distribution of income in the second period.

In this section, then, we consider a model where immigrants, having arrived, vote together with residents over redistributive fiscal policy at the beginning of period 2. The size of the population or workforce for these two periods is $L = 1 + M$, where M is taken as given.

Consider an individual, who may be either an immigrant or a native agent, who has income in period 2 equal to y_2. Such an individual faces the following optimization problem:

$$\max\{\log(c_2) + \beta \log(c_3)\} \tag{6}$$

subject to the budget constraints given by

$$c_2 + s_3 = y_2 \tag{7}$$

and

$$c_3 = (1 - \theta)(r_3 s_3 + w_3) + \tau \tag{8}$$

It is easily seen that the solution to this problem is a decision rule of the form

$$s_3(y_2, \Phi) = \frac{\beta y_2 - \Phi}{1 + \beta} \tag{9}$$

where $\Phi = [w_3 + \tau/(1 - \theta)]/r_3$. Moreover, substitution of the decision rule and constraints into the agent's utility function gives an expression for the agent's maximized utility from period 2 on in terms of the agent's income, y_2, the after-tax return to saving, $(1 - \theta)r_3$, and Φ:

$$(1 + \beta) \log(y_2 + \Phi) + \beta \log[(1 - \theta)r_3] \tag{10}$$

If $\mu_2(\cdot)$ denotes the distribution of period-2 income across all agents in the economy (i.e., new immigrants and previous residents), then aggregate domestic saving for period 3 is given by

$$\begin{aligned} K_3^D &= \int s_3(y_2, \Phi)\mu_2(dy_2) \\ &= L\left[\frac{\beta \bar{y}_2 - \Phi}{1 + \beta}\right] \end{aligned} \tag{11}$$

where $\bar{y}_2$ denotes the average level of period-2 income. Aggregate capital for period 3, K_3, is then the sum of K_3^D and K_3^F, where the latter is given by

Equation (3), i.e.,

$$K_3^F = \lambda^{-1}(\beta(1-\theta)r_3 - 1) \tag{12}$$

We assume that the government rebates all proceeds from the period-3 income tax to agents in the economy via the transfer payment τ, which is identical across agents. Thus,

$$\tau = \theta(r_3 K_3 + w_3 L)/L = \theta\left(r_3 \frac{K_3}{L} + w_3\right) \tag{13}$$

With our Cobb–Douglas technology, the wage–rental ratio is given by

$$\frac{w_3}{r_3} = \left[\frac{1-\alpha}{\alpha}\right]\frac{K_3}{L}$$

Using this, and the previous expression for τ, a little algebra reveals that

$$\Phi = \left[\frac{1-\alpha(1-\theta)}{\alpha(1-\theta)}\right]\frac{K_3}{L} \tag{14}$$

Substituting (14) into (11), and $r_3 = \alpha A(K_3/L)^{\alpha-1}$ into (12), the relationship $K_3 = K_3^D + K_3^F$ becomes an equation that determines a unique value of K_3 for each value of $\theta \in [0, 1]$, given the value of L and the period-2 income distribution μ_2.[14] Using this implicit relationship between θ and K_3, the expression giving the equilibrium return r_3 in terms of K_3, and the relationship (14), giving Φ in terms of θ and K_3, we can evaluate each agent's indirect utility for periods 2 and 3 as a function of the tax rate θ to find that agent's preferred tax rate. In other words, the preferred tax rate for an individual with period-2 income equal to y_2 solves

$$\max_{\theta\in[0,1]}\{(1+\beta)\log(y_2+\Phi) + \beta\log[(1-\theta)r_3]\} \tag{15}$$

subject to (11), (12), and (14), and the conditions $K_3 = K_3^F + K_3^D$ and $r_3 = \alpha A(K_3/L)^{\alpha-1}$.

For the economy we consider here, agents' implied preferences over θ are well behaved; numerical evaluation reveals them to be single peaked, with preferred values of θ weakly decreasing in the agent's income y_2—that is, agents with higher period-2 incomes prefer lower values of the tax rate. As we show in the paper's Technical Appendix (Dolmas and Huffman, 2003), in the special case where there is no foreign capital and the third-period production technology is linear in capital (i.e., $\alpha = 1$), one can actually obtain a simple closed-form solution for any agent's preferred tax rate.

[14] In fact, given the linearity of agents' savings rules, K_3^D depends on the distribution μ_2 only through its mean, $\bar{y}_2$. Less directly, K_3^F, as given in (12), depends on μ_2 only through $\bar{y}_2$ as well—there is a one-to-one relationship between K_3^F and $\bar{y}_2$.

Since the conditions of the median voter theorem apply, we set the equilibrium third-period tax rate equal to the preferred value of the agent with the median level of period-2 income.[15] This implies that the behavior of the economy in period 3—equilibrium prices and quantities and fiscal policy—can be described in terms of three variables, the mean and median of the period-2 income distribution and the level of immigration. Moreover, the utility from period 2 onward of any agent can be described in terms of those three variables, together with the agent's own period-2 income. Let $v\,(y_2; \bar{y}_2, y_2^m, M)$ denote this indirect utility function for an agent who has period-2 income equal to y_2. Here, y_2^m denotes the median level of period-two income. This v is simply the indirect utility function (10), with Φ, θ, and r_3 set equal to their equilibrium values, which in turn depend on the list of aggregate statistics $\bar{y}_2$, y_2^m, and M.

3.3. *The Full Three-Period Model with Redistributive Taxation.* In the last section, we have described the optimization problem faced by immigrants and natives over the last two periods for given levels of period-2 income, and the resulting equilibrium for a given distribution of period-2 income and the level of immigration. We now step back to period 1 and show how the distribution of income in period 2 can be determined, given the level of immigration M. In the end, we will have described the full equilibrium of the economy for a given value of M. Using that information, we can then turn to consider natives' lifetime utilities in terms of M.

First, note that the period-2 income of a native agent is the sum of capital and labor income, and can therefore be written as

$$y_2 = r_2 s_2 + w_2 \tag{16}$$

For an immigrant, either $y_2 = w_2$ or $y_2 = r_2 k^M + w_2$, depending on whether or not immigrants arrive with some capital.

The aggregate stock of capital in period 2 will be the sum of aggregate domestic savings from period 1, foreign capital located in the domestic economy and, possibly, capital brought by immigrants. The latter, when present, is simply given by Mk^M, if M immigrants are admitted and each owns k^M units of capital. Foreign capital employed in the domestic economy in period 2 is given by the $i = 2$ version of (3),

$$K_2^F = \frac{1}{\lambda}(\beta r_2 - 1)$$

The interesting problem is again faced by natives, who must make a consumption–savings decision in period 1, given the level of immigration M and

[15] This is for the benchmark case where all agents are enfranchised in period 2. If, on the other hand, immigrants are not permitted to vote, we set the tax rate to the value preferred by the native with the median level of period 2 income among natives. Because of the monotonicity in current income of agents' next-period savings in this economy, this individual will simply be the native with the median level of initial capital.

expectations about the distribution of income that will prevail in period 2. We may cast a typical native's decision problem as

$$\max_{s_2} \log(k_1 - s_2) + \beta v\big(r_2 s_2 + w_2; \bar{y}_2, y_2^m, M\big)$$

Given the form of the indirect utility function v—it is logarithmic in $y_2 + \Phi$—utility maximization again gives rise to a savings rule that is linear in income. In particular,

$$s_2\big(k_1; w_2, r_2, \bar{y}_2, y_2^m, M\big) = \frac{\beta(1+\beta)k_1 - (w_2 + \Phi)/r_2}{1 + \beta(1+\beta)} \tag{17}$$

where Φ is as defined in (14), evaluated at the period-3 capital stock and tax rate implied by $\bar{y}_2$, y_2^m, M. This then gives aggregate domestic saving—equivalently, domestically owned capital in place for period 2—as

$$\begin{aligned} K_2^D &= \int_{\mathcal{K}} s_2\big(k_1; w_2, r_2, \bar{y}_2, y_2^m, M\big)\mu_1(dk_1) \\ &= \frac{\beta(1+\beta)\bar{k}_1 - (w_2 + \Phi)/r_2}{1 + \beta(1+\beta)} \end{aligned} \tag{18}$$

where $\bar{k}_1$ is the average initial capital holding among natives.

Aggregate capital in period 2 is then $K_2 = K_2^D + K_2^F + K_2^M$, where $K_2^M = Mk^M$ in the case where immigrants each bring $k^M \geq 0$ units of capital. In either case, by substituting $w_2 = (1-\alpha)A(K_2/L)^\alpha$ and $r_2 = \alpha A\,(K_2/L)^{\alpha-1}$ into the previous expressions for K_2^D and K_2^F, the equilibrium condition $K_2 = K_2^D + K_2^F + K_2^M$ becomes an equation that can be solved for K_2 given L and Φ. This is the capital stock in period 2 for a given level of immigration (embodied in L) and a given distribution of period-2 income (captured in Φ).

For a given value of M, then, the first-period savings decision of natives depends on a conjecture about the period-2 distribution of income, since this determines the outcome in period 3. Clearly, the natives' decisions also *imply* a distribution of income in period 2. The economy is in equilibrium when the conjectured and realized distributions coincide. More precisely, the conditions that characterize an equilibrium for this economy in our benchmark case can be summarized as follows.

Given the following initial conditions for the first period, $\mu_1(\cdot)$, K_1^F, L, an equilibrium is then a list $\{K_i, K_i^D, K_i^F, K_2^M, w_i, r_i, y_2^m, y_2, \theta, \tau\}$, for $i = 1, 2$, and a distribution of second-period income $\mu_2(\cdot)$, such that the following conditions hold:

(a) Agents' consumption–savings decisions follow rules (9) and (17).
(b) Factor prices for each period are given by Equations (4) and (5).
(c) The capital stocks obey $K_2 = K_2^D + K_2^F + K_2^M$ and $K_3 = K_3^D + K_3^F$, where K_i^F follows (3) and K_i^D, for $i = 1, 2$, is given by (18) and (11).

(d) The initial distribution of initial capital μ_1, together with the decision rule (17) and the second-period factor prices w_2 and r_2, induces a distribution of income in period 2 given by μ_2, with mean $\bar{y}_2$ and median y_2^m.
(e) The tax rate θ solves the problem (15) for $y_2 = y_2^m$. Also, the lump-sum transfer is determined by Equation (13).
(f) The variable Φ in Equations (9), (11), (15), (17), and (18) is as defined in (14).

Having described how the economy's equilibrium is constructed for a particular given value of $L = 1 + M$, we will now turn to study the preferences of native agents over different levels of immigration. By substituting equilibrium prices, taxes, and transfers at each value of M, together with agents' optimal decision rules, back into the agents' lifetime utility functions, we can study how an individual's lifetime utility over all three periods varies as a function of the level of immigration, M.

The actual construction of an equilibrium is somewhat involved, as one might gather from the discussion above. This is due to the dependence of the third-period outcome—including the government policy variables θ and τ—on the endogenous distribution of income in the second period, which in turn conditions agents' decisions in the first period. In equilibrium, prices and quantities must be such that the optimal choices that individual agents make at various dates are consistent with the laws of motion of the aggregate variables.

Because of the model's complexity, analytical results are difficult to obtain outside of a few special cases—e.g., the case of perfect capital mobility, which we examine below. Consequently, in the following section we report the results from numerical simulations of the model, under alternative assumptions about the degrees of initial income inequality and capital mobility, as well as under alternative assumptions about the wealth, enfranchisement, and entitlements of the immigrant population. The precise method, which we employ for actually computing an equilibrium is detailed in a Technical Appendix, which is available from the authors upon request.

4. SOME NUMERICAL EXAMPLES

4.1. *Results for a Benchmark Case.* We initially abstract from international capital movements (setting $\lambda = +\infty$ and $K_1^F = 0$) and consider an economy in which immigrants, if admitted, arrive with only labor to supply, are enfranchised to vote in the second period over the economy's redistributive tax policy, and are recipients of the lump-sum transfer. This enables us to focus on the mechanisms at work in the model while restraining the added complications introduced by international capital mobility.

Throughout all of our examples, the model's basic taste and technology parameters are set in the following way. The parameter α, capital's share of output, is set equal to 0.30. The common discount factor β is set equal to 0.95.[16] Finally, the

[16] Elsewhere (Dolmas and Huffman, 1997a) we have studied the influence that the preference and production parameters β and α can have on the preferred level of immigration. We have also examined models with a number of different distributions for natives' initial wealth.

technology's scale parameter A is set to yield a 10% return to capital in the middle period, absent any immigration and subsequent taxation.

We also assume throughout that natives' initial capital holdings (k_1) have a lognormal distribution that is translated away from the origin to guarantee that all natives begin with some amount of capital. We limit our attention here to lognormal distributions, as these seem to provide a reasonable approximation to observed distributions of wealth while retaining substantial computational tractability. For all our experiments, we fix the average initial capital holding at 10 units and the minimum initial capital holding at 2 units of capital. For our benchmark case, the variance of the distribution is set to give a Gini coefficient of roughly 0.37, which is close to measures of the Gini coefficient for the distribution of income in the United States.

Figure 1 summarizes some of the results for this economy as the level of immigration is varied from $M = 0$ to $M = 0.25$. The level of immigration M is the variable on the horizontal axis in all the panels of Figure 1, as well as in the subsequent plots of the model's output. Since the size of the native population is normalized to one, values of M are synonymous with numbers of immigrants as a fraction of the native population.

Panel A shows the behavior of the third-period tax rate as we vary M. For this economy, the tax rate rises smoothly as the number of immigrants admitted increases. If the figure were extended rightward, the tax rate would eventually rise to a maximum of roughly 31%. Although it is perhaps intuitive that the addition of agents who are both poor and permitted to vote should lead to higher redistributive taxation, this is not inevitable and depends to a large extent on the shape of the initial distribution of capital. As we show below, for lognormal distributions of initial capital with low degrees of inequality, it is possible for the equilibrium tax rate to fall as immigrants are added to the economy—even falling to zero—despite the fact that immigrants are poorer than the average native and enfranchised to vote.

The explanation for the behavior of the tax rate in the case at hand lies in the plot immediately below, Panel C. Panel C shows the behavior of three different income measures in the second period. The variables relevant for the determination of the tax rate are *median* second-period income and *average* second-period income. Recall that when all agents—both natives and immigrants—are allowed to vote over tax policy, then in equilibrium the third-period tax rate is set at the value preferred by the individual with the median level of income in period 2. However, as in other political-economic models of redistribution, the actual value of the tax chosen by the median income recipient depends on the ratio of that individual's income to *average* income.[17] As immigrants are added to this economy, each immigrant coming with only labor to supply, both median and average second-period income fall, and in this case median second-period income falls faster than average second-period income. Consequently, the gap between median and average second-period income grows, resulting in an increasing tax rate.

[17] This feature is common to a number of different economies (See Persson and Tabellini, 1994). See Dolmas and Huffman (1997b) for a derivation of this feature in a much more specialized environment.

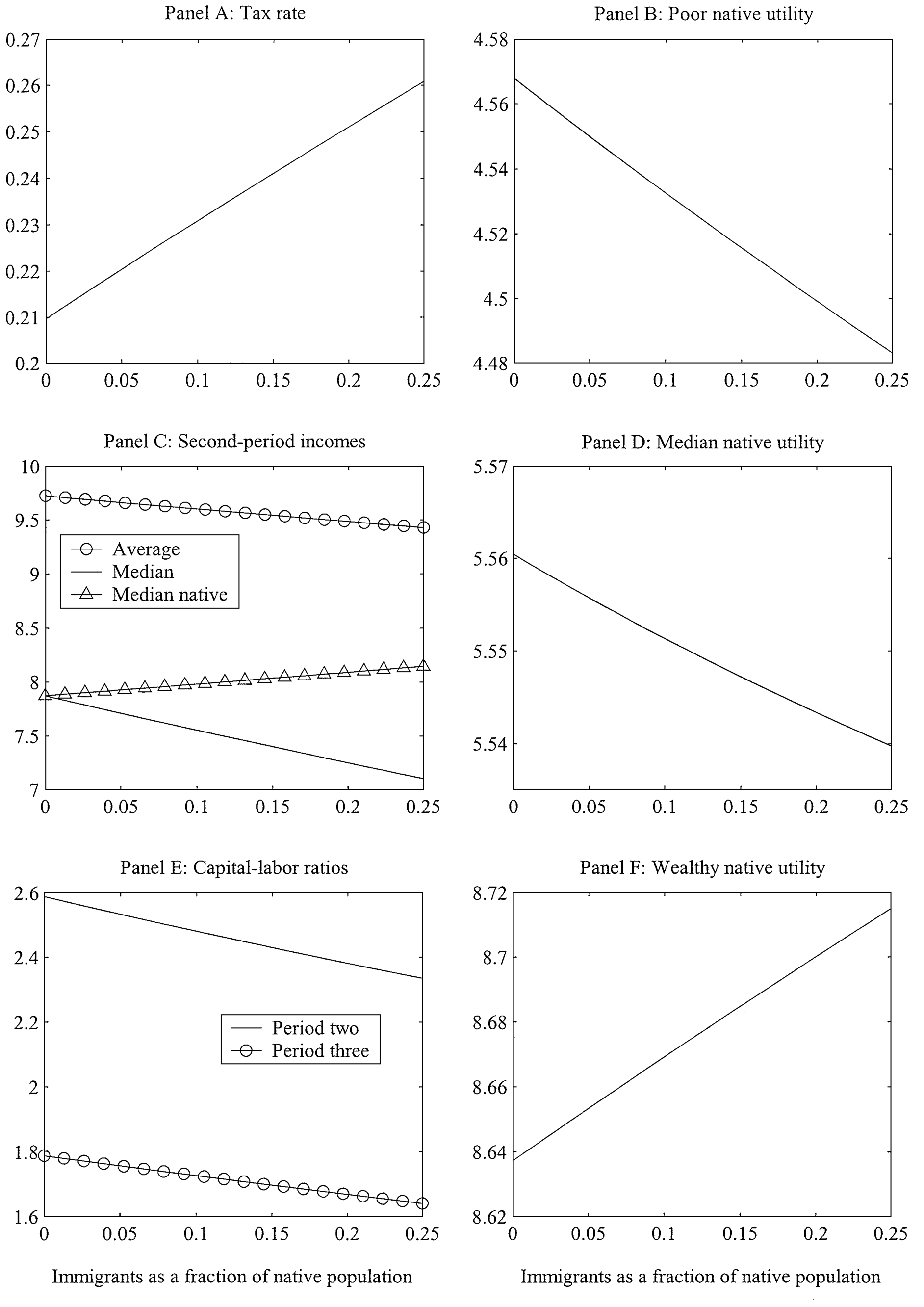

FIGURE 1

RESULTS IN A BENCHMARK CASE

With a lognormal distribution of initial capital and very low initial wealth inequality, it is possible for median second-period income to fall more *slowly* than average second-period income, resulting in tax rates that decline with the number of immigrants. In some cases, the tax rate may then begin to rise after the level of immigration reaches a critical level; in other cases, the tax rate can actually fall to zero and remain there until immigrants outnumber natives.[18]

The behavior of factor prices—the returns to labor and capital in periods 2 and 3—can be deduced from Panel E, which plots the capital–labor ratios in each of the two periods, as functions of the level of immigration. In both period 2 and period 3, the capital–labor ratio falls as M is increased. The declines, though, are less than proportional to the increases in M—aggregate savings in both periods (hence the capital stocks K_2 and K_3) are rising with M, but not by enough to maintain the original capital–labor ratios in the two periods. With our Cobb–Douglas technology, this leads to higher marginal products of capital and lower marginal products of labor in each of the two periods. Thus, as M increases both r_2 and r_3 rise, whereas w_2 and w_3 fall.

The lifetime utilities of some representative natives in this economy are shown in Panels B, D, and F along the right side of the figure. Panel B shows the utility of the poorest native, which declines monotonically as M increases. Poorer natives rely more heavily on their labor income, and consequently suffer as immigration drives down the returns to labor in periods 2 and 3. Even though the tax rate—and associated transfer payment—are increasing with M, this increased redistribution is not sufficient to outweigh the loss in poorer natives' wages. By contrast, the utility of a relatively wealthy native, shown in Panel F, rises monotonically with M in this case, in spite of the higher tax rate. The wealthy native here is endowed with the level of initial wealth that defines the top 1% of the initial wealth distribution. The relatively rich agents prefer higher levels of immigration because it raises the marginal product of capital, and therefore raises their capital income.

The preferences of the median native—the native with the median holding of initial capital—are shown in Panel D. For this distribution of initial wealth, the median native is poorer than average, though not greatly so—the median native's initial capital holding is about 68% of the average initial capital holding. Still, the median is reliant on labor income to a sufficient extent that his or her utility falls as M increases. Were the figure extended rightward, though, this decline would begin to "bottom out" around $M = 0.50$, or an influx of immigrants equal to 50% the size of the native population. Nonetheless, over the interval 0 to 0.25, the median's preferred level of immigration is zero.[19]

[18] This is apt to happen as well when the distribution of initial capital holdings is composed of a finite number of types (e.g., two types of natives: rich natives with capital k^r and poor natives with capital k^p), or if there is a large mass of natives who hold the median quantity. What all these cases have in common is that a large influx of immigrants leads to only a small decrease, or no decrease at all, in the initial capital holding that identifies the median agent in period 2.

[19] A general feature of the closed version of the economy studied here is that so long as a native is endowed with *some* amount of capital, however small, there is a level of immigration, sufficiently large, that that native will prefer to zero immigration. If a large enough quantity of complementary labor is added to the economy, the increase in the value of even a poor native's capital will eventually

Note, too, that whereas the median native's lifetime utility is falling, his or her second-period income—shown in Panel C—is rising. The same is true of the median native's third-period income as well. As the inflow of immigrants reduces the value of the native's labor endowment and increases the return to saving, this native saves more for the future—and consumes less in the first period—than he or she would have chosen to in the absence of immigration. This example illustrates why it would be inappropriate to measure the effect of immigration on the native population merely by how their incomes change—particularly their labor income. Within the context of such a dynamic environment, to calculate the true impact on welfare, it is important to measure how both factor prices and agent's decision rules change in response to the immigration.

In this example all agents prefer either the maximum or minimum allowable level of immigration, with a majority—those at or below the median level of initial capital—preferring zero immigration. This "polarization" of natives' preferences is a result also found by Benhabib (1996) in studying this same issue. The reason for this is straightforward: Agents who rely primarily on labor (respectively capital) income will support (oppose) raising the capital–labor ratio through immigration because of its effect on factor prices. Hence, a randomly chosen native is likely to choose one of the extreme policies. Also, for an agent who holds *any* amount of capital, there is some amount of immigration (however large) that he would support because it would increase the capital–labor ratio by enough, and therefore raise the return to capital and offset the resulting fall in labor income.

However, there are other examples of the present model in which many agent's preferences are single peaked over an interval $[0, \bar{M}]$, with interior maxima over that interval. However, in some of these instances it helps to have a rather large upper bound on the level of immigration.[20]

Additionally, it should be noted that one should not interpret the benchmark model—with no capital mobility—as implying that there should be no observed immigration into the United States. In actual economies, politically powerful interest groups, such as the agricultural lobby, can exaggerate the influence that certain voters can have on policy outcomes. Also, improved capital mobility induces the median voter to desire more immigration. Experimentation with the benchmark model reveals that the median resident voter will prefer immigration if the immigrants have even a small amount of capital (i.e., enough to put them above the bottom 1/10th of 1% of the initial wealth distribution). This seems quite plausible,

offset the decline in the value of that native's labor endowment. Realistically, though, before that point is reached there are other consequences to immigration—e.g., congestion effects or "cultural" effects—that would come into play and are not present in our model. Our upper bound of $M = 0.25$ is already at the edge of historical experience for almost all countries.

[20] There are other instances with an interior optimum in which the native population consists of a two-point distribution, and in which the upper bound on potential immigration ($\bar{M}$) is so big that an immigrant can potentially become the median voter in the subsequent period. Interior optima can also be found if there are some other forces, such as congestion effects, that increasingly mitigate against the positive impact of immigration. Finally, interior optima can exist even for the benchmark model for moderate levels of capital mobility ($\lambda \approx 0.10$), for low values of the discount factor (β), if the immigrant's labor productivity is not as high as that of the natives.

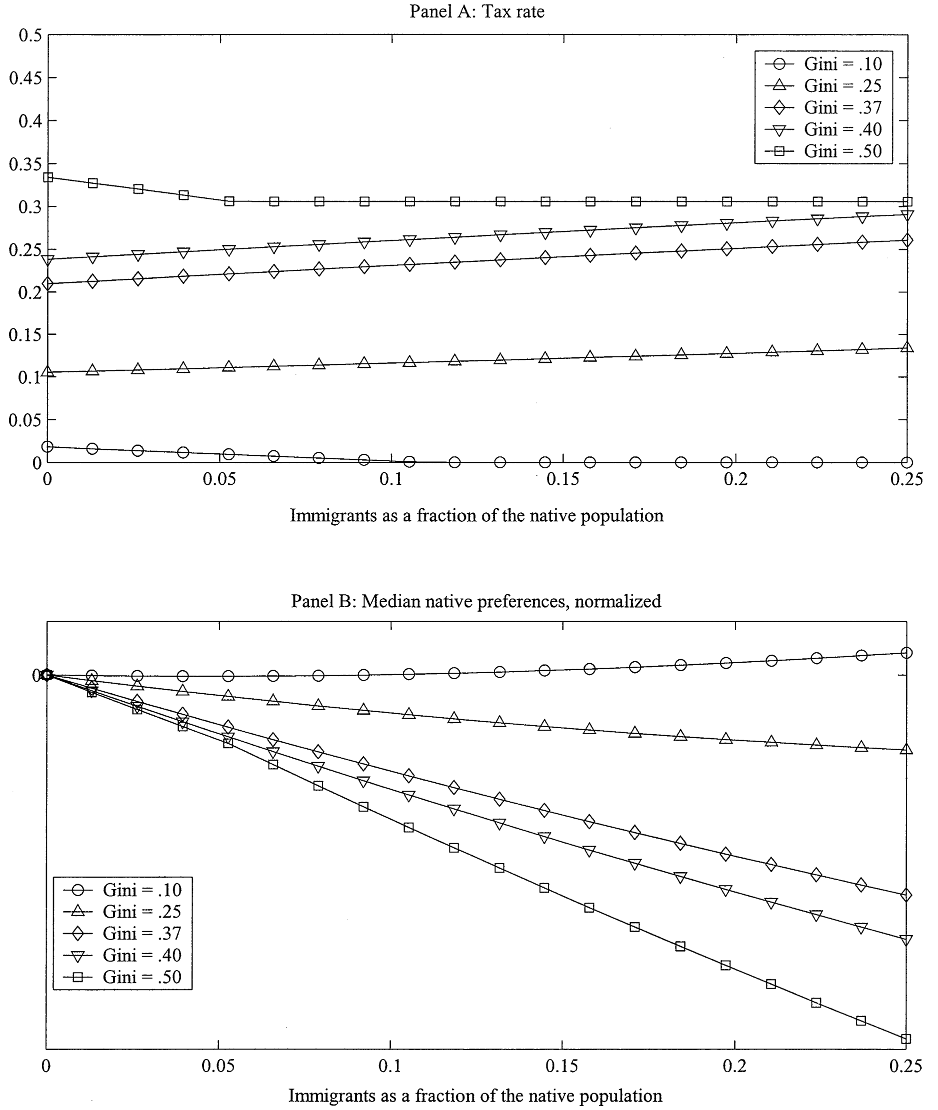

FIGURE 2

RESULTS FOR DIFFERING DEGREES OF INEQUALITY

since although the United States takes in large numbers of relatively poor immigrants, it also is the recipient of a considerable number of skilled professionals from all over the world.

4.2. *The Effect of Changing Inequality.* The two panels of Figure 2 illustrate how the behavior of the benchmark economy changes as we vary the degree of inequality in the initial distribution of capital among natives. Panel A shows the behavior of the tax rate for four different degrees of initial wealth inequality, as measured by the distributions' Gini coefficients.[21] The different degrees of initial wealth inequality affect both the level of the tax rate at zero immigration and the behavior of the tax rate for positive values of immigration. The tax rate corresponding to a Gini coefficient of 0.37 simply replicates the benchmark case shown in Panel A of Figure 1. For a lower degree of initial wealth inequality—a Gini of 0.25—the tax rate at zero immigration is roughly half of its corresponding value in the benchmark economy. With lower initial wealth inequality, the resulting degree of inequality in second-period incomes is also lower, hence the gap between median and average second-period incomes smaller, and so the impetus for redistribution tempered. As in the benchmark case, the tax rate in the 0.25–Gini economy rises with the level of immigration, though more slowly. At a more extreme degree of low inequality—a Gini of 0.10—the tax rate actually *declines* as immigrants are added to the economy, falling quickly to zero near $M = 0.10$. In this case, average income in period 2 initially falls more sharply with the increase in M than median income in period 2, to the point where—near $M = 0.10$—average income falls below median income, and the period-2 median voter prefers a zero tax rate.

With a higher degree of inequality the tax rate is high because the relatively poor median voters in period 2 vote to extract income from the richer agents, irrespective of the size of the immigrant population. With enough initial wealth inequality—in this case a Gini coefficient of 0.50 —the median of the initial capital distribution is so far below the mean that natives at or below the median do not have positive savings for period 2, so the median voter over tax policy is an agent with only labor income regardless of the level of immigration. The preferred income tax rate for such an individual is roughly 31%.[22]

Panel B of Figure 2 illustrates how the preferences of the median native change as the degree of initial wealth inequality changes. Since we are holding fixed average initial capital, the initial capital level held by the median native falls as the degree of inequality increases. Consequently, to facilitate comparability we have normalized the median native's utility by a constant so that the median's utility in each case is zero at zero immigration. The important feature of Panel B is that, as the degree of initial wealth inequality varies from high inequality to low inequality, the median native's distaste for immigration lessens, and is in fact reversed—when the initial wealth distribution is characterized by a Gini coefficient of 0.10, the median native prefers the maximum level of immigration to zero immigration.[23] Since any native with initial capital at least as great as the median also prefers $M = 0.25$ to $M = 0$, at least 50% of the natives in the

[21] In these experiments, we hold constant the mean initial capital holding and the minimum initial capital holding.

[22] In this case, at all values of M the ratio of median to average second-period income is simply labor's share of national income, or $1 - \alpha$. In this case, raising the tax rate even higher does not raise the wage of labor in the last period because it deters investment in capital.

[23] The same pattern arises if we instead hold fixed the median level of initial wealth and allow the mean to change as the degree of inequality changes.

low-inequality economy prefer the maximum level of immigration. If we compare the behavior of this low-inequality economy with the otherwise identical benchmark economy, the two will have sharply different politico-economic equilibria—$M = 0$ and a roughly 21% tax rate in the benchmark economy versus $M = 0.25$ and a zero tax rate in the low-inequality economy.

The basic mechanism at work here is the following. For a fixed average initial endowment of capital, a higher degree of inequality translates into a lower median level of initial capital, relative to average. This has the effect of making the median native more reliant on his or her labor income in periods 2 and 3, hence more averse to immigration. The opposite is true as the degree of inequality is reduced.[24]

4.3. *The Effects of Capital Mobility.* In this section, we examine the consequences that international capital mobility can have for the behavior of this economy.

4.3.1. *Perfect capital mobility.* The model is sufficiently rich that it is difficult to obtain many conclusive analytic results. One exception is the case where there is perfect capital mobility, the case where the adjustment cost parameter λ is equal to zero. The results can be summarized by the following proposition:

PROPOSITION 1. *If $\lambda = 0$, then $\theta = 0$, and this is the preferred tax rate of all citizens voting in the second period. We then have that $r_2 = r_3 = 1/\beta$ and $w_2 = w_3 = (1-\alpha)A(\alpha\beta A)^{\frac{\alpha}{1-\alpha}}$, all independent of M. Consequently, all initial natives are indifferent about the level of immigration.*

PROOF. See the Appendix.

This result holds independent of the nature of the initial distribution of capital, and independent of the parameter values used for preferences and technology.[25] The reason for this is fairly intuitive. With no adjustment cost, the supply of foreign physical capital is perfectly elastic at the time preference rate $1/\beta$, so equilibrium demands that r_2 and $(1-\theta)\,r_3$ equal $1/\beta$. With the after-tax return to capital in period-3 thus fixed, labor bears the full incidence of any tax imposed, and so, in a sense, redistribution is pointless. All agents thus prefer $\theta = 0$, implying $\tau = 0$ as well. With $r_2 = r_3 = 1/\beta$ and our constant-returns technology, the capital–labor ratios in periods 2 and 3 are fixed independent of M, as are the returns to labor w_2 and w_3. Since immigrants then impose no costs on residents—nor do they confer any benefits—the economy's natives are indifferent about the level of immigration. In this case, in effect, each additional immigrant is accompanied by precisely enough physical capital to "correct" the depressing effect that the

[24] It is worth noting that there is nothing special in this example about the lognormal distribution of initial capital. The effects that changes in inequality can have on the results are robust to all distributions that we have analyzed. See Dolmas and Huffman (1997a).

[25] This result is similar to that developed by Obstfeld and Rogoff (1996, Chapter 7), who study the steady-state properties of a slightly different model.

immigrant has on native wages and the positive effect that the immigrant has on the return to capital. Presumably, this result would change if there were some direct costs to immigration (e.g., congestion costs or perhaps administrative costs associated with processing the new immigrants) that were borne by the initial residents. The result would also change if the production technology were not constant-returns-to-scale in capital and labor, or if a nonreproducible factor such as land was present.

4.3.2. *Limited capital mobility.* What happens when there is less-than-perfect capital mobility? In this section, we compare the results from our benchmark case where capital is immobile ($\lambda = +\infty$) with results for economies with some degree of capital mobility. For the cases with some degree of mobility we consider $\lambda = 0.10$ and $\lambda = 0.05$.[26] Although we will not illustrate this in detail, as λ approaches zero, all the results approach the ones described above for the case of perfect capital mobility.

Figure 3 illustrates the effects of alternative levels of capital mobility. Panel A shows the behavior of the third-period tax rate, which both declines at each value of M as capital mobility increases and becomes less responsive to changes in M the greater degree of capital mobility. Of course, the tax rate must ultimately fall to zero at all values of M as $\lambda \to 0$.

In general, the effect of capital mobility on the equilibrium tax rate is complex—in particular, the presence of foreign physical capital complicates the direct link between the level of the tax rate and the ratio of second-period median to average income that obtains in the closed-economy case. The effects of changing the degree of capital mobility are occasionally nonmonotonic as well. In a number of economies we examined, as we increased the degree of capital mobility (i.e., lowered the value of λ from $\lambda = +\infty$), economies that started with very low tax rates over the interval of M values experienced—initially—higher tax rates at some or all values of M, before the taxes eventually fell again.

The preferences of the median voter over the level of immigration, shown in Panel B of the figure, are always decreasing in the level of immigration. However, they are decreasing much less sharply the greater the degree of foreign capital mobility—i.e., the smaller is λ. This is what one would expect, given that in the limit, as $\lambda \to 0$, we must approach indifference over the value of M for all natives in the economy. In other words, the median native dislikes immigration, but the effects of immigration can be ameliorated substantially by the importation of capital.

This result suggests that governments may be able to curtail opposition to immigration by also adopting policies to attract capital. In our model economy, the capital–labor ratios in both production periods, at each level of M, are higher with greater capital mobility than with less mobility. Consequently, the effects of immigration on factor prices are less pronounced the greater the degree of capital

[26] We experimented with various values of λ. It turns out that the behavior of this economy for values of λ as low as $\lambda = 0.20$ is quite close to the behavior of the economy with no capital mobility at all ($\lambda = +\infty$).

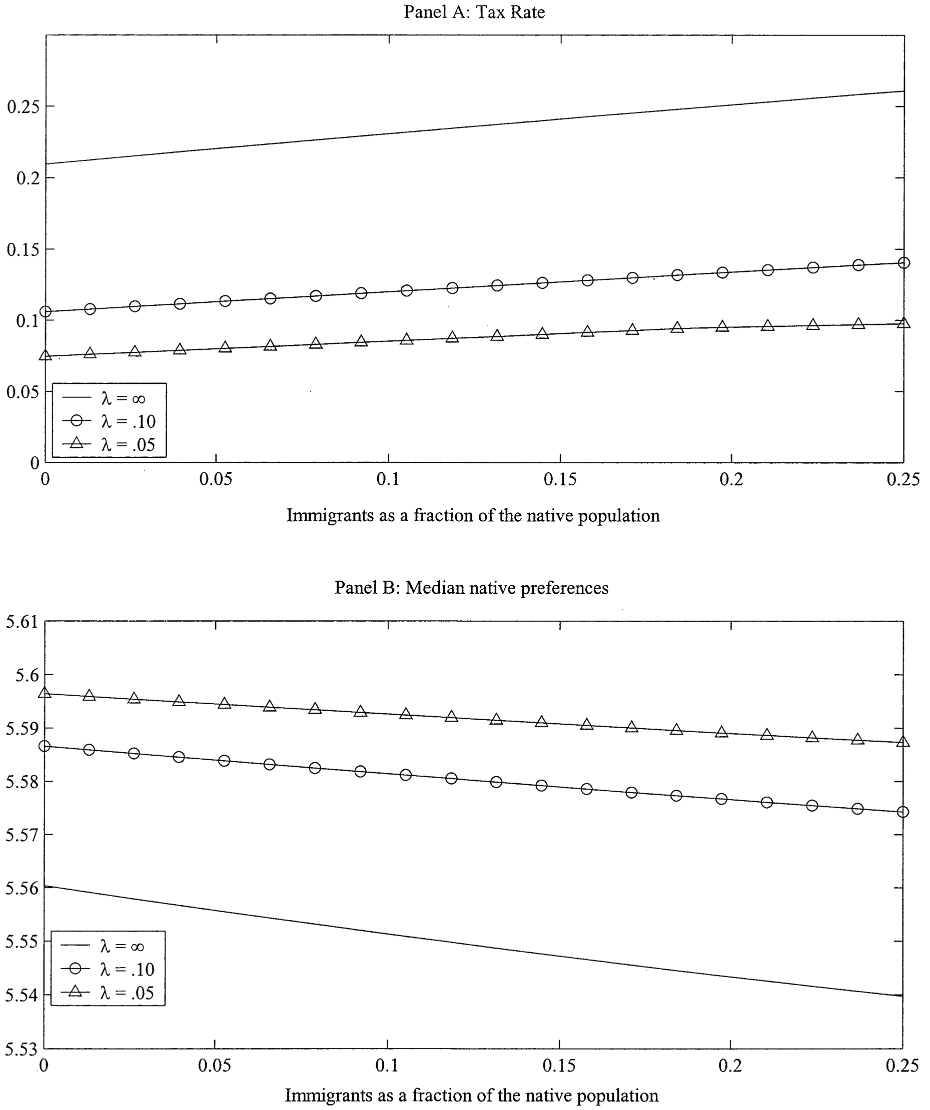

FIGURE 3

RESULTS FOR DIFFERING DEGREES OF CAPITAL MOBILITY

mobility. As a result, capital-poor natives suffer less from immigration when there is greater international mobility of physical capital. Of course, capital-rich natives benefit less from immigration as well.

4.4. *Alternative Assumptions on Immigrants' Voting Rights, Endowments, and Entitlements.* In the experiments of this section, we consider the effects of different assumptions about immigrants' voting rights, their wealth or poverty upon arriving, and their entitlement to government transfer payments. Each of these cases has some relevance from an empirical public policy standpoint. In most countries, voting rights are granted to immigrants only as the culmination of a lengthy process of naturalization. Some countries as well have adopted policies that attempt to alter the composition of their immigrant inflows in ways, that favor immigrants with large amounts of capital.[27] Finally, the view that immigrants represent a drain on public services such as welfare and education, and perhaps ought to be excluded from these services, is prevalent in policy debates over immigration both in the United States and elsewhere.

In each of the examples below, we report two sets of results, one for the closed-economy case of no capital mobility ($\lambda = +\infty$) and one for the case of limited capital mobility ($\lambda = 0.10$). The results for all of the experiments are contained in the panels of Figure 4.

4.4.1. *Disenfranchised immigrants.* First of all, we compare the behavior of our benchmark economy to one in which immigrants are not permitted to vote over fiscal policy, but still pay the tax and receive the transfer τ. The key feature of this regime is that the median voter over tax policy in period 2 is the median native regardless of the level of immigration allowed in period 1.

The top two panels of Figure 4 show the behavior of the third-period tax rate and the preferences of the median native when the economy is closed to foreign capital ($\lambda = +\infty$). In this case, as indicated by the "Δ" symbol, when immigrants are disenfranchised, the third-period tax rate falls as immigrants are added. If immigrants are not permitted to vote in the second period, the population voting over tax policy for period 3 consists solely of natives, and the tax rate is set according to the preferences of the native with the median level of initial capital. In this case, the second-period income of the median native is increasing in M (just as in Panel C of Figure 1), and consequently, this individual would choose lower tax rates at higher values of M. The effect that disenfranchisement of immigrants has on the median native's utility, shown in Panel B, is less pronounced. Compared to the benchmark case, the median native's utility at each level of M is slightly higher, but this individual—and 50% of the native population with lower initial endowments of capital—would still opt for $M = 0$ even if immigrants are disenfranchised. This is reminiscent of a similar result found in Cukierman et al. (1997).

In economies with lower degrees of initial wealth inequality, where the median native is relatively wealthier, it is possible for the disenfranchisement of immigrants to alter the equilibrium immigration outcome—i.e., other things the same, taking voting rights away from immigrants moves the median native's preferred level of immigration from $M = 0$ to $M = \bar{M}$. When inequality is low, and the median native is wealthier, the countervailing factor price effects of immigration on his

[27] For example, the U.S. immigration legislation of 1990 created a visa category specifically for investors who create jobs. However, the nearly 10,000 visas per year allocated to this preference category have gone largely unutilized. Figures for this category are detailed in the U.S. Immigration and Naturalization Service's 1999 Statistical Yearbook (United States Immigration and Naturalization Service, 2002).

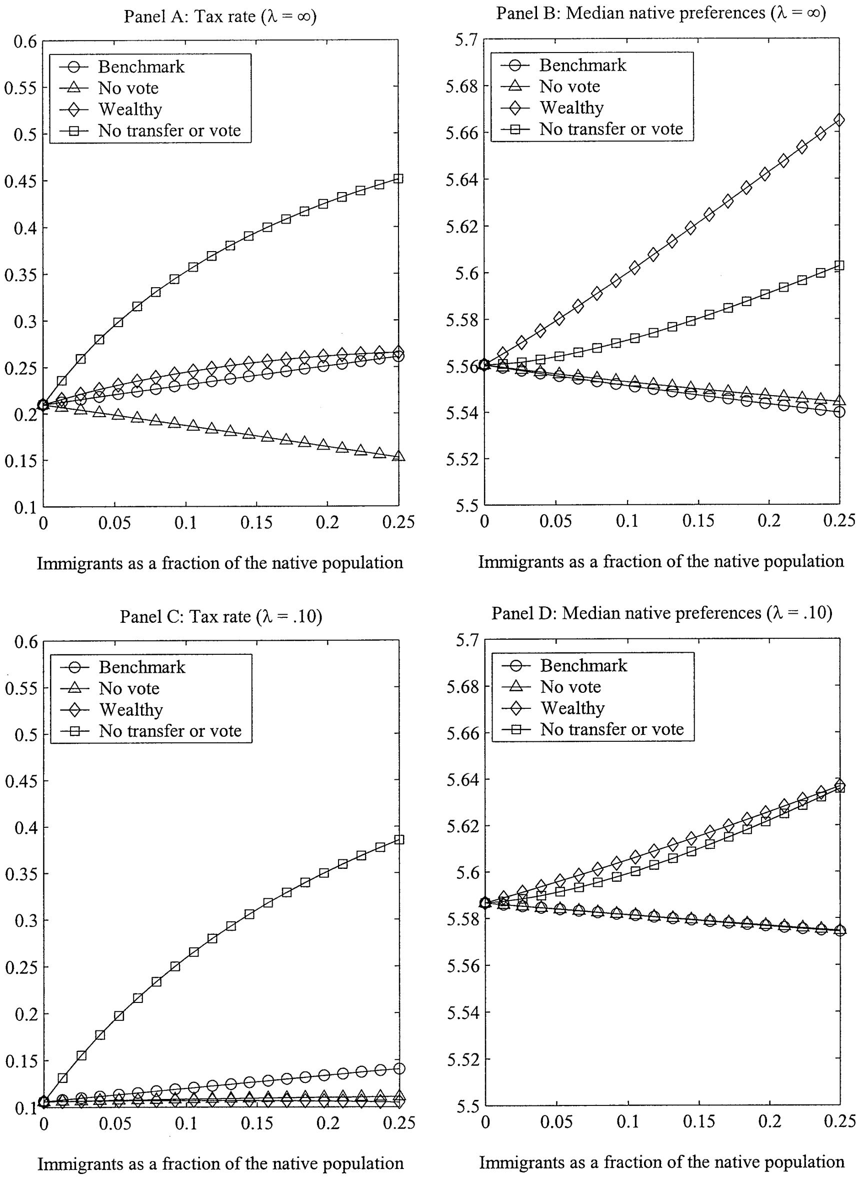

FIGURE 4

RESULTS UNDER VARIOUS REGIMES

or her utility are more offsetting, making the fiscal consequences of immigration more important.

When we allow for limited capital mobility, the third-period tax rate—chosen by the median native when immigrants are disenfranchised—is no longer decreasing in M, but is still considerably lower at positive values of M than it would be were immigrants permitted to vote. The preferences of the median native in the limited-capital-mobility case, shown in Panel D, are even more similar across the two enfranchisement regimes than in the closed-economy case shown in Panel B. This is to be expected, as inflows of foreign capital dampen the changes in factor prices engendered by immigration. As in the closed-economy case, the median native here prefers $M = 0$ regardless of whether immigrants are permitted or barred from voting over redistribution.

Regardless of whether there is no capital mobility or limited capital mobility, the preference for high immigration of wealthier natives (not shown) is significantly stronger when immigrants are not permitted to vote, due to the lower taxes that result when immigrants are disenfranchised.

4.4.2. *Wealthy immigrants.* We now suppose that immigrants, instead of being endowed with only labor to supply—hence coming in at the bottom of the second-period income distribution—are endowed with capital as well. In particular, we consider a case where each immigrant arrives with an amount of capital that would place them at the cutoff for the top 20% of the initial distribution of capital among natives.[28]

We first consider the closed-economy case. Panel A of Figure 4 again shows the behavior of the tax rate for the $\lambda = +\infty$ case. The tax rate when immigrants arrive wealthy is shown by the "◇" line in the panel. Relative to the benchmark economy (shown by the "◯" line), the tax rate at all positive values of M is slightly higher, when immigrants arrive with capital, and is still increasing in the level of immigration. When immigrants come with substantial wealth, the initial capital holding identifying the second-period median voter now *rises* with M. Although the increasing wealth level and second-period income of the median voter would seem, other things equal, to lead to decreasing tax rates, *average* period-2 income—which can be viewed as a measure of the tax base—is increasing even more sharply. Hence, the equilibrium tax rate is still *increasing* as a function of M.

Although the fiscal consequences of immigrants' wealth seem small, whether immigrants are poor or wealthy does make a great deal of difference for the preferences over immigration of the median native. When immigrants are wealthy and capital is immobile, the median native now prefers the maximum level of immigration. Although we do not show the preferences of other agents in the economy, in this case all natives *poorer* than the median also prefer the maximum level of immigration, as immigrants now raise, instead of lower, the return to labor. Of course, coming with capital, immigrants also lower the return to capital in the economy, which harms the natives at the upper end of the initial capital distribution.

If we allow for limited capital mobility, the effect of immigrants' wealth on natives' preferences does not change much—as Panel D shows, we still move from a situation where the median native prefers zero immigration (when immigrants

[28] This is especially interesting given the apparent differences in the immigration policies of Canada and the United States. The United States, until very recently, seems to have given little consideration to the skills or wealth levels of immigrants, whereas Canada gives these factors substantial weight, and has been criticized for selling citizenship.

are poor) to one in which the median native prefers the maximum level of immigration (when immigrants are rich). The behavior of the tax rate shown in Panel C is quite different from what is shown in Panel A. What is happening here is that as more wealthy immigrants enter the economy, this depresses the rate of return to capital. Because capital is mobile, other capital then *leaves the economy*. The tax rate then is lower in this case (compared with the $\lambda = +\infty$ case) to partially counteract this effect and ameliorate the outflow of capital.

4.4.3. *Immigrants without entitlements.* Another experiment that is of interest is to investigate what happens when immigrants, who have no initial capital, can enter the economy and must pay taxes, but do not get to vote, and do not get the resulting transfer (τ). This if of interest since many people seem to view the problem with immigration to be that the immigrants will subsequently become a drain on public services such as welfare or education. The model indicates that in this instance apparently all initial residents favor the maximum level immigration. The reason is simple: Natives now view the immigrants as a tax base that can be exploited and that does not receive its share of the transfer. Because of this, the residents, despite being relatively rich, now favor *much higher levels of taxation* so that they can exploit this immigrant population.

The tax consequences of this modification are apparent from Panels A and C. When immigrants are disenfranchised and barred from receiving the transfer, any level of immigration decided in period 1 leads to sharply higher taxes as compared with the benchmark economy. The cases of no capital mobility and limited capital mobility are distinguished only by the somewhat lower tax rates that obtain when capital is mobile—roughly 35% when $M = 0.25$ in the $\lambda = 0.10$ case versus over 50% when $M = 0.25$ in the $\lambda = +\infty$ case.

As Panels B and D show, the median native has a strong preference for $M = 0.25$ in this case, regardless of whether capital is immobile or mobile. Although we do not report the preferences of other natives, we find that all natives share the median native's preference in this case—the poorer natives in spite of the lower wages that result and the wealthier natives in spite of the higher taxes that result.

These results suggest that apparent opposition to immigration may in fact not be disapproval of immigration per se, but instead might be opposition to the benefits that immigrants will subsequently receive after having emigrated.

5. EMPIRICAL EVIDENCE

The model makes several predictions about the economic impact of immigration and the factors that influence immigration policy. This section briefly reviews some empirical evidence regarding those predictions.

5.1. *Factor Price Effects.* First, an important part of the basic mechanism at work in the model is that immigration affects initial residents through its effect on factor prices—i.e., by lowering wages and raising returns to capital, as in our benchmark model. As regards wages, there is a great deal of research that supports this view. In a series of papers Borjas et al. (1992, 1996) show that immigration (as well as international trade) into the United States has lowered the relative wages of unskilled workers. The report by the National Research Council (1997) also supports this view. Topel (1994) also demonstrates that this negative effect on wages of natives is more pronounced in the western part of the United States. Topel estimates that immigration of unskilled workers reduced the wages of unskilled natives by about 10%. In fact, Topel states that once regional factors are taken into consideration, the evidence indicates that immigration may have had a *large* impact on wage inequality. Examining much earlier city-level wage and immigration data for the United States, covering the period 1890–1923, Goldin (1994) finds a "generally negative and often substantial" effect of immigration on the wages of laborers. There has been other research (namely Card, 1990) that claims to find little effect of immigration on wages. However, more recent work (Borjas, 1995, 1999) has shown why even when immigration does have an important negative impact on wages, this effect may appear to be so muted in an aggregate economy that it is difficult to measure unless adequate controls are employed.

For the United States, there is also some evidence that, regardless of what the true effect of immigration on wages is, natives' voting preferences reflect a belief that immigrants do depress wages. In an interesting empirical study of individual preferences over immigration, which uses data from the 1992 National Election Study survey, Scheve and Slaughter (2001) find that less-skilled workers are significantly more likely to prefer limiting immigration flows into the United States, even controlling for factors other than skill level that might influence individual preferences. In particular, they find no evidence that less-skilled workers are especially anti-immigrationist per se. They interpret their results as suggesting instead that "over time horizons relevant to individuals when evaluating immigration policy, individuals think that the U.S. economy absorbs immigrant inflows at least partly by changing wages."

There is also an abundance of evidence to support the contention that other factor prices are affected by immigration. For example, in a comprehensive analysis of immigration patterns, Martin and Olmstead (1985) state that land prices in the United States are between 10% and 20% higher because of the expected availability of immigrant workers. Given the strong political influence that some farm states can exhibit, this can translate into a nontrivial effect on actual policies.

5.2. *Fiscal Consequences.* A second important feature of the model is the fiscal mechanism whereby immigrants can obtain resources or benefits that may come at a cost for some natives. This view is also supported by the research of the National Research Council (1997). On the fiscal consequences of immigration, MaCurdy et al. (1998) summarize a very disparate literature that points to the conclusion that immigrants are a net economic drain on the resources of the government.

5.3. *The Role of Inequality.* Third, we saw in Section 4 that the model implied that economies with lower degrees of wealth inequality should be more open to immigration. The link between inequality and openness to immigration is supported strongly by the work of Timmer and Williamson (1998), who study the determinants of immigration policies adopted by the major "New World" recipient countries in the late 19th and early 20th centuries. They find the most consistently significant determinant of the openness of immigration policy to be the ratio of the wage of the unskilled to income per capita. Moreover this variable has the correct sign: higher wages for those at the bottom of the income distribution, relative to average income, correspond to more open immigration policies.[29] It is worth noting that the relationship that Timmer and Williamson document is between a measure of inequality and a numerical index of the restrictiveness of immigration policy, instead of flows of immigrants. Flows can vary across countries for a number of reasons, not least being differences in the "supplies" of immigrants to different countries.

That being said, there *is* a correlation between measured inequality and inflows of immigration. This correlation is illustrated in Figure 5, which plots the quantity of long-term immigration, as a fraction of total population, against the level of inequality, as measured by the Gini coefficient, for a large group of countries.[30] There is a significant negative correlation (−0.46) between these two variables. This is consistent with our model, though by no means conclusive, as we have not attempted to control for variation in the supply of immigrants to each of the various countries.[31]

This characterization of the data does not rule out the possibility that immigration itself may be influencing inequality—i.e., that causality might be running from immigration to inequality in Figure 5. Although this is certainly possible in principle—and may in fact have been true during episodes with much larger immigrant flows, such as the period and countries considered by Timmer and Williamson—it seems far from likely in regard to the sample shown in Figure 5. First of all, the immigrant flows depicted in Figure 5 are probably too small to have any appreciable impact on inequality, at least as measured by the Gini coefficient. To illustrate this point, consider the following numerical "thought experiment": Imagine an economy with an initial income distribution that is lognormal, and consider adding a mass of relatively poor immigrants. For an immigrant–native average income gap ranging from 30% to 50% and initial Gini's ranging from 0.25 to 0.50, an influx of immigrants even as large as 25% of the initial population would

[29] See in particular their Figure 2, p. 750.

[30] The Gini coefficients are derived from a data set published by the World Bank (Deininger and Squire, 1996). The data on long-term immigrants are from the United Nations (1991). We look at long-term immigrants to avoid other flows such as tourists. Obviously, these must then be normalized by population to adjust for country size. The set of countries included in Figure 5 represents the intersection of the set of countries for which we have long-term immigration data and the set of countries that have "acceptable" inequality data, as determined by Deininger and Squire. The immigration data are discussed in greater detail in footnote 32 below.

[31] This relationship would be even tighter if Australia were excluded. It is an apparent outlier for interesting reasons. During Australia's gold rush, the Immigration Restriction act of 1901 was enacted that excluded non-European immigration. This act was not repealed until 1971, and since then they have been making up for lost time, since over 50% of current immigrants arriving in Australia are from Asia (see Martin, 1996). Parenthetically, Canada's historical policies have not been substantially different: until 1967, 99% of all Canadian immigrants were of European origin. However, by the year 2000 it is expected that 18% of all Canadians will be "visible minorities."

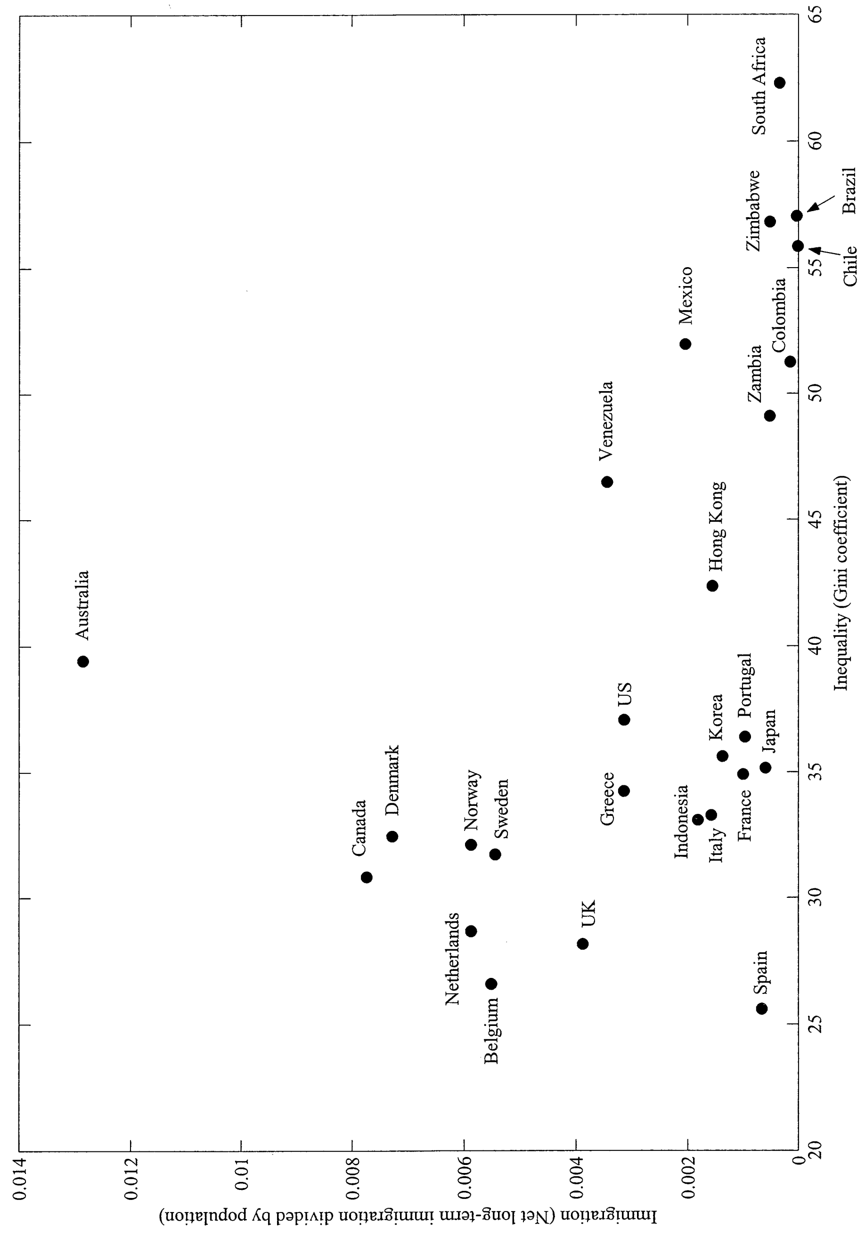

FIGURE 5

DATA ON IMMIGRATION AND INEQUALITY FOR A CROSS SECTION OF COUNTRIES increase the economy's income Gini by at most 0.02. For some combinations of parameters, the Gini coefficient will actually *fall* as immigrants are added—which is to be expected, given that we are adding a homogeneous mass to the income distribution. For example, the amount of immigration for the United States averages less than one-half of 1% of the population over this period; in the numerical experiment described above, an inflow of that magnitude would increase the economy's Gini coefficient by no more than 0.002.

The sort of numerical experiment just described does not take into account the general equilibrium effects of immigration. To get some sense of how these additional effects can impact inequality, we can turn to our model. In our model economy it turns out that there is only a small—and ambiguous—relationship between inflows of immigrants and income inequality. In our benchmark case—where the distribution of initial native income has a Gini coefficient of 0.37—the Gini coefficient of the second-period income distribution declines slightly as M increases. In the low-inequality case—with an initial Gini of 0.25—increasing M from 0% to 25% of the size of the initial population raises the second period Gini by less than 0.01.

It's important to note that the tax policy effects of immigration, which we examine, rely on movement in the ratio of median-to-mean income, not inequality per se, or Gini. In the benchmark model, although the second-period income Gini falls with increases in M, the median mean income ratio also falls (from about 81% to 75%) and the period-3 tax rate rises (from 21% to 26%). In the low-inequality case, Gini rises by about 0.008 whereas the median–mean income ratio falls by 2.5% points and the tax rate rises from 10.5% to 13.5%.

5.4. *Capital Movements.* Another implication of the model is that with capital mobility between countries, the countries that receive plenty of immigration would also be importing capital. Now it must be granted that there are a multitude of factors that determine which countries are the recipients of foreign investment (i.e., technology, taxes, property rights, and human capital, to name only a few). It would be surprising if the primary determinant of international capital flows was merely the abundance of labor. Nevertheless, it is instructive to see if there is any relationship at all. Table 1 shows a few regressions that characterize the relationship between foreign direct investment and immigration for 1985 and also for 1990. Here, α represents the intercept term, whereas β is the slope coefficient. In these simple regressions (using OLS) the dependent variable is foreign direct investment expressed as a percentage of gross domestic product, and the independent variable is a measure of immigration, expressed as a percentage of population, during the period 1980–95.[32]

[32] In particular, the data on Foreign Direct Investment, as a share of GDP, are derived from the United Nations (1998b). These data are available for both 1985 and 1990. The data on immigration are derived from the United Nations (1991, 1998a). The data are constructed by taking the average annual quantity of "long-term immigrants" and dividing it by the average annual population for the same years. The use of "long-term immigrants" is intended to capture the number of people who might be emigrating and seeking employment, and to avoid counting such people as tourists, temporary business travelers, and those seeking education. These data are somewhat spotty in that they are not

TABLE 1

	α	β	R^2	Sample Size
For 1985 data	8.05	1109.58**	0.165	21
	(3.44)	(1.94)		
For 1990 data	9.61	1598.92**	0.215	21
	(3.36)	(2.28)		

NOTES: Dependent variable is the ratio of foreign direct investment to GDP, and the independent variable is the ratio of long-term immigrants to population; *t*-statistics are in parentheses.
** indicates significance at the 95% level.

Table 1 shows the statistical relationship for the countries whose population exceeded 10 million during the sample periods. As can be seen in the table, there is a significant positive relationship between immigration, as measured by long-term immigrants, and foreign direct investment, for both sample periods. When we evaluate this relationship using the data from all available countries, the relationship is still positive, but not significant. This might indicate that the other factors that have an important influence over foreign investment can overwhelm the effects suggested in this article for very small economies.

Additionally, there is ample anecdotal evidence on this point. Until recently, the economies of both Singapore and Malaysia had been growing at approximately 9% per year for a sustained period of time, primarily by importing large quantities of both labor and capital.[33] Martin (1996) states that in the early 1990s nearly 7% of the GDP in Malaysia was attributable to foreign direct investment. Our own calculations reveal an even higher number for Singapore in the 1980s. Furthermore, it is well known that there have been large amounts of both Asian capital and labor imported into the Vancouver region of Canada for the past 10–15 years, with a concomitant escalation in real estate prices.

Of course, this loose characterization of the data is rather descriptive and suggestive. Of course, this by itself does not guarantee that capital movements are responding to the movements in labor, instead of the other way around.[34] However, there does not appear to be any existing empirical evidence that suggests this relationship. Additionally, capital appears to be a much more mobile factor than is labor, leading one to conclude that it is more likely (and able) to follow the labor.

6. FINAL REMARKS

The model that we have constructed and studied is unique in that it attempts to explore both the general equilibrium factors that can influence an economy's

reported for a number of countries, and even for those countries for which they are reported, they are not available for all years. We then compute these averages for the years for which it is available. We have also excluded members of the old Eastern Bloc since it could not be said to have had open immigration until recently.

[33] See Martin (1996). As much as 70% of the jobs in the construction sector in Malaysia are taken up by foreign workers.

[34] With the very limited data that we have, there does not seem to be any way to test for this occurrence.

immigration policy decision, as well as the effects arising from the interaction of immigration and the determination of other domestic policies—in particular, how the immigration decision will influence the future distribution of income in the economy, and therefore how this will *influence future fiscal policies*. The preferences of natives over the quantity of immigration take into account both of these sets of consequences. Immigration in one period will affect factor prices in subsequent periods in ways that benefit the relatively capital rich and harm the relatively capital poor, if immigrants are themselves capital poor. When immigrants are enfranchised to vote over subsequent fiscal policy, the model implies that natives must take into consideration how the level of immigration in the current period affects the identity of the median voter over subsequent redistributive taxes and transfers.

In this article we have studied an extremely streamlined model in which agents can vote on one redistributive policy parameter, the tax rate θ, which ultimately determines the level of the transfer τ. In reality, there are a plethora of government policy variables and programs that can be used to transfer capital from one group of people to others.

Our model also shows how native residents' preferences over the quantity of immigration are influenced by various factors, including the degree of domestic income or wealth inequality and the degree of international capital mobility.

Other things equal, increased inequality in the native population leads the median native to be less likely to prefer high levels of immigration, because with higher inequality in the initial distribution of capital, the median native is an individual more reliant on labor income, hence more sensitive to the adverse effects that immigration has on the return to labor. At higher degrees of initial native inequality, immigration leads to higher taxes being chosen by the subsequent median voter who, because of the high inequality, will be relatively poor. As initial wealth inequality shrinks, poorer natives become relatively more wealthy (relative to the average native) and, as a result, more sensitive to the higher return to capital that results from immigration. In our parameterization, if inequality in the initial distribution of capital is low enough, a majority of natives prefer a high level of immigration to zero immigration.

International capital movements can also have a significant impact on an economy's openness to immigrants. In particular, the more mobile is international capital, the less likely is it that natives will be opposed to immigration. This is because, with a constant returns-to-scale technology, equal proportions of capital and labor can be imported, leaving the returns to labor and capital unchanged. We show that, in fact, in a world of perfect physical capital mobility, natives are indifferent with respect to the level of immigration. Increased capital mobility also tends to result in a lower tax rate on income, and this rate approaches zero as we approach a state with perfect capital mobility.

The results here also show why it is inappropriate to study the effect of immigration merely by analyzing the impact on wages or even incomes. In a number of our experiments, natives experience rising incomes in some periods as a result of immigration, but are nonetheless worse off in terms of lifetime utility. This is because the changes in factor prices caused by immigration influence the savings decisions of natives in ways that lead these natives to reallocate resources from earlier to later periods. Incomes in later periods may be higher as a result, but the agents are making trade-offs that they would not make in the absence of immigration.

The model also sheds some light on other factors that influence native residents' desire for increased immigration, including the wealth levels of immigrants, their enfranchisement to vote once admitted, and the extent to which they can be denied subsequent benefits, and yet still be made to pay taxes.

As with any model, the framework studied here has many features missing. In order to focus on the strictly economic factors determining preferences over immigration, we have assumed that immigrants are all identical, and that the only dimension in which they differ from natives is in how much wealth they hold. In another paper (Dolmas and Huffman, 2000) we abstract from international capital movements, but assume that the prospective pool of immigrants can bring capital with them. In this analysis there is a *heterogeneous* pool of potential immigrants. The natives can then choose which immigrants, and how many of them, to admit. In the model, a majority will then wish to admit those immigrants first who have the most capital. It is shown that for "reasonable" parameter values, there can exist multiple steady-state equilibria, with different immigration policies in these steady states. It is the initial conditions that determine which steady state each economy will converge to. This article then lends some insight as to why there may be substantial observed heterogeneity among immigration policies, even among countries that may appear to be similar in many respects.

APPENDIX

A.1. *Proof of the Proposition Regarding Perfect Capital Mobility.* If $\lambda = 0$ then in any equilibrium it must be the case that $\beta r_2 = 1$, and $\beta(1-\theta)\, r_3 = 1$, or else K_i^F would be $+\infty$ or $-\infty$ in some period. Then, in the second period of any agent's life, he must solve the following optimization problem:

$$\max_{s_3} \log(y_2 - s_3) + \beta \log\left(\beta^{-1} s_3 + (1-\theta) w_3 + \tau\right)$$

which gives rise to the following indirect utility function:

$$(1+\beta)\log(y_2 + \beta[(1-\theta)w_3 + \tau])$$

It should be clear from the previous expression that the agent will then choose the tax rate θ to maximize the term $(1-\theta)w_3 + \tau$. Note that this implies that an agent's preferred tax rate is independent of his or her level of income.

Since $\tau = \theta(r_3 K_3 + w_3 L)/L$, it is possible to show that

$$(1-\theta)w_3 + \tau = (1 - \alpha + \alpha\theta) A (K_3/L)^{\alpha}$$

Using $1 = \beta(1-\theta) r_3 = \beta(1-\theta)\, \alpha A (K_3/L)^{\alpha - 1}$, this expression can be written as

$$(1-\theta)w_3 + \tau = (1 - \alpha + \alpha\theta) A [(1-\theta)\, \alpha\beta A]^{\frac{\alpha}{1-\alpha}}$$

Differentiation of this expression reveals that it is concave and maximized when $\theta = 0$.

The remainder of the result follows from the fact that with $\theta = 0$, the condition $\beta r_2 = \beta r_3 = 1$ then obtains, so that $K_2/L = K_3/L = (\alpha\beta A)^{1/(1-\alpha)}$ independent of L. As a result, $w_2 = w_3 = (1-\alpha)\ A(\alpha\beta A)^{\alpha/(1-\alpha)}$, also independent of L. Since taxes and transfers are zero for any M, and factor prices are independent of M, natives' opportunity sets and equilibrium utility levels are independent of M as well. ■

A.2. *Simultaneous Voting over θ and M.* In this section of the Appendix, we provide some analysis of the case in which, at the outset, natives vote simultaneously on the number of immigrants to admit and a redistributive tax policy. Of the various alternative environments that we have analyzed in the numerical examples above, the one to which the results of this section may be sensibly compared is that of Section 4.4.1, in which immigrants were not permitted to vote once admitted.

We first calculate the lifetime utility, and preferred policy, of the median native under the same taste and technology parameters as in our benchmark economy. We then compare the median's preferred policy in this setting to the equilibrium immigration and tax policies obtained in the sequential setting of Section 4.4.1. The only difference that we find under simultaneous voting, as compared to sequential voting, is that the median prefers a much lower tax rate when the issues are decided simultaneously in the first period. The intuition for this result is straightforward—when the tax rate is decided in period 1, the median native takes into account the effect that θ has on the period-2 capital stock, whereas in the sequential case of Section 4.4.1 the median native selects θ taking as given the period-2 capital stock.

Finally, we verify that the policy pair (θ, M) preferred by the median is a (local) majority-rule equilibrium in the sense of Plott (1967): We show that for any native above (respectively, below) the median, and for any small change in policy that raises utility for that native, there is another native below (respectively, above) the median who is made worse off by the change in policy. Thus, there exist no small "motions" away from the median's preferred point that would garner the support of more than half of the native population.

The analysis is carried out for the case in which there is no foreign capital. With the logarithmic preferences and Cobb–Douglas technology that we have specified, tedious algebra reveals the lifetime utility, given θ and M, of a native whose initial capital relative to average initial capital is x, is (up to a constant) given by the following expression:

$$
\begin{aligned}
V(\theta, M; x) = {} & (1+\delta)\log(\alpha x + (1-\alpha+\psi(\theta)\xi(\theta))\Pi(\theta, M)) + \beta^2 \log(1-\theta) \\
& - \beta(1-\alpha)(1+\beta+\alpha\beta)\log(\Pi(\theta, M)) - \beta^2(1-\alpha)\log(\xi(\theta))
\end{aligned}
$$

where we have let $\delta = \beta(1+\beta)$, and have employed the following shorthand:

$$\psi(\theta) = \frac{1 - \alpha(1-\theta)}{\alpha(1-\theta)}$$

$$\xi(\theta) = \frac{\alpha\beta(1-\theta)}{1 + \alpha\beta(1-\theta)}$$

and

$$\Pi(\theta, M) = \frac{\alpha\delta}{1 + \alpha\delta + \alpha(1+\delta)M + \psi(\theta)\xi(\theta)}$$

The functions ψ, ξ, and Π have the following interpretation. The equilibrium period-3 capital–labor ratio is $\xi(\theta)$ times average period-2 income; the present value (in period 2) of period 3's wage and transfer income is $\psi(\theta)$ times the period-3 capital–labor ratio; and, the period-2 capital–labor ratio is $\Pi(\theta, M)$ times average native initial capital.

We can find the preferred policy of any native by maximizing V over $(\theta, M) \in [0, 1] \times [0, \bar{M}]$. For the same taste and technology parameters as in Section 4.4.1, and assuming the same degree of inequality in natives' initial wealth as in our benchmark case, performing this maximization for the median native yields a preferred immigration level of zero, as in Section 4.4.1, and a preferred tax rate of roughly 9.3%. The preferred tax rate in this case is substantially lower than the roughly 21% tax rate (at zero immigration) obtained under sequential voting in Section 4.4.1. This difference in tax rates seems to be due primarily to the fact that, under simultaneous voting in the first period, the median native takes account of the effect that the third-period tax rate has on the second-period capital stock—a higher tax rate reduces natives' incentives to accumulate capital for period 2 as well as for period 3. In the sequential case, the third-period tax rate is set conditional on the levels of income and capital in the second period, whereas those levels are determined by equilibrium considerations, conditional on the tax rate; the actual equilibrium levels of period-2 income and capital and the period-3 tax rate are then determined as a solution to a fixed point problem, as described in the body of the paper and the Technical Appendix (Dolmas and Huffman, 2003).

We now turn to verifying that the median's preferred point is, in fact, a local majority-rule equilibrium. Suppose, then, that the policy preferred by the median native is such that $M = 0$, $\theta \in (0, 1)$ and $V_\theta(\theta, M; x^m) = 0$. Let $(\theta^m, 0)$ denote this policy. We can show that for any pair of natives x' and x'' with $x' > x^m > x''$, there is no small change in policy from $(\theta^m, 0)$ that can make one native better off without making the other native worse off. That is, any deviation that would garner the vote of a native above the median would be opposed by a native below the median, and vice versa.

To see this, note that for any native x,

$$V_M(\theta^m, 0; x) = -\frac{\Pi_M}{\Pi} \times \left\{ \beta(1-\alpha)(1+\beta+\alpha\beta) - (1+\delta)\frac{(1-\alpha+\psi\xi)\Pi}{\alpha x + (1-\alpha+\psi\xi)\Pi} \right\}$$

where $\Pi_M = \Pi_M(\theta^m, 0) < 0$. It follows that there is a critical value of x, call it $\hat{x}$, such that $V_M(\theta^m, 0; x) > 0$ for $x > \hat{x}$ and $V_M(\theta^m, 0; x) < 0$ for $x < \hat{x}$. Since the median's preferred point has $M = 0$, it follows that $\hat{x} \geq x^m$.

Along similar lines—and using the assumption that $V_\theta(\theta^m, 0; x^m) = 0$—one can show with some effort that $V_\theta(\theta^m, 0; x) < 0$ for $x > x^m$ and $V_\theta(\theta^m, 0; x) > 0$ for $x < x^m$. This is also intuitive, as poorer natives prefer a higher tax rate, whereas wealthier natives prefer a lower tax rate.

As in Plott (1967), consider a "motion" $(\Delta\theta, \Delta M)$, where $\Delta M \geq 0$, as $M = 0$ at the original policy. Let $V_i(x)$ denote $V_i(\theta^m, 0; x)$ for $i = \theta, M$, and suppose first that $\hat{x} > x' > x^m > x''$. The motion is an improvement for the wealthier native x' only if $V_\theta(x')\Delta\theta + V_M(x')\Delta M > 0$. Since $\hat{x} > x'$, $V_M(x') < 0$; as $\Delta M \geq 0$, the motion is an improvement only if $\Delta\theta < 0$. Since the poorer native x'' has $V_M(x'') < 0$ and $V_\theta(x'') > 0$, the effect of this motion on the poorer native's utility is clearly negative—$V_\theta(x'')\Delta\theta + V_M(x'')\Delta M < 0$. By the same token, a motion that improves the utility of the poorer agent must have $\Delta\theta > 0$ and $\Delta M \geq 0$ and so will be opposed by the native x' with $\hat{x} > x' > x^m$.

If the wealthier native has $x' > \hat{x}$, things are somewhat more complicated, but we arrive at a similar conclusion. In this case, the wealthier native has $V_M(x') > 0$ and $V_\theta(x') < 0$, whereas a poorer-than-median native has $V_M(x'') < 0$ and $V_\theta(x') > 0$. To show that any motion that is an improvement for x' is harmful for x'' (or vice versa), we need to consider the two natives' marginal rates of substitution at the candidate equilibrium. Again, through tedious algebra, one can verify that

$$-\frac{V_\theta(x')}{V_M(x')} > -\frac{V_\theta(x'')}{V_M(x'')}$$

The details of this derivation are provided in the Technical Appendix. The argument then proceeds as follows: $(\Delta\theta, \Delta M)$ is an improvement for x' only if $V_\theta(x')\Delta\theta + V_M(x')\Delta M > 0$, or

$$\Delta M > -\frac{V_\theta(x')}{V_M(x')}\Delta\theta$$

The motion does not harm x'' only if $V_\theta(x'')\Delta\theta + V_M(x'')\Delta M \geq 0$, or

$$\Delta M \leq -\frac{V_\theta(x'')}{V_M(x'')}\Delta\theta$$

Combining, any motion that would have the support of x' without being opposed by x'' must satisfy

$$-\frac{V_\theta(x'')}{V_M(x'')}\Delta\theta \geq \Delta M > -\frac{V_\theta(x')}{V_M(x')}\Delta\theta$$

Since $-V_\theta(x'')/V_M(x'') > 0$ any nontrivial motion that leaves x'' as well off as before must have $\Delta\theta > 0$. But then the last inequality implies

$$-\frac{V_\theta\,(x'')}{V_M\,(x'')} > -\frac{V_\theta\,(x')}{V_M\,(x')}$$

contrary to the actual ranking of the natives' marginal rates of substitution at the candidate equilibrium. Thus, there is no motion that would be an improvement

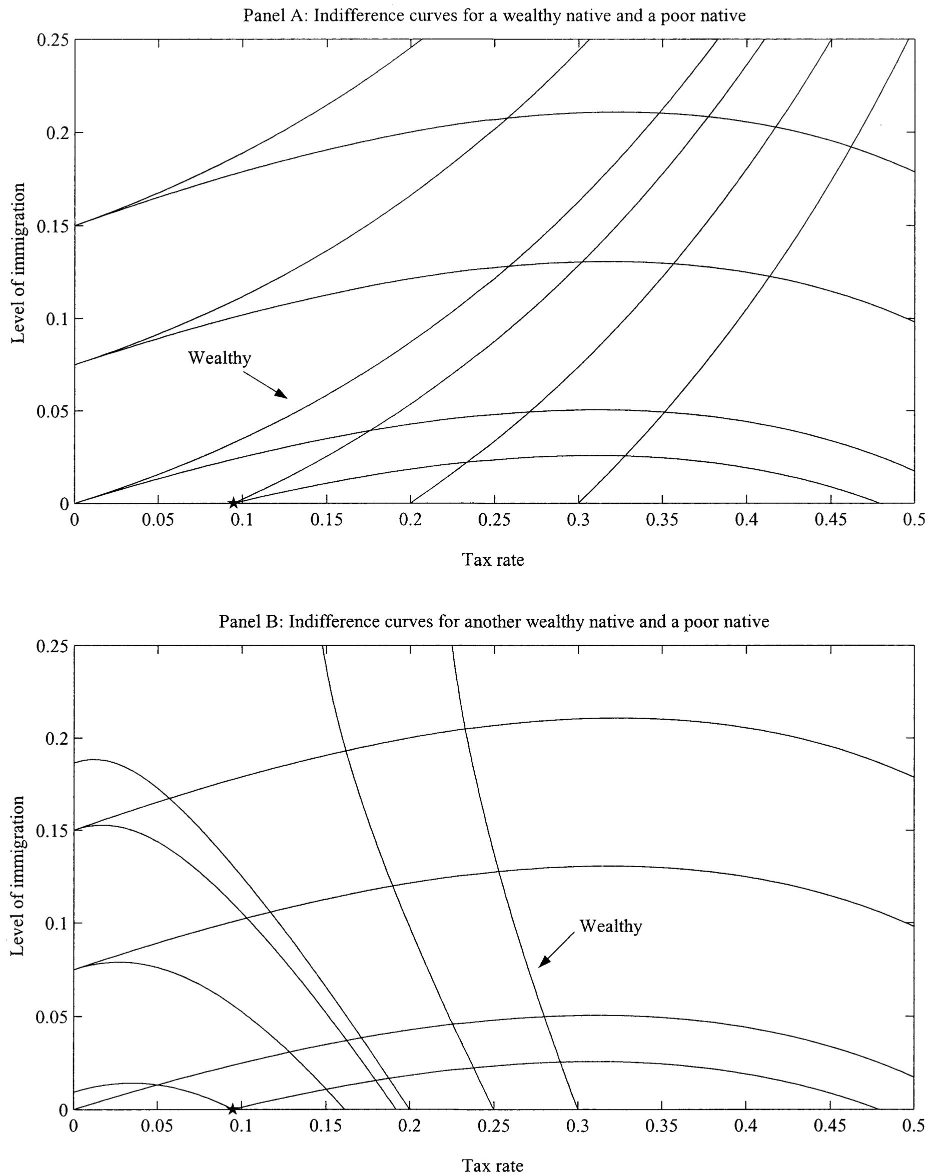

FIGURE 6

INDIFFERENCE CURVES OVER IMMIGRATION AND THE TAX RATE for x' and, at the least, not harmful for x''. The argument that any policy that is an improvement for x'' is harmful for x' proceeds analogously.

We conjecture that the median's preferred point is, in fact, a global majority-rule equilibrium. The basis for this conjecture is the fact that, for any two natives x' and x'', at any point (θ, M) in the issue space, the native's marginal rates of substitution between θ and M can be shown to be equal if and only if $x' = x''$. "Contract curves" between any pair of distinct natives will then, necessarily, follow the boundaries of the issue space. This is borne out computationally, as the panels of Figure 6 illustrate. The top panel shows indifference curves for a wealthy native and a poor native, where the relative initial wealth levels x' and x'' satisfy $x' > \hat{x} > x^m > x''$; the preferred point of the median native is indicated with a star. The bottom panel shows indifference curves for the same poor native and a wealthier native—one whose relative initial wealth level in this case satisfies $\hat{x} > x' > x^m$. Again, the median native's preferred point is indicated by a star.

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