On the Political Economy of Immigration and Income Redistribution

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Abstract

In this paper, 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.

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1 Introduction

In this paper, 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. Recently in the US, attention has turned as well to the role which naturalized citizens play in the determination of domestic election outcomes. One surprising result in our analysis is that the addition of immigrants who are both poorer than the native population and permitted 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.

Secondly, our analysis examines the effect of immigration from the perspective of natives' utility levels, rather than income. In so doing, we also document why measures of the impact of immigration which focus solely on natives' income may be inappropriate. Such measures may be misleading because they ignore the effects which 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, while their lifetime utilities are in fact falling as they are making intertemporal trade-offs which they would otherwise not. In this respect, the dynamic nature of our analysis is crucial.

Finally, we study how the degree of international capital mobility affects natives' preferences over the immigration and taxation issues.[1] 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

[1] We would like to thank the co-editor for encouraging us to pursue this issue.

combine to give sharp native preferences over the level of immigration.

The importance of immigration in the world economy is often under-appreciated. According to United Nations data, in 1990 there were 120 million "foreign-born persons" in 214 countries. This amounts to 2.3 percent of the world's population, or a population that is roughly the size of Japan. This percentage of the world's population has stayed roughly constant at least since 1965.[2] Immigration patterns differ radically across countries: The fraction of the population that is "foreign-born" ranges from 0.035% in Egypt to over 90% in the United Arab Emirates. Australia, Canada, and the US, which account for only 5% of the world's population, have received three quarters of the world's immigrants in the 1990's. Immigration accounts for 40% of the US 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 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.[3]

The intent of this paper is to shed some light on the *economic* factors which 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 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 [18] conducts an empirical analysis of the effect that immigration can have on the fiscal position of the US federal government. Benhabib [4] 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

[2] See Martin [14] for a comprehensive analysis of immigration patterns. He describes much of the UN data described here. There is also monthly internet newsletter titled the "Migration News" that reports on world-wide immigration issues. It is available at http://migration.ucdavis.edu/mn/mntxt.htm.

[3] Eberstadt [11] describes this data, which is forthcoming in the United Nations volume entitled *World Population Prospects*. For example, in the post-unification Eastern Germany, the fertility rate is less than one birth per woman *per lifetime*. Similarly, Japan has had sub-replacement fertility for over 40 years.

studied in the model below. Cukierman, Hercowitz and Pines [8] 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 considers 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 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.[4]

There is also a substantial body of empirical work that seeks to measure the costs or benefits of immigration into the US. Borjas ([5],[6]) 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. In contrast, Card [7] finds the effect of the 1980 immigration of people into Miami during the Mariel Boatlift to have had a negligible effect on the unskilled labor market.

The remainder of this paper 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 which 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. We offer some concluding remarks in section 5. An appendix contains a proof of a proposition given in section 4 and an analysis of a special case in which the equilibrium tax rate has a particularly simple closed-form expression.

2 The economic environment

We analyze an economy which 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

[4] The effect of immigration on factor prices should not be minimized. Martin [15] states that land prices in the US are between 10 and 20 percent 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 non-trivial effect on actual policies. Borjas [6] and Card [7] certainly focus on factor prices in the labor market in their empirical analyses.

permitted to vote once admitted and are not entitled to transfers.

A novel feature of this model is that the policy adopted in period one, 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 one—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 two. This is an important ingredient which will enhance our understanding of the political mechanism which determines these policy parameters.

2.1 The decision problem of initial residents

We assume that there are 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 income 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 two is again divided between consumption and savings for period three. 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 three. We assume that the revenue which 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.

2.2 The decision problem of immigrants

Immigrants are assumed to arrive at the beginning of period two. 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 two and three 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 two and three, 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 two 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 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. If 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.

[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 non-excludable goods such as roads or parks. This certainly seemed to be a pertinent area of concern for many people in California in recent discussions about immigration policies.

[6] That the immigrants are relatively poor is a very plausible benchmark. Martin [14] 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.

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 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

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

subject to $c_i = \tilde{r}_i K_i^F - K_{i+1}^F - \gamma\left(K_i^F, K_{i+1}^F\right)$. 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 $\gamma\left(K_i^F, K_{i+1}^F\right)$, which we assume to have the quadratic form

$$\gamma\left(K_i^F, K_{i+1}^F\right) = \frac{\lambda}{2}\left(K_i^F - K_{i+1}^F\right)^2.$$

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

$$K_{i+1}^F = K_i^F + \frac{1}{\lambda}\left(\beta \tilde{r}_{i+1} - 1\right) \tag{2}$$

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 is λ, 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 $K_{i+1}^F = K_i^F$ for $i = 1, 2$; if, also, $K_1^F = 0$, then we are back to the closed-economy case.[7]

[7] 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 Baxter and Crucini [3], Mendoza [12], Mendoza and Tesar [13]). There is other research that adopts a slightly different approach from our adjustment cost set-up—for example, Backus, Kehoe, and Kydland [1] use a "time-to-build" structure while Backus, Kehoe, and Kydland [2] 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.

2.4 Production technology

Production, which takes place only in periods two and three, 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.[8] As both natives and immigrants inelastically supply one unit of labor per person, the aggregate labor input in periods two and three is simply $L_i = L = 1 + M$.

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

$$r_i = F_1(K_i, L_i) = \alpha A (K_i/L_i)^{\alpha-1} \tag{3}$$

and

$$w_i = F_2(K_i, L_i) = (1-\alpha) A (K_i/L_i)^{\alpha}. \tag{4}$$

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.[9]

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 two, and then natives and newly-arrived immigrants vote over further immigration and taxation for period three—would seem to detract from the main mechanisms at work, as well as rendering

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

[9] A more complete description of the underlying two-party competition is given in the technical appendix, which is available on request from the authors.

the analysis hopelessly complicated. Proving the existence of, and calculating, a majority-rule equilibrium[10] in a single election with a two-dimensional issue space is difficult even in more idealized settings, let alone in a model with as many equilibrium interactions as are present here.[11]

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.[12] 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 two. 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.

3.2 The model from period two on

In order to describe the economy's equilibrium, we work backwards 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 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 one to consider the economic decisions which determine the distribution of income in the second period.

[10] For example, by verifying Plott's [17] condition.

[11] 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.

[12] 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.

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 two. 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 two equal to y_2. Such an individual faces the following optimization problem

$$\max\{\log(c_2) + \beta\log(c_3)\} \tag{5}$$

subject to the budget constraints given by

$$c_2 + s_3 = y_2, \tag{6}$$

and

$$c_3 = (1-\theta)(r_3 s_3 + w_3) + \tau. \tag{7}$$

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

$$s_3(y_2, \Phi) = \frac{\beta y_2 - \Phi}{1+\beta}, \tag{8}$$

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 two on in terms of the agent's income, y_2, the after-tax return to saving, $(1-\theta)r_3$, and Φ—

$$(1+\beta)\log(y_2 + \Phi) + \beta\log[(1-\theta)r_3]. \tag{9}$$

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

$$\begin{aligned} K_3^D &= \int s_3(y_2, \Phi)\mu_2(dy_2) \\ &= L\left[\frac{\beta\bar{y}_2 - \Phi}{1+\beta}\right], \end{aligned} \tag{10}$$

where $\bar{y}_2$ denotes the average level of period-two income. Aggregate capital for period three, K_3, is then the sum of K_3^D and K_3^F, where the latter is given by equation (2), *i.e.*,

$$K_3^F = K_2^F + \lambda^{-1}(\beta(1-\theta)r_3 - 1). \tag{11}$$

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

$$\tau = \theta(r_3K_3 + w_3L)/L = \theta\left(r_3\frac{K_3}{L} + w_3\right). \tag{12}$$

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

$$\Phi = \left[\frac{1-\alpha(1-\theta)}{\alpha(1-\theta)}\right]\frac{K_3}{L}. \tag{13}$$

Substituting (13) into (10), and $r_3 = \alpha A (K_3/L)^{\alpha-1}$ into (11), 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 values of L, K_2^F and the period-two income distribution μ_2.[13] 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 (13), giving Φ in terms of θ and K_3, we can evaluate each agent's indirect utility for periods two and three 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-two income equal to y_2 solves:

$$\max_{\theta\in[0,1]} \{(1+\beta)\log(y_2+\Phi) + \beta\log[(1-\theta)r_3]\} \tag{14}$$

subject to (10), (11) and (13), 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-two incomes prefer lower values of the tax rate. As we show in the appendix, section 6.2 below, 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.

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-two income.[14] This implies that the behavior of the economy in period three—equilibrium prices and quantities and fiscal policy—can be described in terms of three variables, the mean and median of the period-two income distribution and the level of immigration. Moreover, the utility from period two onward of any agent can be described in terms of those three variables, together with the agent's own period-two income. Let $v(y_2; \bar{y}_2, y_2^m, M)$ denote this indirect utility function for an agent who has period-two 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 (9), 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.

[13] 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 (11), depends on μ_2 only through $\bar{y}_2$ as well—there is a one-to-one relationship between K_2^F and $\bar{y}_2$.

[14] This is for the benchmark case where all agents are enfranchised in period two. 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 two 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.

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-two income, and the resulting equilibrium for a given distribution of period-two income and level of immigration. We now step back to period one and show how the distribution of income in period two 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-two income of a native agent is the sum of capital and labor income, and can therefore be written as

$$y_2 = r_2 s_2 + w_2. \tag{15}$$

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 two will be the sum of aggregate domestic savings from period one, 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 two is given by the $i = 2$ version of (2),

$$K_2^F = K_1^F + \frac{1}{\lambda}(\beta r_2 - 1).$$

The interesting problem is again faced by natives, who must make a consumption-savings decision in period one, given the level of immigration M and expectations about the distribution of income which will prevail in period two. We may cast a typical native's decision problem as

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

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 which is linear in income. In particular,

$$s_2(k_1; w_2, r_2, \bar{y}_2, y_2^m, M) = \frac{\beta(1+\beta)k_1 - (w_2 + \Phi)/r_2}{1 + \beta(1+\beta)}, \tag{16}$$

where Φ is as defined in (13), evaluated at the period-three 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 two—as

$$\begin{aligned} K_2^D &= \int_K s_2(k_1; w_2, r_2, \bar{y}_2, y_2^m, M)\,\mu_1(dk_1) \\ &= \frac{\beta(1+\beta)\bar{k}_1 - (w_2 + \Phi)/r_2}{1 + \beta(1+\beta)}, \end{aligned} \tag{17}$$

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

Aggregate capital in period two 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 which can be solved for K_2 given L and Φ. This is the capital stock in period two for a given level of immigration (embodied in L) and a given distribution of period-two 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-two distribution of income, since this determines the outcome in period three. Clearly, the natives' decisions also *imply* a distribution of income in period two. 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 $\{K_i, K_i^D, K_i^F, K_2^M, w_i, r_i, y_2^m, \bar{y}_2, \theta, \tau\}$, for $i = 1, 2$, and a distribution of capital $\mu_2(\cdot)$, such that the following conditions hold:

1. Agents' consumption-savings decisions follow the rules (8) and (16).
2. Factor prices for each period are given by equations (3) and (4).
3. 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 (2) and K_i^D, for $i = 1, 2$, is given by (17) and (10).
4. The initial distribution of initial capital μ_1, together with the decision rule (16) and the second-period factor prices w_2 and r_2, induces a distribution of income in period two given by μ_2, with mean $\bar{y}_2$ and median y_2^m.
5. The tax rate θ solves the problem (14) for $y_2 = y_2^m$. Also, the lump sum transfer is determined by equation (12).
6. The variable Φ in equations (8), (10), (14), (16) and (17) is as defined in (13).

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 which 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.[15]

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.

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 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 log-normal distribution which is translated away from the origin to guarantee that all natives begin with some amount of capital. We limit our attention here to log-normal 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 US.[17]

Figure 1 summarizes some of the results for this economy as the level of immigration is varied from $M = 0$ to $M = .25$. 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

[15] The numerical examples we present below were computed using programs written for MATLAB. The programs are also available on request.

[16] Elsewhere [9] we have studied the influence which the preference and production parameters β and α can have on the preferred level of immigration.

[17] We have also examined models with a number of different distributions for natives' initial wealth. (See [9]).

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 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%. While 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 log-normal 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 two. 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.[18] 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.

With a log-normal 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 which 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.[19]

The behavior of factor prices—the returns to labor and capital in periods two and three—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 two and period three, the capital-labor ratio falls as M is increased. The

[18] This feature is common to a number of different economies (See Persson and Tabellini [16]). See Dolmas and Huffman [10] for a derivation of this feature in a much more specialized environment.

[19] 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 which identifies the median agent in period two.

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, while 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 two and three. 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 which defines the top 1% percent 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 $M = .50$, or an influx of immigrants equal to 50% the size of the native population. Nonetheless, over the interval 0 to .25, the median's preferred level of immigration is zero.[20]

Note, too, that while 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.

[20] 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, which 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 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—which would come into play and are not present in our model. Our upper bound of $M = .25$ is already at the edge of historical experience for almost all countries.

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 [4] in studying this same issue. 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.

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 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 $M = .10$. In this case, average income in period two initially falls more sharply with the increase in M than median income in period two, to the point where—near $M = .10$—average income falls below median income, and the period-two 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 two 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 two, 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]

[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.

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 $M = .25$ to $M = 0$, at least 50% of the natives in the 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* $M = .25$ 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 two and three, hence more averse to immigration. The opposite is true as the degree of inequality is reduced.[24]

Ceteris paribus, then, we would expect economies with lower degrees of wealth inequality to be more open to immigration. Some evidence in favor of this result is shown in Figure 3, which illustrates the relationship between the quantity of long term immigration, as a fraction of total population, and the level of inequality, as measured by the Gini coefficient.[25] There is a significant negative correlation between these two variables, as predicted by the model.[26]

[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.

[24] It is worth noting that there is nothing special in this example about the log-normal distribution of initial capital. The effects which changes in inequality can have on the results are robust to all distributions that we have analyzed. See Dolmas and Huffman [9].

[25] The Gini coefficients are derived from a data set published by the World Bank. The data on long term immigrants is from the United Nations [19]. 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.

[26] 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 which 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 [14]). 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'.

4.3 The effects of capital mobility

In this section, we examine the consequences which 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. 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-three 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 two and three 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 which the immigrant has on native wages and the positive effect which 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) which 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 non-reproducible factor such as land were 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 $\lambda = 0.05$.[27] Although

[27] 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 ($\lambda = +\infty$).

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 4 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 which obtains in the closed economy case. The effects of changing the degree of capital mobility are occasionally non-monotonic 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 which 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 mobility. As a result, capital-poor natives suffer less from immigration when there is greater international mobility of physical capital.[28]

Our model would imply that if capital were mobile, then countries that were to have plenty of immigration would also be importing capital. We have found a significant positive correlation between the size of a country's foreign-born population, and the level of net foreign direct investment. 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.[29] Martin [14] 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

[28] Though, of course, capital-rich natives benefit less from immigration as well.

[29] See Martin [14]. As much as 70% of the jobs in the construction sector in Malaysia are taken up by foreign workers.

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 over the past 10–15 years, with a concomitant escalation in real estate prices.

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 which attempt to alter the composition of their immigrant inflows in ways which favor immigrants with large amounts of capital.[30] 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 US 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 ($\lambda = .10$). The results for all of the experiments are contained in the panels of Figure 5.

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 two is the median native regardless of the level of immigration allowed in period one.

The top two panels of Figure 5 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 three 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 which 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

[30] *E.g.*, the US 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 US Immigration and Naturalization Service's 1996 Statistical Yearbook [20].

is slightly higher, but this individual—and the 50% of the native population with lower initial endowments of capital—would still opt for $M = 0$ even if immigrants are disenfranchised.

In economies with lower degrees of initial wealth inequality, where the median native is wealthier, it is possible for the disenfranchisement of immigrants to alter the equilibrium immigration outcome. When the median native is wealthier, the countervailing factor price effects of immigration on his or her utility are more off-setting, 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 which result when immigrants are disenfranchised.

4.4.2 Wealthy immigrants

We now suppose that immigrants, rather than 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 which would place them at the cut-off for the top 20% of the initial distribution of capital among natives.[31]

We first consider the closed-economy case. Panel A of Figure 5 again shows the behavior of the tax rate for the $\lambda = +\infty$ case. The tax rate when immigrants arrive wealthy is shown by the '$\diamondsuit$' line in the panel. Relative to the benchmark economy (shown by the '$\bigcirc$' 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. While 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-two 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.

[31] This is especially interesting given the apparent differences in the immigration policies of Canada and the US. The US, 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.

While 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. While 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, rather than 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 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 which 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 one 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 which obtain when capital is mobile—roughly 35% when $M = .25$ in the $\lambda = .10$ case versus over 50% when $M = .25$ in the $\lambda = +\infty$ case.

As Panels B and D show, the median native has a strong preference for $M = .25$ in this case, regardless of whether capital is immobile or mobile. While 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 which result and the wealthier natives in spite of the higher taxes which result.

5 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 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 paper 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 which 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 which results from immigration. In our parametrization, 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 merely 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 which lead these natives to re-allocate resources from earlier to later periods. Incomes in later periods may be higher as result, but the agents are making trade-offs which they would not in the absence of immigration.

The model also sheds some light on other factors which 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.

6 Appendix

6.1 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. ■

6.2 Determination of the tax rate in a special case

In the special case where there is no foreign capital, and agents have only capital income in the final period, it is possible to derive a simple closed-form solution for agents' preferred tax rates. In this section of the appendix, we present that solution, which is useful for garnering some intuition regarding the relationship between the equilibrium tax rate and median and average second-period income.

Suppose that, then, there is no foreign capital—equivalently, that $\lambda = +\infty$ and $K_1^F = 0$—and that third-period production possibilities are given by $F(K) = AK$, so that the equilibrium after-tax return to saving is $(1-\theta) A$. Consider an agent—either a native or immigrant—who begins period two with income equal to y_2. Given values for the tax rate θ and transfer payment τ, the problem faced by such an agent is

$$\max_{s_3} \{\log (y_2 - s_3) + \beta \log [(1-\theta) A s_3 + \tau]\}. \tag{18}$$

It is straightforward to verify that the optimal choice of savings is given by

$$s_3 = \frac{1}{1+\beta}\left(\beta y_2 - \frac{\tau}{(1-\theta) A}\right).$$

By aggregating this expression across all agents, and using the fact that the lump-sum transfer (τ) equals the tax rate times the amount of per-capita capital income, it can be shown that

$$\tau = \frac{\theta A \beta (1-\theta)}{(1-\theta)(1+\beta)+\theta}\bar{y}_2.$$

By substituting this expression, together with the equations determining optimal consumption and saving decisions, back into the utility function (18), we then get an indirect utility function that describes preferences over these two periods, and this can be written as follows:

$$w(\theta; y_2/\bar{y}_2) = \eta + (1+\beta)\log(\bar{y}_2) + (1+\beta)\log\left(\frac{(1+\beta)\frac{y_2}{\bar{y}_2} + \theta\beta\left(1 - \frac{y_2}{\bar{y}_2}\right)}{1+\beta-\theta\beta}\right) + \beta\log(1-\theta),$$

where $\eta = -(1+\beta)\log(1+\beta) + \beta\log(\beta A)$.Written in this manner, it becomes clear that an individual's indirect utility depends not only on the parameters θ and A, but also on his income *relative to the average.* The reason for this is clear: the agent's resulting transfer payment depends on the average level of income.

It is straightforward to verify that this expression is differentiable in θ, and is decreasing in θ when $y_2/\bar{y}_2 \geq 1$—*i.e.*, when the agent is richer than average. The preferred tax rate of any agent with $y_2 \geq \bar{y}_2$ is always $\theta = 0$.

For agents with $y_2/\bar{y}_2 < 1$, one can verify that w is strictly concave in θ on $(0,1)$. Concavity is easier to see if the two last terms involving θ are written out as

$$(1+\beta)\log\left[(1+\beta)\frac{y_2}{\bar{y}_2}+\theta\beta\left(1-\frac{y_2}{\bar{y}_2}\right)\right]-(1+\beta)\log(1+\beta-\theta\beta)+\beta\log(1-\theta),$$

which is the sum of three strictly concave functions.

Hence a poorer-than-average agent who wishes to calculate his or her most preferred value of θ subject to the constraint $\theta\in[0,1]$, could perform this calculation by merely taking the derivative of $w(\theta; y_2/\bar{y}_2)$, and setting it equal to zero. This yields a quadratic expression and after some tedious algebra it can be shown that the most preferred tax rate of an agent with $y_2/\bar{y}_2 \equiv z < 1$ is given by

$$\theta^*(z)=\frac{1+\beta}{\beta}\frac{1+2\beta(1-z)-\sqrt{1+4\beta(1-z)}}{2\beta(1-z)}.$$

Some properties of $\theta^*(z)$ are worth noting. First, $\theta^*(z)$ is decreasing in z: the relatively poorer is an agent, the higher is his or her preferred tax rate (and transfer). Also, $\lim_{z\to 1}\theta^*(z)=0$, so there is no discontinuity in the preferred tax rates as we move from the relatively wealthy—those agents with $z\geq 1$, whose preferred tax rate is zero—to the relatively poor. While $\theta^*(z)$ varies monotonically with z, it's dependence on the time-preference parameter β is more complex. Finally, as is shown in Dolmas and Huffman [10], for sufficiently small values of z, $\theta^*(z)$ may be on the 'wrong' side of the economy's Laffer curve—*i.e.*, for small z, $\theta^*(z)$ may be higher than the value of θ which maximizes total tax revenue.

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Figure 1: Results in a benchmark case

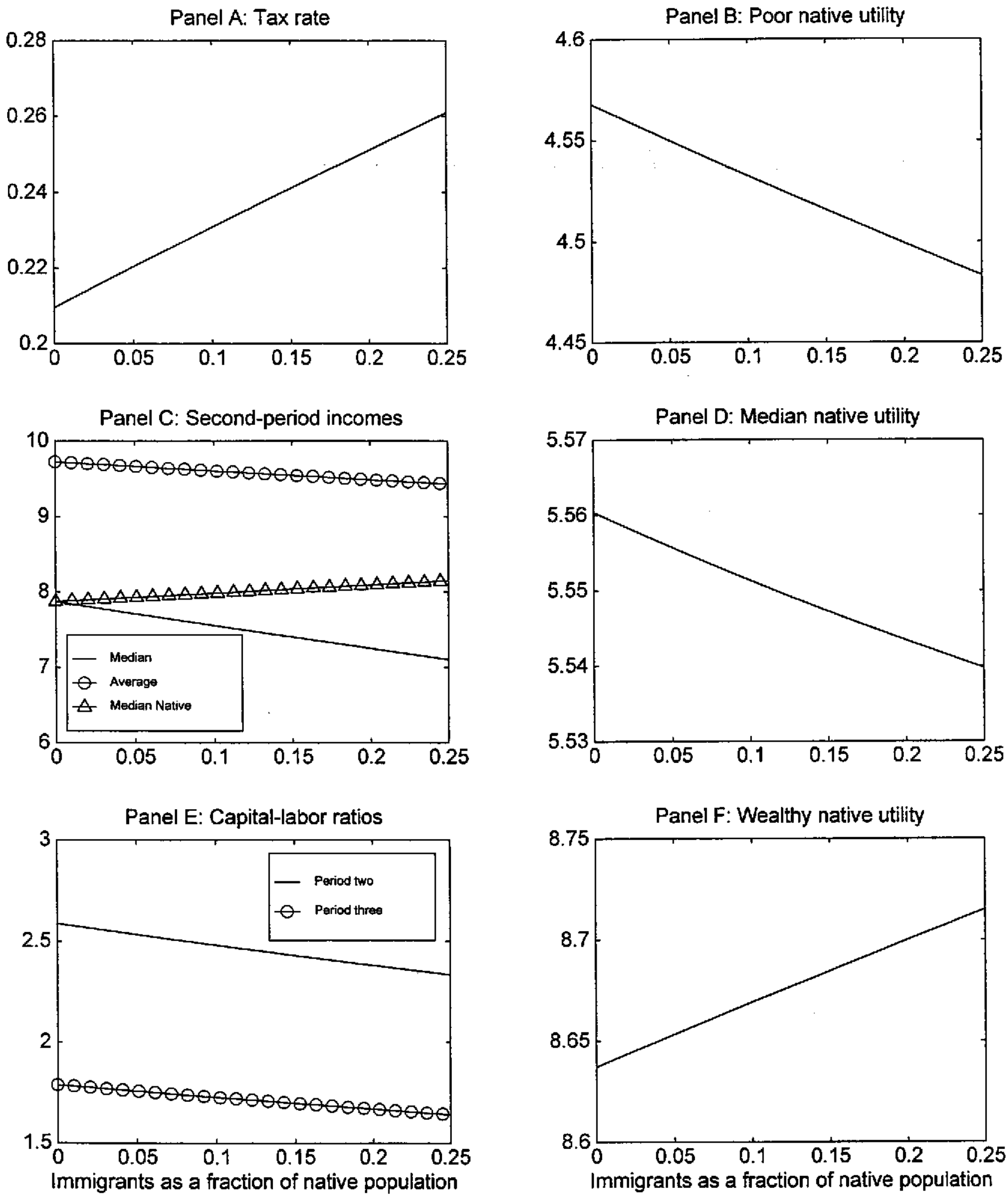


Figure 2: Results for differing degrees of inequality

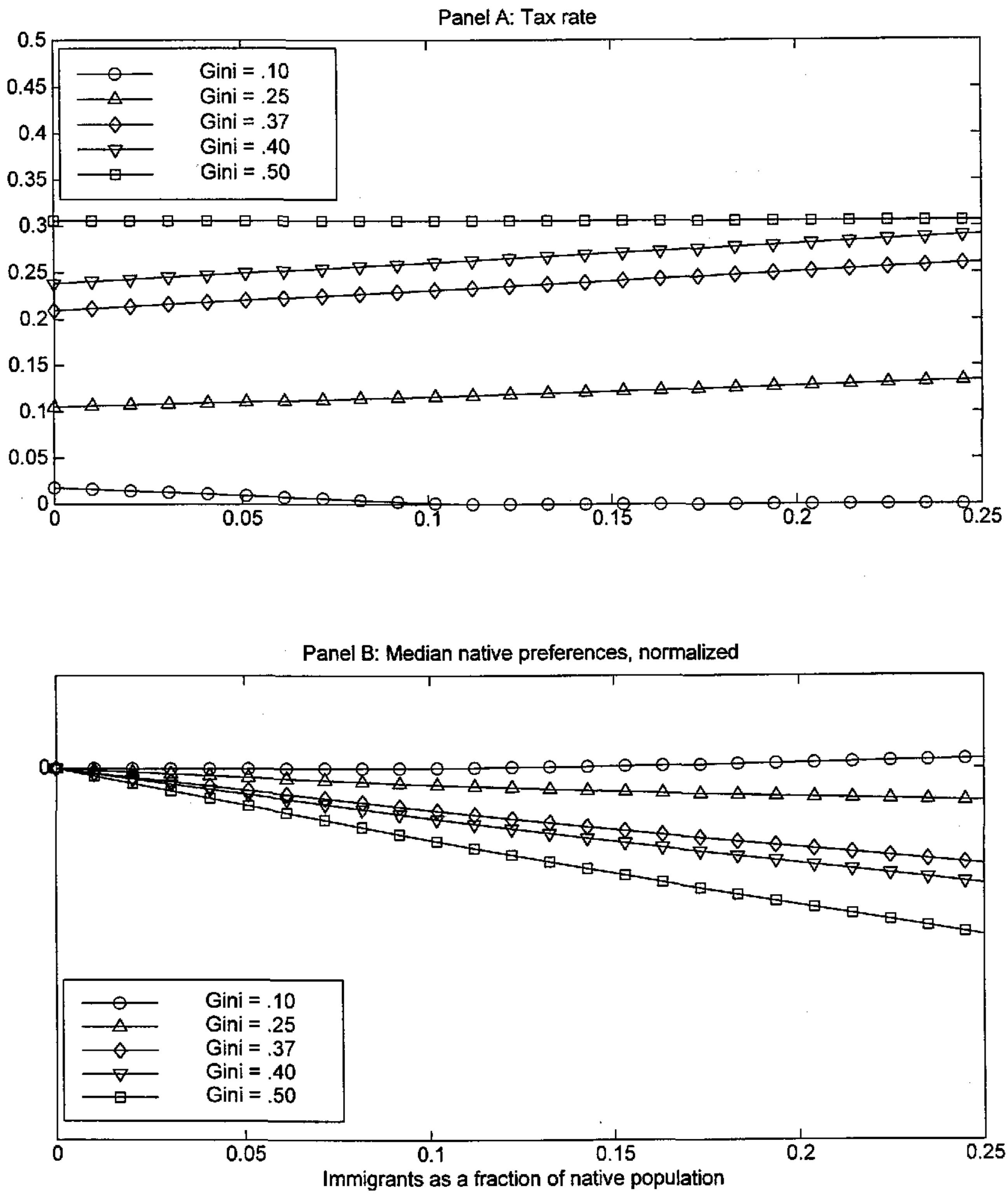
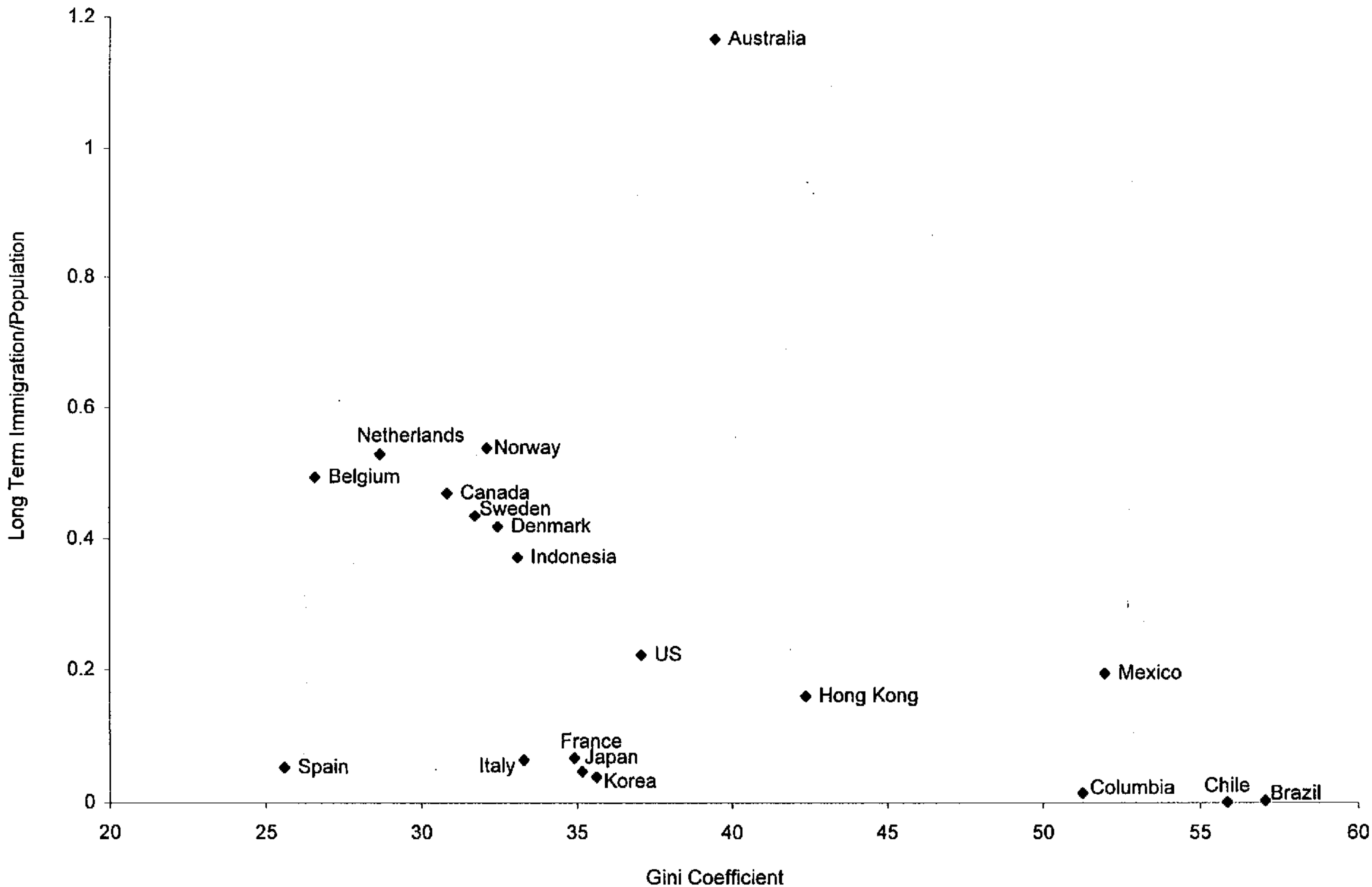


Figure 3



Long Term Immigration/Population
1.2
1
0.8
0.6
0.4
0.2
0
20
25
30
35
40
45
50
55
60
Gini Coefficient
Australia
Netherlands
Norway
Belgium
Canada
Sweden
Denmark
Indonesia
US
Mexico
Hong Kong
France
Japan
Korea
Italy
Spain
Columbia
Chile
Brazil

Figure 4: Results for differing degrees of capital mobility

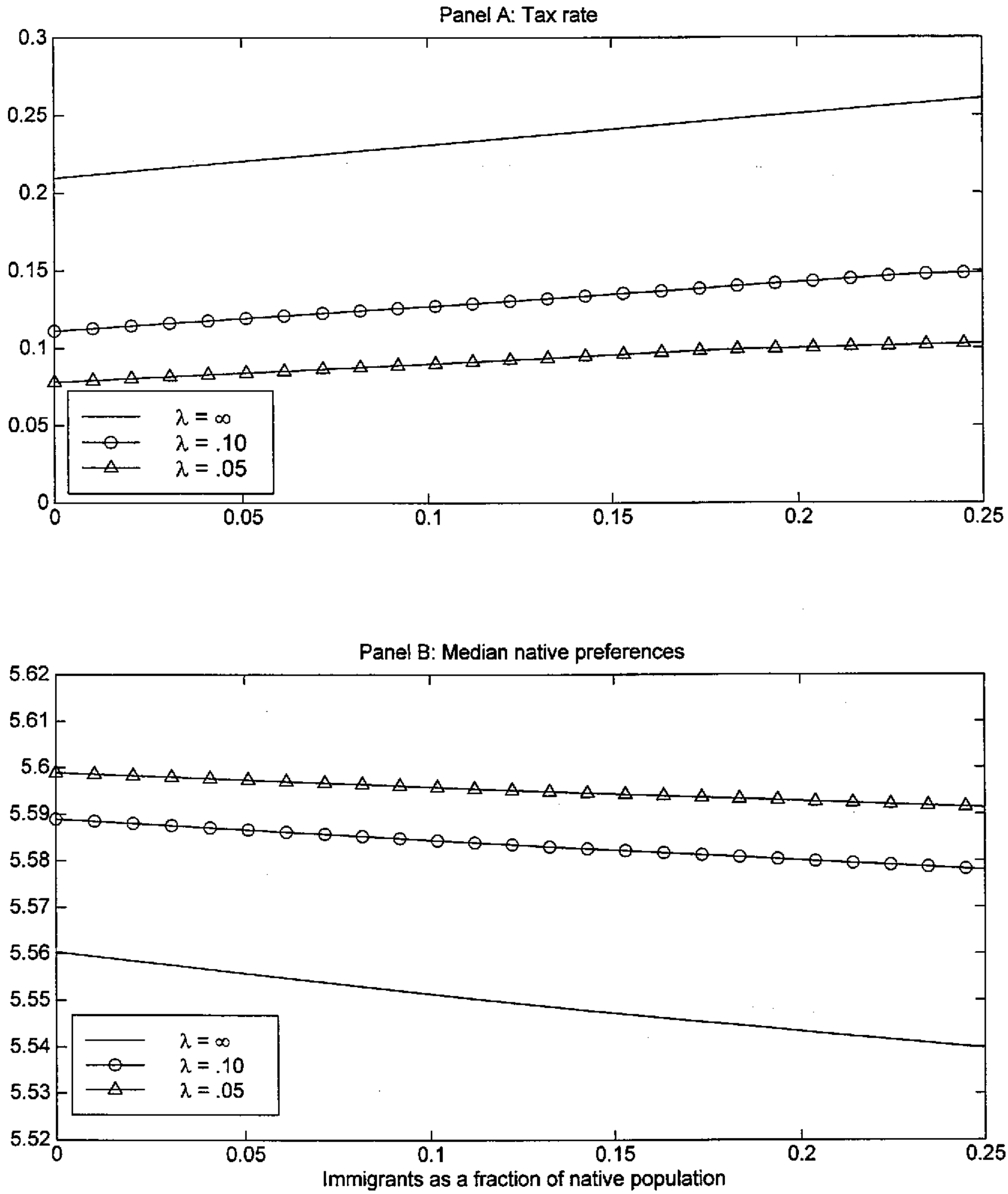
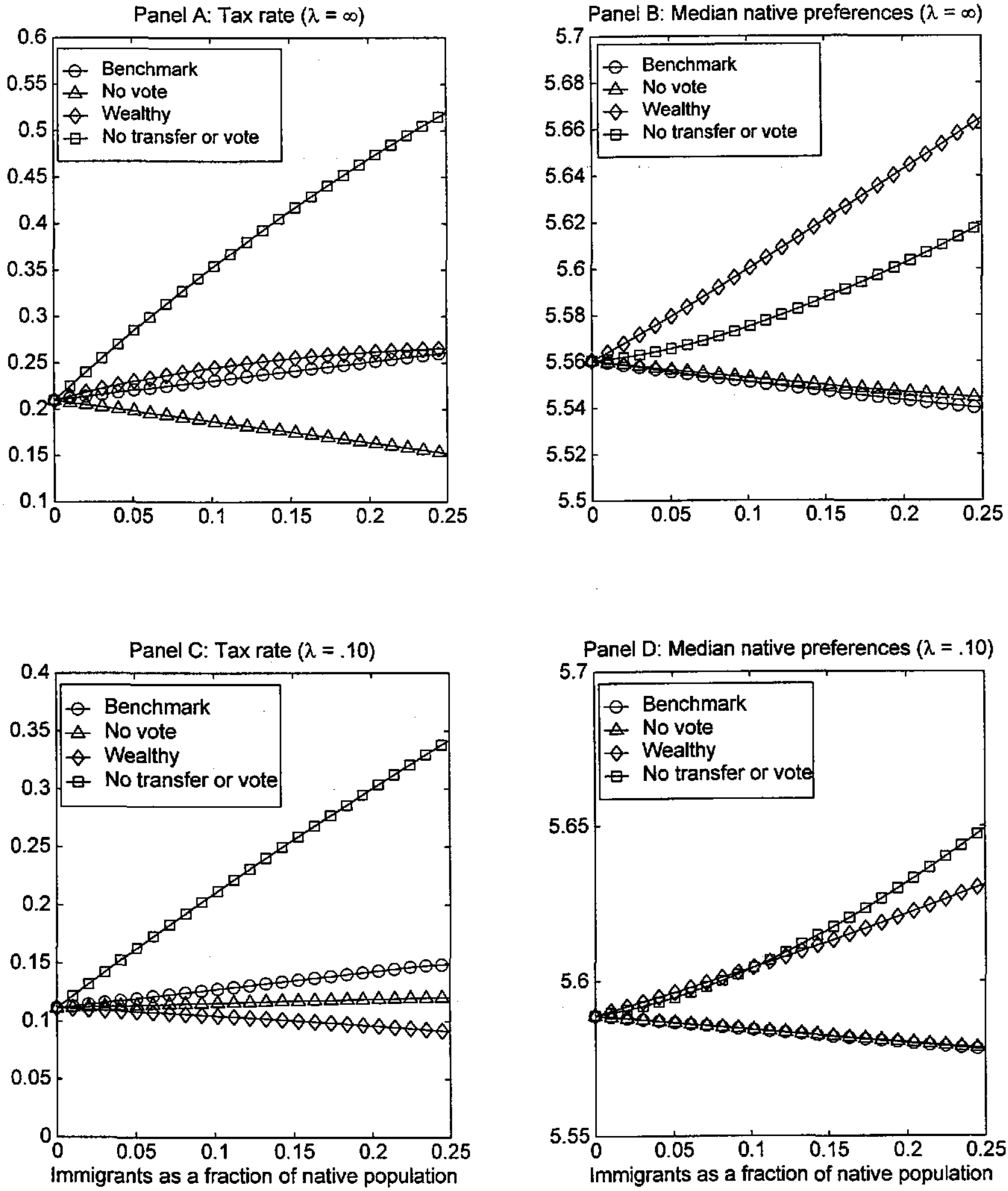


Figure 5: Results under various regimes



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