On The Political Economy of Immigration

Jim Dolmas

and

Gregory W. Huffman

June 1997

Research Department

Working Paper

97-06

Federal Reserve Bank of Dallas

On the political economy of immigration*

Jim Dolmas† Gregory W. Huffman‡

Abstract

This paper explores the interactions between immigration, inequality and redistributive fiscal policy in a dynamic general equilibrium model in which government policies are endogenously determined through voting. A model is constructed in which agents vote on the level of immigration into the economy. It is shown that agents' preferences over the level of immigration are influenced by the effects of immigration on factor prices. Agents' preferences over immigration are shown to depend non-trivially on the characteristics of immigrants and whether they will receive the franchise to vote in the future. It is shown that subtle changes in the distribution of wealth among existing citizens can have a dramatic impact on the equilibrium behavior of the economy.

*The authors wish to thank seminar participants at Southern Methodist University for numerous comments. The views expressed here are solely those of the authors and do not reflect those of the Federal Reserve Bank of Dallas or the Federal Reserve System.

†Department of Economics, Southern Methodist University.

‡Department of Economics, Southern Methodist University, and Federal Reserve Bank of Dallas.

On the political economy of immigration

Abstract

This paper explores the interactions between immigration, inequality and redistributive fiscal policy in a dynamic general equilibrium model in which government policies are endogenously determined through voting. A model is constructed in which agents vote on the level of immigration into the economy. It is shown that agents' preferences over the level of immigration are influenced by the effects of immigration on factor prices. Agents' preferences over immigration are shown to depend non-trivially on the characteristics of immigrants and whether they will receive the franchise to vote in the future. It is shown that subtle changes in the distribution of wealth among existing citizens can have a dramatic impact on the equilibrium behavior of the economy.

1 Introduction

In this paper, we study several general equilibrium models in which agents in an economy must decide on the appropriate level of immigration into the country. Residents or citizens of an economy have identical preferences (*i.e.*, utility functions) over consumption goods but may be endowed with different amounts of capital. This alone gives rise to alternative levels of desired immigration. In a simple two-period model we show why agents might have 'polarized' preferences over alternative levels of immigration—agents prefer either the maximum or minimum level of immigration. In a three-period framework, we show that the citizens' 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 the distribution of initial wealth among existing residents can have a dramatic influence over the equilibrium immigration outcome. Lastly, these results are contrasted with the case in which new immigrants are totally disenfranchised in the future.

Immigration is a controversial topic of much recent discussion in many countries. In the US recently, discussion has been directed to the issue of whether new immigrants are 'net contributors' to the economy or whether they 'drain' resources away from existing residents.[1] Presumably, if the latter is true there is less reason for a country to open its doors to new immigrants. However, this is hardly a new topic of concern. Many European countries have fought for decades over the issue of determining the appropriate level of immigrant workers to admit into their countries. Japan has also allowed a large number of 'guest workers' to gain temporary employment in their country. Furthermore, it is well known that during the 1930s US immigration was reduced to a trickle, resulting in disaster for some who were stranded in Europe.

The issue here is not just whether or not to admit immigrants to a country, or in what numbers, but also "what skills" to admit to a country. Not all potential immigrants have the same skills or human capital, and many countries have the option of selecting the immigrants they wish to admit. Existing citizens are likely to be more inclined to permit immigration if these immigrants can potentially generate positive economic externalities. Presumably someone without any education or employment is less likely to generate external benefits for existing citizens than would someone who has rare and valued skills.[2] Similarly, citizens with high levels of financial capital might be more likely to generate these externalities if they can be made to invest in domestic capital. However, it would appear that the ability to generate positive externalities would not be the sole criterion for a potential immigrant gaining admittance into the country. In an economy where the level of immigration is determined by endogenous political considerations, a potential immigrant with highly valued skills may not necessarily gain admittance if his presence is likely to negatively affect an influential voting bloc within the country. Since any country would seem to be able to adjust its immigration policy so as to accept only the 'most desirable' immigrants, it is then of interest to know what type of people a country should be seeking, and whether the existing political mechanism will permit this immigration to take place.

Canada and the US are an interesting contrast in this regard. Immigration presently accounts for 40% of the annual US population growth, while being even more important in Canada. Immigration into the US seems to be primarily determined by the unification of family members, plus the imposition of quotas for prospective immigrants from various geographical areas. By contrast, the Canadian government has for some time offered citizenship to foreigners who could meet a certain capital requirement. The point being here that someone who could meet these standards would be more likely to promote investment within Canada and less likely to need government-provided social benefits.[3] In this way, Canada seems somewhat unique,

[1] See, for example, Borjas [2] and the references therein.

[2] Unless, of course, you are an existing citizen with those same skills—*e.g.*, consider the impact on US and other Western mathematicians of the influx of mathematicians from former-Soviet states.

[3] This hardly seems like a fool-proof strategy since it would appear that there are many ways that one could foil the intent of this requirement, for example, by shipping capital offshore once the individual obtains residence.

Nevertheless the change in immigration policy for Canada is visibly apparent to anyone walking the streets of cities such as Vancouver or Toronto. Untile 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'.

since most immigration around the world appears to take the form of individuals with low levels of human capital departing for another country. There is a plethora of examples to illustrate this: workers move from Turkey to Germany, Korea to Japan, Mexico to the US, and from many countries to South Africa. In many of these cases, these guest workers have low levels of human capital and are a major source of hard currency for the poorer countries from which they emigrate.

At times in Canada it seems that it is the rule that the migrants have high levels of capital. Vancouver has been the beneficiary of a substantial increase in real estate prices, and it is thought that this has been fueled by Asian nationals, particularly from Hong Kong, fleeing their home with capital and buying up property. Furthermore it would be quite feasible to gear immigration policy so as to target to workers with a particular type of *human* capital, such as engineers or mathematicians. We explore this issue below by analyzing the impact of having a pool of potential immigrants who have comparatively high levels of capital.

These economic arguments often stray into cultural territory as well. In France, it appears to be a constant concern to some citizens that new immigrants will alter the domestic language, institutions and culture, as well as procure economic benefits from the government. This is one of the reasons why the more conservative parties in France, who are not in favor of increased immigration, have been the beneficiaries of a resurgence in popularity.

There are many interesting immigration case studies around the world. Japan and Korea essentially prohibit the entrance of unskilled workers. On the other hand, Singapore, Thailand and Malaysia rely heavily on foreign workers. Thailand has half a million citizens working abroad, while having between 500,000 and 900,000 foreign workers in the country. Malaysia is a fascinating example, with between one and two million foreign workers in a labor force of 8 million. It has been attracting large quantities of foreign investment, which has help to generate a labor shortage which can only be remedied by importing foreign workers. Consequently, the growth in GNP has been between 8% and 9% in recent years. 70% of construction jobs and 30% of agriculture and forestry jobs are occupied by foreign workers.[4]

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, the dynamic aspects to this question will be emphasized, since this would appear to be a question with some serious dynamic implications. Altering the immigration policy in one period will influence the quantity of the factors of production, factor prices and the distribution of wealth in future periods. 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. Benhabib [1] studies a simple model in which agents' motives are determined by purely economic considerations over alternative economic

[4]See Martin [6] for an excellent summary of the flows of workers around the world.

policies, though the analysis does not contain many of the details studied in the model below. Cukierman, Hercowitz and Pines [3] also study immigration, but they look at an environment in which the potential migrants must make optimal decisions in considering whether to 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.

The remainder of this paper is organized as follows. In the next section, we analyze a simple two-period economy in which agents have an endowment and must save from one period to the next. Agents subsequently receive capital and labor income. The agents must vote on the number of immigrants to admit and are cognizant of all the general equilibrium effects of this potential change in the labor force. This gives rise to an indirect utility function for each agent over the number of immigrants to admit, and those preferences can be parametrized by an individual's initial capital holding. We show that if there is no upper bound on the number of potential immigrants, then all agents would prefer to drive the number of immigrants to infinity. If there is some maximum number of potential immigrants, then residents are 'polarized' with respect to immigration—each resident's most preferred point on the issue space is either zero or the maximum allowable number of immigrants, with the initially capital-poor preferring zero and the initially capital-rich preferring the maximum. There is a critical level of capital at which an agent is indifferent between the two poles; consequently, the majority-voting outcome depends on whether the median level of capital is above or below this critical point. Within the context of a particular family of distributions of initial capital—the Pareto family—we show that there is a monotonic relationship between the degree of initial wealth inequality in the society and the majority-voting winner. Zero immigration prevails high levels of inequality, while the maximum allowable prevails at low levels of inequality.

In section 3 we briefly examine a variant of the original model in which residents must pay a direct cost if a given number of immigrants are to be admitted. The cost might be interpreted as a sort of direct disutility from immigration or simply as a tax which residents must pay to cover the costs of admitting new citizens. We show that, depending on the structure of the cost function, residents' indirect utilities over immigration may be single-peaked in the level of immigration with a finite 'most-preferred' point.

In section 4 we extend the original model to three periods. Domestic residents are assumed to receive capital and labor income in the second period, but only capital income and government transfers in the third. In the benchmark case potential immigrants have no capital in the second period, but can work to generate labor income. The immigration decision must be made in the first period, but in the following period agents must vote on the level of income tax that will be used to finance lump-sum transfers to all agents. Not surprisingly, poorer agents will then favor higher rates of taxation and transfers. There are many interesting dynamic interactions that can arise. For example, if new immigrants are subsequently given the franchise to vote, then domestic residents must take this into account when formulating their desired level of immigration. This is likely to curtail the desired level of immigration. In contrast, if these immigrants are not given the right to vote, then domestic residents who own plenty of capital can expect to benefit from having these laborers in the economy. We analyze the factors determining the residents' desired levels in detail and conduct some numerical experiments to examine the relationship between properties of the initial distribution of wealth in the economy and the existence and nature of majority-voting outcomes over the issue of immigration.

2 A two-period model with only pecuniary effects

Initially, we consider an economy which lasts for two periods. It is assumed that there is an unlimited supply of potential immigrant, relative to the initial size of the economy under consideration. Immigrants, if admitted, arrive in the second period, without capital, and simply consume income from the inelastic supply of labor. Consequently, the only non-trivial decision problem is that faced by residents. Each resident is endowed with some amount of capital in the first period, which the resident divides into consumption in the first period and savings for the second period. In the second period, the resident consumes his or her income from savings and income from labor services which the resident supplies inelastically. The labor endowments of all agents, both residents and immigrants, are normalized to one.

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

$$u(c_1, c_2) = \log(c_1) + \beta \log(c_2).$$

All residents have the same preferences over the two consumption goods. A resident endowed initially with k units of capital faces the following budget constraints for consumption in the two periods:

$$k = c_1 + s$$

and

$$c_2 = rs + w,$$

where s denotes savings, w is the wage rate in period two and r is the rental rate on capital.

Production, which takes place only in the second period, is undertaken by competitive firms with access to a constant-returns-to-scale Cobb-Douglas production technology, using capital (aggregate savings) and labor as inputs—

$$F(K, L) = AK^{\alpha}L^{1-\alpha}.$$

If r denotes the rental rate on capital, and w the wage rate, in equilibrium we will have $r = F_1(K, L) = \alpha A (K/L)^{\alpha-1}$ and $w = F_2(K, L) = (1-\alpha)(K/L)^{\alpha}$.

Immigration policy is decided on in the first period, prior to the residents' consumption-savings decision. To describe the political equilibrium, we use the standard model of two-party competition over a single issue, where the issue here is the number of immigrants to admit. Initially, we take the issue space to be R_+—*i.e.*, we assume an unlimited supply of potential immigrants. Later we will consider the case where the issue space is a closed interval from zero to some maximum number of immigrants.

Even though residents have identical preferences over consumption goods, if they differ in their initial holdings of capital they will in general not have identical preferences over the number of immigrants to admit. Let μ denote the distribution of initial capital holdings in the resident population with support over some set $\mathcal{K} \subset R_+$. The size of the resident population is normalized to one, so that $\int_{\mathcal{K}} \mu(dk) = 1$.

In order to describe residents' induced preferences over immigration, fix some number of immigrants, N. Given N, we can calculate the general equilibrium for the economy, solving for prices, aggregate savings and, ultimately, residents' utility levels, as functions of N.

A resident who begins with initial capital k—agent k for short—chooses savings s so as to maximize

$$\log(k - s) + \beta \log[rs + w]$$

given k and the prices r and w. The prices of course depend on the aggregate state of the economy, which here will consist of aggregate period-two capital, which we denote by K, and the number of immigrants admitted, N. The solution to this problem is

$$s(k; w/r) = \frac{\beta}{1+\beta}k - \frac{1}{1+\beta}\frac{w}{r} \tag{1}$$

which gives rise to the indirect utility function

$$\begin{aligned} v(k; w, r) &= \ln[k - s(k; w/r)] + \beta \ln[rs(k; w/r) + w] \\ &= \nu + (1+\beta)\log\left[k + \frac{w}{r}\right] + \beta \log[r], \end{aligned} \tag{2}$$

where $\nu = \beta\log(\beta) - (1+\beta)\log(1+\beta)$.[5]

If the number of immigrants is N, aggregate labor supply in the second period is $L = 1 + N$. Given aggregate period-two capital equal to K, the prices r and w then satisfy

$$\begin{aligned} w &= F_2(K, 1+N) = (1-\alpha)A\left(\frac{K}{1+N}\right)^{\alpha} \\ r &= F_1(K, 1+N) = \alpha A\left(\frac{K}{1+N}\right)^{\alpha-1}, \end{aligned}$$

so that the wage-rental ratio is

$$\frac{w}{r} = \frac{1-\alpha}{\alpha}\frac{K}{1+N}.$$

[5]Note that we have not imposed any nonnegativity constraint on residents' savings; consequently, in equilibrium, some residents may be borrowing from other residents. This could be modified without substantitively altering our results, but at the cost of much less clarity.

In equilibrium, aggregate period-two capital, K, and the individual savings decisions, $\{s(k; w/r) : k \in \mathcal{K}\}$, must satisfy

$$\begin{aligned} K &= \int_{\mathcal{K}} s(k; w/r)\, \mu(dk) \\ &= \frac{\beta}{1+\beta} \int_{\mathcal{K}} k\mu(dk) - \frac{1}{1+\beta}\frac{w}{r}, \end{aligned}$$

where we have used (1) and the fact that $\int_{\mathcal{K}} \mu(dk) = 1$. Substituting $[(1-\alpha)/\alpha][K/(1+N)]$ for w/r, and rearranging, gives

$$K = \frac{\alpha\beta}{\alpha(1+\beta) + (1-\alpha)\frac{1}{1+N}} \bar{k},$$

where $\bar{k} \equiv \int_{\mathcal{K}} k\mu(dk)$. Thus, the equilibrium capital-labor ratio is given by

$$\frac{K}{1+N} = \frac{\alpha\beta}{\alpha(1+\beta)(1+N) + 1 - \alpha} \bar{k},$$

and the equilibrium wage-rental ratio by

$$\frac{w}{r} = \frac{(1-\alpha)\beta}{\alpha(1+\beta)(1+N) + 1 - \alpha} \bar{k}.$$

For compactness, let

$$\Phi(N) = \frac{(1-\alpha)\beta}{\alpha(1+\beta)(1+N) + 1 - \alpha},$$

so that $w/r = \Phi(N)\bar{k}$. Note that $\Phi(N)$ is strictly decreasing in N for $N \geq 0$ with $\Phi(0) = (1-\alpha)\beta/(1+\alpha\beta)$ and $\Phi(+\infty) = 0$.

Given this notation, the equilibrium rental rate on capital can be expressed in terms of $\Phi(N)\bar{k}$ by

$$\begin{aligned} r &= \alpha A \left(\frac{K}{1+N}\right)^{\alpha-1} \\ &= \alpha A \left(\frac{\alpha}{1-\alpha}\frac{w}{r}\right)^{\alpha-1} \\ &= \alpha^{\alpha}(1-\alpha)^{1-\alpha} A \left[\Phi(N)\bar{k}\right]^{\alpha-1}. \end{aligned}$$

The indirect utility function of a resident with initial capital k from equation (2) can then be written as

$$V(N;k) = \text{constant} + (1+\beta)\log\left[k + \Phi(N)\bar{k}\right] - \beta(1-\alpha)\log\left[\Phi(N)\bar{k}\right].$$

For computational purposes, it convenient to distinguish agents by the relative capital holdings—precisely, by the ratio of agents' initial capital holdings to the mean initial capital holding.[6] Let $x = k/\bar{k}$. We can

[6] Alternatively, one can view this transformation as a rescaling of the units in which initial capital is measured so that the mean initial holding is one. Below, in analyzing the three-period model, we will make a similar transformation of agents' utilities from period two onward. In that case, the interpretation as a change of units is no longer available, since period-two average income will depend on the level of immigration and we clearly cannot choose units so that average period-two income is one for all possible levels of immigration.

then write a typical resident's indirect utility function as

$$V(N;x) = \text{constant} + (1+\beta)\log[x+\Phi(N)] - \beta(1-\alpha)\log[\Phi(N)], \tag{3}$$

where the constant term is given by $\nu + \beta\log\left(\alpha^{\alpha}(1-\alpha)^{1-\alpha}A\right) + (1+\alpha\beta)\log\left(\bar{k}\right)$.

It is straightforward to show that $V(N;x)$ is, for x small, not globally concave in N, and, in any case, does not attain a maximum on $\{N : N \geq 0\}$. This is clear, since $\Phi(N)$ converges to zero as N goes to infinity; consequently, the $(1+\beta)\log[x+\Phi(N)]$ term in (3) converges to $(1+\beta)\log(x)$, while the $-\beta(1-\alpha)\log[\Phi(N)]$ term goes to $+\infty$.

One can actually say more, given the functional forms we have assumed. In particular, given x, $V(N;x)$ is strictly increasing or strictly decreasing in N as

$$N > \frac{1+\alpha\beta}{\alpha+\alpha\beta}\left(\frac{1}{x}-1\right)$$

or

$$N < \frac{1+\alpha\beta}{\alpha+\alpha\beta}\left(\frac{1}{x}-1\right).$$

Thus, for the relatively wealthy—residents with relative capital holdings $x \geq 1$—$V(N;x)$ is increasing in N over all of $\{N : N \geq 0\}$. This is because the immigration of new workers raises the marginal product of capital. For the relatively poor, those with $x < 1$, $V(N;x)$ is decreasing from $N = 0$ to $N = [(1+\alpha\beta)/(\alpha+\alpha\beta)][(1/x)-1]$ and increasing thereafter. Presumably this is because the new immigrants lower the wage of exiting workers, though the increase in the value of residents' capital that results from immigration eventually outweighs this negative effect on poorer residents' labor income. If the issue space is taken to be $\{N : N \geq 0\}$, there is clearly no majority-rule equilibrium outcome—for any potential number of immigrants N, there is always an $\hat{N} > N$ which more than half the resident population prefers to N.

If, on the other hand, there is an upper bound $\bar{N}$ on the number of potential immigrants, then one can show that each resident's indirect utility is maximized over $\left[0,\bar{N}\right]$ at one of the two endpoints depending on the individual's relative capital holding x. For x sufficiently small, $N = 0$ is preferred, while for x sufficiently large, $N = \bar{N}$ is preferred. Clearly, the relatively wealthy all prefer $\bar{N}$ to any level of immigration $N \in \left[0,\bar{N}\right]$ since $V(N;x)$ is increasing in N on $\left[0,\bar{N}\right]$ when $x \geq 1$. For the relatively poor, those residents with $x < 1$, the indirect utility function $V(N;x)$ is U-shaped on $\{N : N \geq 0\}$, and hence is either U-shaped or simply decreasing and convex on $\left[0,\bar{N}\right]$ depending on $\bar{N}$ and the individual's relative wealth. For standard parameter values, there is a value of x, call it $x\left(\bar{N}\right)$, such that if $x < x\left(\bar{N}\right)$ then agent x strictly prefers $N = 0$ to any other $N \in \left[0,\bar{N}\right]$, while if $x > x\left(\bar{N}\right)$, x prefers $N = \bar{N}$.[7] Thus, the voting outcome hinges on whether the median voter's relative capital holding is above or below $x\left(\bar{N}\right)$. If the median relative initial

[7] The critical value, which is defined by $V(0;x) = V\left(\bar{N};x\right)$, is $x\left(\bar{N}\right) = \left[\Phi(0)^{\eta}\,\Phi\left(\bar{N}\right)^{1-\eta} - \Phi(0)\right] / \left[1 - \left[\Phi(0)/\Phi\left(\bar{N}\right)\right]^{\eta}\right]$, where $\eta = \beta(1-\alpha)/(1+\beta)$.

capital holding is below $x(\bar{N})$, a majority of residents then have relative capital holdings below the critical value $x(\bar{N})$, and so a majority of residents prefer $N = 0$ to any alternative in $[0, \bar{N}]$. Conversely, if the median value of relative wealth is greater than $x(\bar{N})$, then a majority of residents prefer $N = \bar{N}$ to any alternative, making maximal immigration a majority-rule outcome.

Figure 1 illustrates the value function (3) for various values of x. Here we set $\beta = 1$ and $\alpha = .30$. Clearly, the relatively poor agents prefer zero immigration, while the relatively rich want to have the maximum quantity. The primary source of income for the rich is capital income, and therefore they want to have more workers in order to raise the marginal product of capital. The very poor, who derive most of their income from labor, are in the opposite situation—they would prefer fewer workers in order to raise the marginal product of labor. For intermediate values of x, preferences are not single-peaked but are, rather, 'single-caved'.[8]

Not to put too much stress on this example, but one can readily imagine distributions of initial capital where the median value of $x = k/\bar{k}$ falls as income inequality rises.[9] We can then have situations where the majority-favored policy swings from one extreme to the other if inequality is increasing or decreasing over time—that is, it is possible to imagine a situation where an economy like this one may have in the past adopted a closed-border policy, $N = 0$, but in which inequality is falling and x_m, the ratio of k_m to $\bar{k}$, rising. Eventually, if inequality decreases sufficiently, the economy may pass the treshhold where the majority-favored policy switches to $N = \bar{N}$, and borders are opened to the maximum available immigration. One might even imagine cycles in immigration in which the influx of immigrants reverses the decline in inequality, and policy eventually swings back to $N = 0$.

It is also worth pointing out that, given the other parameters of the model, the larger is the maximum level of immigration $\bar{N}$, the more likely is it that $\bar{N}$ will be the majority-rule outcome. Put differently, in a choice of $N \in [0, \bar{N}]$, while a majority of residents might prefer zero immigration to a small $\bar{N}$, a majority may also prefer a larger $\bar{N}$ to zero. This is straightforward, since the fraction of residents preferring $N = \bar{N}$ to $N = 0$—call it $f(\bar{N})$—is simply

$$\begin{aligned} f(\bar{N}) &= \mu\left\{k : k/\bar{k} > x(\bar{N})\right\} \\ &= \mu\left\{k : v(\bar{N}; k/\bar{k}) > v(0; k/\bar{k})\right\}, \end{aligned}$$

and $v(N; k/\bar{k})$ is increasing in N for N sufficiently large.

[8] See Sen [7]. This result is also consistent with the findings of Benhabib [1], who studies a different model.

[9] The median value of x is simply the median value of k, divided by the mean, $\bar{k}$. A decline in the ratio of median to mean of the initial wealth distribution would be taken by some to be synonymous with an increase in inequality.

3 A model with additional direct costs of immigration

The simple example with only pecuniary effects has the unfortunate feature of $N = +\infty$ being the favored choice if no upper bound is placed on the number of potential immigrants. However, it is possible to slightly alter this environment so as to obtain preferences which have single peaks at finite values of N. Suppose that there is an immigration cost that must be borne by existing residents in a per capita fashion. In particular suppose that if N immigrants are admitted, then an agent with initial wealth k faces the following budget constraint in the first-period:

$$k - g(N)\bar{k} = c_1 + s,$$

where g is some nonnegative, increasing, convex function. The multiplication of $g(N)$ by $\bar{k}$ here is useful for maintaining the scale-invariance features of the previous model, but is otherwise inessential.

Because the direct cost of immigration enters a resident's utility-maximization problem as a sort of 'shift' of the resident's initial wealth, the arguments of the last section, which established the form of residents' indirect utilities over N, go through without modification except for the substitution of $k - g(N)\bar{k}$ for k. In particular, we have

$$V(N;x) = \text{constant} + (1+\beta)\log[x - g(N) + \Phi(N)] - \beta(1-\alpha)\log[\Phi(N)]$$

as the indirect utility function over N for an resident whose initial capital relative to the mean is x. With enough convexity in the function $g(N)$, $V(N;x)$ becomes concave in N.[10]

Consider the following specification: $g(N) = .016N^2$. With this introduction of this direct cost, Figure 2 illustrates the indirect utility function for parameters identical to those used to generate Figure 1. As can be seen, the indirect utility function is now concave, and interior maxima can be found for some values of x. Figure 3 illustrates the dependence of the indirect utility function, including the immigration cost $g(N)$, on the discount factor β.[11] The two examples presented are for $\beta = 1$ and $\beta = 1.2$, for a value of $x = 1$. Of course, the 'peak' in the indirect utility function corresponds to agent x's most preferred level of immigration and, as the examples show, this preferred level increases with β. The result is intuitive—the higher an individual's discount factor, the more the individual wishes to invest, hence the more important is the rate of return to capital. The most obvious way to increase the rate of return to capital is to increase the labor force, since this will raise capital's marginal product.

It is also of interest to see how modifications to the production technology can alter the desired level of immigration. Figure 4 illustrates two such (scaled) indirect utility functions for $\alpha = .30$ and $\alpha = .35$, while holding constant $\beta = 1$ and $x = 1$. Increasing α corresponds to increasing the return to capital by making it

[10] One way to think of this cost is as a lump-sum tax levied on citizens to finance immigration costs. Of course, it is assumed that agents with the lowest wealth can afford to pay this tax.

[11] These are scaled by a constant to facilitate comparison.

more important in the production technology. Consequently, existing citizens find the return to investment to be higher and more important in solving their optimization problem. Therefore, they will want to have more immigration.

In subsequent sections economies will be studied in which the preferences of agents are not necessarily concave or single-peaked in the level of immigration. These economies are enlightening because they illustrate the economic interactions at play; moreover, we can in many cases show that majority-rule immigration levels exist even absent single-peakedness. Nevertheless, if this should bother the reader, the introduction of convex immigration costs can, as is illustrated with the examples of Figures 2–4, help produce concavity.

4 A three-period model with redistributive taxation

In this section, we consider a model where immigrants, having arrived, vote together with residents over redistributive fiscal policy. To the extent that immigrants arrive poorer, on average, than natives, they may favor a policy of high taxes and large transfers. The effects of such policies on natives may serve to temper the preference for unbounded immigration which manifested itself in the previous section.

Precisely, we augment the model of the previous the section in the following way. Residents live for three periods and are each endowed with some initial holding of capital. In the first period, as before, residents vote over the number of immigrants to admit, then make a consumption-savings decision. In the second period, immigrants arrive, and are assumed to be endowed with labor only. The second-period income of residents consists of income from labor and first-period savings; the income of immigrants is solely from labor. All citizens—residents and immigrants—make a second consumption-savings decision in period two. Savings from period two to period three earn a fixed rate of return, R, and income from savings is taxed at a constant rate θ. Income in period three, which is also equal to consumption in period three, consists of after-tax savings income plus a lump-sum transfer which is identical for all agents. The fiscal policy to be enacted in period three—which can be reduced, through government budget balance and general equilibrium considerations, to a one-dimensional choice of tax rate—is voted on by the entire population in period two prior to the consumption-savings decision.

Residents are again assumed to have identical preferences over consumption in the three periods, with utility taking the time-additive logarithmic form

$$\ln(c_1) + \beta \ln(c_2) + \beta^2 \ln(c_3).$$

A resident who begins with initial capital k faces the following sequence of budget constraints for the three periods:

$$k = c_1 + s_2,$$

$$rs_2 + w = c_2 + s_3,$$

and

$$(1-\theta)\,Rs_3+\tau=c_3,$$

where $(1-\theta)\,R$ is the after-tax return to savings in period three and τ is the lump-sump transfer payment. As before, the returns to savings and labor in period two, w and r, will be given in equilibrium by the marginal products of capital and labor, and will depend on the capital-labor ratio in period two. We assume the return to savings in period three, R, is a constant.[12]

An immigrant has preferences over consumption in periods two and three given by

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

and faces the pair of budget constraints

$$w=c_2+s_3$$

and

$$(1-\theta)\,Rs_3+\tau=c_3.$$

The lump-sum transfer in period three, τ, is identical across agents and is financed from tax revenue collected on savings income in period three. The government is assumed to have a balanced budget, so that if $\bar{s}_3$ denotes average savings brought into period three, the transfer payment is given by

$$\tau=\theta R\bar{s}_3.$$

Given the sequence of economic and political decisions described above, the politico-economic equilibrium for this economy can be solved using backward induction. In particular, given a distribution of citizens' income at the start of period two, we can solve for the equilibrium level of savings for period three and the transfer payment as a function of the tax rate θ. This induces, for each agent, an indirect utility function for the last two periods as a function of θ and the agent's level of income at the start of period two. We show that for each level of period-two income, this utility function is single-peaked in θ and apply the median voter theorem to obtain the majority-rule period-three tax rate as a function of the median level of period-two income. Consequently, each agent's utility from period two on can be summarized as a function of his or her period-two income and the median level of period-two income.

We then step back to period one. For a given level of immigration N, we can solve each resident agent's period-one consumption-savings problem, where utility from period two onward is given by the indirect utility function described in the previous paragraph. We assume that individuals act taking as given the median level of income in period-two and assume rational expectations in the sense that, in equilibrium,

[12]In other, words, the production technology in period three is simply $F(K)=RK$. Alternatively, it could be assumed that labor is a factor of production in this period as well. This would reduce the tractability of the formulation, without having a substantial impact on the results.

the expected and actual median values of period-two income coincide. As before, equilibrium in the capital market determines aggregate period-two capital, the capital-labor ratio and returns to capital and labor as functions of N. As a consequence, each resident's lifetime utility can be reduced to a function of N and the agent's initial holding of capital. Finally, we can then characterize the majority-rule level of N chosen in the initial period.

The next section examines the subgame starting in period two, given a distribution of income at the start of the period. We characterize the equilibrium tax rate in terms of the median level of period-two income, and derive an expression for each agent's utility in terms of the median level of income and the agent's own income.

4.1 The problem from period-two on

Consider an agent—either a native or immigrant—who begins period two with income equal to y. Given values for the tax rate θ and transfer payment τ, the problem faced by such an agent is

$$\max_s \{\ln(y-s) + \beta \ln[(1-\theta)Rs+\tau]\}.$$

The first-order condition for this problem is

$$\frac{1}{y-s} = \frac{\beta(1-\theta)R}{(1-\theta)Rs+\tau},$$

so that the optimal choice of savings is given by

$$s = \frac{\beta}{1+\beta}y - \frac{\tau}{(1-\theta)R(1+\beta)}.$$

Consumption in the two periods is then given by

$$\begin{aligned} c_2 &= y-s \\ &= \frac{1}{1+\beta}\left[y+\frac{\tau}{(1-\theta)R}\right] \end{aligned} \tag{4}$$

and

$$\begin{aligned} c_3 &= (1-\theta)Rs+\tau \\ &= \frac{\beta}{1+\beta}(1-\theta)R\left[y+\frac{\tau}{(1-\theta)R}\right]. \end{aligned} \tag{5}$$

Given θ and τ, let $s(y;\tau,\theta)$ denote savings of an agent with income y. Then, the transfer payment in equilibrium satisfies

$$\tau = \frac{\theta R \int s(y;\tau,\theta)\,\nu(dy)}{M},$$

where $\nu(dy)$ is the distribution of agents according to income levels, and M is the total measure of agents.[13] Plugging in $s(y;\tau,\theta)$ gives

$$\begin{aligned}\tau &= \frac{\theta R}{M}\int\left[\frac{\beta}{1+\beta}y-\frac{\tau}{(1-\theta)R(1+\beta)}\right]\nu(dy)\\ &= \theta R\frac{\beta}{1+\beta}\bar{y}-\frac{\theta\tau}{(1-\theta)(1+\beta)}\end{aligned}$$

where $\bar{y}\equiv\int y\nu(dy)/M$ is average period-two income. Then

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

Remembering the expressions for individuals' consumption—equations (4) and (5)—note that

$$\frac{\tau}{(1-\theta)R}=\frac{\theta\beta}{(1-\theta)(1+\beta)+\theta}\bar{y},$$

so that for individual y,

$$\begin{aligned}y+\frac{\tau}{(1-\theta)R} &= y+\frac{\theta\beta}{(1-\theta)(1+\beta)+\theta}\bar{y}\\ &= \frac{(1+\beta)y+\theta\beta(\bar{y}-y)}{1+\beta-\theta\beta}.\end{aligned} \tag{6}$$

Combining (6) with (4) and (5), individual y's consumption in the two periods can be expressed as

$$c_2=\frac{1}{1+\beta}\left[\frac{(1+\beta)y+\theta\beta(\bar{y}-y)}{1+\beta-\theta\beta}\right]$$

and

$$c_3=\frac{\beta}{1+\beta}(1-\theta)R\left[\frac{(1+\beta)y+\theta\beta(\bar{y}-y)}{1+\beta-\theta\beta}\right].$$

Then, individual y's indirect utility function—maximized utility as a function of y, $\bar{y}$, θ and other parameters has the form

$$v(y,\bar{y},\theta)=\eta+(1+\beta)\ln\left[\frac{(1+\beta)y+\theta\beta(\bar{y}-y)}{1+\beta-\theta\beta}\right]+\beta\ln(1-\theta), \tag{7}$$

where the constant term is $\eta=\ln\left(\frac{1}{1+\beta}\right)+\beta\ln\left(\frac{\beta}{1+\beta}\right)+\beta\ln(R)$. As in the two-period model of the previous section, it is convenient to express an agent's indirect utility in terms of his or her income relative to the mean level of period-two income. Let

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

so that an agent's indirect utility function can be written as

$$v(y,\bar{y},\theta)=\eta+(1+\beta)\ln(\bar{y})+w(\theta;y/\bar{y}).$$

[13]If N immigrants have been admitted in period one, then $M=1+N$.

While the term $(1+\beta)\log(\bar{y})$ will come into play when we step back to consider the immigration decision in period one, for the purposes of characterizing the politico-economic equilibrium tax rate in period three it may be safely ignored. For the remainder of the section, we focus on $w(\theta; y/\bar{y})$.

Let z stand for an individual's income relative to the mean in period two—*i.e.*, $z = y/\bar{y}$. Consider the problem of maximizing $w(\theta; z)$ with respect to θ, subject to the constraint $0 \leq \theta \leq 1$. The constraint $\theta \leq 1$ will not be binding, of course, as $w(1; z) = -\infty$, and $w(\theta; z) > -\infty$ is attainable for $\theta < 1$. The constraint $\theta \geq 0$ will be binding, however, for individuals with $z \geq 1$. It's easy to show that for $z \geq 1$, $w(\theta; z)$ is maximized at $\theta = 0$. To see this, note that $w(\theta; z)$ can be written as

$$w(\theta; z) = (1+\beta)\ln[(1+\beta)z + \theta\beta(1-z)] + [\beta\ln(1-\theta) - (1+\beta)\ln(1+\beta-\theta\beta)], \tag{8}$$

and, for $z \geq 1$, the first term is decreasing in θ—strictly so, if $z > 1$. The second, bracketed term is also decreasing in θ over the interval $[0,1]$ for any $\beta > 0$. In sum, for any individual with period-two income greater than the average level of period-two income, the agent's indirect utility function over tax rates is trivially single-peaked, and $\theta = 0$ is the agent's most preferred tax rate.

When $z < 1$, $w(\theta; z)$ is increasing in θ at $\theta = 0$, so neither the constraint of $\theta \leq 1$ nor $\theta \geq 0$ are binding. One can show that $w(\theta; z)$ is strictly concave in θ on $[0,1]$ and attains a unique maximum at some $\theta \in (0,1)$. Concavity is most easily seen by considering the last expression for $w(\theta; z)$, equation (8). Differentiation reveals the second, bracketed term is strictly concave in θ, while the $\ln[(1+\beta)z + \theta\beta(1-z)]$ term is concave as the composition of concave functions.

For the $z < 1$ case, tedious algebra[14] shows that the first-order condition for an interior solution to

$$\max\{w(\theta; z) : 0 \leq \theta \leq 1\}$$

reduces to the following quadratic equation in θ:

$$\beta^2(1-z)\theta^2 - (1+\beta)[1+2\beta(1-z)]\theta + (1+\beta)^2(1-z) = 0.$$

The appropriate solution to this quadratic equation—the root between zero and one—is

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

The function $\theta^*(z)$ thus gives the most-preferred tax rate for individuals whose period-two income is less than the average level of period-two income across all agents.

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

[14] See the appendix.

$z \geq 1$, 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 [4], for sufficiently small values of z, $\theta^*(z)$ may be on the 'wrong' side of the economy's Laffer curve.

Let

$$\theta(z) = \begin{cases} 0 & \text{if } z \geq 1 \\ \theta^*(z) & \text{if } z < 1 \end{cases}. \tag{9}$$

Then, $\theta(z)$ is the preferred tax rate an individual who begins period two with income y such that $y/\bar{y} = z$ for any $z \geq 0$. Since each individual's preferences over the tax rate are single-peaked, the median voter theorem applies, and the majority-rule tax rate in period three will be given by $\theta(z_m)$, where z_m is the median value of relative income in period-two—*i.e.*, $z_m = y_m/\bar{y}$. If $z_m \geq 1$—so that the median voter has income higher than the mean—then the majority-rule tax rate is zero; otherwise, it is given by $\theta^*(z_m)$.

Given our solutions for each individual's preferred tax rate, for any distribution of income at the start of period two we can calculate the median level of income, the mean level of income and the corresponding majority-rule tax rate. The utility which each agent receives from period two onward can then be summarized in terms of three variables—the agent's own period-two income, the median level of period-two income and the mean level of period-two income. Using (7), when the tax-rate in period three is set according to the preferences of the median voter—*i.e.*, $\theta = \theta(y_m/\bar{y})$—the utility from period two on of an agent who begins period two with income y is

$$\begin{aligned} v(y, \bar{y}, \theta(y_m/\bar{y})) &= \eta + (1+\beta)\ln\left[\frac{(1+\beta)y + \theta(y_m/\bar{y})\beta(\bar{y}-y)}{1+\beta-\theta(y_m/\bar{y})\beta}\right] + \beta\ln[1-\theta(y_m/\bar{y})] \\ &\equiv W(y; y_m, \bar{y}). \end{aligned} \tag{10}$$

Note that with $y = w$, $W(w; y_m, \bar{y})$ also gives the utility from period two onward of an immigrant who arrives with only an endowment of labor services to supply.

4.2 Back to the initial period

We now step back to period one. An agent's income y in period two comes potentially from two sources, capital income and labor income—that is $y = w$ or $y = rs + w$, depending on whether the agent is an immigrant or resident and, if the latter, whether the resident engaged in a positive amount of savings in the first period. The problem we now turn to consider is the decision problem faced by a resident at the start of the first period.

Taking as given prices, the amount of immigration and the period-two income distribution, a resident with capital k in period one chooses savings s to maximize his or her lifetime utility, given by

$$\ln(k-s) + \beta W(rs+w; y_m, \bar{y}). \tag{11}$$

As before, in equilibrium, the factor prices w and r will be functions of the ratio of aggregate period-two capital to aggregate labor, $1+N$. Given the logarithmic form of the agent's first-period utility and the indirect utility function W, it's possible to derive exact decision rules conditional on the level of immigration, N, aggregate capital, K, and the median and mean of the period-two income distribution, y_m and $\bar{y}$. In a rational expectations equilibrium it must be the case that individual decisions are consistent with the aggregates K, y_m and $\bar{y}$.

Our solution procedure is as follows. For each level of immigration N, we conjecture values for the aggregates K and y_m, and solve the agents' decision problems.[15] The agents' decision rules, in particular their savings decision can be aggregated using the distribution of initial capital holdings, to arrive at updated values K' and y'_m for aggregate capital and median period-two income. The process is then repeated using the updated values[16] and terminated when the changes in K and y_m from one iteration to the next were negligible. This procedure proved to be stable and to converge rather quickly to equilibrium. Thus, for each possible level of immigration we obtain the resulting equilibrium capital-labor ratios, factor prices, medians and means of the period-two income distribution and period-three tax rates. As a consequence, we can associated with each resident k a utility function $V(N;k)$ giving k's lifetime utility as a function of the level of immigration.

One issue which of potential importance in our quantitative analysis is whether or not residents, in period one, are allowed to borrow. To understand why this may matter, consider that if residents face a nonnegativity constraint on savings in the first period, then the period-two income of every resident is at least as large as the income of an immigrant, which is simply w. This means that the median voter over redistributive policy in period two—the individual with the median level of period-two income—will be a resident for all levels of immigration less than 100% of the resident population. On the other hand, when residents are allowed to borrow in period one, those who do so will enter period two with income net of loan repayments which is less than w, placing them at the bottom of the period-two income distribution. Consequently, if a positive fraction of the resident population borrows in period one, the median voter in period two will be an immigrant for levels of immigration less than 100% of the resident population.

In practice, however, a choice between one of these two environments has a significant impact on the quantitative results only when the fractions of residents who either borrow or are constrained are implausibly large—in particular, greater than one-half the initial resident population. This is true because whether the lower end of the period-two income distribution consists of, say, q period-one borrowers below N immigrants or N immigrants below p constrained residents, individuals at all but the very bottoms of the two distributions are roughly identical—in fact, any one of the p constrained resident is, in terms of period-two income, identical

[15] Note that $\bar{y}$ is implied by a choice of K, given N, since $\bar{y} = K^{\alpha}(1+N)^{1-\alpha}/(1+N)$.

[16] In some cases we employ a smoother form of updating, setting the period-two capital stock for the subsequent iteration equal to $qK' + (1-q)K$, $q \in (0,1)$, rather than K'.

to an immigrant. If the fraction of borrowers q is small, these individuals will not figure into the politico-economic equilibrium in period two, except insofar as their presence may lower period-two average income from what it would be if no borrowing were allowed. In particular, no citizen with period-two income less than w would ever be the median voter in period two.

If the fraction of residents who borrow is extremely large—large enough that the median voter in period two is, for some levels of immigration, a borrower[17]—then the results can differ significantly across the two environments. Though we view this case as highly implausible, it's worth examining inasmuch as it serves to illustrate a key feature in the determination of the period-three tax rate. Suppose initially we are in the environment in which residents are constrained not to borrow, so that the resident with the smallest income in period two still has income at least equal to w, which is the income of all immigrants. Then, because the equilibrium third-period tax rate, from (9), depends only on the ratio of the median period-two income to average period-two income, the period-three tax rate is bounded above by $\theta(1-\alpha)$, since for any level of immigration we will have

$$\begin{aligned}\frac{y_m}{\bar{y}} &\geq \frac{w}{\bar{y}}\\ &= \frac{(1-\alpha)A[K/(1+N)]^{\alpha}}{AK^{\alpha}(1+N)^{1-\alpha}/(1+N)}\\ &= 1-\alpha.\end{aligned}$$

Since $\theta(z)$ is decreasing in z, we have $\theta(y_m/\bar{y}) \leq \theta(1-\alpha)$ for all levels of immigration. For standard parameter values, this value is around 39%. When borrowing is permitted, and the fraction of residents who borrow is large enough that for some levels of immigration the median voter is a borrower, the period-three tax rate will be higher than $\theta(1-\alpha)$.

In either case, though, if the economy admits a large enough number of immigrants, and if immigrants have only labor to supply in period two, then the median level of period-two income will either rise or fall to w, and remain there even as more immigrants are added. Consequently, the tax rate—whatever its level for small amounts of immigration—will become fixed at $\theta(1-\alpha)$ if enough immigrants are admitted in the first period.

5 Some numerical examples

Because of the complicated nature of the typical agent's objective function, given by equations (10) and (11), and constraints, described above, it is difficult to obtain analytic results concerning the equilibrium level of immigration and taxation. Instead, it is instructive to consider a few numerical examples, which are presented below. The experiments below consider several alternative specifications of the environment.

[17]If $q(N)$ denotes the fraction of residents who borrow, then the case described here arises if $q(N) \geq \frac{1}{2}(1+N)$, implying at the least that $q(N) \geq \frac{1}{2}$, so more than half the resident population must be borrowing.

Initially, we look at distributions with two types of agents, in which the population is evenly split between two levels of initial wealth. This example is useful in highlighting the role which initial wealth inequality can play in determining the majority-rule level of immigration. We then consider the case of a uniform distribution of initial wealth, focussing on the effect of immigrants' enfranchisement—or lack thereof—on residents' preferences over alternative levels of immigration. Finally, we examine an environment in which residents' initial wealth has an approximate lognormal distribution, focussing on both the consequences changes in the degree of initial wealth inequality as well as the way in which the shape of the initial wealth distribution impacts on tax policy and preferences over immigrants.

The primitives of the economies examined below are the parameters α and β, and the initial distribution of residents' wealth. In all the examples that follow we set $\beta = 1$ and $\alpha = .30$, and normalize the size of the initial resident population to unity.

5.1 Example 1

Consider an economy in which half the residents having initial wealth of 10 units, while the remaining residents have wealth of 5 units. It is assumed that the level of immigration can be any level between zero and 120% of the resident population.

The indirect utility functions of the wealthier and poorer residents, as functions of the level of immigration, as well as the equilibrium third-period tax rate, are shown in Figure 5. The units on the horizontal axis in all three panels of the figure are immigrants as a percent of the resident population. For a moment, focus on the range of zero to 100%, putting aside for now the sharp discontinuities which occur when the number of immigrants exceeds the size of the resident population.

In this example, the poorer residents are made worse off by increased immigration, with zero being the preferred immigration level for residents of this type. This comes about because the new citizens have no capital and therefore merely lower the return to labor. The relatively poor residents in this example rely heavily on their labor income, relative to their richer counterparts. The rich citizens in contrast are in favor of large levels of immigration, preferring a level of immigration of just up to 100% of the resident population. Since immigrants increase the supply of labor, immigration raises the marginal product of capital, and therefore raises the welfare of rich citizens, and this overwhelms the fact that their labor income falls.

It should be noted that, in this dynamic setting, in which residents make two non-trivial consumption-savings decisions, it is altogether possible—and in fact the case in this example—that even as a poorer resident's welfare is being reduced by immigration, their income from labor and savings combined may be rising. Welfare falls nonetheless as the poorer agents are forced to make trade-offs which they would not absent immigration. In particular, the savings of poorer residents—both from period one to period two and then from period two to period three—rise as the level of immigration rises, while their consumption in both the first and second periods (not shown) declines. In particular, absent immigration, with a consequently higher return to labor in the second period, these residents would not have had to save so large a fraction of their initial wealth endowment, and would have enjoyed higher first-period consumption. The rich, in contrast, would save a large fraction of their initial endowment in any event, and the higher return to savings that comes with an influx of immigrants only enhances their welfare.

The equilibrium period-three tax rate, shown in the bottom panel of Figure 5, is the preferred tax rate of the individual with the median level of period two income, calculated according to (9). For levels of immigration between zero and 100% of the resident population, this median voter is a poorer resident.[18] Over this range, the tax rate is decreasing in the level of immigration. This is because new immigrants represent a 'drain' on the resources of existing citizens. They do not generate as much income, but nevertheless receive a transfer payment.[19] Therefore, the more immigration there is, the lower will be the tax and transfer level that existing poor citizens will choose. In this case, as the level of immigration approaches 0.9, the tax and transfer level will be zero.

Things change dramatically once immigrants represent more than half of the total population in period two. At this point, the median voter over tax policy switches from being a poor resident to an (even poorer) immigrant. The level of period-two income which defines the median drops discontinuously from the income of an individual with both labor income and income from savings, to someone who has only labor income. This much poorer median voter consequently prefers a much higher tax rate. Because the period-two income of an immigrant here is simply w, for all levels of immigration beyond 100% of the resident population, the tax rate in period three is $\theta\left(w/\bar{y}\right) = \theta\left(1-\alpha\right)$, or roughly 39%. The sharp increase in the tax rate—and, consequently, in the redistributive transfer payment—harms both types of initial residents, the wealthier more so, as one would expect. This pattern recurs in all of our subsequent experiments; consequently we will focus below only on levels of immigration between zero and 100% of the resident population.

While preferences of the wealthier residents are not single-peaked, it is nonetheless clear that zero immigration—preferred over any other level by the poorer half of the population—is a majority-rule outcome.

The four panels of Figure 6 show the second period-capital stock, wage rate and return to capital as functions of the level of immigration, as well as the median and average levels of period-two income, the ratio of which determines the period-three tax rate. As one would expect, higher levels of immigration are associated with lower wages, a higher return to capital and a greater stock of capital. Qualitatively, this pattern of behavior for the second-period prices and quantities recurs in all of our subsequent experiments; consequently, in what follows we will focus primarily on residents' indirect utilities over the level of immigration as well as the behavior of the third-period tax rate. The fairly constant decline in average period-two

[18]At zero immigration we assume a poorer resident is the median voter.

[19]Recall from the derivation of an agent's preferred tax rate (9) that it is not simply the agent's income that matters, but rather the agent's income relative to average income, and average income here is falling as immigrants enter the economy.

income, shown as the dashed line in the bottom panel, is also a typical pattern in all of our experiments in which immigrants arrive with only labor income. The increase in median period-two income (the solid line) over the range 0 to 100%, comes, as mentioned above, from the greater savings out of initial wealth undertaken by poor residents as immigrants both lower the value of these residents' period-two labor income and raise the return to savings. At the 100% immigration level, the identity of the median period-two income recipient switches from a poor citizen to an immigrant; it is this discontinuous drop which causes the large jump in the period-three tax rate shown in Figure 5.

The fact that the return to capital is increasing in the level of immigration lends credence to the argument that immigration is good for growth. In a model in which there were many more periods one might imagine how immigration, by immediately raising the return to capital, would cause investment to increase for many periods. If there were constant aggregate returns to capital, this would further generate an increase in the growth rate.

This case should be contrasted with the case in which the poor agents have initial wealth of 9 units instead of 5. This case is illustrated in Figure 7. In this instance both the rich and poor agents prefer a large level of immigration. The reasoning is simple: since both rich and poor rely heavily on their capital income and are not too disparately affected by immigration, their preferences over alternative levels of immigration are similar. Figure 7 also shows that the equilibrium level of the tax rate, as chosen by the poorer citizens when immigrants are less than 100% of the size of the resident population, is also very low and equal to zero for immigration levels above 12%. Again, there is a dramatic discontinuity as the number of immigrants becomes so large that the preferences of an immigrant dictates the third-period fiscal policy. As before, both types of residents suffer from this large tax increase. Loosely speaking, this example illustrates why one might expect to observe an association between wealth inequality and the existence of programs to redistribute this wealth.

In this example, it is clear that immigration equal to just up to 100% of resident population is a majority-rule outcome.[20]

Another feature to note in this example is that as long as immigrants do not outnumber residents, the median voters in the first and second periods are essentially the same agent—a poor citizen. Therefore, there is no need for the median voter in the first period to predict the behavior of another future median voter in the subsequent period. This is not the case in the next example.

5.2 Example 2

Consider an economy similar to that of the previous example except now assume that the initial wealth level is uniformly distributed between 1 and 9, with the initial median voter having a wealth level of 5 units. In

[20]If we assume that when the numbers of natives and immigrants are equal, a native's preferences are decisive, then the utilities shown in the Figure would be upper-semicontinuous, with maxima at 100.

this case, the median voter in period one must calculate how his choice of immigration will influence the behavior of the succeeding median voter in the subsequent period, who will be choosing the equilibrium tax rate. At zero immigration, the median period-two income recipient is the resident with the median initial level wealth; for all other levels of immigration, though, the median period-two income recipient is a resident further down in the initial wealth distribution.

Figure 8 shows the utilities of the wealthiest, median and poorest residents, as a function of the level of immigration. *Again*, it must be recalled that this is the expected sicounted utility from period one onward. The bottom panel also shows the equilibrium period-three tax rate as a function of the level of immigration. As more (poor) immigrants are admitted into the economy, the median voter in period two becomes poorer, and therefore becomes more inclined to choose a higher tax rate, and therefore a higher level of transfers. For immigration levels above 80%, the tax rate is unchanged at 39%. The reason is that for levels of immigration above this quantity, the median voter in period two becomes someone an individual with only labor income, and therefore is someone identical to a new immigrant.[21] As discussed in the preceding section, once the level of immigration rises to the point where median period-two income is equal to the wage rate w, then the ratio of median to average income is simply labor's share of income, which is $1 - \alpha$ given our Cobb-Douglas specification of production. Adding more immigrants beyond this critical value does not change anything.

While the utility of the wealthiest resident is decidedly not single-peaked, nor even is the utility of the median resident, nonetheless at least half of the resident population, from the median initial wealth-holder on down, does not wish to have any immigration. In this case, the median resident's preference for zero immigration owes primarily to the rise in the tax rate that results in period two, while the poorest resident's preference for zero immigration owes primarily to the depressing effect which immigrants have on the return to labor. This can be seen very clearly in example 3 below, in which immigrants are disenfranchised in the second-period, resulting in a zero tax rate over almost the entire range of immigration from zero to 100%. The preferences over immigration levels of the median resident are completely reversed by this change, while the poorest resident continues to prefer a zero level of immigration.

One might be tempted to think that much of the behavior in this example stems from the fact that the immigrants have no capital, and the results would be reversed if they were relatively rich—*i.e.*, the median voter would then prefer more immigration. In fact, only some of this statement is true. Figure 9 shows the results for the case in which immigrants have 9 units of capital, rather than zero, as in the economy of Figure 8. In this sense, immigrants are as rich as as the richest citizens. Rich residents now prefer no immigration while poor residents now prefer the maximum level. These effects are present because the investment generated by the immigrants will raise the wage of workers while lowering the marginal product

[21] That is, in this example a small fraction of residents—around 10% of the resident population—are constrained in their first-period savings decision, choosing $s = 0$. Such individuals enter period two with only labor income.

of capital.

The tax rate chosen by the mdeian period-two voter is also shown, and it is positive for small levels of immigration, but then rapidly falls to zero. The reason for this is tha as this immigration of the rich increases, the median voter eventually becomes richer than the mean and this median voter then wants a zero tax rate.

The median resident in this case prefers zero immigration—just as in Figure 8. The reason for this is that although this individual benefits from the increase in the marginal product of labor, and the fall in the tax rate, this is outweighed by the fall in the return to capital.

5.3 Example 3

Let us return to the case in which immigrants have zero capital. The results differ dramatically, as compared to the economy shown in Figure 8, if immigrants are not franchised to vote over fiscal policy in the second period. To see this consider an economy identical to the one just described but suppose that immigrants are never given the right to vote. Consequently, the median voter is the same individual in periods one and two.

Figure 10 shows the same information conveyed in Figure 8 for this case. In contrast with the previous results, the tax rate is now decreasing in the level of immigration, and is very quickly—at a level of immigration somewhere around 4% of the resident population—equal to zero. The reason for this is that, with immigrants disenfranchised, the median voter who decides on the third-period tax rate is unchanging, and is simply the initial median resident. The period-two income of this resident rises with the level of immigration, as immigration raises the return to saving. Meanwhile, as in the previous examples, immigration drives down the average level of period-two income. Eventually—around 4% immigration—the median voter's period-two income is higher than average period-two income, so that this resident prefers a zero tax rate and zero transfer.[22] Figure 11 shows average period-two income, median period-two income and the income of the median resident as a function of the level of immigration.

The message to be gleaned from these examples is that if immigrants are relatively poor, then granting them voting rights may result in relatively high taxes. From the perspective of a wealthy resident, immigration is good because it raises the return to capital. However, this benefit is tempered by the fact that immigrants are able to vote in the future. These residents would then be in favor of a prolonged period of residency for new immigrants before they earned the right to vote.

[22] In fact, this small segment with $\theta > 0$, from $N = 0$ to $N = 4\%$, is due to the savings constraint ($s \geq 0$) which we imposed in the computations of this case. For residents who do save, savings is linear in initial wealth. If all residents had positive savings in the first-period, then average period two income at zero immigration would be the income of the average initial wealth-holder—who is also the median initial wealth-holder, given the uniform distribution of initial wealth. If some residents do not save—and here, a small fraction do not—then average period-two income at zero immigration will be higher than the income of the average initial wealth-holder, who is also the median period-two voter when immigrants are not given the right to vote.

5.4 Example 4

In this example, we assume that residents' initial wealth consists of a minimum level of wealth which is identical for all residents plus a component which is distributed across residents lognormally. In all of following the experiments, the minimum wealth component is set at five units and the mean of the lognormal component is set at 10 units.

We initially consider the case of an economy with a fairly low level of inequality, setting the remaining free parameter of the distribution[23] so that the lognormally distributed component of initial wealth has a Gini coefficient of approximately 0.25. Figure 12 plots the tax rate in period three as a function of the number of immigrants. The tax rate initially falls, then rises—at immigration equal to 100% of the resident population it necessarily equals $\theta(1-\alpha)$, and if the graph were extended to the right, the tax rate would be constant at this value. The explanation for this pattern in the tax rate lies at least partially in the nature of the lognormal distribution, a point we will return to momentarily. For now, however, we turn to the resulting indirect utilities of residents over the level of immigration.

In this case, as one can see from Figure 13, residents have well-behaved, single-peak preferences over the level of immigration, with two of the three types of resident shown having preferred points which are interior to the range of immigration from 0 to 100% of the resident population. The peaks are also monotone in the resident's level of initial wealth, with the poorest resident preferring zero immigration, the median resident preferring immigration equal to roughly 88% of the resident population, and the wealthy resident[24] preferring immigration just over 89% of the resident population. It is interesting to note, though not entirely unexpected, that the median resident's peak does not minimize the period-three tax rate; the tax rate at the median resident's preferred level of immigration is approximately 5%.

If we apply the median voter theorem in this instance—which is applicable given the single-peaked preferences—the majority-rule equilibrium level of immigration will be near 88% of the resident population, with a resulting tax rate in the third period which is near 5%.

We now consider an increase in the degree of initial wealth inequality, keeping other parameters, such as the mean and minimum wealth level, fixed. In particular, suppose that the Gini coefficient of inequality for the lognormal component of resident's wealth is roughly 0.75 rather than 0.25. Figure 14 shows the tax rate on savings income in the third period, which is now increasing over the whole range of immigration levels, and is also uniformly quite higher than in the low-inequality setting. The higher level of the tax rate that now obtains is not surprising given that the tax rate is a decreasing function of the ratio of median

[23]Precisely, a typical resident's initial wealth takes the form $k_{\min} + X$, where $\log(X) \sim N\left(\mu, \sigma^2\right)$. The Gini coefficient for X depends only on σ^2 (see Lambert [5], p.45) while the mean of X is $\exp\left[\mu + \left(\sigma^2/2\right)\right]$. Given a value for Gini, hence a σ^2, we set μ to give a mean of 10. Note that the median value of X is $\exp(\mu)$.

[24]The 'wealthy' resident is defined as the resident whose wealth level is the cut-off for the top 1% of the initial wealth distribtution.

period-two income to average period-two income, and so is, in a sense, increasing in the degree of income inequality in period two. The greater degree of initial wealth inequality in this example translates into a greater degree of income inequality in the second period, thus leading to a higher tax rate at all levels of immigration.

Utilities over immigration are shown in Figure 15. While the wealthy resident continues to have a preferred immigration level which is interior—though somewhat higher—both the median and poor residents now prefer zero immigration. In part, this is due to the fact that greater initial wealth inequality translates into a lower level of median initial wealth—the median resident is now an individual who starts off poorer than in the low inequality case. Conversely, the 'wealthy' individual whose utility is shown in the figure—the individual whose wealth holding defines the top 1% of the initial wealth distribution—is now a much wealthier individual than the corresponding individual in Figure 13.[25]

How can we explain the particular shapes which the equilibrium level of taxation has in the two experiments? Consider the low inequality case first, where the equilibrium tax rate was initially decreasing then increasing in the level of immigration. With the low level of inequality considered in this example, the median of the initial wealth distribution is slightly to the right of the mode. Figure 16 plots portions of the initial wealth distribution for both the low and high inequality cases, with circles identifying the medians. At zero immigration, the median level of initial wealth also identifies the median voter over the third-period tax policy—since savings are monotonic in initial wealth, the median initial wealth-holder has the median value of period-two income absent any immigration. Imagine for a moment that the pool of potential immigrants is not a continuum; rather suppose that immigrants come in multiples of some constant, small unit of mass—call it Δ for concreteness. Since immigrants arrive at the bottom of the period-two income distribution, for each 'unit' of immigration which the economy admits, the level of wealth which defines the median period-two voter moves leftward—*i.e.*, downward in the initial wealth distribution—in discrete, though non-constant, steps. Thus, each successive mass Δ of entrants moves the identity of the median period-two voter, in terms of initial wealth, downward, and the size of these 'steps' must be such that the mass over each is equal to Δ.

On the right side of the mode, the requisite 'step-size' adjustment in the identity of the period-two median voter actually shrinks as each discrete mass immigrants arrives, since the height of the density is rising as we move downward in the distribution—each Δ units of mass correspond to successively smaller steps. For each constant unit of immigration which arrives, the wealth level identifying the median period-two voter necessarily falls, but at a decreasing rate. To the left of the mode, on the other hand, the step sizes must increases as each successive mass of immigrants arrives, since the height of the density is now falling as

[25] In moving from the low inequality to the high inequality case, the median initial wealth level falls from about 14 units to 11 units; the level of wealth defining the top 1% of the initial wealth distribution rises from about 31 units to about 64 units.

we move downward in the distribution. Consequently, for each constant unit of immigration which arrives, the wealth level identifying the median period-two voter must fall at an increasing rate. If these effects are large relative to other general equilibrium effects in the model, we can expect the median level of period-two income to fall at first slowly as the level of immigration is increased, then more rapidly, as the level of initial wealth identifying the median period-two vote drops sharply. This is precisely what happens in our example, as shown in the top panel of Figure 17.

Average period-two income, on the other hand, should be more robust to each successive unit of immigration—in fact, in the examples here, as in the previous ones, it falls at a roughly constant rate as the level of immigration rises, as both panels of Figure 17 show. As a consequence, in the low inequality case, the ratio of median period-two income to average period-two income initially rises then falls—resulting in a third-period tax rate which initially falls than rises. That is, the income of the median period-two voter is initially—at zero immigration—below average and hence this individual prefers a positive tax rate. As the level of immigration increases, the median period-two voter becomes more like the average period-two income recipient, and so favors smaller taxes and transfers. Finally—as the level of immigrants pushes the median period-two voter down the left side of the mode of the initial wealth distribution—the median period-two voters are residents whose incomes are falling rapidly below average; consequently, they are individuals who prefer increasingly high taxes and transfers.

When the level of initial wealth inequality is high, the median of the initial wealth distribution is farther to the right of the mode, which is now much nearer the minimum level of initial wealth. [See again Figure 16] As a result, the range and associated mass over which the wealth level identifying median period-two voter falls precipitously as immigrants arrive—as we come down the density on the left side of the mode—is much smaller than in the low inequality case. The mass between the median and the mode is much larger than that between the mode and the minimum wealth level, the opposite of the low inequality case.[26] Consequently, the gap between median and average period-two income grows rapidly only at a high level of immigration. Up to that point, as the bottom panel of Figure 17 shows, median period-two income falls fairly constantly, though somewhat more rapidly than period-two average income. Thus, the third-period tax rate gradually rises over most of the range of immigration from zero to 100%, increasing rapidly only as immigration nears 100% of the resident population.

6 Conclusions

The economies studied here are, of course, necessarily highly stylized so that one can study all the complicated forces at play. The fact that tax and immigration policies are determined endogenously implies that

[26] Roughly 17% of the mass is to the left of the mode in the high inequality case, versus roughly 33% in the low inequality case.

agents must examine all of these complicated interactions when expressing their preferences over the desired immigration and fiscal policies. Nevertheless, the model does give some insights as to what factors lead to a higher preference for increased immigration.

The results that appear to be forthcoming from this model can be enumerated as follows. First, the more farsighted are agents—*i.e.*, the higher is the discount factor—the more they will prefer higher immigration. This is because the increased labor force will raise the return to capital, which is important if agents strongly care about future consumption.

Second, for similar reasons, the higher is capital's share of income, the greater will be the desired level of immigration.

Thirdly, the higher is the level of initial wealth equality, as measured by the ratio of mean wealth to median wealth, the greater will be the desired level of immigration. There is some loose support for this prediction. Most measures of wealth or income show there is more inequality in the US than in Canada or Australia, and these latter countries have higher rates of immigration than does the former.

Fourth, if immigrants are relatively poor and quickly receive the franchise to vote over the allocation of resources, then increased immigration is likely to lead to higher future taxes and transfers.

Fifth, some subtle changes in the distribution of initial wealth can lead to drastic changes in the level of desired immigration. The initial median voter must weigh the benefits provided by increased immigration (*i.e.*, a higher marginal product of capital) with the costs (*i.e.*, lower wage rates, higher future taxes and transfers). Perhaps the most important of these costs is to consider exactly which policies the future median voters may select. If the introduction of 5% more workers is likely to drastically change the wealth level of the subsequent median voter, and therefore radically change the subsequent policies that will be chosen, then the desired level of immigration chosen by the initial median voter may not be very high. Although many of the arguments against increased immigration in European countries are often couched in terms of cultural impact, it would appear that this is really economically indistinguishable (or observationally equivalent) to a "fear" of what sorts of policies these immigrants will favor in the future if they are given the right to vote and thereby determine policies.

Many of the experiments we conducted had the premise that immigrants were relatively poor. This is not an unreasonable assumption since this is exactly hat is witnessed in immigration patterns around the world. If these immigrants were instead relatively rich, then it is easy to see why existing rich agents would not want as much immigration, since it would lower the return to existing capital. Similarly, poorer agents might wish to have more immigration since it would raise the wage to labor, and provide a higher tax base for redistributive fiscal policies.

7 Appendix: the first-order condition for an agent's preferred tax rate

Let $z \equiv y/\bar{y}$. Up to a constant, the objective is given by

$$(1+\beta)\log\left[(1+\beta)z+\theta\beta(1-z)\right]-(1+\beta)\log(1+\beta-\theta\beta)+\beta\log(1-\theta).$$

The first-order condition is then

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

or

$$\beta(1+\beta)\left[\frac{1-z}{(1+\beta)z+\theta\beta(1-z)}+\frac{1}{1+\beta-\theta\beta}\right]=\frac{\beta}{1-\theta}.$$

Consider the bracketed expression on the left-hand side. Combining the two fractions inside the brackets gives a fraction the denominator of which is

$$\begin{aligned}\left[(1+\beta)z+\theta\beta(1-z)\right](1+\beta-\theta\beta) &= \left[(1+\beta-\theta\beta)z+\theta\beta\right](1+\beta-\theta\beta)\\ &= (1+\beta-\theta\beta)^2 z+\theta\beta(1+\beta-\theta\beta).\end{aligned}$$

while the numerator is

$$\begin{aligned}(1-z)(1+\beta-\theta\beta)+(1+\beta)z+\theta\beta(1-z) &= (1-z)(1+\beta-\theta\beta)+(1+\beta-\theta\beta)z+\theta\beta\\ &= 1+\beta-\theta\beta-z(1+\beta-\theta\beta)+(1+\beta-\theta\beta)z+\theta\beta\\ &= 1+\beta.\end{aligned}$$

We thus obtain

$$\beta(1+\beta)\frac{1+\beta}{(1+\beta-\theta\beta)^2 z+\theta\beta(1+\beta-\theta\beta)}=\frac{\beta}{1-\theta},$$

or

$$(1+\beta)^2(1-\theta)=(1+\beta-\theta\beta)^2 z+\theta\beta(1+\beta-\theta\beta).$$

Expanding out the terms on the right-hand side gives

$$(1+\beta)^2 z-2(1+\beta)\beta z\theta+\beta^2 z\theta^2+(1+\beta)\beta\theta-\beta^2\theta^2,$$

or

$$(1+\beta)^2 z+\beta(1+\beta)(1-2z)\theta-\beta^2(1-z)\theta^2.$$

Collecting these together with terms on the left—$(1+\beta)^2-(1+\beta)^2\theta$—gives

$$\beta^2(1-z)\theta^2-\left[(1+\beta)^2+\beta(1+\beta)(1-2z)\right]\theta+(1+\beta)^2(1-z)=0.$$

The coefficient on the term in θ can be further simplified to

$$
\begin{aligned}
-(1+\beta)[1+\beta+\beta(1-2z)] &= -(1+\beta)[1+2\beta-2\beta z] \\
&= -(1+\beta)[1+2\beta(1-z)].
\end{aligned}
$$

Substituting back $z = y/\bar{y}$, we arrive at the form stated in the text above:

$$
\beta^2\left(1-\frac{y}{\bar{y}}\right)\theta^2-(1+\beta)\left[1+2\beta\left(1-\frac{y}{\bar{y}}\right)\right]\theta+(1+\beta)^2\left(1-\frac{y}{\bar{y}}\right)=0.
$$

References

[1] Jess Benhabib, A note on the political economy of immigration, C. V. Starr Center for Applied Economics research report #92–42, New York University (1992).

[2] George Borjas, The economic benefits from immigration, *Journal of Economic Perspectives* **9**, no. 2 (1995), 3–22.

[3] Alex Cukierman, Zvi Hercowitz and David Pines, The Political economy of immigration, The Foerder Institute for Economic Research report #17–93, Tel Aviv University (1993).

[4] Jim Dolmas and Gregory W. Huffman, The political economy of endogenous taxation and redistribution, forthcoming in *Economics Letters* (1997).

[5] Peter Lambert, *The distribution and redistribution of income*, Oxford: Basil Blackwell (1989).

[6] Philip Martin, International migration: Challenges and opportunities, mimeo, University of California–Davis (1996).

[7] Amartya Sen, *Collective choice and social welfare*, San Francisco: Holden Day (1970).

Figure 1
Residents' utilities over immigration in the two-period model, various ratios of initial wealth to average initial wealth.

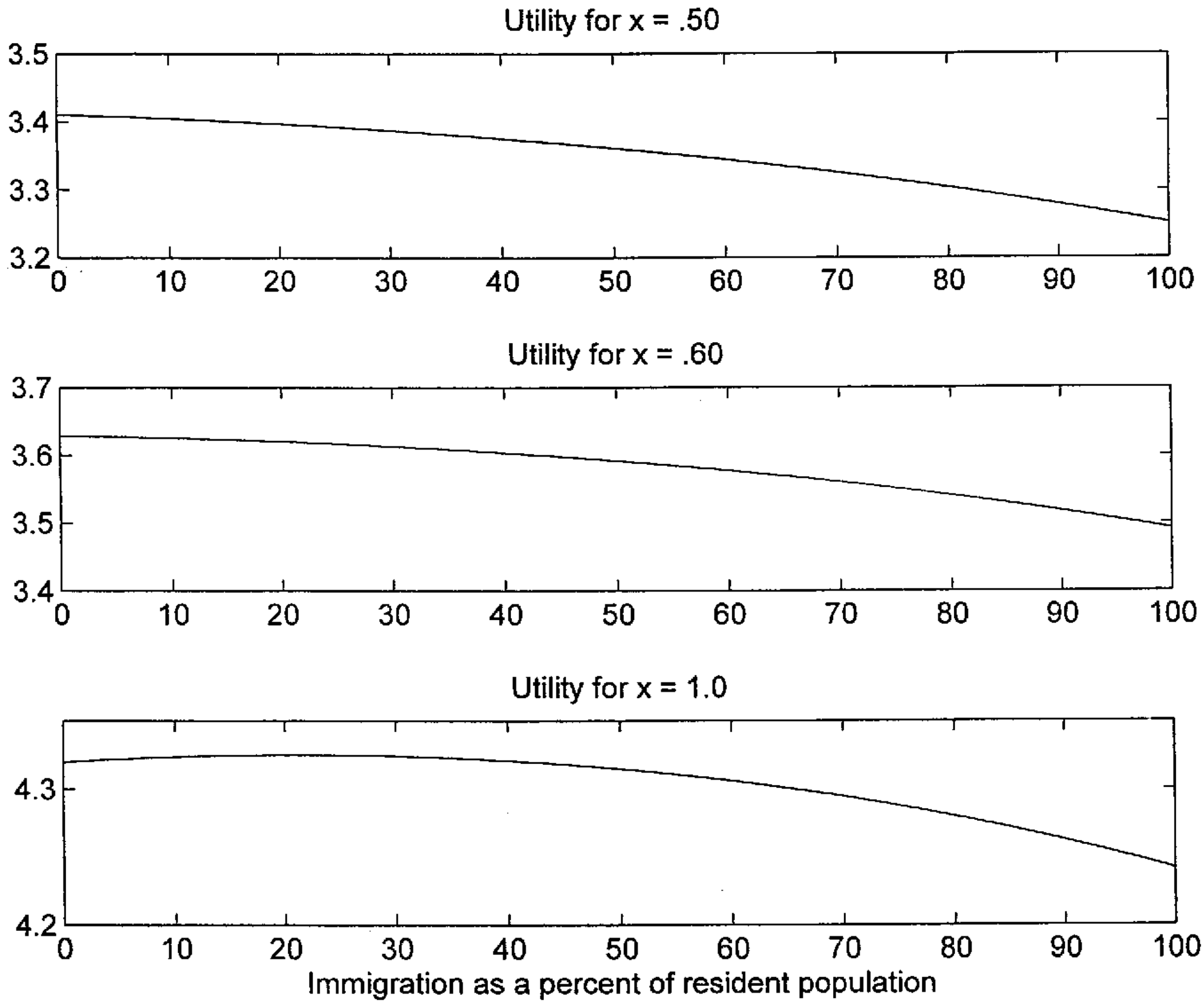


Figure 2
Residents' utilities over immigration in the two-period model with direct immigration costs, various ratios of initial wealth to average initial wealth.

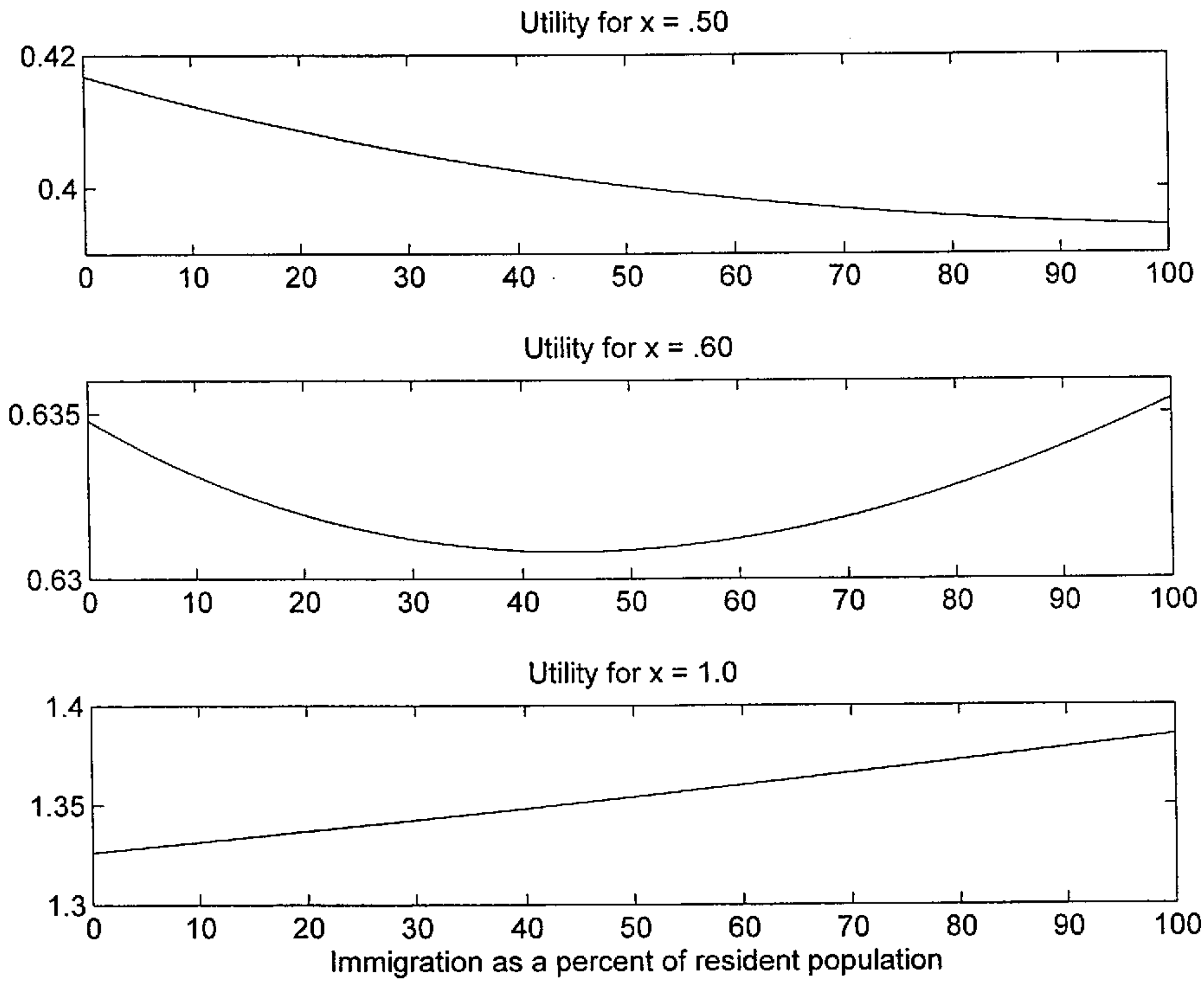


Figure 3

Utility of resident with average initial wealth holding in the two-period model with direct immigration costs, various values of β. The solid line is $\beta = 1.0$, the dashed line is $\beta = 1.2$.

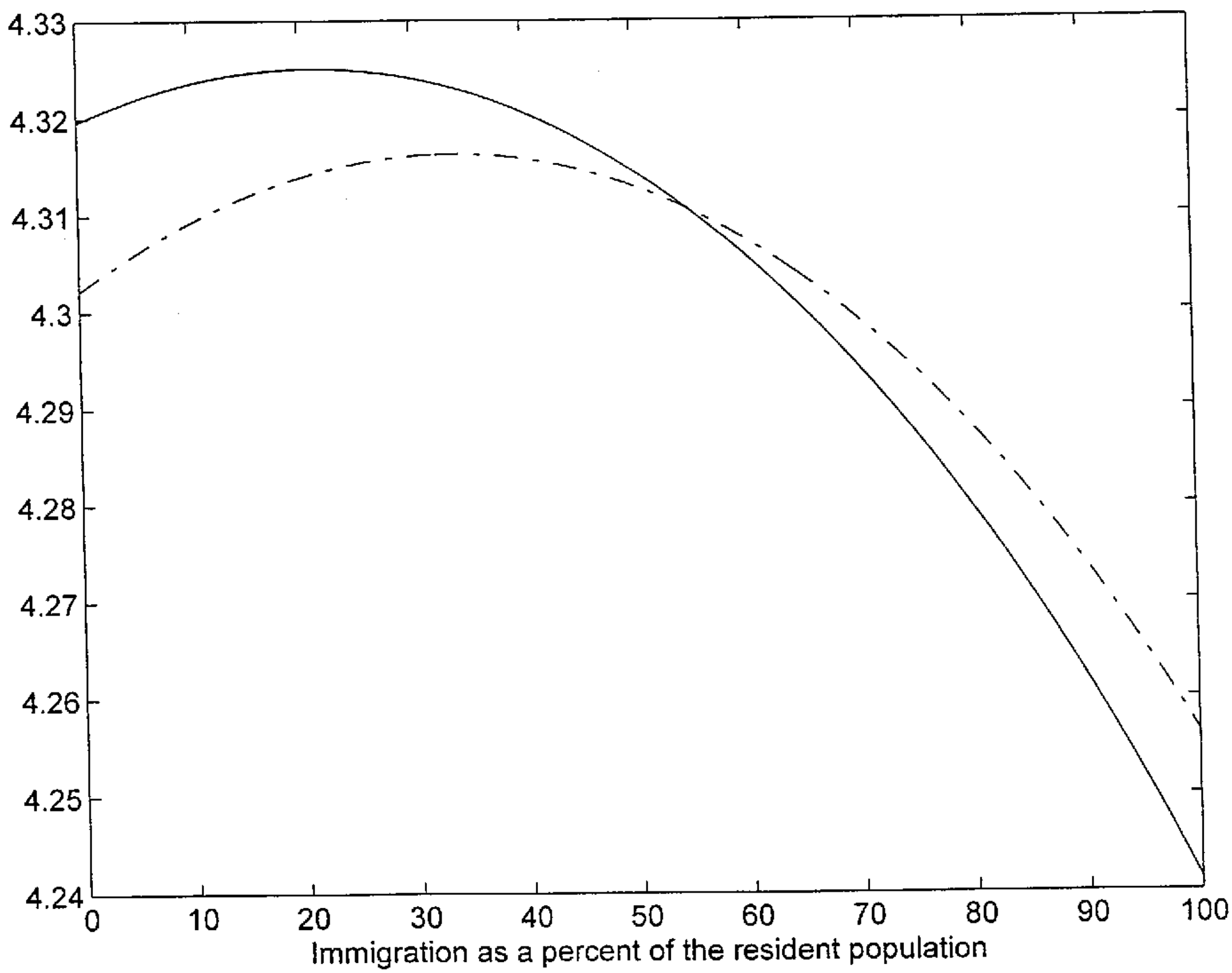


Figure 4
Utility of resident with average initial wealth holding in the two-period model with direct immigration costs, various values of α. The solid line is $\alpha = .30$, the dashed line is $\alpha = .35$.

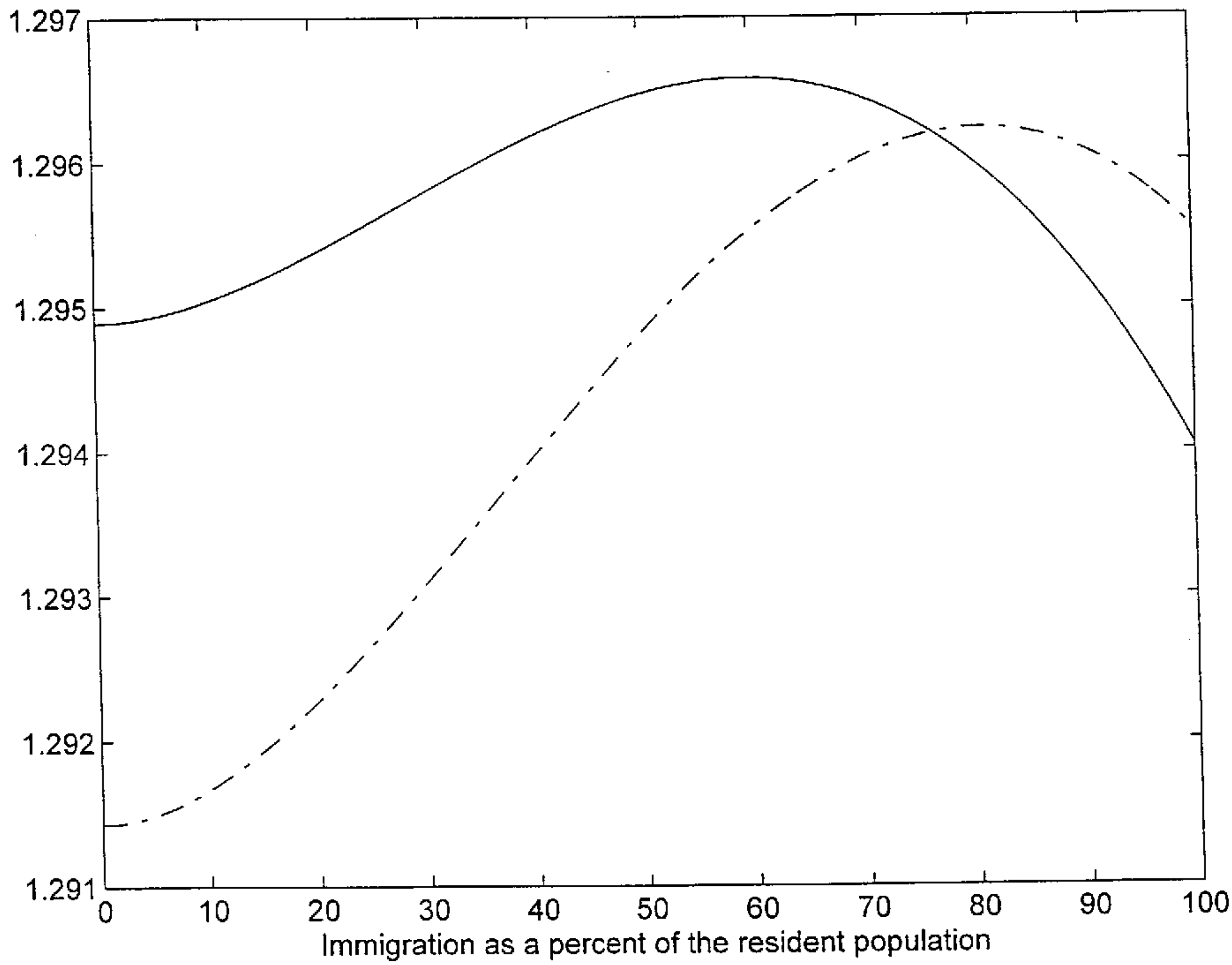


Figure 5
Utilities and period-three tax rate for the economy with two types of residents—$k \in \{5, 10\}$, with equal numbers of each type.

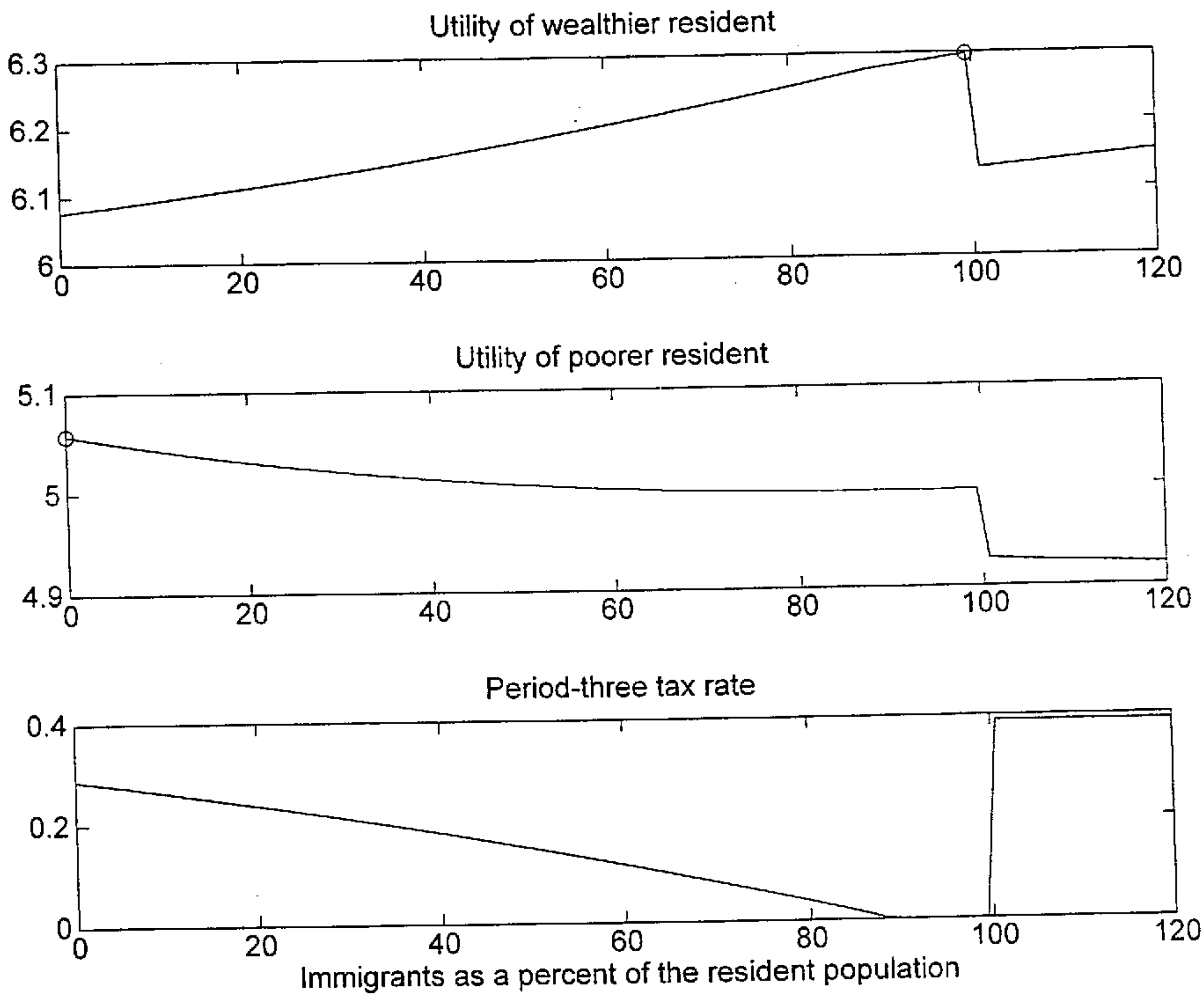


Figure 6
Capital stock, prices and period-two incomes for the economy with two types of residents—$k \in \{5, 10\}$, with equal numbers of each type.

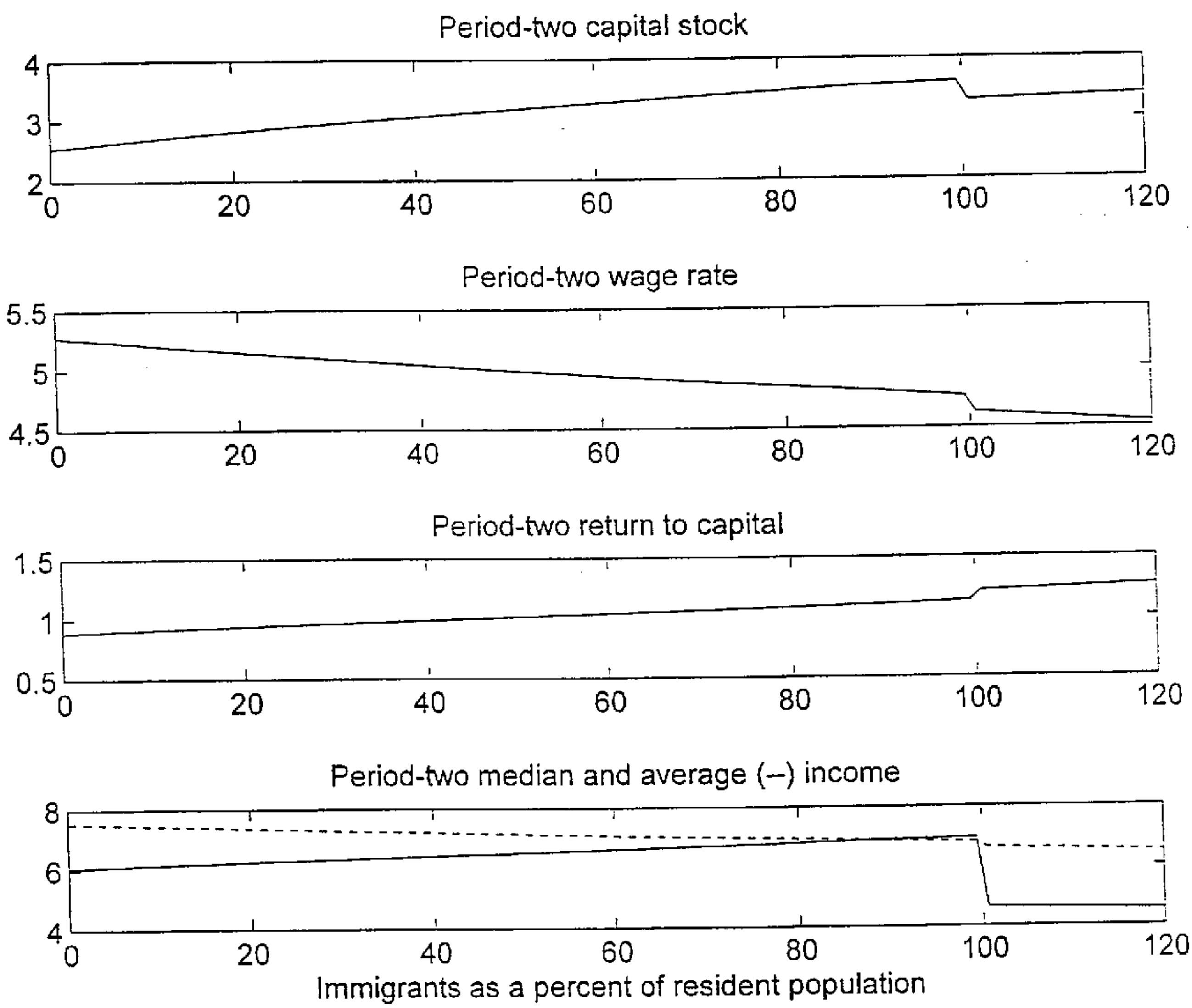


Figure 7
Results for the economy with two types of residents—$k \in \{9, 10\}$, with equal numbers of each type.

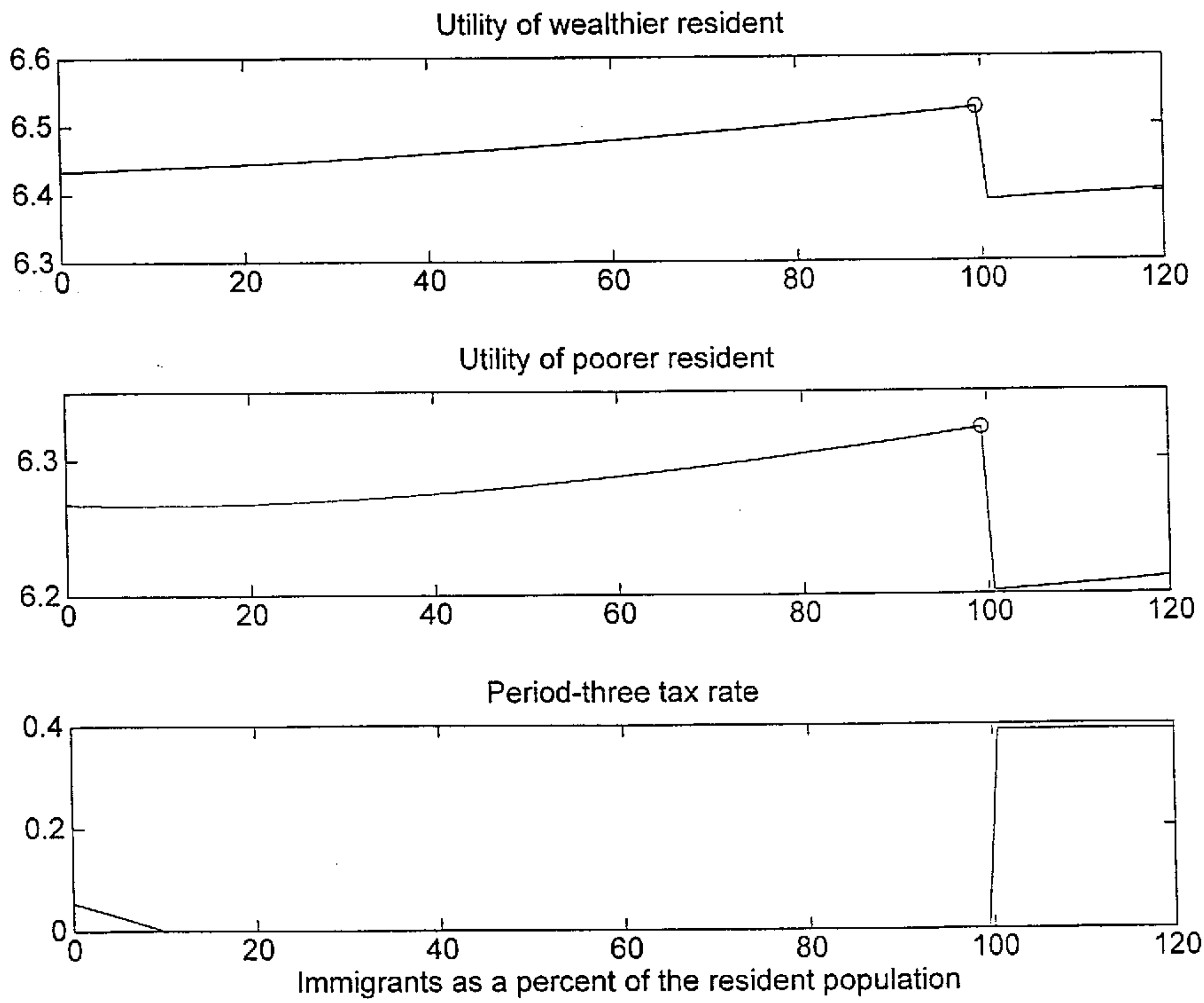


Figure 8
Results for the economy with a uniform distribution of initial wealth.

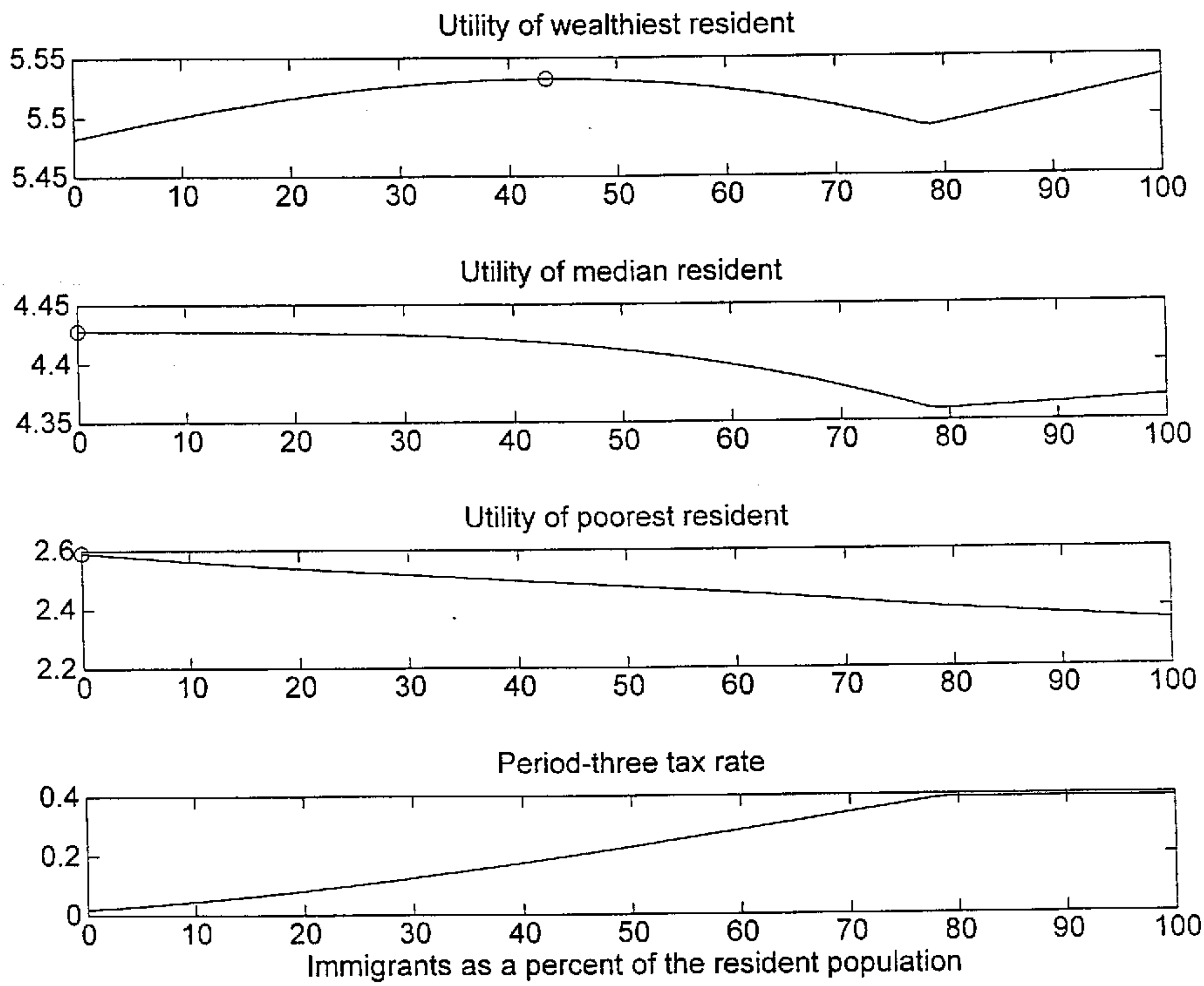


Figure 9
Results for the economy with a uniform distribution of initial wealth; immigrants arrive with capital equal to that of the wealthiest resident.

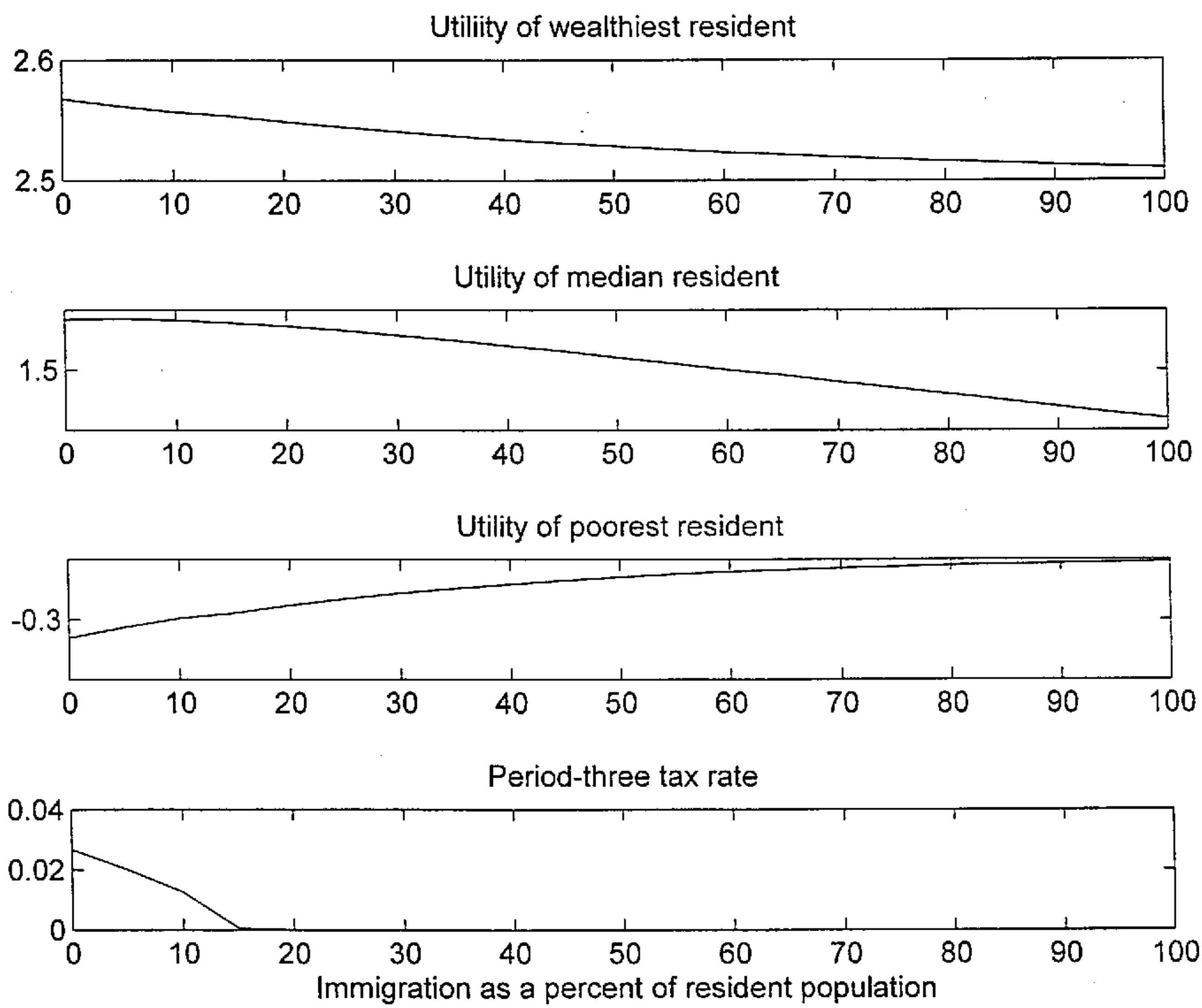


Figure 10
Results for the economy with a uniform distribution of initial wealth; immigrants are not permitted to vote in period two.

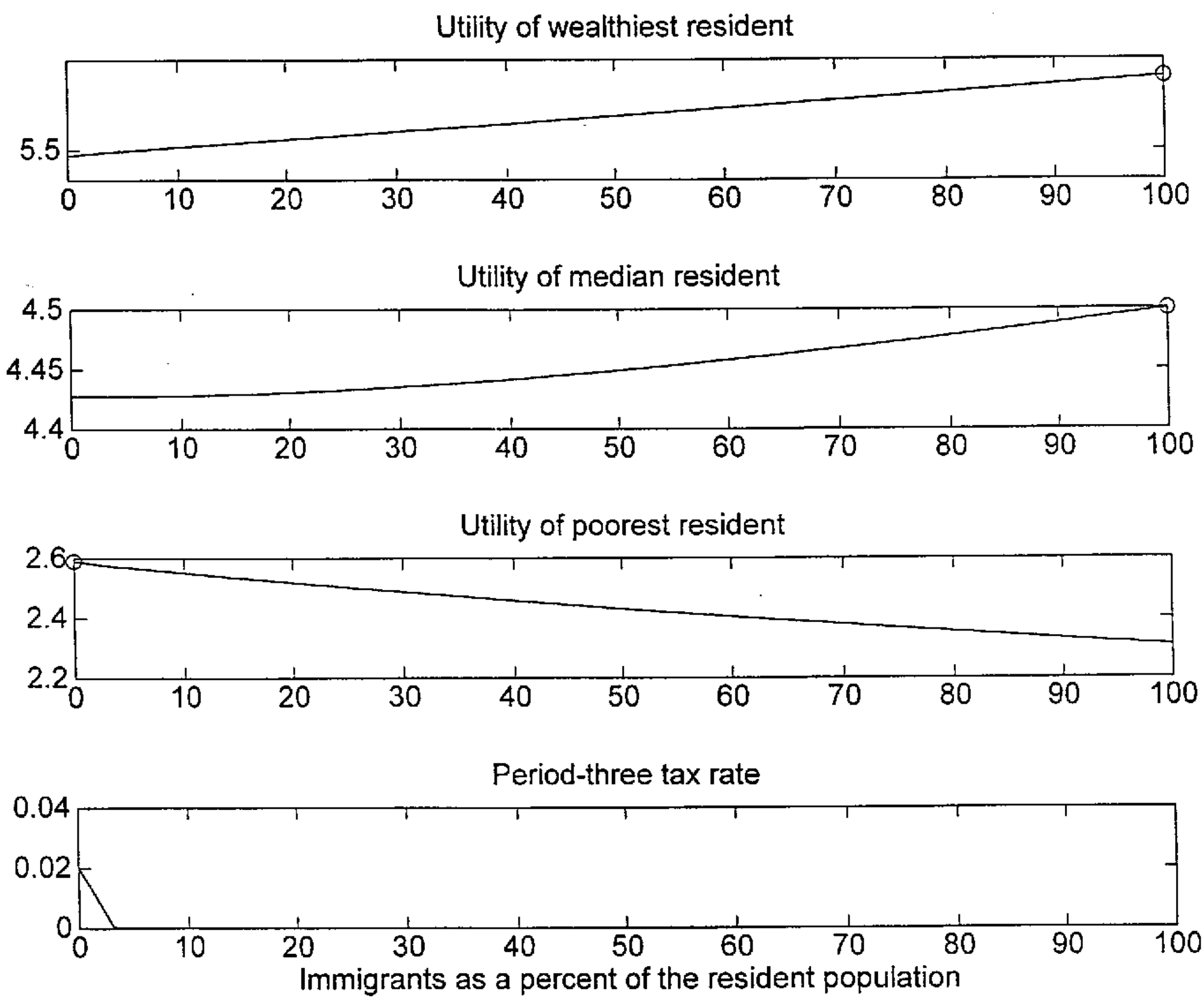


Figure 11
Incomes in period two from the economy with a uniform distribution of initial wealth; immigrants are not permitted to vote in period two.

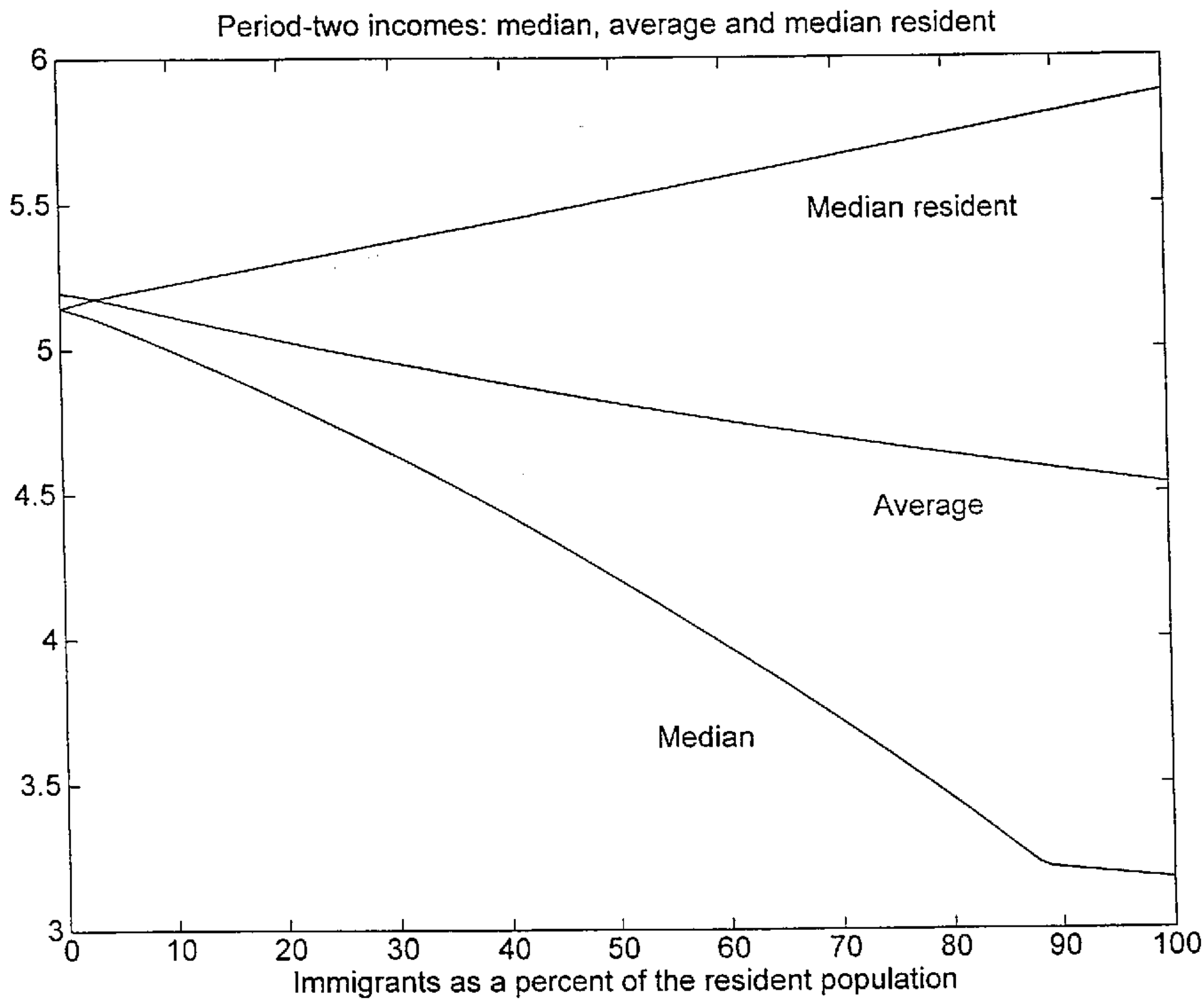


Figure 12
Equilibrium period-three tax rate in the economy with an approximate lognormal distribution of initial wealth—low inequality case.

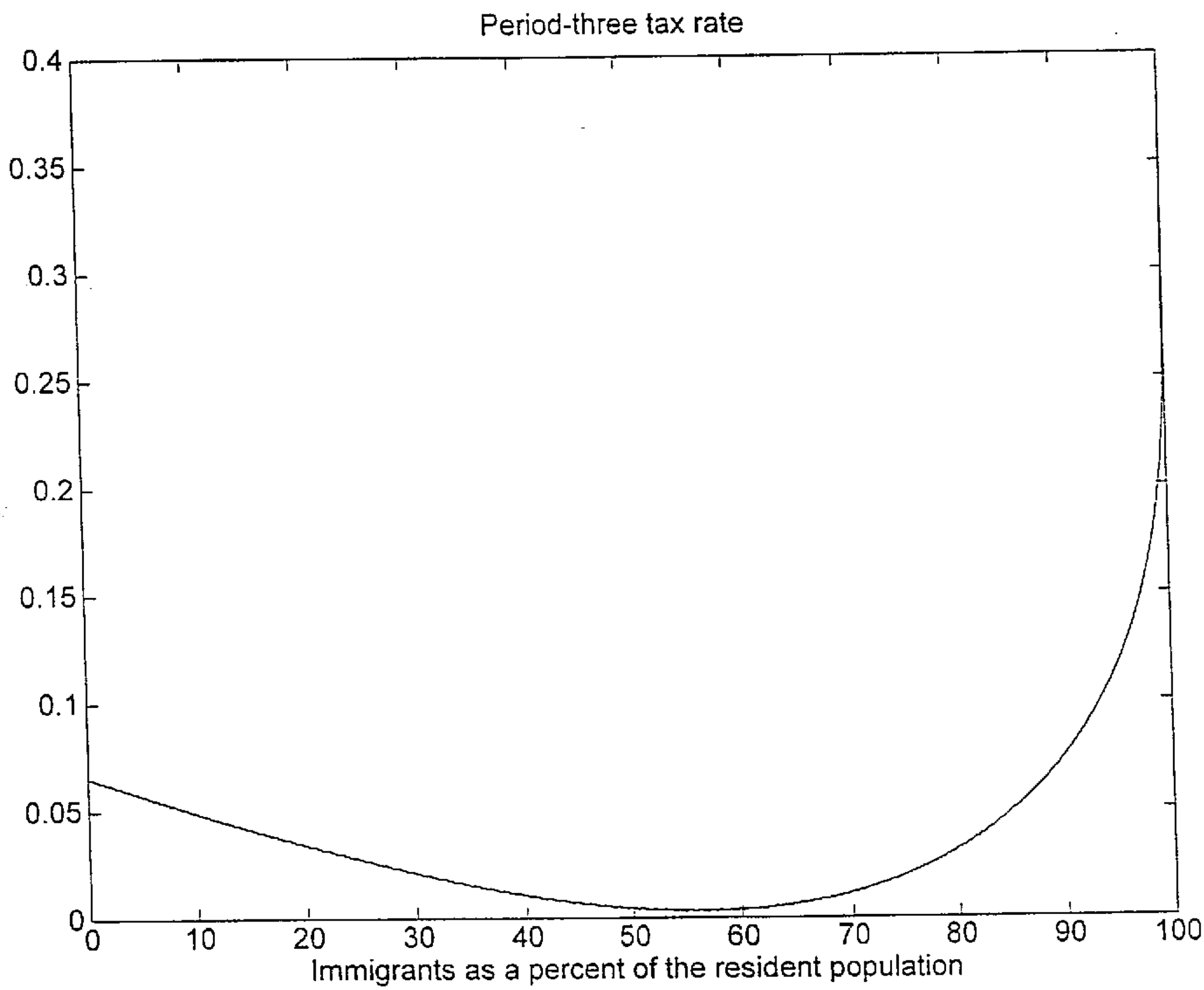


Figure 13
Residents' utilities over immigration in the economy with an approximate lognormal distribution of initial wealth—low inequality case.

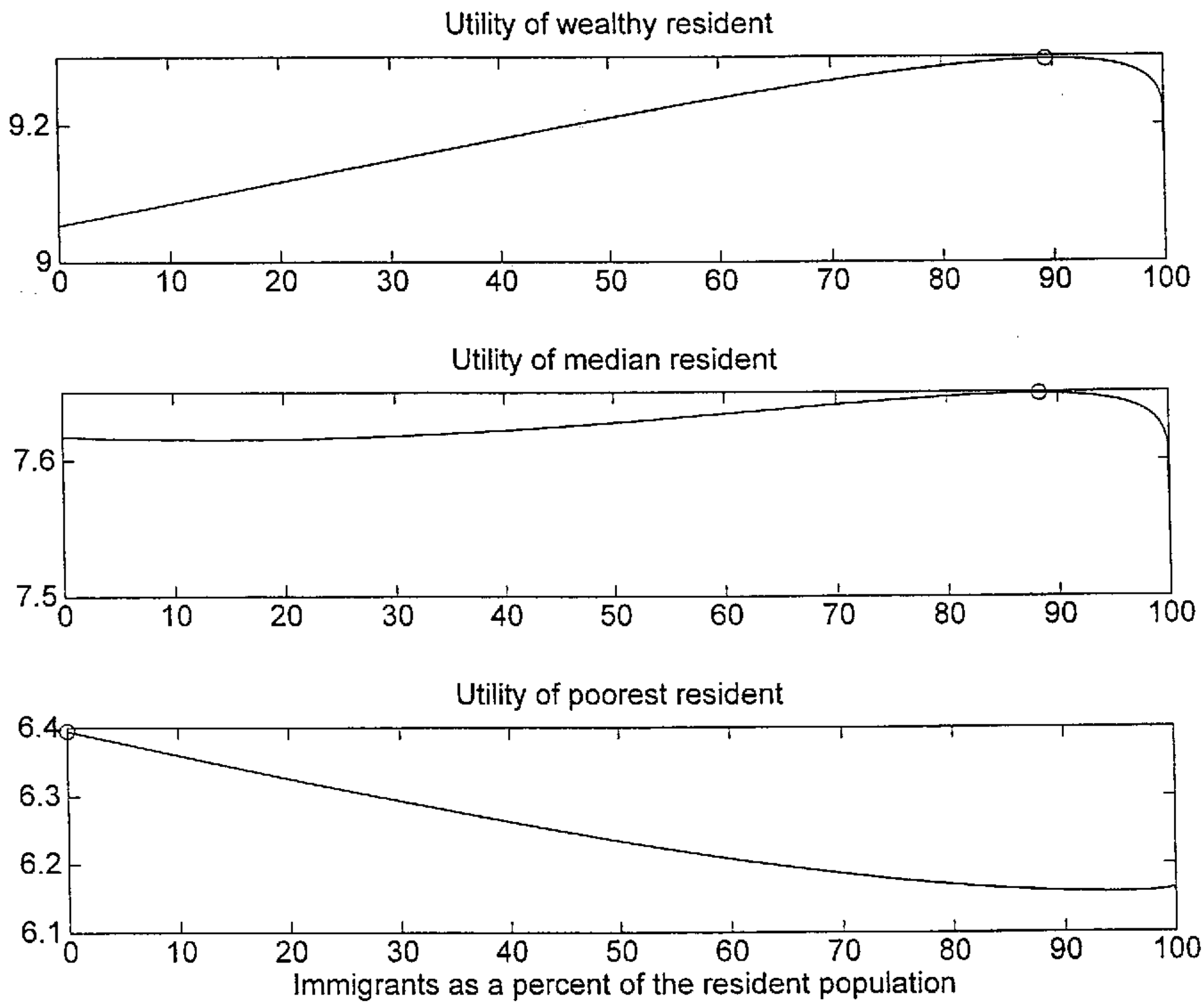


Figure 14
Equilibrium period-three tax rate in the economy with an approximate lognormal distribution of initial wealth—high inequality case.

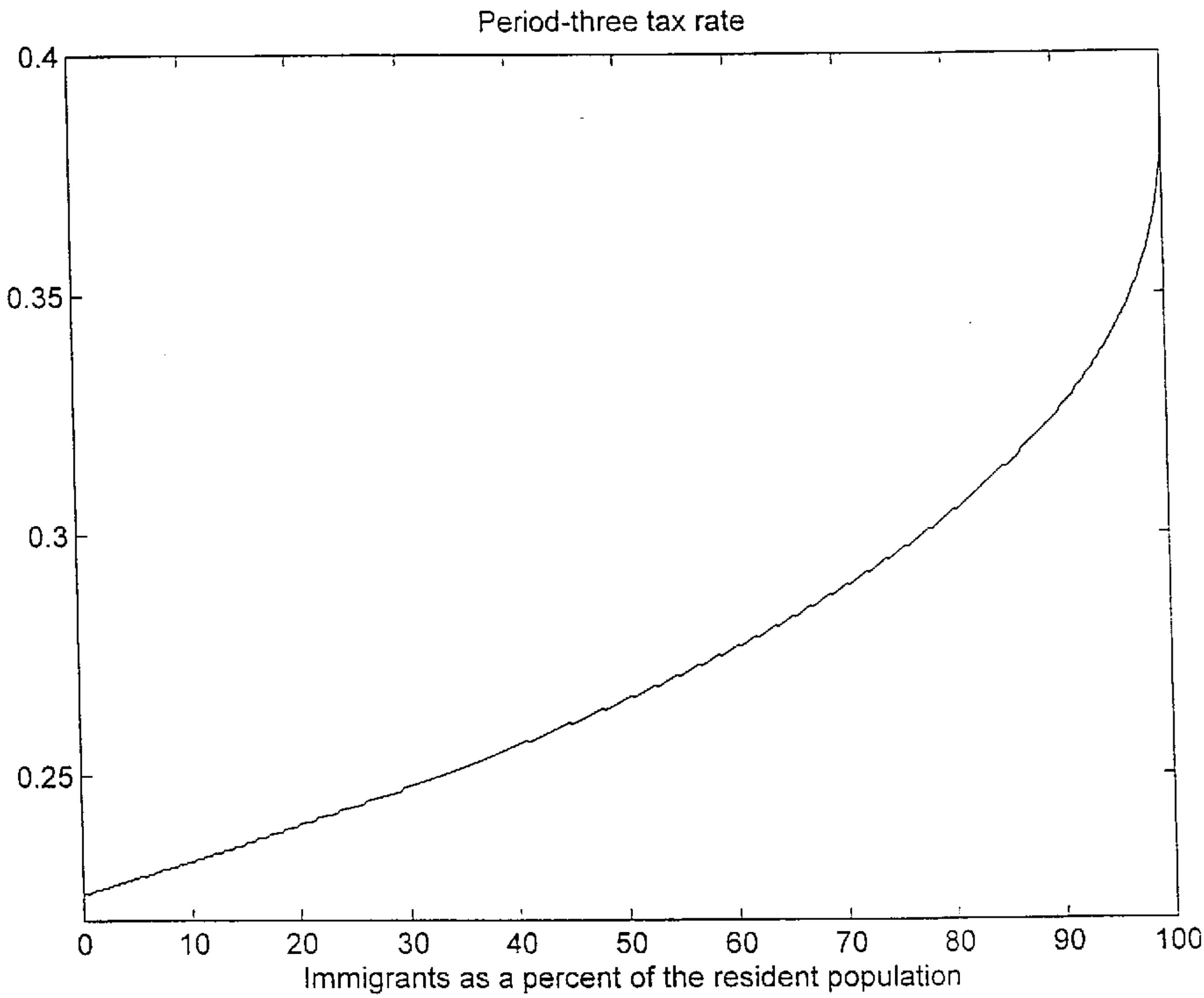


Figure 15
Residents' utilities over immigration in the economy with an approximate lognormal distribution of initial wealth—high inequality case.

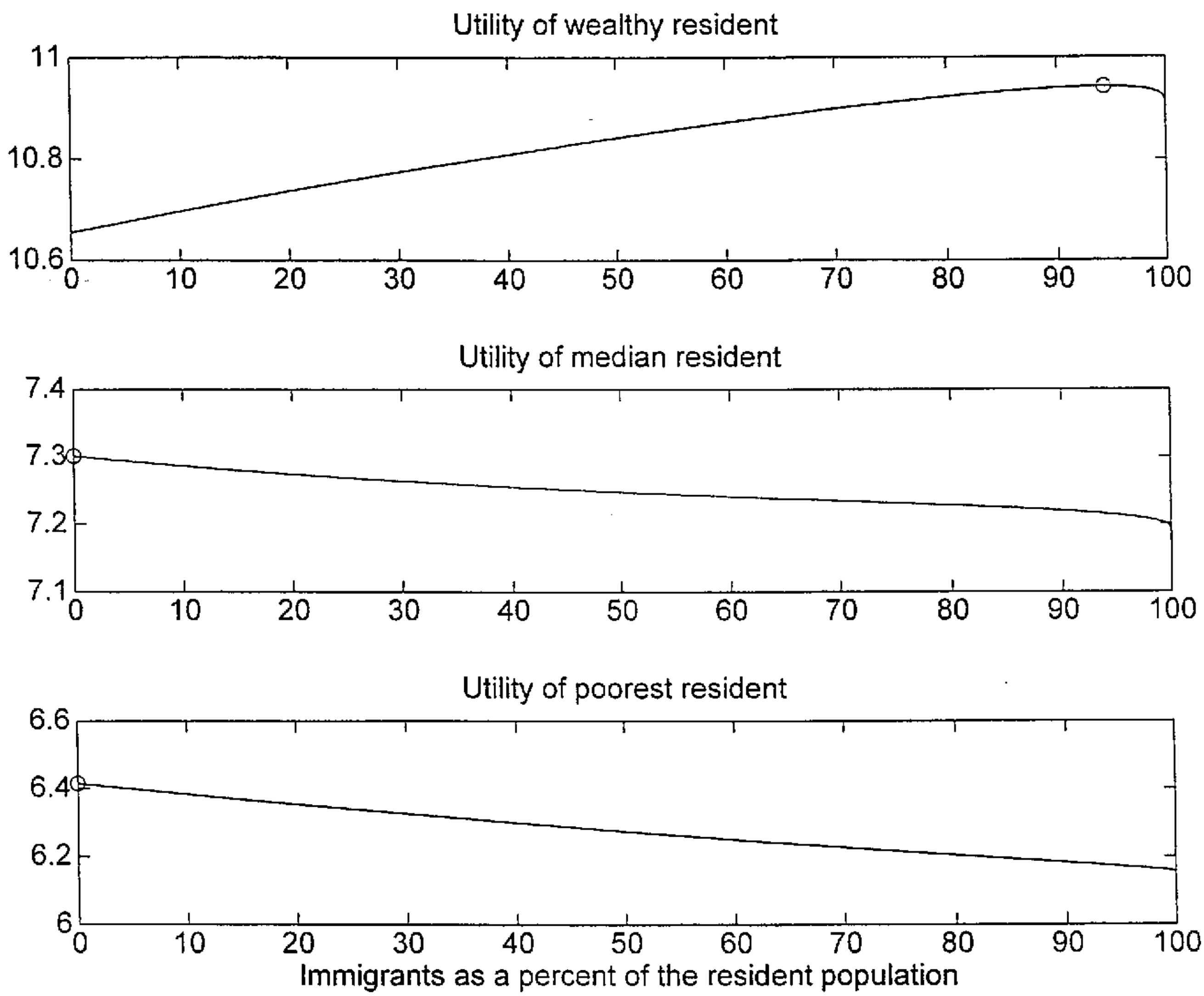


Figure 16
The two distributions of initial wealth in the lognormal example.

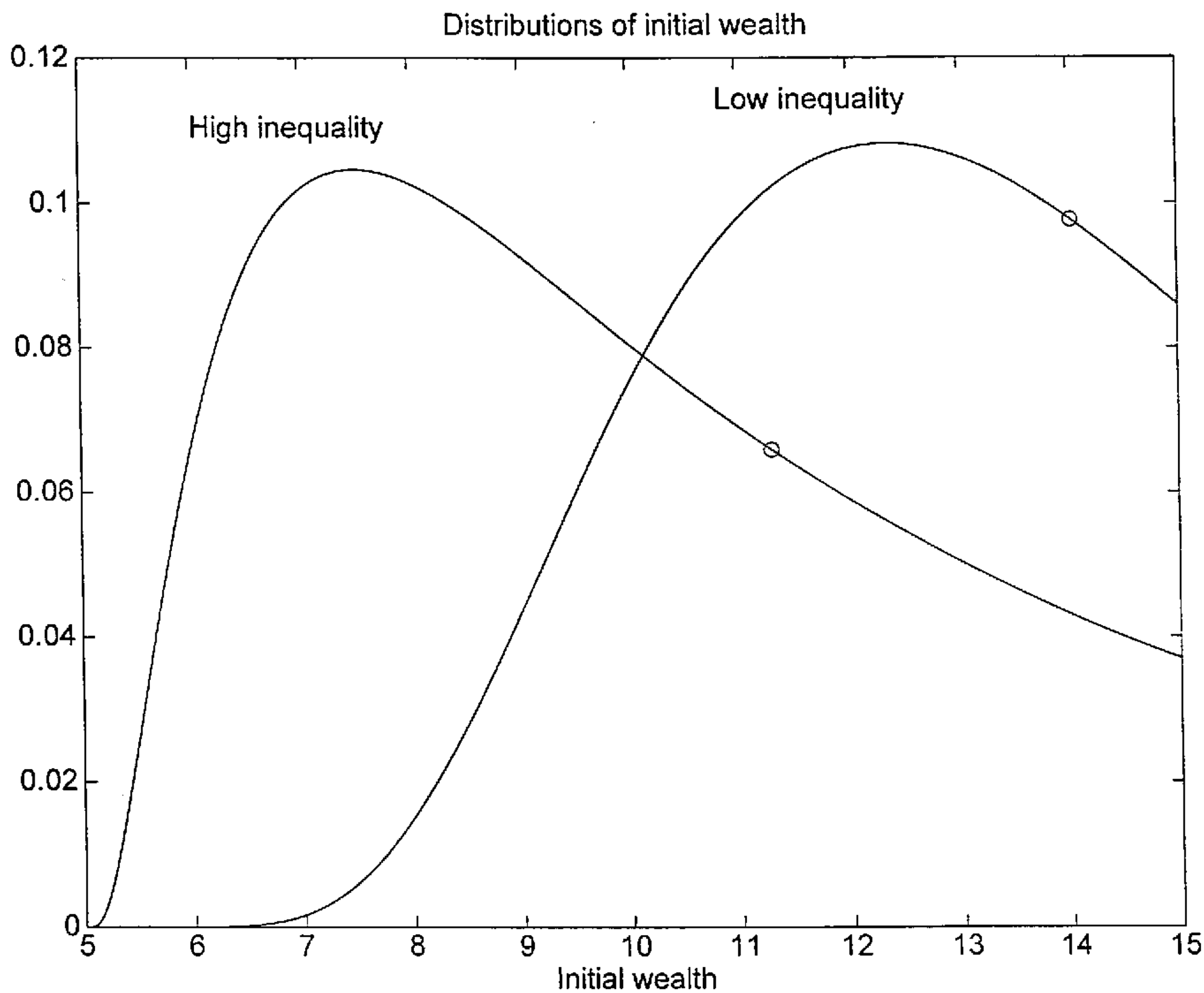
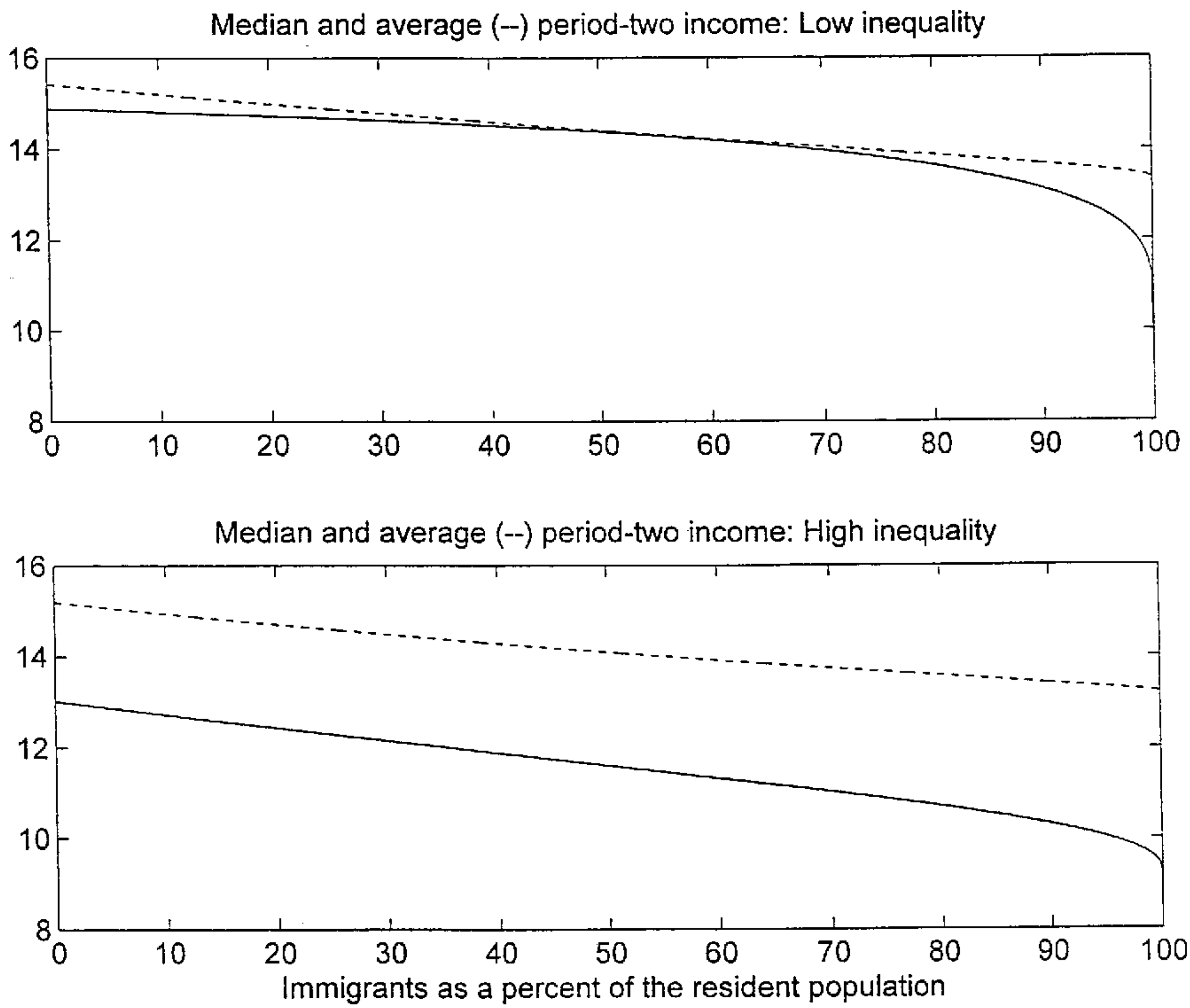


Figure 17
Median and average period-two income in the two lognormal economies.



RESEARCH PAPERS OF THE RESEARCH DEPARTMENT
FEDERAL RESERVE BANK OF DALLAS

Available, at no charge, from the Research Department
Federal Reserve Bank of Dallas, P. O. Box 655906
Dallas, Texas 75265-5906

Please check the titles of the Research Papers you would like to receive:

___ 9201 Are Deep Recessions Followed by Strong Recoveries? (Mark A. Wynne and Nathan S. Balke)
___ 9202 The Case of the "Missing M2" (John V. Duca)
___ 9203 Immigrant Links to the Home Country: Implications for Trade, Welfare and Factor Rewards (David M. Gould)
___ 9204 Does Aggregate Output Have a Unit Root? (Mark A. Wynne)
___ 9205 Inflation and Its Variability: A Note (Kenneth M. Emery)
___ 9206 Budget Constrained Frontier Measures of Fiscal Equality and Efficiency in Schooling (Shawna Grosskopf, Kathy Hayes, Lori L. Taylor, William Weber)
___ 9207 The Effects of Credit Availability, Nonbank Competition, and Tax Reform on Bank Consumer Lending (John V. Duca and Bonnie Garrett)
___ 9208 On the Future Erosion of the North American Free Trade Agreement (William C. Gruben)
___ 9209 Threshold Cointegration (Nathan S. Balke and Thomas B. Fomby)
___ 9210 Cointegration and Tests of a Classical Model of Inflation in Argentina, Bolivia, Brazil, Mexico, and Peru (Raul Anibal Feliz and John H. Welch)
___ 9211 Nominal Feedback Rules for Monetary Policy: Some Comments (Evan F. Koenig)
___ 9212 The Analysis of Fiscal Policy in Neoclassical Models[1] (Mark Wynne)
___ 9213 Measuring the Value of School Quality (Lori Taylor)
___ 9214 Forecasting Turning Points: Is a Two-State Characterization of the Business Cycle Appropriate? (Kenneth M. Emery & Evan F. Koenig)
___ 9215 Energy Security: A Comparison of Protectionist Policies (Mine K. Yücel and Carol Dahl)
___ 9216 An Analysis of the Impact of Two Fiscal Policies on the Behavior of a Dynamic Asset Market (Gregory W. Huffman)
___ 9301 Human Capital Externalities, Trade, and Economic Growth (David Gould and Roy J. Ruffin)
___ 9302 The New Face of Latin America: Financial Flows, Markets, and Institutions in the 1990s (John Welch)
___ 9303 A General Two Sector Model of Endogenous Growth with Human and Physical Capital (Eric Bond, Ping Wang, and Chong K. Yip)
___ 9304 The Political Economy of School Reform (S. Grosskopf, K. Hayes, L. Taylor, and W. Weber)
___ 9305 Money, Output, and Income Velocity (Theodore Palivos and Ping Wang)
___ 9306 Constructing an Alternative Measure of Changes in Reserve Requirement Ratios (Joseph H. Haslag and Scott E. Hein)
___ 9307 Money Demand and Relative Prices During Episodes of Hyperinflation (Ellis W. Tallman and Ping Wang)
___ 9308 On Quantity Theory Restrictions and the Signalling Value of the Money Multiplier (Joseph Haslag)
___ 9309 The Algebra of Price Stability (Nathan S. Balke and Kenneth M. Emery)
___ 9310 Does It Matter How Monetary Policy is Implemented? (Joseph H. Haslag and Scott Hein)
___ 9311 Real Effects of Money and Welfare Costs of Inflation in an Endogenously Growing Economy with Transactions Costs (Ping Wang and Chong K. Yip)
___ 9312 Borrowing Constraints, Household Debt, and Racial Discrimination in Loan Markets (John V. Duca and Stuart Rosenthal)
___ 9313 Default Risk, Dollarization, and Currency Substitution in Mexico (William Gruben and John Welch)
___ 9314 Technological Unemployment (W. Michael Cox)
___ 9315 Output, Inflation, and Stabilization in a Small Open Economy: Evidence from Mexico (John H. Rogers and Ping Wang)
___ 9316 Price Stabilization, Output Stabilization and Coordinated Monetary Policy Actions (Joseph H. Haslag)
___ 9317 An Alternative Neo-Classical Growth Model with Closed-Form Decision Rules (Gregory W. Huffman)

___ 9318 Why the Composite Index of Leading Indicators Doesn't Lead (Evan F. Koenig and Kenneth M. Emery)
___ 9319 Allocative Inefficiency and Local Government: Evidence Rejecting the Tiebout Hypothesis (Lori L. Taylor)
___ 9320 The Output Effects of Government Consumption: A Note (Mark A. Wynne)
___ 9321 Should Bond Funds be Included in M2? (John V. Duca)
___ 9322 Recessions and Recoveries in Real Business Cycle Models: Do Real Business Cycle Models Generate Cyclical Behavior? (Mark A. Wynne)
___ 9323* Retaliation, Liberalization, and Trade Wars: The Political Economy of Nonstrategic Trade Policy (David M. Gould and Graeme L. Woodbridge)
___ 9324 A General Two-Sector Model of Endogenous Growth with Human and Physical Capital: Balanced Growth and Transitional Dynamics (Eric W. Bond, Ping Wang,and Chong K. Yip)
___ 9325 Growth and Equity with Endogenous Human Capital: Taiwan's Economic Miracle Revisited (Maw-Lin Lee, Ben-Chieh Liu, and Ping Wang)
___ 9326 Clearinghouse Banks and Banknote Over-issue (Scott Freeman)
___ 9327 Coal, Natural Gas and Oil Markets after World War II: What's Old, What's New? (Mine K. Yücel and Shengyi Guo)
___ 9328 On the Optimality of Interest-Bearing Reserves in Economies of Overlapping Generations (Scott Freeman and Joseph Haslag)
___ 9329* Retaliation, Liberalization, and Trade Wars: The Political Economy of Nonstrategic Trade Policy (David M. Gould and Graeme L. Woodbridge) (Reprint of 9323 in error)
___ 9330 On the Existence of Nonoptimal Equilibria in Dynamic Stochastic Economies (Jeremy Greenwood and Gregory W. Huffman)
___ 9331 The Credibility and Performance of Unilateral Target Zones: A Comparison of the Mexican and Chilean Cases (Raul A. Feliz and John H. Welch)
___ 9332 Endogenous Growth and International Trade (Roy J. Ruffin)
___ 9333 Wealth Effects, Heterogeneity and Dynamic Fiscal Policy (Zsolt Becsi)
___ 9334 The Inefficiency of Seigniorage from Required Reserves (Scott Freeman)
___ 9335 Problems of Testing Fiscal Solvency in High Inflation Economies: Evidence from Argentina, Brazil, and Mexico (John H. Welch)
___ 9336 Income Taxes as Reciprocal Tariffs (W. Michael Cox, David M. Gould, and Roy J. Ruffin)
___ 9337 Assessing the Economic Cost of Unilateral Oil Conservation (Stephen P.A. Brown and Hillard G. Huntington)
___ 9338 Exchange Rate Uncertainty and Economic Growth in Latin America (Darryl McLeod and John H. Welch)
___ 9339 Searching for a Stable M2-Demand Equation (Evan F. Koenig)
___ 9340 A Survey of Measurement Biases in Price Indexes (Mark A. Wynne and Fiona Sigalla)
___ 9341 Are Net Discount Rates Stationary?: Some Further Evidence (Joseph H. Haslag, Michael Nieswiadomy, and D. J. Slottje)
___ 9342 On the Fluctuations Induced by Majority Voting (Gregory W. Huffman)
___ 9401 Adding Bond Funds to M2 in the P-Star Model of Inflation (Zsolt Becsi and John Duca)
___ 9402 Capacity Utilization and the Evolution of Manufacturing Output: A Closer Look at the "Bounce-Back Effect" (Evan F. Koenig)
___ 9403 The Disappearing January Blip and Other State Employment Mysteries (Frank Berger and Keith R. Phillips)
___ 9404 Energy Policy: Does it Achieve its Intended Goals? (Mine Yücel and Shengyi Guo)
___ 9405 Protecting Social Interest in Free Invention (Stephen P.A. Brown and William C. Gruben)
___ 9406 The Dynamics of Recoveries (Nathan S. Balke and Mark A. Wynne)
___ 9407 Fiscal Policy in More General Equilibriium (Jim Dolman and Mark Wynne)
___ 9408 On the Political Economy of School Deregulation (Shawna Grosskopf, Kathy Hayes, Lori Taylor, and William Weber)
___ 9409 The Role of Intellectual Property Rights in Economic Growth (David M. Gould and William C. Gruben)

___ 9410 U.S. Banks, Competition, and the Mexican Banking System: How Much Will NAFTA Matter? (William C. Gruben, John H. Welch and Jeffery W. Gunther)

___ 9411 Monetary Base Rules: The Currency Caveat (R. W. Hafer, Joseph H. Haslag, andScott E. Hein)

___ 9412 The Information Content of the Paper-Bill Spread (Kenneth M. Emery)

___ 9413 The Role of Tax Policy in the Boom/Bust Cycle of the Texas Construction Sector (D'Ann Petersen, Keith Phillips and Mine Yücel)

___ 9414 The P* Model of Inflation, Revisited (Evan F. Koenig)

___ 9415 The Effects of Monetary Policy in a Model with Reserve Requirements (Joseph H. Haslag)

___ 9501 An Equilibrium Analysis of Central Bank Independence and Inflation (Gregory W. Huffman)

___ 9502 Inflation and Intermediation in a Model with Endogenous Growth (Joseph H. Haslag)

___ 9503 Country-Bashing Tariffs: Do Bilateral Trade Deficits Matter? (W. Michael Cox and Roy J. Ruffin)

___ 9504 Building a Regional Forecasting Model Utilizing Long-Term Relationships and Short-Term Indicators (Keith R. Phillips and Chih-Ping Chang)

___ 9505 Building Trade Barriers and Knocking Them Down: The Political Economy of Unilateral Trade Liberalizations (David M. Gould and Graeme L. Woodbridge)

___ 9506 On Competition and School Efficiency (Shawna Grosskopf, Kathy Hayes, Lori L. Taylor and William L. Weber)

___ 9507 Alternative Methods of Corporate Control in Commercial Banks (Stephen Prowse)

___ 9508 The Role of Intratemporal Adjustment Costs in a Multi-Sector Economy (Gregory W. Huffman and Mark A. Wynne)

___ 9509 Are Deep Recessions Followed By Strong Recoveries? Results for the G-7 Countries (Nathan S. Balke and Mark A. Wynne)

___ 9510 Oil Prices and Inflation (Stephen P.A. Brown, David B. Oppedahl and Mine K. Yücel)

___ 9511 A Comparison of Alternative Monetary Environments (Joseph H. Haslag))

___ 9512 Regulatory Changes and Housing Coefficients (John V. Duca)

___ 9513 The Interest Sensitivity of GDP and Accurate Reg Q Measures (John V. Duca)

___ 9514 Credit Availability, Bank Consumer Lending, and Consumer Durables (John V. Duca and Bonnie Garrett)

___ 9515 Monetary Policy, Banking, and Growth (Joseph H. Haslag)

___ 9516 The Stock Market and Monetary Policy: The Role of Macroeconomic States (Chih-Ping Chang and Huan Zhang)

___ 9517 Hyperinflations and Moral Hazard in the Appropriation of Seigniorage: An Empirical Implementation With A Calibration Approach (Carlos E. Zarazaga)

___ 9518 Targeting Nominal Income: A Closer Look (Evan F. Koenig)

___ 9519 Credit and Economic Activity: Shocks or Propagation Mechanism? (Nathan S. Balke and Chih-Ping Chang)

___ 9601 The Monetary Policy Effects on Seignorage Revenue in a Simple Growth Model (Joseph H. Haslag)

___ 9602 Regional Productivity and Efficiency in the U.S.: Effects of Business Cycles and Public Capital (Dale Boisso, Shawna Grosskopf and Kathy Hayes)

___ 9603 Inflation, Unemployment, and Duration (John V. Duca)

___ 9604 The Response of Local Governments to Reagan-Bush Fiscal Federalism (D. Boisso, Shawna Grosskopf and Kathy Hayes)

___ 9605 Endogenous Tax Determination and the Distribution of Wealth (Gregory W. Huffman)

___ 9606 An Exploration into the Effects of Dynamic Economic Stabilization (Jim Dolmas and Gregory W. Huffman)

___ 9607 Is Airline Price Dispersion the Result of Careful Planning or Competitive Forces? (Kathy J. Hayes and Leola B. Ross)

___ 9608 Some Implications of Increased Cooperation in World Oil Conservation (Stephen P.A. Brown and Hillard G. Huntington)

___ 9609 An Equilibrium Analysis of Relative Price Changes and Aggregate Inflation (Nathan S. Balke and Mark A. Wynne)

___ 9610 What's Good for GM...? Using Auto Industry Stock Returns to Forecast Business Cycles and Test the Q-Theory of Investment (Gregory R. Duffee and Stephen Prowse)
___ 9611 Does the Choice of Nominal Anchor Matter? (David M. Gould)
___ 9612 The Policy Sensitivity of Industries and Regions (Lori L. Taylor and Mine K. Yücel)
___ 9613 Oil Prices and Aggregate Economic Activity: A Study of Eight OECD Countries (Stephen P.A. Brown, David B. Oppedahl and Mine K. Yücel)
___ 9614 The Effect of the Minimum Wage on Hours of Work (Madeline Zavodny)
___ 9615 Aggregate Price Adjustment: The Fischerian Alternative (Evan F. Koenig)
___ 9701 Nonlinear Dynamics and Covered Interest Rate Parity (Nathan S. Balke and Mark E. Wohar)
___ 9702 More on Optimal Denominations for Coins and Currency (Mark A. Wynne)
___ 9703 Specialization and the Effects of Transactions Costs on Equilibrium Exchange (James Dolmas and Joseph H. Haslag)
___ 9704 The Political Economy of Endogenous Taxation and Redistribution (Jim Dolmas and Gregory W. Huffman)
___ 9705 Inequality, Inflation, and Central Bank Independence (Jim Dolmas, Gregory W. Huffman, and Mark A. Wynne)
___ 9706 On The Political Economy of Immigration (Jim Dolmas and Gregory W. Huffman)

Name:	**Organization:**
Address:	**City, State and Zip Code:**
Please add me to your mailing list to receive future Research Papers: _____ **Yes** _____ **No**	

Research Papers Presented at the
1994 Texas Conference on Monetary Economics
April 23-24, 1994
held at the Federal Reserve Bank of Dallas, Dallas, Texas

Available, at no charge, from the Research Department
Federal Reserve Bank of Dallas, P. O. Box 655906
Dallas, Texas 75265-5906

Please check the titles of the Research Papers you would like to receive:

____ 1 A Sticky-Price Manifesto (Laurence Ball and N. Gregory Mankiw)

____ 2 Sequential Markets and the Suboptimality of the Friedman Rule (Stephen D. Williamson)

____ 3 Sources of Real Exchange Rate Fluctuations: How Important Are Nominal Shocks? (Richard Clarida and Jordi Gali)

____ 4 On Leading Indicators: Getting It Straight (Mark A. Thoma and Jo Anna Gray)

____ 5 The Effects of Monetary Policy Shocks: Evidence From the Flow of Funds (Lawrence J. Christiano, Martin Eichenbaum and Charles Evans)

Name:	**Organization:**
Address:	**City, State and Zip Code:**
Please add me to your mailing list to receive future Research Papers:	____**Yes** ____ **No**