What is the Optimal Immigration Policy? Migration, Jobs and Welfare*

Joao Guerreiro[†], Sergio Rebelo[‡], and Pedro Teles[§]

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Abstract

We study the immigration policy that maximizes the welfare of the native population in an economy where the government designs an optimal redistributive welfare system and supplies public goods. We show that when immigrants can be excluded from the welfare system, free immigration is optimal. It is also optimal to use the tax system to encourage the immigration of high-skill workers and discourage that of low-skill workers. When immigrants and natives must be treated alike, it is optimal to ban low-skill immigration and have free immigration for high-skill workers. However, high-skill workers may choose not to immigrate when there are heavy taxes levied on all high-skill workers, natives and immigrants alike.

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[†]Northwestern University.
[‡]Northwestern University, NBER and CEPR.
[§]Católica-Lisbon School of Business & Economics, Banco de Portugal and CEPR.

1 Introduction

In a televised address aired in 1977, Milton Friedman discussed the change in U.S. attitude towards immigration. *"Suppose you go around and ask people: the United States, as you know, before 1914 had completely free immigration; [...]—was that a good thing or a bad thing? You will find hardly a soul who will say it was a bad thing. Almost everybody will say it was a good thing. But then suppose I say to the same people: but now what about today, do you think we should have free immigration? 'Oh no,' they'll say, 'we couldn't possibly have free immigration today.' [...] What's the difference? How can people be so inconsistent? Why is it that free immigration was a good thing before 1914 and free immigration is a bad thing today? [...]There is a sense in which free immigration in the same sense as we had it before 1914 is not possible today. Why not? Because it is one thing to have free immigration to jobs, it is another thing to have free immigration to welfare, and you cannot have both. If you have a welfare state, if you have a state in which every native is promised a certain minimum level of income or a minimum level of subsistence regardless of whether he works or not, produces it or not, well then it really is an impossible thing."*[1]

The question of what is the optimal immigration policy and how it interacts with domestic redistribution programs has become even more important since Friedman's televised address. In both Europe and the United States, immigration policy has become a central political issue that is influencing electoral outcomes (see, e.g. Manacorda, Manning, and Wadsworth (2018)).

In this paper, we study the immigration policy that maximizes the welfare of the native population in an economy where the government designs an optimal redistributive welfare system and supplies public goods. The provision of public goods is assumed

[1]Immigration to the U.S. was not completely free prior to 1914. In 1882, the U.S. Congress passed the Chinese Exclusion Act which restricted Chinese immigration. However, these restrictions had a minor effect on immigration flows. The Immigration Act of 1917 and that of 1924 ended the era of relatively free immigration. In 1917, a literacy requirement was imposed. Visa requirements and nation-wide immigration quotas were imposed in the act of 1924.

to be non-excludable and subject to congestion.

We start by showing that there is no role for quotas (*free immigration* is optimal) in a first-best setting where the government can implement different transfers or taxes for low- and high-skill workers, natives and immigrants. In this case, immigrants are allowed to enter freely as long as they pay a levy that compensates for the congestion they create in the provision of public goods.[2] Immigrants are excluded from the welfare system. They do not receive transfers and do not pay domestic taxes, other than the public-goods congestion charge.

Next, we consider two second-best settings where the government faces Mirrlees (1971)-style information constraints in distinguishing between high- and low-skill workers. In the first setting, the government can discriminate between native and immigrant workers. In the second setting, immigrants cannot be excluded from the welfare system.

We show that free immigration is still optimal as long as the Mirrleesian planner can discriminate between native and immigrant workers. The reason for this result is that immigrant specific taxes are preferable to quotas in affecting immigration flows. If skill types are perfect substitutes, as in the traditional Mirrleesian literature, the optimal immigration policy is the same as in the first best: immigrants are allowed to enter freely as long as they pay taxes that charge for the congestion in the provision of public goods. When low- and high-skill workers are imperfect substitutes, immigration affects the skill premium through general-equilibrium effects.[3] Taxes/subsidies on immigrants that encourage high-skill immigration, and discourage low-skill immigration, reduce the skill premium, improving the planner's ability to redistribute income from high-skill natives to low-skill natives.[4] The optimal immigration policy is to levy a tax on low-skill immigrants that is higher than their contribution to the social cost of providing

[2]This policy is similar to the one proposed by Gary Becker in Becker and Posner (2009), which involves charging immigrants for the right to enter the country.

[3]The importance of general-equilibrium effects to the design of Mirrleesian tax systems has been emphasized by Stiglitz (1982) and Naito (1999), among others.

[4]A number of empirical studies have shown that low-skill immigration has a positive impact on the skill premium, see e.g. Borjas, Freeman, and Katz (1992), Topel (1994), and Card (2009).

public goods and a tax on high-skill immigrants that is lower than their contribution to the social cost of providing public goods. In our quantitative analysis, we find that the general-equilibrium effects of immigration on the skill premium play an important role in shaping optimal immigration policy.

When discriminating between immigrants and natives is unfeasible, free immigration is no longer optimal and there is a role for immigration quotas. Since the planner wants to redistribute income towards low-skill native workers, and immigrants and natives must be treated alike, the planner chooses to ban low-skill immigration. The reason for this ban is that low-skill immigrants add to the pool of workers who receive transfers that need to be financed with distortionary taxes on high-skill workers. The optimal immigration policy may feature free immigration for high-skill workers. However, theses workers may choose not to immigrate when there are heavy taxes levied on all high-skill workers, natives and immigrants alike. These results hold whether or not there are general-equilibrium effects of immigration on the skill premium. However, they are reinforced if immigration affects the skill premium because low-skill immigration increases the skill premium making it harder for the planner to redistribute in favor of low-skill native workers.

Milton Friedman partially anticipated these results in his 1977 address: "*Look at the obvious immediate, practical case of Mexican illegal immigration. Mexican immigration over the border is a good thing for the illegal immigrants and the United States. But it is only good so long as it's illegal. [...] As long as it's illegal people do not qualify for welfare, for social security, and for all the myriad of benefits that we pour out from our left pocket into our right pocket. As long as they don't qualify, they migrate to jobs.*"

Our analysis shows that the ability to exclude immigrants from the welfare system is critical in order for the native population to benefit from free immigration. However, there are several important nuances. Illegal immigration is not always good. On the one hand, immigration creates congestion in the provision of public goods. On the other hand, when different skill types are imperfect substitutes, low-skill immigration raises the skill premium, reducing the government's ability to redistribute income towards low-skill natives.

Our results are related to the literature on the optimality of production efficiency with Mirrleesian optimal taxation (see e.g. Atkinson and Stiglitz (1976)). In the absence of general-equilibrium effects, production efficiency is optimal. In our model this result translates into the optimality of free immigration combined with taxes that correct for congestion effects. In the presence of the general-equilibrium effects emphasized by Stiglitz (1982) and Naito (1999), taxes can affect relative wages. As a result, production efficiency ceases to be optimal. In our model, this result translates into the optimality of levying different taxes on high- and low-skill immigrant workers.

Our results are also related to the literature on the net benefits of immigration (see e.g. Borjas (1995) and Giordani and Ruta (2011)). This literature, which abstracts from the implications of immigration for optimal fiscal policy, emphasizes the presence of an "immigration surplus." This surplus is the net benefit of immigration that results from increases in income to non-labor factors such as land. In the appendix, we show that the immigration surplus emerges under two conditions. First, workers are homogeneous, so there is no need to implement redistribution policies. Second, immigrants are excluded from the welfare state and from the provision of public goods.

We illustrate and develop our results further with a quantitative analysis. We use a calibrated version of our model to compute the optimal immigration policy for the period between 1994 and 2008, for the U.S.

Both in the case of unrestricted taxes and Mirrleesian income taxes with discrimination between native workers and immigrants, we find that optimal immigration flows are high, much higher than those observed in the data.

We find an important quantitative role for the effect of immigration policy on the skill premium. Compared to the first-best solution, the case with Mirrleesian income taxes and discrimination of immigrants features higher high-skill immigration and lower low-skill immigration. We show that, in this solution, the planner reduces the skill premium by 2.3 percent when compared to the first-best allocation.

When discriminating between natives and immigrants is infeasible, the optimal immigration policy features zero quotas for low-skill immigrants. This finding agrees broadly with Friedman's intuition. It is indeed optimal to ban low-skill immigration when the planner seeks to redistribute income towards low-skill natives. High-skill workers are still free to immigrate, even if they may choose not to. We find that, in the first part of the period we consider, there is no high-skill immigration. This highlights a *domestic redistribution regime* in which the high-skill workers are heavily taxed, in order to redistribute to low-skill natives. As a result of the heavy tax burden associated with being a high-skill worker, high-skill immigrants choose not to immigrate. In the later period, as a result of further skill-biased technical change, high-skill immigration jumps up to 0.2. This highlights a *immigration surplus regime* in which high-skill workers pay low taxes, that roughly cover the congestion of public goods. Transfers to low-skill workers are financed with the high value of land income.

The paper is organized as follows. In Section 2, we present the model. We discuss the properties of the solution with unrestricted taxes in Section 3. Section 4 contains the analysis of Mirrleesian optimal immigration policy with and without the ability to discriminate between immigrants and natives. Section 5 is devoted to the quantitative analysis. Section 6 summarizes the conclusions.

2 The model

We consider a simple static economy inhabited by a continuum of unit measure of workers, which we call *natives*. Native workers are heterogeneous with respect to their labor productivity. We assume that out of the total native population, a share $\pi_{n,l}$ are low-skill workers and a share $\pi_{n,h}$ are high-skill workers. These shares add up to one: $\pi_{n,l} + \pi_{n,h} = 1$. Each household is composed of a single worker. For simplicity, we do not consider the possibility of emigration by native workers.[5]

Native workers with ability $a \in \{l, h\}$ derive utility from consumption, $c_{n,a}$, and disutility from supplying labor, $n_{n,a}$. Furthermore, they also benefit from a publicly provided good, G. For simplicity, we assume that the utility function is strictly separable in public goods,

$$U_{n,a} \equiv u(c_{n,a}, n_{n,a}) + v(G). \tag{1}$$

We make the standard assumptions that the utility function is twice continuously differentiable, strictly increasing in consumption, $u_c > 0$, and government spending, $v_G > 0$, and decreasing in hours worked, $u_n < 0$.[6] We also assume that the utility function satisfies the following *consumption-leisure normality* condition.[7]

Assumption 1 (Consumption-leisure normality condition)**.** *We assume that the utility function satisfies*

$$\frac{u_{cc}}{u_c} - \frac{u_{cn}}{u_n} \leq 0, \quad \text{and} \quad \frac{u_{cn}}{u_c} - \frac{u_{nn}}{u_n} \leq 0, \tag{2}$$

with at least one strict inequality.

A large pool of potential immigrants, indexed by i, stands ready to enter the country. Immigrants can be high- or low-skill workers. We denote the mass of entering immigrants with skill a by $\pi_{i,a}$. After entering the country, immigrants choose how much to consume, $c_{i,a}$, and work, $n_{i,a}$, and obtain the following utility

$$U_{i,a} \equiv u(c_{i,a}, n_{i,a}) + v(G). \tag{3}$$

Implicitly, we are assuming that there is no exclusion in the consumption of public goods, i.e. all workers derive utility from the total provision of public goods. Immigrants

[5]See Mirrlees (1982) for a treatment of optimal income taxation with emigration.

[6]Whenever it is not confusing, we use f_x to denote $\partial f(x, y)/\partial x$ for some function $f(x, y)$.

[7]In our environment, assuming consumption-leisure normality also implies that the utility function verifies the Spence-Mirrlees *single-crossing* condition: $d\left(-u_n\left(c, \frac{y}{w}\right) / \left[wu_c\left(c, \frac{y}{w}\right)\right]\right)/dw < 0$. This is because $d\left(\frac{-u_n(c,y/w)}{wu_c(c,y/w)}\right)/dw = -\frac{u_n}{wu_c}\left[-\frac{1}{w} + \frac{y}{w^2}\left(\frac{u_{cn}}{u_c} - \frac{u_{nn}}{u_n}\right)\right]$, which, using normality, is strictly negative.

with skill a enter the country only if their utility is not below their reservation utility, $\overline{U}_a$:

$$U_{i,a} \geq \overline{U}_a, \text{ if } \pi_{i,a} > 0. \tag{4}$$

To simplify, we assume that the outside options are exogenous, i.e. these options do not change with immigration flows. This assumption, together with the presence of a large pool of potential immigrants is appropriate if the country is small relative to the world economy.[8]

Goods production combines native and immigrant labor with a fixed factor (land), L, according to the production function $F(L, N_l, N_h)$, where total labor of skill type a is the sum of native and immigrant labor supplies, $N_a \equiv \pi_{n,a}n_{n,a} + \pi_{i,a}n_{i,a}$. The aggregate endowment of land is $\overline{L}$. We make the standard assumptions that the production function is strictly increasing, $F_L, F_l, F_h > 0$, strictly concave, and homogeneous of degree one. Furthermore, we assume that production is weakly separable in land, so the stock of land does not affect the skill premium.[9]

Assumption 2 (Weak separability in land)**.** *Assume that F_h/F_l is independent of L.*

The economy's resource constraint is given by

$$\sum_{b\in\{n,i\}} \sum_{a\in\{l,h\}} \pi_{b,a}c_{b,a} + \sigma(\pi_i) G \leq F(L, N_l, N_h). \tag{5}$$

where $\pi_i \equiv \pi_{i,l} + \pi_{i,h}$ and $\sigma : R_+ \to [1, \infty)$, $\sigma'(\pi_i) \in [0, 1]$, and $\sigma''(\pi_i) \geq 0$. This function is meant to capture the *congestion effects* on public goods provision associated with immigration. To provide a total of G units of public goods per household, the government must spend $\sigma(\pi_i) G$ of resources. If $\sigma(\pi_i) = 1$ for all π_i then there are no congestion effects. If instead $\sigma(\pi_i) = 1 + \pi_i$ then there is full congestion, in the sense

[8]This assumption could be relaxed in different ways. An interesting way to endogenize the outside options is to extend the analysis to a more complex multi-country model.

[9]Krusell, Ohanian, Rios-Rull, and Violante (2000) estimate an aggregate production function that includes skilled and unskilled labor. In their formulation, the stock of structures–the analogue of land in our model–does not affect the skill premium.

that public goods provision has the same congestion effects as that of private goods. In our numerical application, we look at the case $\sigma(\pi_i) = 1 + \kappa\pi_i$, where κ is meant to capture the share of public goods that are subject to congestion.

Native and immigrant households A worker with skill a chooses consumption and hours of work to maximize utility subject to the budget constraint

$$c_{n,a} \leq w_a n_{n,a} + r l_{n,a} - \mathcal{T}_{n,a}(w_a n_{n,a}, r l_{n,a}). \tag{6}$$

The worker receives a wage rate, w_a, which depends only on their skill and pays taxes according to the tax function $\mathcal{T}_{n,a}$. Native workers with ability a own $L_{n,a}$ units of land. Land owners decide to rent $l_{n,a} \in [0, L_{n,a}]$ units of land to firms, earning a rental rate r. We assume that high-skill workers own more land than low-skill workers, $L_{n,l} \leq L_{n,h}$. The assumption that taxes are a function of labor and non-labor income is equivalent to assuming that only labor and land incomes are observable, but not the wage and labor supplied independently or the amount of land owned.

Immigrant households own no land, $L_{i,a} = 0$, and choose consumption and hours worked to maximize utility subject to the budget constraint

$$c_{i,a} \leq w_a n_{i,a} - \mathcal{T}_{i,a}(w_a n_{i,a}, 0), \tag{7}$$

where $\mathcal{T}_{i,a}$ denotes taxes on immigrant workers, which are potentially different from those paid by native workers.[10]

A note on land ownership The assumption that land is privately owned and heterogeneous across households is not standard in the Mirrleesian taxation literature. The standard assumptions are either that wealth is publicly owned, as in Werning

[10]To keep the model simple, we make the extreme assumption that immigrants only have labor income. While this assumption seems natural in terms of land ownership in the host country, our model is silent about financial wealth/income which agents can carry across borders. Fully addressing this issue would require a more complex multi-country model.

(2007), or that it is equally distributed across households, as in Kocherlakota (2010). In these models, because skill is private information, the government needs to elicit this information. The two assumptions described above are useful because they prevent the government from learning the agent's skill level by observing wealth. This property means that the agent's skill type must be inferred using the worker's labor income alone. As a result, the logic of the Mirrlees-taxation model is preserved.

We consider a model in which land is privately owned and unequally distributed. We assume that taxes cannot be directly levied on the endowments of land, but rather on the income derived from it. Since agents can choose not to rent all their land endowment, it is still possible to conceal information.

Government The government sets up a tax/transfer scheme. For the sake of generality, we write the tax function to allow for potential discrimination between natives and immigrants, as well as between low- and high-skill workers. The notation also allows taxes to be arbitrary functions of labor and capital income. In the next sections, we discuss the consequences of different restrictions on the ability of the government to discriminate between worker types for the design of optimal immigration policies.

The government must satisfy the budget constraint:

$$\sum_{b\in\{n,i\}}\sum_{a\in\{l,h\}}\pi_{b,a}\mathcal{T}_{b,a}\left(w_a n_{b,a}, rl_{b,a}\right)\geq\sigma\left(\pi_i\right)G. \tag{8}$$

We also assume that the government can choose the number of immigrants of each type that enter the economy through immigration quotas $\{\pi_{i,a}\}_a$, subject to the participation constraint (4).

Firms and factor prices The production technology is operated by competitive firms, hiring labor and renting land to maximize profits. The firms' first-order conditions imply that factor prices are equal to their marginal productivities:

$$w_a = \frac{\partial F(l, N_l, N_h)}{N_a} \equiv F_a(L, N_l, N_h),$$
$$r = \frac{\partial F(l, N_l, N_h)}{N_a} \equiv F_L(L, N_l, N_h).$$

Because the production function has constant returns to scale, equilibrium profits are zero.

Equilibrium and free immigration We start by defining the equilibrium for a fixed number of immigrants.

Definition 1. *(Equilibrium) For a given number of immigrants of each type,* $\{\pi_{i,a}\}_{a=l,h}$*, a competitive equilibrium consists of allocations* $c_{b,a}$*,* $n_{b,a}$*,* $l_{i,a}$*, factor prices* w_l*,* w_h*, and* r*, and taxes* $T_{b,a}$ *for all* b, a*, such that: (i) given taxes and factor prices, native households maximize their utility (1) subject to their budget constraint (6), and immigrant households who enter the country maximize their utility (3) subject to their budget constraint (7); (ii) firms maximize profits, implying that factor prices are equal to the marginal productivities; (iii) the government's budget constraint is satisfied; (iv) The goods market, labor, and land markets clear: (5), and*

$$N_a = \sum_{b \in \{n,i\}} \pi_{b,a} n_{b,a},$$

$$L = \sum_{a \in \{l,h\}} \pi_{n,a} l_{n,a};$$

and (v) the immigrants' participation constraint, (4), is satisfied.

We say that there is *free immigration of skill type* a if in equilibrium the participation constraint of immigrants of that skill type holds with equality ($U_{i,a} = \overline{U}_{i,a}$) if $\pi_{i,a} > 0$, and the following inequality holds $U_{i,a} \leq \overline{U}_{i,a}$ if $\pi_{i,a} = 0$. The concept of free immigration is related to the idea of open borders. With free immigration the government imposes no quantity restrictions, i.e. quotas, on immigration. It allows entry of as many immigrants of skill type a as those willing to immigrate.

The government can restrict immigration either by directly limiting $\pi_{i,a}$ or by taxing immigrants to discourage them from moving. While free immigration is a situation in which the government does not restrict $\pi_{i,a}$ directly, the government might still use the income tax schedule to indirectly affect the level of immigration.

We define a *free immigration with no taxes equilibrium* as an equilibrium in which there is free immigration for all skill types, and the government does not tax or subsidize immigrants. Formally, this is an equilibrium in which immigrants solve the problem:

$$U_{i,a} = \max u\left(c_{i,a}, n_{i,a}\right) + v\left(G\right) \quad \text{subject to } c_{i,a} \leq w_a n_{i,a}$$

and if $\pi_{i,a} > 0$ then $U_{i,a} = \overline{U}_{i,a}$. The concept of free immigration with no taxes is useful because it relates to Friedman's views about illegal immigration. It corresponds to a situation in which immigrants are fully excluded from the tax system. They do not pay taxes, nor receive transfers. In the following sections, we discuss conditions under which this kind of immigration can be optimal.

3 Policy with unrestricted taxes/transfers: first best

We start by assuming that the government can implement discriminatory transfers between all household types: low- and high-skill, natives and immigrants. The government's objective is to maximize a weighted average of the utility of the native population. The weight placed by the government on a native agent with ability a is $\omega_a \geq 0$, and they are such that $\pi_{n,l}\omega_l + \pi_{n,h}\omega_h = 1$. Social welfare is given by

$$\sum_{a\in\{l,h\}} \omega_a \pi_{n,a} \left[u\left(c_{n,a}, n_{n,a}\right) + v(G)\right]. \tag{9}$$

To evaluate the consequences of immigration, we consider a two-stage problem. The first-stage is to find allocations $\{c_{b,a}, n_{b,a}, l_{b,a}\}_{b,a}$ plus government spending G, and land used in production L that maximize welfare (9), subject to the participation constraint of immigrant workers, (4), the resource constraint, (5), using market clearing to replace aggregate labor and land in production.[11] We use $\mathcal{W}$ to denote the maximal welfare for a given level of immigration.

The second stage is to find optimal immigration levels using the condition $d\mathcal{W}/d\pi_{i,a} \leq 0$ which must be satisfied with equality if $\pi_{i,a} > 0$.

Because L only enters the production function, then it is optimal to set it as high as possible so that $l_{n,a} = L_{n,a}$ is optimal (and $L = \sum \pi_{n,a} l_{n,a}$).

The optimal solution for the consumption and labor of immigrant workers has to satisfy the following conditions

$$-\frac{u_l\left(c_{i,a}, n_{i,a}\right)}{u_c\left(c_{i,a}, n_{i,a}\right)} = F_a\left(L, N_l, L_h\right),$$

$$u\left(c_{i,a}, n_{i,a}\right) + v(G) = \overline{U}_a,$$

where N_a denotes the aggregate labor supply of type a workers. For a fixed $\pi_{i,a}$, this allocation can be implemented by setting the lump-sum transfer on immigrants, $\mathcal{T}_{i,a}\left(y_N, y_L\right) = T_{i,a}$ for all $y_N, y_L \in \mathbb{R}$ and some $T_{i,a} \in \mathbb{R}$, defined as

$$T_{i,a} \equiv F_a\left(L, N_l, N_h\right) l_{i,a} - c_{i,a}.$$

The envelope condition with respect to π_i is

$$\frac{d\mathcal{W}}{d\pi_{i,a}} = \lambda\left[F_a\left(L, N_l, L_h\right) l_{i,a} - c_{i,a} - \sigma'\left(\pi_i\right) G\right] = \lambda\left[T_{i,a} - \sigma'\left(\pi_i\right) G\right],$$

where λ is the Lagrange multiplier on the resource constraint. Clearly, optimality requires $T_{i,a} = \sigma'\left(\pi_i\right) G$ if $\pi_{i,a} > 0$.

Proposition 1. *Suppose that the government can discriminate between all worker types. Then, the optimal policy imposes an equal lump-sum tax on all immigrant workers to*

[11] In appendix A.3 we show that these are necessary and sufficient conditions for implementability of the allocations as an equilibrium with unrestricted taxes.

correct congestion effects in the provision of public goods, but imposes no marginal distortions

$$\mathcal{T}_{i,a} = \sigma' (\pi_i) G, \quad a = l, h.$$

Free immigration of all skill types is optimal.

Corollary 1. *Suppose further that there are no congestion effects on public-goods provision, $\sigma(\pi_i) = 1$. Then, free immigration with no taxes is optimal.*

This proposition shows that the optimal immigration policy in this case satisfies two conditions: (1) any immigrant should be free to enter the country, which leads to the condition $U_{i,a} = \overline{U}_a$; and (2) upon entering the country, the optimal policy taxes immigrant workers only to correct for congestion effects. Free immigration with no taxes is optimal only if there are no congestion effects on public goods.

4 Mirrleesian policy

In general, the benchmark discussed above cannot be implemented when the government cannot discriminate between low- and high-skill native workers. In this case, redistributing across agents requires the use of distortionary taxation. We now study the effects of immigration in a second-best economy with Mirrleesian non-linear income taxation. We consider two cases. In the first case, the government can discriminate between natives and immigrants. In the second case, this discrimination is not possible, so immigrants cannot be excluded from the welfare state.

4.1 Mirrleesian policy with discrimination: immigration to jobs

Consider first the case in which the government can distinguish between natives and immigrants but is restricted in the way in which it can redistribute resources between low- and high-skill natives. As in Mirrlees (1971), we allow for arbitrary, non-linear income-tax functions. These assumptions mean that

$$\mathcal{T}_{n,l}(y_N, y_L) = \mathcal{T}_{n,h}(y_N, y_L) \equiv \mathcal{T}_n(y_N, y_L)$$

for all y_N and y_L, but the government is otherwise unrestricted. We continue to assume that the government can use tax schedules that discriminate between immigrants of different skills, thus using the tax system to affect $\pi_{i,l}$ and $\pi_{i,h}$.

In appendix A.5 we show that under these assumptions on the tax functions, the resource constraint (5), the participation constraints (4), and the incentive constraints for native workers:

$$u\left(c_{n,l}, n_{n,l}\right) \geq u\left(c_{n,h}, \frac{F_h n_{n,h}}{F_l}\right), \text{ if } l_{n,h} \leq L_{n,l}, \tag{10}$$

$$u\left(c_{n,h}, n_{n,h}\right) \geq u\left(c_{n,l}, \frac{F_l n_{n,l}}{F_h}\right), \tag{11}$$

are necessary and sufficient conditions to characterize an equilibrium for $\{c_{b,a}, n_{b,a}, l_{b,a}\}_{b,a}$, $\pi_{i,l}$, $\pi_{i,h}$, L, and G. The problem of the government is to maximize welfare, (9), subject to the constraints that describe the implementable set.

Given that production is weakly separable in land, the amount of land in use does not affect the skill premium directly. Land use enters the problem through the production function and it influences the ability of low-skill native workers to imitate high-skill native workers. If $l_{n,h} > L_{n,l}$ then the maximum land income of low-skill native workers is too low to allow them to imitate high-skill workers. Increasing $l_{n,a}$ has benefits in terms of increasing production and either does not affect incentive constraints or helps remove one constraint, if $l_{n,h} > L_{n,l}$. Therefore, it is optimal to use all available land, $l_{n,a} = L_{n,a}$ and $L = \sum_a \pi_{n,a} L_{n,a}$.

Lemma 1. *Suppose that the government can distinguish between natives and immigrants and that the production function satisfies weak separability in land. Then, the optimal plan is such that native workers use all their productive land* $l_{n,a} = L_{n,a}$.

In general, the skill premium, F_h/F_l, is endogenous because it depends on aggregate labor supplies. Standard Mirrlees-style models often assume that different skill types are perfect substitutes in production, differing only in the number of efficiency units produced by one hour of labor, so the skill premium is exogenous.[12]

Assumption 3 (Perfect substitution in skill types). *Assume that the production function can be written as $F(L, \theta_l N_l + \theta_h N_h)$ for scalars $\theta_l, \theta_h \in \mathbb{R}_+$ such that $\theta_h > \theta_l$.*

This assumption implies that the skill premium is constant and given by

$$\frac{F_h}{F_l} = \frac{\theta_h}{\theta_l}.$$

In this case, the skill premium is exogenous. If this assumption holds, the implications for optimal immigration policy are the same as in the case of unrestricted taxation. The optimal plan implies the following conditions

$$-\frac{u_n(c_{i,a}, n_{i,a})}{u_c(c_{i,a}, n_{i,a})} = F_N(L, N)\,\theta_a, \quad \text{and} \qquad u(c_{i,a}, n_{i,a}) + v(G) = \overline{U}_a,$$

and the envelope condition is

$$\frac{\partial W}{\partial \pi_{i,a}} = \lambda \left[F_N(L, N)\theta_a l_{i,a} - c_{i,a} - \sigma'(\pi_i)\,G\right].$$

The optimal plan features free immigration with the possibility of a lump-sum tax to correct the congestion externality. If there are no congestion effects, $\sigma(\pi_i) = 1$, then more immigration is desirable as long as the immigrants' contribution to production is lower than their consumption, i.e. $F_N(L, N)\theta_a l_{i,a} - c_{i,a} > 0$. It turns out that the optimal immigration policy is free immigration with no taxes. We summarize these results in the following proposition and corollary which are proved in the appendix.

Proposition 2. *Suppose that the government can discriminate between natives and immigrants, and that there is perfect substitution in skill types. Then, free immigration*

[12] See, for example, Golosov, Kocherlakota, and Tsyvinski (2003), Werning (2008), and Kocherlakota (2010).

of all skill types is optimal. The optimal policy imposes an equal lump-sum tax on all immigrant workers to correct the congestion externality, no further distortions are imposed:

$$\mathcal{T}_{i,a}(\cdot) = \sigma'(\pi_i) G.$$

Corollary 2. *Suppose further that there are no congestion effects on public-goods provision, $\sigma(\pi_i) = 1$. Then, free immigration with no taxes is optimal.*

These results can be interpreted as optimality of production efficiency.[13] Immigration can be interpreted as a technology and, in that sense, free immigration with no taxes corresponds to production efficiency provided there are no externalities. If there are congestion effects on public goods, production efficiency requires lump-sum taxation of immigrants.

As implied by Atkinson and Stiglitz (1976), production efficiency is optimal in a Mirrleesian settings. The result in proposition 2 is an application of that principle, which, in this case, crucially relies on two assumptions. The first assumption is the absence of general-equilibrium effects on relative wages. This assumption is important because it implies that changes in the total level of immigrants do not affect the incentive constraints. The second assumption is that immigrants can be excluded from the welfare system. In what follows, we analyze the case with general equilibrium effects. The case of no exclusion from the welfare system is analyzed in the next section.

Stiglitz (1982) analyzes optimal Mirrleesian taxation in a model with general equilibrium effects, resulting from imperfect skill substitutability. He shows that the optimal plan involves marginal subsidies to high-skill workers and larger marginal taxes on low-skill workers. This tax configuration induces larger relative high-skill labor supply which reduces the skill premium. Naito (1999) extends this analysis to optimal commodity taxation, and concludes that the same rationale implies deviations from uniform taxation. In our setting, general equilibrium effects on wages can be a reason to design

[13] See Diamond and Mirrlees (1971), Atkinson and Stiglitz (1976), and Scheuer and Werning (2018).

immigration policies which deviate from the principles of production efficiency. To analyze the impact of these general-equilibrium effects on the optimal immigration policy, we make the following assumption.

Assumption 4 (Skill-premium monotonicity)**.** *Assume that F_h/F_l is strictly increasing in N_l and strictly decreasing in N_h.*

Under the assumption of skill-premium monotonicity, by increasing the aggregate supply of high-skill labor and decreasing the aggregate supply of low-skill labor the planner can reduce the skill premium. This result implies that the planner can use immigration policy to affect the composition of the labor force and improve income redistribution in the economy.

Proposition 3. *Suppose that the government can discriminate between natives and immigrants, that the skill premium is endogenous and satisfies the skill-premium monotonicity condition. Suppose further that the incentive constraint of high-skill workers, (11), binds, and that of low-skill workers, (10), does not bind. Then, free immigration of all skill types is optimal. However, the taxes paid by high-skill workers are lower than those required to correct for congestion effects*

$$\mathcal{T}_{i,h}(w_h n_h, 0) < \sigma'(\pi_i) G,$$

and taxes paid by low-skill workers are higher than those required to correct for congestion effects

$$\mathcal{T}_{i,l}(w_l n_l, 0) > \sigma'(\pi_i) G.$$

If the planner has a strong incentive to redistribute to low-skill workers, then the incentive constraint of high-skill workers binds and that of low-skill workers does not. In that case, the planner has an incentive to reduce the skill premium to loosen the binding incentive constraint. In order to decrease the skill premium, the optimal immigration policy gives relatively more transfers to high-skill workers than to low-skill workers. By affecting the extensive margin choice in this way, the planner incentivizes more high-skill immigrants and less low-skill immigrants to enter the country. The optimal plan delivers a shift in the composition of the labor force towards a bigger share of high-skill workers.

The marginal subsidies for high-skill workers and higher marginal taxes for low-skill workers in Stiglitz (1982) are also part of the optimal tax/transfer system in our model. Both native and immigrant high-skill workers are subsidized on the margin, in order to induce higher labor supply and reduce the skill premium. For the same reason, low-skill native and immigrant workers are subject to higher marginal taxes.

Even in the case where high and low skill are perfect substitutes, the optimality of production efficiency requires that immigrants can be discriminated by the tax system. This discrimination is important because it gives the government the ability to redistribute income only across the workers included in its welfare function. This ability means that the government can prevent immigrants from reaping the benefits of a generous welfare system. It also allows the government to incentivize high-skill immigrants to enter the country, while still being able to tax heavily high-skill natives. The next subsection studies the case where immigrants cannot be excluded from the welfare system.

4.2 Mirrleesian policy without discrimination: immigration to welfare

In this section, we assume that the government cannot condition taxes on the immigration status. The planner must set the same tax function for all worker types: $\mathcal{T}_n(y_N, y_L) = \mathcal{T}_i(y_N, y_L) \equiv \mathcal{T}(y_N, y_L)$. To avoid the uninteresting case in which the government would distinguish between native and immigrant workers on the basis of land ownership, we assume that $L_{n,l} = 0$. This assumption means that immigrant workers can feasibly imitate low-skill workers. As a result, the present model can capture the trade-offs emphasized by Friedman.

In appendix A.9, we show that the set of implementable allocations is constrained by the resource constraint, (5), the participation constraint of immigrants with ability a if $\pi_{i,a} > 0$ the following incentive constraints

$$u(c_{b,a}, n_{b,a}) = \max_{(b',a')\in\Theta_{b,a}} u\left(c_{b',a'}, \frac{F_{a'} n_{b',a'}}{F_a}\right),$$

for all (b, a), where

$$\Theta_{b,a} \equiv \{(b', a') : \pi_{b',a'} > 0 \text{ and } l_{b',a'} \leq L_{b,a}\},$$

There are potentially three incentive constraints per worker type, which amount to twelve incentive constraints to keep track of. However, the next lemma shows that we can greatly simplify the analysis. Intuitively, it shows that because low-skill workers face the same productivity and tax function, the optimal plan features the same consumption and labor supply for natives and immigrants: $c_{n,l} = c_{i,l}$ and $l_{n,l} = l_{i,l}$.

The lemma also shows that, as before, because the production function is weakly separable in land, the optimal plan features full land use.

Lemma 2. *Suppose that the government cannot distinguish between natives and immigrants and low-skill native workers own no land. Suppose further that the production function is weakly separable in land. Then, the optimal plan is such that high-skill native workers use all their productive land, $l_{n,h} = L_{n,h}$, and both native and immigrant low-skill workers receive the same consumption-labor bundle, $c_{n,l} = c_{i,l}$ and $n_{n,l} = n_{i,l}$.*

With the simplification provided by this lemma, the problem can be reduced to maximizing welfare subject to the resources constraint, the participation constraint for the immigrant of skill type a, and one of the following two sets of incentive constraints. If $\pi_{i,h} > 0$, the following incentive constraints must be satisfied: the high-skill-native incentive constraint

$$u(c_{n,h}, n_{n,h}) \geq u(c_{i,h}, n_{i,h}),$$

the high-skill-immigrant incentive constraint

$$u\left(c_{i,h}, n_{i,h}\right) \geq u\left(c_l, \frac{F_l n_l}{F_h}\right),$$

and the low-skill incentive constraint

$$u\left(c_l, n_l\right) \geq u\left(c_{i,h}, \frac{F_h n_{i,h}}{F_l}\right).$$

The first and second conditions combined also imply that the high-skill native worker does not want to mimic a low-skill worker. Instead, if $\pi_{i,h} = 0$, then the only relevant incentive constraint is the one of high-skill natives mimicking low-skill workers:

$$u\left(c_{n,h}, n_{n,h}\right) \geq u\left(c_l, \frac{F_l n_l}{F_h}\right).$$

Low-skill workers cannot mimic high-skill natives, because they have no land endowment.[14]

Proposition 4. *Suppose that the government cannot distinguish between natives and immigrants, and that there is perfect substitution in labor types. Then, in the optimal plan, either:*

1. *Low-skill workers receive no net transfers:* $c_l = w_l n_l - \sigma'(\pi_i)G$*; or,*
2. *The government bans low-skill immigration:* $\pi_{i,l} = 0$ *and* $c_l > w_l n_l - \sigma'(\pi_i)G$.

In contrast with the case with discrimination, new immigrants may not be valued even if their reservation utility is very low. The participation constraint of low skill immigrants may not bind because these immigrants have the same utility as low-skill natives.

Intuitively, if the government wants to redistribute resources towards low-skill workers (the relatively poor), then low-skill immigrants reap the benefits of this redistribution. As a result, the government finds it optimal to ban low-skill immigration.

[14]See appendix A.11 for a proof of the sufficiency of these constraints.

The proposition pertains to the extreme case where low- and high-skill workers are perfect substitutes. This case is useful because it makes clear that, even when the skill premium is exogenous, production efficiency is not optimal if immigrants cannot be discriminated. When the tax system can discriminate based on immigration status (as in the previous section) there is no reason to deviate from production efficiency .

If the planner wants to redistribute to low-skill workers, and the incentive constraint of high-skill workers is binding, an endogenous skill premium reinforces the previous result because it reduces the desirability of low-skill immigration.

5 Optimal immigration policy: a quantitative exercise

In this section, we discuss the features of optimal immigration policy in a calibrated version of our model. For this purpose, we consider the following production function:

$$F\left(L, N_l, L_h\right) = AL^{\gamma}\left[\left(1-\alpha\right)N_l^{\frac{\varepsilon-1}{\varepsilon}} + \alpha\left(SN_h\right)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}(1-\gamma)}.$$

Skill-biased technical change is represented by the parameter S which increases the productivity of high-skill workers versus low-skill workers. For simplicity, we assume that immigrants and natives are perfect substitutes

$$N_a = \pi_{n,a}n_{n,a} + \pi_{i,a}n_{i,a},$$

for $a = h, l$.[15]

Perfectly competitive firms hire the two labor types and rent capital to maximize profits, implying that the factor's price is equal to its marginal productivity. For given labor supplies, an increase in S implies a higher skill premium, w_h/w_l:

$$\frac{w_h}{w_l} = \frac{\alpha}{1-\alpha}S^{\frac{\varepsilon-1}{\varepsilon}}\left(\frac{N_l}{N_h}\right)^{\frac{1}{\varepsilon}}. \tag{12}$$

[15] Card (2009) considers models in which immigrants and natives are imperfect substitutes for a given skill level. However, his. estimate of the elasticity of substitution between immigrants and natives is very high, around 20.

This expression also makes clear that changes in relative labor supplies have an impact on the skill premium. An increase in the supply of high-skill labor relative to low-skill labor decreases the skill premium. This characteristic implies the existence of the general-equilibrium effects which underlie the results of Stiglitz (1982) and others. In our model with Mirrleesian taxation, these general equilibrium effects make low-skill immigration less desirable and high-skill immigration more desirable. By restricting low-skill immigration and incentivizing high-skill workers to enter the country, the government can reduce the skill premium and improve redistribution. As we have emphasized, the optimal immigration policy no longer involves production efficiency. How and by how much should production efficiency be distorted becomes a quantitative question to which we now turn.

Calibration of status-quo economy We consider a sequence of static economies to match different features of the period between 1994 to 2008.[16] Our status-quo economy is an equilibrium with taxes and government spending.

Using the IPUMS-Current Population Survey (IPUMS-CPS)[17] database we compute the shares of native and immigrant, low- and high-skill workers in the total population for this period. In the following figure, we normalize the native population to one in each period, and look at the empirical counterparts of $\pi_{b,a}$ for each b, a.[18]

[16] We focus on the pre-financial crisis period starting in 1994 due to availability of data about immigrants of different skills in the CPS.

[17] Flood, King, Rodgers, Ruggles, and Warren (2018).

[18] We remove high-frequency variation on changes in population shares by working with the fitted values of a quadratic time trend, which we fit using a least squares procedure.

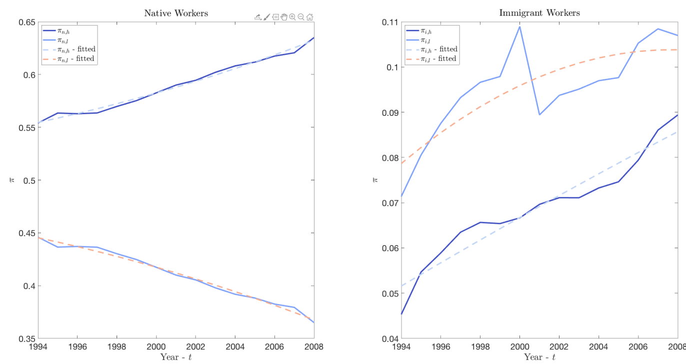

Figure 1: Native and immigrant low- and high-skill worker shares

We assume that preferences are separable and isoelastic. Consistent with the findings discussed in Chetty (2006) we set the consumption elasticity to unity and the Frisch elasticity equal to 0.75, i.e.

$$u(c,n) = \log(c) - \zeta \frac{n^{1+\nu}}{1+\nu},$$

with $\nu = 4/3$. The labor disutility parameter is set such that low-skill households work, on average, a third of their time endowment, $\zeta = 11.06$.

The tax function is assumed to be the same for all worker types, and to take the same form as in Benabou (2000) and Heathcote, Storesletten, and Violante (2018) for labor and land income:

$$\mathcal{T}(wn, rl) = wn + rl - \lambda(wn + rl)^{1-\tau}$$

The government sets spending equal to a fraction of aggregate income $G = gY$. We use the time series for the ratio of government spending to GDP from Jaimovich and Rebelo (2017). We follow the method proposed by Ferriere and Navarro (2018) to obtain estimates of tax progressivity from the *NBER TAXSIM* data. Finally, we let λ adjust to maintain budget balance.

We set $\sigma(\pi_i) = 1 + \kappa\pi_i$. In this formulation $\kappa \in [0, 1]$ is interpreted as the share of government spending subject to congestion effects. In the calibration, we set this parameter equal to the ratio of non-military spending to total spending in each year. We set $v(G) = \chi \log(G)$ and choose χ such that, on average, the marginal utility of spending and the weighted-average marginal utilities of consumption are equated.

Table 1: Model Calibration

Parameters	Description	Value	Source/Target
Time period		$1994 - 2008$	
Preferences			
ν	Inverse-Frisch elast.	4/3	Chetty (2006)
ζ	Labor disutility	11.06	$n = 1/3$
χ	Preference for G	0.2026	$\chi = (\sum_a \omega_a \pi_{n,a}/c_{n,a})\sigma(\pi_i)G$
Production			
A	*TFP*	1	Normalization
$\overline{L}$	Land endowment	1	Normalization
γ	Land share	0.05	V&H (2008)
ε	Skill elasticity	1.69	A&A (2010)
α	High-skill share prod.	0.66	U.S. skill premium
S	SBTC	*Time Series*	U.S. skill premium
Population			
$\pi_{n,a}$	Share natives skill a	*Time Series*	*CPS*
$\overline{U}_{i,h}$	Outside opt. - h	*Time Series*	Free immigration status quo
$\overline{U}_{i,l}$	Outside opt. - l	*Time Series*	Skill premium *LAC-7*
Government			
κ	Congestion parameter	0.93	Non-military spending
ω_h	High-sk welfare weight	1	Utilitarian planner

The calibration chooses the skill-biased technical change parameter S such that the baseline economy replicates the skill premium in Acemoglu and Autor (2010).[19][20] Finally, we assume that high-skill workers own all the land in the economy, $L_{n,l} = 0$, and

[19] There is a vast literature showing that the skill premium has been increasing in the US over the past four decades, e.g. Katz and Murphy (1992), Autor, Katz and Krueger (1998), and Acemoglu and Autor (2011). This increase has occurred despite a large rise in the share of college-educated workers.

[20] We remove high-frequency variation on the skill premia by working with the fitted values of a quadratic time trend, which we fit using a least squares procedure.

normalize the aggregate labor endowment and the total-factor productivity parameter to one. Consistent with the findings in Valentinyi and Herrendorf (2008), we set the land share of production to 5 percent, i.e. $\gamma = 0.05$. Consistent with the estimates in Acemoglu and Autor (2010) and Card (2009), we choose ε, the parameter that controls the elasticity of substitution between low- and high-skill workers to 1.69.

To recover the outside options of immigrants, we assume that there is free immigration for high-skill workers. We can recover the outside option of high-skill immigrants using their equilibrium utility value. To the extent that the actual immigration policy does not feature free immigration of high-skill immigrants, this calibration is an upper bound on the value of the outside option. In a robustness exercise, we consider lowering the outside options for all immigrants.

Because we do not assume that there is free immigration for low-skill occupations, we cannot recover the outside option of low-skill immigrants from their equilibrium utility value. Instead, we assume that the outside options scale with the skill premium outside of the U.S. We use the time-series data for the skill premium in Latin America from de la Torre, Yeyati, and Pienknagura (2013),[21] and assume that:

$$\overline{U}_{i,l} = \overline{U}_{i,h} - \log\left(\frac{w_{h,LAC7}}{w_{l,LAC7}}\right).$$

This approximation is consistent with the assumption of log-utility in consumption. Implicitly, we assume that all other benefits abroad (other than labor income) scale with the wage.

[21] De la Torre, Yeyati, and Pienknagura (2013) document that the skill premium started to fall in the late 1990s for a group of 7 Latin American countries (*LAC-7*). This group includes Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Uruguay.

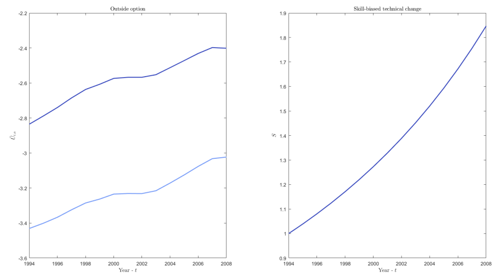

Figure 2: Calibration - outside options and skill-biased technical change

Policy with unrestricted taxes/transfers: first best We now consider the unrestricted taxes benchmark. The government maximizes a utilitarian welfare function, $\omega_h = \omega_l = 1$, subject to the resource constraint and participation constraints of immigrant workers.

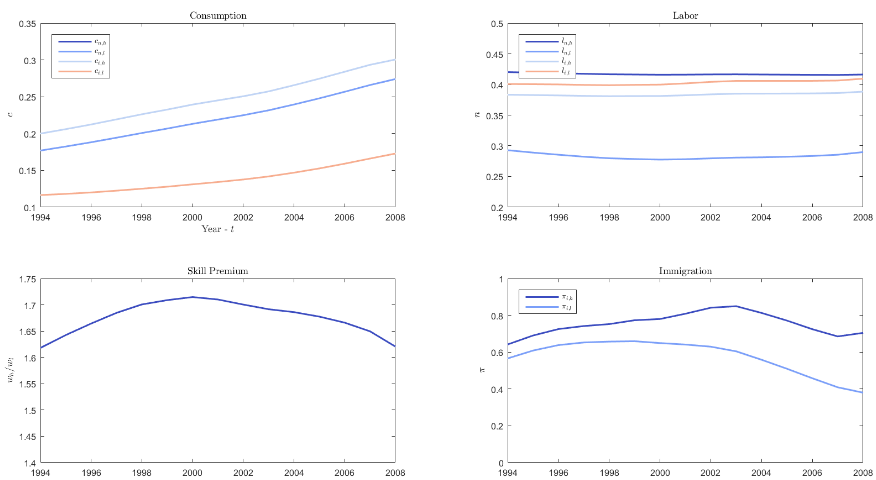

Figure 3: Policy with unrestricted taxes

Figure 4 shows consumption, labor, skill premium, and optimal immigration in this case. The optimal level of immigration is such that immigrant workers have the same utility upon entering the country as their outside option, i.e. their participation constraint is binding. The composition of the immigrant population is such that the behavior of the skill premium closely mimics that of the foreign skill premium.

Immigrant high-skill workers outside options are high, so the government must assign them a good consumption-labor bundle to convince them to immigrate. Indeed, high-skill immigrants consume more and work less than high-skill natives. This property reflects the fact that the status-quo economy, which we use to infer the outside options of high-skill immigrants, features very little redistribution and therefore a high equilibrium utility for high-skill workers.

Immigration starts at 0.57 for low-skill immigrants and 0.64 for high-skill immigrants per native. These numbers rise to 0.66 and 0.85 respectively. The level of immigration then starts falling until reaching 0.38 low-skill immigrants and 0.70 high-skill immigrants in 2008. This fall occurs because the skill premium abroad falls. The outside option of low-skill immigrants' improves, so they require better conditions to choose to immigrate. As a result, the optimal plan features lower levels of low-skill immigrants.

Mirrleesian policy with discrimination: immigration to jobs We now consider the case in which taxation can be conditioned on immigration status, but not on the native workers' skill.

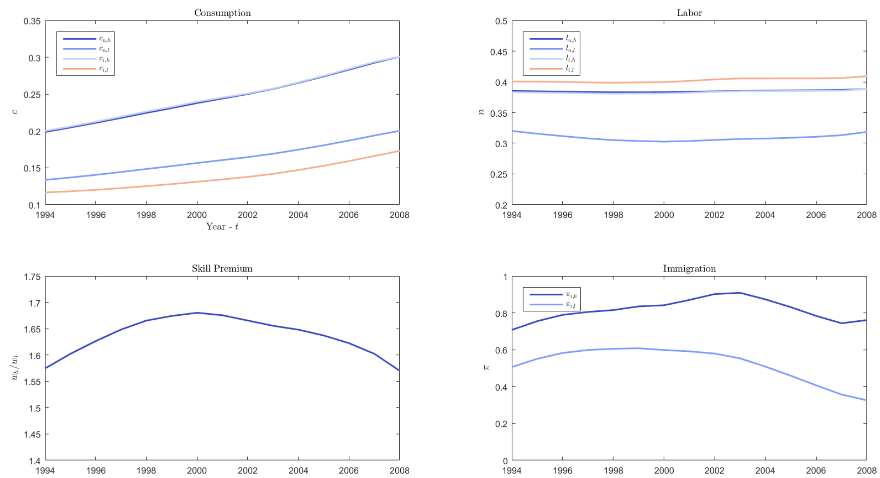

Figure 4: Mirrleesian policy with discrimination

Figure 4 shows consumption, labor, skill premium, and optimal immigration policy for this case. The Mirrleesian policy with discrimination features higher consumption for high-skill native workers than for low-skill native workers. This result is a consequence of the need to provide incentives for high-skill workers to work more.

Relative to the case with unrestricted taxes, high-skill immigration is higher and low-skill immigration is lower. On average, high-skill immigration increases by 0.05, while low-skill immigration decreases by 0.06. This result is largely driven by general-equilibrium effects. By shifting the composition of the labor force towards high-skill workers, the planner can reduce the skill premium. Indeed, compared to the previous case the skill premium is on average 2.34 percent lower.

We can decompose the change in the skill premium into three terms: the first capturing the effects of changing native labor supply, the second capturing changes in immigrant labor supply, and the third capturing the consequences of the change in the composition of the labor force.[22]

[22]We show the exact decomposition in appendix A.13.

Interestingly, labor supply changes end up having a positive effect on the skill premium when compared to the case with unrestricted taxation. If the shares of immigrants were the same as in the previous case, the skill premium would have risen 4.02 percent because of changes in relative labor supplies. These changes are mostly driven by native workers. Changes in the labor supply of immigrant workers are negligible. Changes in the composition of the labor force more than overcome the changes in relative supplies inducing a fall in the skill premium. Indeed, in this decomposition, changes in the composition of the labor force alone account for a -6.36 percent change in the skill premium. Our quantitative results show a strong role for skill premium in the design of optimal immigration policy.

In this case, we assume that the government can still discriminate between immigrants of different skill types. In general, the government may need to use this flexibility to implement the optimal allocations. Interestingly, the optimal policy in our calibrated model does not need to discriminate between low- and high-skill immigrant workers. This is because the optimum is such that neither low-skill workers nor high-skill workers want to mimic the other skill type. A single non-linear income tax function on immigrants can implement the optimal allocation.

Mirrleesian policy without discrimination: immigration to welfare Finally, we consider the case in which immigrants cannot be discriminated. Entering migrants have access to the full benefits and obligations of the welfare state.

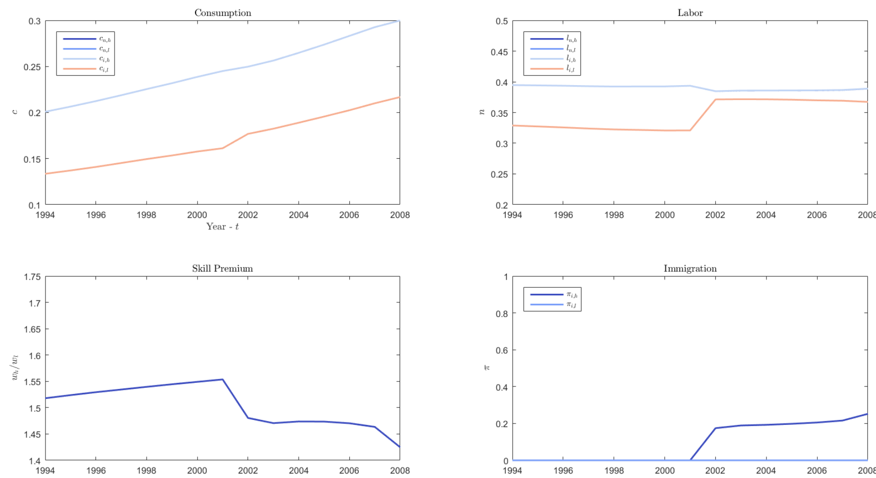

Figure 5: Mirrleesian policy without discrimination

With no discrimination, there is no immigration of low-skill workers under the optimal policy (see Figure 5). Initially, this solution also features no immigration of high-skill workers. The heavy tax burden associated with being a high-skill worker implies that their utility is below the outside option of high-skill immigrants. As a result, high-skill immigrants choose not to immigrate to the country.

The optimal policy responds to increases in skill-biased technical change by eventually allowing for a discrete jump in the level of high-skill immigrants. High-skill immigration jumps from zero to close to 0.2. This is associated with a sizable reduction in the tax burden of high-skill workers, native and immigrant alike.

In this solutions, high-skill workers are always free to immigrate, even if they may choose not to. The results discussed above show the existence of two competing regimes: a *domestic redistribution regime* and a *immigration surplus regime*. Initially, when the productivity of high-skill workers is relatively low, the domestic redistribution regime is optimal. In this regime, high-skill workers face heavy taxation which finance transfers to low-skill workers. As a result of the heavy tax burden associated with being a high-skill worker, high-skill immigrants choose not to immigrate.

In the later period, the *immigration surplus regime* is optimal. In this regime, high-skill workers pay low taxes, that roughly cover the congestion of public goods. This policy with low taxes on high-skill workers is designed to attract high-skill immigration. Transfers to low-skill workers are financed with the high value of land income.

Comparing policies Figure 6 shows the utility level of high- and low-skill natives under the different policies. Overall utility is improving over time reflecting the fact that the economy is growing with rises in the skill-biased technical change.

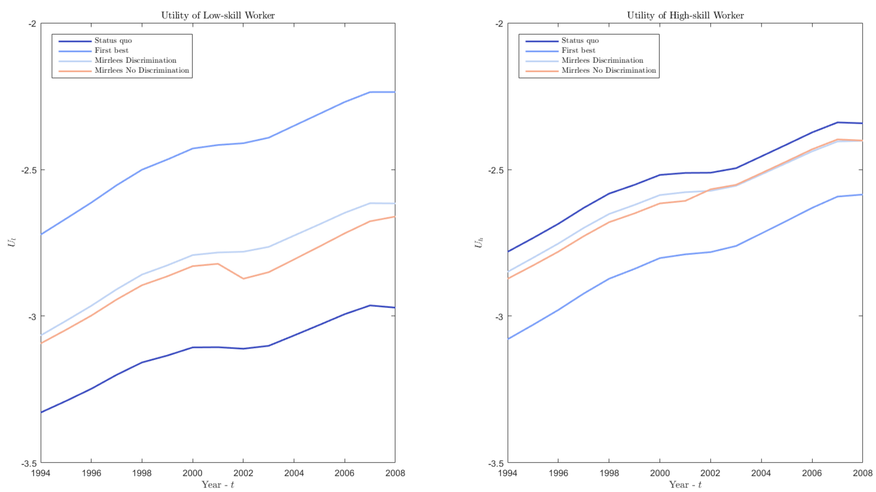

Figure 6: Comparing policies

The first panel shows the utility of low-skill natives. Low-skill natives rank highest the first best and lowest the status quo. This is a consequence of the fact that those are the policies with highest and lowest levels of redistribution, respectively. Not surprisingly, low-skill natives prefer the policy with discrimination to that without discrimination.

The second panel shows the utility of high-skill natives. High-skill natives prefer the status quo to any of the other policies, which reflects the fact that there is less redistribution in this equilibrium. Initially, high-skill natives prefer the policy with discrimination to that under no discrimination. By allowing for immigration, the policy with discrimination reaches a better outcome for both types of worker. Eventually, skill-biased technical change is high enough that the optimal policy without discrimination allows for immigration of high-skill workers. When that happens, high-skill natives prefer the policy without discrimination to that with discrimination. In order to attract high-skill immigrants, the optimal tax/transfer system features relatively low taxes on the high-skill.

6 Conclusions

We study the immigration policy that maximizes the welfare of the native population in an economy where the government designs an optimal redistributive welfare system and supplies public goods.

We show that when the government can setup an income tax system that discriminates between native and immigrant workers, it is always optimal to have free immigration, i.e. no quotas. Abstracting from general-equilibrium effects on the skill premium, the optimal policy is such that immigrants pay no taxes other than a levy that internalizes the congestion they create in the provision of public goods.

Since immigration affects the skill premium, it is optimal to use the tax system to encourage the immigration of high-skill workers and discourage the immigration of low-skill workers. This is achieved by relatively subsidizing high-skill immigrants, and taxing more low-skill immigrants. This policy reduces the skill premium, allowing the planner to redistribute more towards low-skill workers.

When immigrant and native workers must be treated alike in their access to the welfare system, the optimal immigration policy bans the immigration of low-skill workers. High-skill workers are still free to immigrate, but they may choose not to. However, because high-skill workers, both native and immigrants, can be heavily taxed, the system can discourage the immigration of high-skill workers. This scenario resembles the experience of the Scandinavian countries. Despite having liberal immigration policies for high-skill workers, the heavy taxes levied on both native and foreign high-skill workers results in very little high-skill immigration to these countries.

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A Appendix

A.1 The immigration surplus with homogeneous workers

To build our intuition, we review the *immigration surplus* discussed in Borjas (1995) and Giordani and Ruta (2011). These authors show that, in an economy without taxes and worker heterogeneity, native households always benefit from a marginal increase in the number of immigrants. This benefit occurs because the productivity of the land owned by the natives rises. This result is stronger than the optimality of free immigration, it implies that each inframarginal immigrant raises native welfare.

Native households earn the rents on land, which are not taxed so that optimality requires that all land is used in production (with a slight abuse of notation, we also use L to denote the aggregate endowment of land).

To derive their result, Borjas (1995) and Giordani and Ruta (2011) assume that the labor supply is exogenous, so household income can be easily computed. The immigration surplus results from the rise in aggregate labor supply generated by the increase in the pool of workers. This higher labor supply reduces wages, but increases the productivity of land, a benefit that accrues only to natives. When each worker supplies an exogenous number of hours, immigration always results in an increase in labor supply. When hours worked are endogenous, this implication is true if the following condition is satisfied:[23]

$$\frac{dN}{d\pi_i} = \frac{dn_n}{d\pi_i} + \pi_i \frac{dn_i}{d\pi_i} + n_i > 0. \tag{A.1}$$

Because labor supply is endogenous, it is possible for native households' total income to fall as the number of immigrants rises. This fall would be caused by a reduction in the number of hours worked by natives. Nevertheless, immigration leads to a local positive change in the consumption-leisure possibility frontier, thus increasing household welfare.

We make the following assumptions. First, we assume that there is no worker heterogeneity in the economy and we drop the index a. The production function is

[23] For ease of exposition, we do not discuss what this assumption implies in terms of model primitives.

then given by $F(L, n_n + \pi_i n_i)$. Second, we assume that the government does not tax any worker: $\mathcal{T}_n \equiv 0$ and $\mathcal{T}_i \equiv 0$. In this case, the natives' budget constraint is $c_n = wn_n + rL$. The immigrants' budget constraint is given by $c_i = wn_i$. The aggregate labor supply is $N \equiv n_n + \pi_i n_i$. The result also requires that there are no congestion effects. For simplicity, we abstract from public goods, and assume that $G = v(G) = 0$.

It is now quite simple to derive the immigration surplus result. Replacing factor prices in the native workers budget constraint and differentiating with respect to π_i, we obtain the following relation:

$$\frac{dc_n}{d\pi_i} = F_N(L, N)\frac{dn_n}{d\pi_i} - F_{NN}(L, N)\pi_i n_i \frac{dN}{d\pi_i}.$$

Clearly, if $dn_n/d\pi_i = 0$, as in Borjas (1995) and Giordani and Ruta (2011), then $dc_n/d\pi_i > 0$ always, and we say there is an "immigration surplus."

However, with endogenous labor supply, income is no longer a good measure of welfare. Instead, we look at the effect of immigration on equilibrium utility

$$\frac{dU_n}{d\pi_i} = u_c(c_n, n_n)\frac{dc_n}{d\pi_i} + u_n(c_n, n_n)\frac{dn_n}{d\pi_i} = -u_c(c_n, n_n)F_{NN}(L, N)\pi_i n_i \frac{dN}{d\pi_i} \geq 0,$$

where the last equality follows from replacing $dc_n/d\pi_i$ and using the marginal condition for labor supply. The value of $dU_n/d\pi_i$ is zero only when $\pi_i = 0$, otherwise native households always benefit from the rise in production associated with further immigration. As a result, the equilibrium with the highest level of native utility is that associated with free immigration, i.e. $U_i = \overline{U}_i$.

The existence of a positive immigration surplus requires a number of restrictive assumptions. First, we assumed that all natives have the same skill level. A number of empirical studies have shown that low-skill immigration has a significant impact on the relative wage of low-skill workers, e.g. Borjas, Freeman, and Katz (1992), Topel (1994), and Card (2009). We also assume that immigrants are excluded from the "welfare state", in the sense that they are not entitled to transfers or obliged to pay taxes, and that there is no congestion of public goods. Friedman (1978) argues that "free-immigration to jobs" and "free-immigration to welfare" have very different consequences for natives. The first creates new opportunities for natives, while the second requires transfers to immigrants that have to be financed using distortionary taxation. To discuss these issues, sections 4 and 5 use an heterogeneous-agent model to evaluate the impact of immigration on the welfare of the native population.

A.2 Model equilibrium

An equilibrium as in definition 1, is composed of allocations $c_{b,a}, n_{b,a}$, and $l_{b,a}$ for all b, a, prices w_l, w_h, and r , and policies $\pi_{i,l}, \pi_{i,h}, G$ and $\mathcal{T}_{b,a}$ for all b, a that satisfy the following conditions:

$$(c_{b,a}, n_{b,a}, l_{b,a}) \in \arg \max_{(c,n,l)\in\mathcal{B}_{b,a}} u(c, n), \tag{A.2}$$

where $\mathcal{B}_{b,a} \equiv \left\{(c, n, l) \in \mathbb{R}^3_+ : l \leq L_{b,a} \ \& \ c \leq w_a n + rl - \mathcal{T}_{b,a}(w_a n, rl)\right\}$,

$$w_a = F_a(L, N_l, N_h), \tag{A.3}$$

$$r = F_L(L, N_l, N_h), \tag{A.4}$$

$$u\left(c_{i,a}, l_{i,a}\right) + v\left(G\right) \geq \overline{U}_a, \text{ if } \pi_{i,a} > 0 \tag{A.5}$$

$$\sum_b \sum_a \pi_{b,a} c_{b,a} + \sigma\left(\pi_{i,l} + \pi_{i,h}\right) G \leq F\left(L, N_l, N_h\right) \tag{A.6}$$

and the factor market clearing conditions

$$L = \sum_b \sum_a \pi_{b,a} l_{b,a}, \tag{A.7}$$

$$N_a = \sum_b \pi_{b,a} n_{b,a}. \tag{A.8}$$

To simplify, we often write F_a and F_L instead of $F_a(L, N_l, N_h)$ and $F_L(L, N_l, N_h)$.

A.3 Policy with unrestricted taxes - implementability constraints

We look for a set of equilibrium conditions which are necessary and sufficient for the implementability of the allocations

$$\mathcal{A} \equiv \{\{c_{b,a}, n_{b,a}, l_{b,a}\}_{b,a}, \pi_{i,l}, \pi_{i,h}, G\},$$

where $c_{b,a}, n_{b,a}, \pi_{i,a}, G \in \mathbb{R}_+$, and $l_{b,a} \in [0, L_{b,a}]$.

To simplify the exposition we write in the text the equilibrium conditions directly in terms of L, N_l, and N_h instead of separate variables and imposing market clearing, (A.7) and (A.8).

Lemma 3. *Suppose that the government has access to unrestricted taxation. Then the allocations $\mathcal{A}$ can be implemented as an equilibrium if and only if the resource constraint, (A.6), and the participation constraints, (A.5), are satisfied.*

Necessity of (A.6) and (A.5) follows trivially from the fact that these are equilibrium conditions.

For sufficiency note that we can construct aggregate labor and land, N_a and L, from their definitions, and prices

$$w_a = F_a(L, N_l, N_h), \quad \& \quad r = F_L(L, N_l, N_h).$$

This result means that (A.3)-(A.8) are satisfied.

Now we need only to find tax functions $\mathcal{T}_{b,a}$ such that the choices $c_{b,a}, n_{b,a}$, and $l_{b,a}$ are optimal. For each $b = n, i$ and $a = l, h$, this problem can be solved by setting

$$\mathcal{T}_{b,a}(y_N, y_L) \equiv y_N + y_L - \max\left\{c : u\left(c, \frac{y_N}{w_a}\right) \leq u(c_{b,a}, n_{b,a})\right\}$$

for all $y_N, y_L \in \mathbb{R}_+$. Since this tax function implies that $(c_{b,a}, n_{b,a}, l_{b,a}) \in \mathcal{B}_{b,a}$, and for all $(c, n, l) \in \mathcal{B}_{b,a}$ it implies that $u(c, n) \leq u(c_{b,a}, n_{b,a})$.

A.4 Proof of proposition 1

We write the value function for given $\pi_{i,l}, \pi_{i,h}$ as:

$$\mathcal{W}(\pi_{i,l}, \pi_{i,h}) \equiv \max \sum_a \omega_a \pi_{n,a}[u(c_{n,a}, n_{n,a}) + v(G)] \quad \text{s.to.}$$

$$[\eta_a] \quad u(c_{i,a}, n_{i,a}) + v(G) \geq \overline{U}_{i,a}$$

$$[\lambda] \quad F(L, N_l, N_h) \geq \sum_b \sum_a \pi_{b,a} c_{b,a} + \sigma(\pi_i)G,$$

where η_l,η_h, and λ denote the Lagrange multipliers of each constraint.

Clearly the participation constraint of immigrants must bind, or else it would be possible to increase native welfare by decreasing immigrant consumption and increasing that of natives.

The first-order conditions with respect to $c_{i,a}$ and $n_{i,a}$ are given by

$$\eta_a u_c(c_{i,a}, n_{i,a}) = \lambda \pi_{i,a}$$

$$-\eta_a u_n(c_{i,a}, n_{i,a}) = \lambda F_a \pi_{i,a}$$

which together imply that

$$\frac{u_n(c_{i,a}, n_{i,a})}{u_c(c_{i,a}, n_{i,a})} = F_a.$$

Finally, the envelope condition with respect to $\pi_{i,a}$ is

$$\frac{d\mathcal{W}}{d\pi_{i,a}} = \lambda[F_a n_{i,a} - c_{i,a} - \sigma'(\pi_i)G],$$

and note that $\lambda > 0$. Optimality with interior immigration requires that

$$\frac{d\mathcal{W}}{d\pi_{i,a}} = 0 \Rightarrow c_{i,a} = F_a n_{i,a} - \sigma'(\pi_i)G.$$

A possible implementation of this allocation sets

$$\mathcal{T}_{i,a}(y_N, y_L) = \sigma'(\pi_i)G,$$

for all y_N, y_L.

When there are no congestion effects ($\sigma(\pi_i) = 1$) then $\sigma'(\pi_i) = 0$ and the optimal plan is such that:

$$\mathcal{T}_{i,a}(y_N, y_L) = 0.$$

A.5 Mirrleesian policy with discrimination - implementability constraints

Suppose that

$$\mathcal{T}_{n,l}(y_N, y_L) = \mathcal{T}_{n,h}(y_N, y_L) \equiv \mathcal{T}_n(y_N, y_L),$$

for all $y_N, y_L \in \mathbb{R}_+$, but immigrant can still be discriminated

$$\mathcal{T}_{i,l}(y_N, y_L) \neq \mathcal{T}_{i,h}(y_N, y_L) \neq \mathcal{T}_n(y_N, y_L).$$

Lemma 4. *Suppose that the government cannot discriminate natives based on their skill type, but can perfectly discriminate between immigrants and natives. Then, the allocations $\mathcal{A}$ can be implemented as an equilibrium if and only if the resource constraint, (A.6), the participation constraints, (A.5), and the following incentive constraints*

$$u(c_{n,h}, n_{n,h}) \geq u\left(c_{n,l}, \frac{F_l n_{n,l}}{F_h}\right) \tag{A.9}$$

$$u(c_{n,l}, n_{n,l}) \geq u\left(c_{n,h}, \frac{F_h n_{n,h}}{F_h}\right), \text{ if } l_{n,h} \leq L_{n,l}. \tag{A.10}$$

are satisfied.

Necessity of (A.6) and (A.5) is again trivial. To show necessity of (A.9) and (A.10) note first that

$$(c_{n,a}, n_{n,a}, l_{n,a}) \in \arg \max_{(c,n,l) \in \mathcal{B}_{n,a}} u(c, n),$$

which implies that $(c_{n,a}, n_{n,a}, l_{n,a}) \in \mathcal{B}_{n,a}$. Furthermore, we can now see that because $L_{n,h} \geq L_{n,l}$ then $(c_{n,l}, w_l n_{n,l}/w_h, l_{n,l}) \in \mathcal{B}_{b,h}$ because

$$l_{n,l} \leq L_{n,l} \Rightarrow l_{n,l} \leq L_{n,h}$$

$$c_{n,l} \leq w_l n_{n,l} + r l_{n,l} - \mathcal{T}_n\left(w_l n_{n,l}, r l_{n,l}\right) \Rightarrow c_{n,l} \leq w_h \frac{w_l n_{n,l}}{w_h} + r l_{n,l} - \mathcal{T}_n\left(w_l \frac{w_h n_{n,l}}{w_h}, r l_{n,l}\right)$$

This result implies that

$$u(c_{n,h}, n_{n,h}) \geq u\left(c_{n,l}, \frac{w_l n_{n,l}}{w_h}\right),$$

or, replacing $w_a = F_a$, we obtain (A.9). Instead, $(c_{n,h}, w_h n_{n,h}/w_l, l_{n,h}) \in \mathcal{B}_{b,l}$ only if $l_{n,h} \le L_{n,l}$, i.e. only the high-skill worker's land use is low enough. As a result, we obtain the necessary condition:

$$u(c_{n,l}, n_{n,l}) \ge u\left(c_{n,h}, \frac{F_h n_{n,h}}{F_l}\right), \text{ if } l_{n,h} \le L_{n,l}.$$

To show sufficiency, suppose that $\mathcal{A}$ satisfies (A.6), (A.5), (A.9), and (A.10). We can construct prices, aggregate labor endowment for each skill, aggregate land use using equations (A.3), (A.4), (A.7), and (A.8).

As before, define

$$\mathcal{T}_{i,a}(y_N, y_L) \equiv y_N + y_L - \max\left\{c : u\left(c, \frac{y_N}{w_a}\right) \le u(c_{b,a}, n_{b,a})\right\}$$

for $a = l, h$. This choice of $\mathcal{T}_{i,a}(y_N, y_L)$ guarantees that

$$(c_{i,a}, n_{i,a}, 0) \in \arg \max_{(c,n,l) \in \mathcal{B}_{i,a}} u(c, n).$$

If $l_{n,h} \le L_{n,l}$ we set

$$\mathcal{T}_n(y_N, y_L) = y_N + y_L - \max\left\{c : u\left(c, \frac{y_N}{w_a}\right) \le u(c_{b,a}, n_{b,a}),\ \forall a\right\}$$

and if $l_{n,h} > L_{n,l}$ then

$$\mathcal{T}_n(y_N, y_L) = \begin{cases} y_N + y_L - c_{n,l}, & \text{if } y_N = w_l n_{n,l} \ \&\ y_L = r l_{n,l} \\ y_N + y_L - c_{n,h}, & \text{if } y_N = w_h n_{n,h} \ \&\ y_L = r l_{n,h} \\ y_N + y_L, & \text{otherwise.} \end{cases}$$

A.6 Proof of lemma 1

We write the value function for given $\pi_{i,l}, \pi_{i,h}$ as:

$$\mathcal{W}(\pi_{i,l}, \pi_{i,h}) \equiv \max \sum_a \omega_a \pi_{n,a}[u(c_{n,a}, n_{n,a}) + v(G)] \quad \text{s.to.}$$

$$[\eta_{i,a}] \quad u(c_{i,a}, n_{i,a}) + v(G) \geq \overline{U}_{i,a}$$

$$[\lambda] \quad F(L, N_l, N_h) \geq \sum_b \sum_a \pi_{b,a} c_{b,a} + \sigma(\pi_i) G,$$

$$[\eta_{n,h}] \quad u(c_{n,h}, n_{n,h}) \geq u\left(c_{n,l}, \frac{F_l n_{n,l}}{F_h}\right)$$

$$[\eta_{n,l}] \quad u(c_{n,l}, n_{n,l}) \geq u\left(c_{n,h}, \frac{F_h n_{n,h}}{F_l}\right), \text{ if } l_{n,h} \leq L_{n,l}.$$

where the variables in square brackets denote the Lagrange multipliers of each constraint.

To work towards a contradiction, suppose that the optimum $\mathcal{A}$ is such that $l_{n,a} < L_{n,a}$ for some a. Consider the perturbation $\mathcal{A}'$, which is such that that keeps the following allocations constant: $c'_{b,a} = c_{i,a}$ for $a = l, h$, $n'_{b,a} = n_{b,a}$ for $b = n, i$ and $a = l, h$; but in which all land is used $l'_{n,a} = L_{n,a}$ and government spending is increased

$$G' = G + F(L', N_l, N_h) - F(L, N_l, N_h).$$

First note that $G' > G$, because $L' > L \Rightarrow F(L', N_l, N_h) > F(L, N_l, N_h)$. To see that this allocation is still feasible note that: (1) because $v'(G) > 0$, the participation constraint of immigrants is still satisfied; (2) because G is strictly separable in the utility function, and $d(F_l/F_h)/dL = 0$, the incentive compatibility constraint of high-skill natives is still satisfied; (3) the low-skill native incentive compatibility is either still satisfied for the same reason, or if $L_{n,h} > L_{n,l}$ does not require being satisfied anymore; and, finally, (4) the resource constraint is still satisfied.

Finally, note that $\mathcal{A}'$ yields strictly higher welfare than $\mathcal{A}$, because $v'(G) > 0$.

A.7 Proof of proposition 2

We write the value function for given $\pi_{i,l}, \pi_{i,h}$ as:

$$\mathcal{W}(\pi_{i,l}, \pi_{i,h}) \equiv \max \sum_a \omega_a \pi_{n,a}[u(c_{n,a}, n_{n,a}) + v(G)] \quad \text{s.to.}$$

$$[\eta_{i,a}] \quad u(c_{i,a}, n_{i,a}) + v(G) \geq \overline{U}_{i,a}$$

$$[\lambda] \quad F(L, N_l, N_h) \geq \sum_b \sum_a \pi_{b,a} c_{b,a} + \sigma(\pi_i) G,$$

$$[\eta_{n,h}] \quad u(c_{n,h}, n_{n,h}) \geq u\left(c_{n,l}, \frac{\theta_l n_{n,l}}{\theta_h}\right)$$

$$[\eta_{n,l}] \quad u(c_{n,l}, n_{n,l}) \geq u\left(c_{n,h}, \frac{\theta_h n_{n,h}}{\theta_l}\right), \text{ if } L_{n,h} = L_{n,l}.$$

where the variables in square brackets denote the Lagrange multipliers of each constraint.

Clearly the participation constraint of immigrants must bind, or else it would be possible to increase native welfare by decreasing immigrant consumption and increasing that of natives.

The first-order conditions with respect to $c_{i,a}$ and $n_{i,a}$ are given by

$$\eta_a u_c(c_{i,a}, n_{i,a}) = \lambda \pi_{i,a}$$

$$-\eta_a u_n(c_{i,a}, n_{i,a}) = \lambda F_a \pi_{i,a}$$

which together imply that

$$\frac{u_n(c_{i,a}, n_{i,a})}{u_c(c_{i,a}, n_{i,a})} = F_a.$$

Finally, the envelope condition with respect to $\pi_{i,a}$ is

$$\frac{d\mathcal{W}}{d\pi_{i,a}} = \lambda[F_a n_{i,a} - c_{i,a} - \sigma'(\pi_i) G],$$

with $\lambda > 0$. Optimality with interior immigration requires that

$$\frac{d\mathcal{W}}{d\pi_{i,a}} = 0 \Rightarrow c_{i,a} = F_a n_{i,a} - \sigma'(\pi_i) G.$$

A possible implementation of this allocation sets

$$\mathcal{T}_{i,a}(y_N, y_L) = \sigma'(\pi_i)G,$$

for all y_N, y_L.

When there are no congestion effects ($\sigma(\pi_i) = 1$), then $\sigma'(\pi_i) = 0$ and the optimal plan is such that:

$$\mathcal{T}_{i,a}(y_N, y_L) = 0.$$

A.8 Proof of proposition 3

We write the value function for given $\pi_{i,l}, \pi_{i,h}$ as:

$$\begin{aligned}
\mathcal{W}(\pi_{i,l}, \pi_{i,h}) \equiv \max \sum_a \omega_a \pi_{n,a}[u(c_{n,a}, n_{n,a}) + v(G)] \quad \text{s.to.} \\
[\eta_{i,a}] \quad u(c_{i,a}, n_{i,a}) + v(G) \geq \overline{U}_{i,a} \\
[\lambda] \quad F(L, N_l, N_h) \geq \sum_b \sum_a \pi_{b,a} c_{b,a} + \sigma(\pi_i)G, \\
[\eta_{n,h}] \quad u(c_{n,h}, n_{n,h}) \geq u\left(c_{n,l}, \frac{F_l n_{n,l}}{F_h}\right) \\
[\eta_{n,l}] \quad u(c_{n,l}, n_{n,l}) \geq u\left(c_{n,h}, \frac{F_h n_{n,h}}{F_l}\right), \text{ if } L_{n,h} = L_{n,l}.
\end{aligned}$$

where the variables in square brackets denote the Lagrange multipliers of each constraint.

Clearly the participation constraint of immigrants must bind, or else it would be possible to increase native welfare by decreasing immigrant consumption and increasing that of natives.

The envelope conditions are given by

$$\begin{aligned}
\frac{d\mathcal{W}}{d\pi_{i,a}} =& \lambda\left[F_a n_{i,a} - c_{i,a} - \sigma'(\pi_i)G\right] - \eta_{n,h} u_n\left(c_{n,l}, \frac{F_l n_{n,l}}{F_h}\right) n_{n,l} \frac{d(F_l/F_h)}{dN_a} n_{n,a} \\
& - \eta_{n,l} u_n\left(c_{n,h}, \frac{F_h n_{n,h}}{F_l}\right) n_{n,l} \frac{d(F_h/F_l)}{dN_a} n_{n,a}.
\end{aligned}$$

If the incentive constraint of the high skill binds and that of the low skill does not, then $\eta_{n,h} > 0$ and $\eta_{n,l} = 0$.

As a result, the total tax paid by an immigrant worker of skill a is

$$\mathcal{T}_{i,a}(w_a n_{i,a}, 0) = \sigma'(\pi_i)G - \eta_{n,h}\left[-u_n\left(c_{n,l}, \frac{F_l n_{n,l}}{F_h}\right) n_{n,l} n_{n,a}\right]\frac{d(F_l/F_h)}{dN_a}.$$

By the skill-premium monotonicity assumption we have that $\frac{d(F_l/F_h)}{dN_l} < 0$ and that $\frac{d(F_l/F_h)}{dN_l} > 0$, which implies that

$$\mathcal{T}_{i,h}(w_h n_{i,h}, 0) < \sigma'(\pi_i)G$$
$$\mathcal{T}_{i,l}(w_l n_{i,l}, 0) > \sigma'(\pi_i)G.$$

When there are no congestion effects ($\sigma(\pi_i) = 1$) then $\sigma'(\pi_i) = 0$ and the optimal plan is such that:

$$\mathcal{T}_{i,h}(w_h n_{i,h}, 0) < 0$$
$$\mathcal{T}_{i,l}(w_l n_{i,l}, 0) > 0.$$

A.9 Mirrleesian policy without discrimination - implementability constraints

Suppose that the government cannot discriminate between immigrants and natives:

$$\mathcal{T}_{n,l}(y_N, y_L) = \mathcal{T}_{n,h}(y_N, y_L) = \mathcal{T}_{i,l}(y_N, y_L) = \mathcal{T}_{i,h}(y_N, y_L) \equiv \mathcal{T}(y_N, y_L),$$

for all $y_N, y_L \in \mathbb{R}_+$.

Lemma 5. *Suppose that the government cannot discriminate between households based on skill or immigration status. Then the allocations $\mathcal{A}$ can be implemented as an equilibrium if and only if the resource constraint, (A.6), the participation constraints, (A.5), and the following incentive constraints*

$$u(c_{b,a}, n_{b,a}) = \max_{(b',a')\in\Theta_{b,a}} u\left(c_{b',a'}, \frac{w_{a'} n_{b',a'}}{w_a}\right) \tag{A.11}$$

are satisfied, where $\Theta_{b,a} \equiv \{(b',a') : \pi_{b',a'} > 0 \;\&\; l_{b',a'} \leq L_{b,a}\}$

Necessity of (A.6) and (A.5) is again trivial. To show necessity of (A.11) note that $(c_{b',a'}, w_{a'}n_{b',a'}/w_a, l_{b',a'}) \in \mathcal{B}_{b,a}$ only if $l_{b',a'} \in L_{b,a}$.

To show sufficiency, suppose that $\mathcal{A}$ satisfies (A.6), (A.5), and (A.11). We can construct prices, aggregate labor endowment for each skill, aggregate land use using equations (A.3), (A.4), (A.7), and (A.8).

Furthermore, we construct the following tax system. If $\pi_{i,l}, \pi_{i,h} > 0$, then

$$\mathcal{T}(y_N, y_L) = \begin{cases} y_N + y_L - c_{n,l}, & \text{if } y_N = w_l n_{n,l} \ \& \ y_L = r l_{n,l} \\ y_N + y_L - c_{n,h}, & \text{if } y_N = w_h n_{n,h} \ \& \ y_L = r l_{n,h} \\ y_N + y_L - c_{i,l}, & \text{if } y_N = w_l n_{i,l} \ \& \ y_L = r l_{i,l} \\ y_N + y_L - c_{i,h}, & \text{if } y_N = w_h n_{i,h} \ \& \ y_L = r l_{i,h} \\ y_N + y_L, & \text{otherwise.} \end{cases}$$

If $\pi_{i,l} = 0$ and $\pi_{i,h} > 0$, then

$$\mathcal{T}(y_N, y_L) = \begin{cases} y_N + y_L - c_{n,l}, & \text{if } y_N = w_l n_{n,l} \ \& \ y_L = r l_{n,l} \\ y_N + y_L - c_{n,h}, & \text{if } y_N = w_h n_{n,h} \ \& \ y_L = r l_{n,h} \\ y_N + y_L - c_{i,h}, & \text{if } y_N = w_h n_{i,h} \ \& \ y_L = r l_{i,h} \\ y_N + y_L, & \text{otherwise.} \end{cases}$$

If $\pi_{i,l} > 0$ and $\pi_{i,h} = 0$, then

$$\mathcal{T}(y_N, y_L) = \begin{cases} y_N + y_L - c_{n,l}, & \text{if } y_N = w_l n_{n,l} \ \& \ y_L = r l_{n,l} \\ y_N + y_L - c_{n,h}, & \text{if } y_N = w_h n_{n,h} \ \& \ y_L = r l_{n,h} \\ y_N + y_L - c_{i,l}, & \text{if } y_N = w_h n_{i,l} \ \& \ y_L = r l_{i,l} \\ y_N + y_L, & \text{otherwise.} \end{cases}$$

Finally, if $\pi_{i,l} = \pi_{i,h} = 0$, then

$$\mathcal{T}(y_N, y_L) = \begin{cases} y_N + y_L - c_{n,l}, & \text{if } y_N = w_l n_{n,l} \ \& \ y_L = r l_{n,l} \\ y_N + y_L - c_{n,h}, & \text{if } y_N = w_h n_{n,h} \ \& \ y_L = r l_{n,h} \\ y_N + y_L, & \text{otherwise.} \end{cases}$$

A.10 Proof of lemma 2

Full land use We write the value function for given $\pi_{i,l}, \pi_{i,h}$ as:

$$
\begin{aligned}
\mathcal{W}(\pi_{i,l}, \pi_{i,h}) \equiv \max \sum_a \omega_a \pi_{n,a}[u(c_{n,a}, n_{n,a}) + v(G)] \quad \text{s.to.} \\
[\eta_{i,a}] \quad u(c_{i,a}, n_{i,a}) + v(G) \geq \overline{U}_{i,a} \\
[\lambda] \quad F(L, N_l, N_h) \geq \sum_b \sum_a \pi_{b,a} c_{b,a} + \sigma(\pi_i) G, \\
[\chi_{b,a}] \quad u(c_{b,a}, n_{b,a}) \geq \max_{(a',b') \in \Theta_{b,a}} u\left(c_{a',b'}, \frac{F_{a'} n_{a',b'}}{F_a}\right)
\end{aligned}
$$

To work towards a contradiction, suppose that the optimum $\mathcal{A}$ is such that $l_{n,a} < L_{n,a}$ for some a. Consider the perturbation $\mathcal{A}'$, which keeps the following allocations constant: $c'_{b,a} = c_{i,a}$ for $a = l, h$, $n'_{b,a} = n_{b,a}$ for $b = n, i$ and $a = l, h$; but in which all land is used $l'_{n,a} = L_{n,a}$ and government spending is increased

$$G' = G + F(L', N_l, N_h) - F(L, N_l, N_h).$$

First note that $G' > G$, because $L' > L \Rightarrow F(L', N_l, N_h) > F(L, N_l, N_h)$.

To see that this allocation is still feasible note that: (1) because $v'(G) > 0$, the participation constraint of immigrants is still satisfied; (2) because G is strictly separable in the utility function, and $d(F_l/F_h)/dL = 0$, the incentive compatibility constraint of high-skill natives is still satisfied; (3) the low-skill native incentive compatibility is either still satisfied for the same reason, or if $L_{n,h} > L_{n,l}$ does not require being satisfied anymore; and, finally, (4) the resource constraint is still satisfied. Finally, note that $\mathcal{A}'$ yields strictly higher welfare than $\mathcal{A}$, because $v'(G) > 0$.

Low-skill allocation If $\pi_{i,l} = 0$ then we can set $x_{i,l} = x_{n,l}$ for $x = c, n, l$ without loss of generality. Consider instead the case with $\pi_{i,l} > 0$. Define $U_{b,a} = u(c_{b,a}, n_{b,a}) + v(G)$ and note that the same problem implies that the incentive constraints imply that $U_{n,l} \geq U_{i,l}$ and $U_{i,l} \geq U_{n,l}$. Then, $U_{n,l} = U_{i,l} \equiv U_l$.

The program can be written as follows:

$$
\begin{aligned}
\mathcal{W}(\pi_{i,l}, \pi_{i,h}) \equiv \max \sum_a \omega_a \pi_{n,a} U_{n,a} \quad & \text{s.to.} \\
[\eta_{i,a}] \quad & U_{i,a} \geq \overline{U}_{i,a} \\
[\lambda] \quad & F(L, N_l, N_h) \geq \sum_b \sum_a \pi_{b,a} c_{b,a} + \sigma(\pi_i) G, \\
[\chi_{n,h}] \quad & U_{n,h} \geq U_{i,h} \\
[\chi^n_{n,h}] \quad & U_{i,h} \geq U_l + u\left(c_{n,l}, \frac{F_l n_{n,l}}{F_h}\right) - u(c_{n,l}, n_{n,l}) \\
[\chi^i_{n,h}] \quad & U_{i,h} \geq U_l + u\left(c_{i,l}, \frac{F_l n_{i,l}}{F_h}\right) - u(c_{i,l}, n_{i,l}) \\
[\phi_{b,h}] \quad & u(c_{b,h}, n_{b,h}) + v(G) = U_{b,h} \\
[\phi_{b,l}] \quad & u(c_{b,l}, n_{b,l}) + v(G) = U_l.
\end{aligned}
$$

Suppose, to work towards a contradiction, that $n_{b,l} < n_{b',l}$. This inequality implies that $c_{b,l} < c_{b',l}$, since both bundles must achieve the same utility. Furthermore, using the single-crossing condition

$$
u(c_{b,l}, n_{b,l}) = u(c_{b',l}, n_{b',l}) \Rightarrow u\left(c_{b,l}, \frac{F_l n_{b,l}}{F_h}\right) < u\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right).
$$

As a result, the incentive constraint of high skill mimicking b, l is not binding, i.e. $\chi^b_{n,h} = 0$ and $\chi^{b'}_{n,h} \geq 0$.

The first-order necessary conditions with respect to $c_{b,l}$, $n_{b,l}$, $c_{b',l}$, $n_{b',l}$ are

$$\lambda \pi_{b,l} = \phi_{b,l} u_c(c_{b,l}, n_{b,l})$$
$$\lambda F_l \pi_{b,l} = -\phi_{b,l} u_n(c_{b,l}, n_{b,l})$$
$$\lambda \pi_{b',l} = \left(\phi_{b',l} + \chi_{n,h}^{b'} - \chi_{n,h}^{b'} \frac{u_c\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{u_c\left(c_{b',l}, n_{b',l}\right)} \right) u_c(c_{b',l}, n_{b',l})$$
$$\lambda F_l \pi_{b',l} = -\left(\phi_{b',l} + \chi_{n,h}^{b'} - \chi_{n,h}^{b'} \frac{u_n\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{u_n\left(c_{b',l}, n_{b',l}\right)} \right) u_n(c_{b',l}, n_{b',l}).$$

This condition implies that

$$\frac{-u_n(c_{b,l}, n_{b,l})}{u_c(c_{b,l}, n_{b,l})} = F_l,$$
$$\frac{-u_n(c_{b',l}, n_{b',l})}{u_c(c_{b',l}, n_{b',l})} = \frac{\left(\phi_{b',l} + \chi_{n,h}^{b'} - \chi_{n,h}^{b'} \frac{u_c\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{u_c\left(c_{b',l}, n_{b',l}\right)} \right)}{\left(\phi_{b',l} + \chi_{n,h}^{b'} - \chi_{n,h}^{b'} \frac{u_n\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{u_n\left(c_{b',l}, n_{b',l}\right)} \right)} F_l.$$

Furthermore, the single-crossing condition also implies that

$$\frac{\left(\phi_{b',l} + \chi_{n,h}^{b'} - \chi_{n,h}^{b'} \frac{u_c\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{u_c\left(c_{b',l}, n_{b',l}\right)} \right)}{\left(\phi_{b',l} + \chi_{n,h}^{b'} - \chi_{n,h}^{b'} \frac{u_n\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{u_n\left(c_{b',l}, n_{b',l}\right)} \right)} \leq 1 \Leftrightarrow \frac{-u_n\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{-u_n\left(c_{b',l}, n_{b',l}\right)} \leq \frac{u_c\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{u_c\left(c_{b',l}, n_{b',l}\right)}$$
$$\Leftrightarrow \frac{-u_n\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)}{u_c\left(c_{b',l}, \frac{F_l n_{b',l}}{F_h}\right)} \leq \frac{-u_n\left(c_{b',l}, n_{b',l}\right)}{u_c\left(c_{b',l}, n_{b',l}\right)}.$$

Finally, using this observation and the first marginal rates of substitution derived above, we note that

$$\frac{-u_n(c_{b,l}, n_{b,l})}{u_c(c_{b,l}, n_{b,l})} \geq \frac{-u_n(c_{b',l}, n_{b',l})}{u_c(c_{b',l}, n_{b',l})},$$

which is a contradiction of the fact that $n_{b',l} > n_{b,l}$ and $c_{b',l} > c_{b,l}$, provided the utility function satisfies the consumption-leisure normality assumption. Therefore, it must be that $n_{n,l} = n_{i,l}$ and $c_{n,l} = c_{i,l}$.

A.11 Mirrleesian policy without discrimination - *simplified* implementability constraints

The original problem was required to verify the constraints:

$$u(c_{b,a}, n_{b,a}) = \max_{(b',a') \in \Theta_{b,a}} u\left(c_{b',a'}, \frac{F_{a'} n_{b',a'}}{F_a}\right) \tag{A.12}$$

for all $b = n, i$ and $a = l, h$.

Lemma 6. *Suppose that the allocations $\mathcal{A}$ satisfy $c_{n,l} = c_{i,l} \equiv c_l$ and $n_{n,l} = n_{i,l} \equiv n_l$, $l_{n,h} = L_{n,h}$, and if $\pi_{i,h} > 0$*

$$u(c_{n,h}, n_{n,h}) \geq u(c_{i,h}, n_{i,h}) \tag{A.13}$$

$$u(c_{i,h}, n_{i,h}) \geq u\left(c_l, \frac{F_l n_l}{F_h}\right) \tag{A.14}$$

$$u(c_l, n_l) \geq u\left(c_{i,h}, \frac{F_l n_{i,h}}{F_h}\right), \tag{A.15}$$

or, if $\pi_{i,h} = 0$

$$u(c_{i,h}, n_{i,h}) \geq u\left(c_l, \frac{F_l n_l}{F_h}\right). \tag{A.16}$$

Then, the allocations $\mathcal{A}$ satisfy (A.12).

Note that because $L_{n,h} > 0 = L_{b,a}$ then $(n, h) \notin \Theta_{b,a}$ for $(b, a) = (n, l), (i, h), (i, l)$.

Suppose first that $\pi_{i,h} > 0$. Note that (A.13), combined with (A.14) and $x_{n,l} = x_{i,l}$ for $x = c, n$, imply that

$$u(c_{n,h}, n_{n,h}) \geq \max\left\{u(c_{i,h}, n_{i,h}), u\left(c_{n,l}, \frac{F_l n_{n,l}}{F_h}\right), u\left(c_{i,l}, \frac{F_l n_{i,l}}{F_h}\right)\right\},$$

i.e. $u(c_{n,h}, n_{n,h}) = \max_{(b',a') \in \Theta_{n,h}} u\left(c_{b',a'}, \frac{F_{a'} n_{b',a'}}{F_h}\right)$, irrespective of $\pi_{i,h}$.

High-skill immigrants can only mimic low-skill workers $\Theta_{i,h} \subset \{(n,l),(i,l)\}$, and then (A.14) implies that $u(c_{i,h}, n_{i,h}) = \max_{(b',a') \in \Theta_{i,h}} u\left(c_{b',a'}, \frac{F_{a'} n_{b',a'}}{F_h}\right)$. In a similar way, $\Theta_{n,l} \subset \{(i,h),(i,l)\}$ and $\Theta_{i,l} = \{(n,l),(i,h)\}$. Note that because low-skill natives and immigrants have the same allocation, that incentive compatibility is satisfied. Furthermore, (A.15) implies that $u(c_l, n_l) = \max_{(b',a') \in \Theta_{b,l}} u\left(c_{b',a'}, \frac{F_{a'} n_{b',a'}}{F_l}\right)$. Because low-skill natives and immigrants have the same consumption bundle, whether $\pi_{i,l} > 0$ or $\pi_{i,l} = 0$ is irrelevant.

Finally, suppose that $\pi_{i,h} = 0$. Then, $\Theta_{n,h} \subset \{(n,l),(i,l)\}$, and (A.16) guarantees incentive compatibility, i.e. $u(c_{n,h}, n_{n,h}) = \max_{(b',a') \in \Theta_{n,h}} u\left(c_{b',a'}, \frac{F_{a'} n_{b',a'}}{F_h}\right)$. No low-skill workers can mimic high-skill native workers, then $\Theta_{n,l} \subset \{(i,l)\}$ and $\Theta_{i,l} = \{(n,l)\}$. Since all low-skill workers obtain the same consumption bundle, incentive compatibility is trivially satisfied.

A.12 Proof of proposition 4

We write the value function for given $\pi_{i,l}, \pi_{i,h}$ as:

$$\mathcal{W}(\pi_{i,l}, \pi_{i,h}) \equiv \max \omega_h \pi_{n,h}[u(c_{n,h}, n_{n,h}) + v(G)] + \omega_l \pi_{n,l}[u(c_l, n_l) + v(G)] \quad \text{s.to.}$$

$$\begin{aligned}
[\eta_{i,h}] \quad & u(c_{i,h}, n_{i,h}) + v(G) \geq \overline{U}_{i,a} \\
[\eta_{i,l}] \quad & u(c_l, n_l) + v(G) \geq \overline{U}_{i,a} \\
[\lambda] \quad & F(L, N_l, N_h) \geq \sum_b \sum_a \pi_{b,a} c_{b,a} + \sigma(\pi_i) G, \\
[\chi_{n,h}] \quad & u(c_{n,h}, n_{n,h}) \geq u\left(c_{i,h}, \frac{\theta_l n_{n,l}}{\theta_h}\right) \\
[\chi_{i,h}] \quad & u(c_{i,h}, n_{i,h}) \geq u\left(c_l, \frac{\theta_l n_l}{\theta_h}\right) \\
[\chi_l] \quad & u(c_l, n_l) \geq u\left(c_{i,h}, \frac{\theta_h n_{i,h}}{\theta_l}\right),
\end{aligned}$$

where the variables in square brackets denote the Lagrange multipliers of each constraint.

The envelope condition is

$$\frac{d\mathcal{W}}{d\pi_{i,l}} = \lambda \left[F_l n_l - c_l - \sigma'(\pi_i) G\right].$$

If $\pi_{i,l} > 0$ the following condition must hold:

$$\frac{d\mathcal{W}}{d\pi_{i,l}} = 0 \Leftrightarrow c_l = F_l n_l - \sigma'(\pi_i) G,$$

otherwise $\pi_{i,l} = 0$.

A.13 Skill premium change decomposition

In an equilibrium with allocations $\mathcal{A}$, the skill premium is computed as follows:

$$SP\left(N_l, N_h\right) \equiv \frac{\alpha}{1-\alpha} S^{\frac{\varepsilon-1}{\varepsilon}} \left(\frac{N_l}{N_h}\right)^{\frac{1}{\varepsilon}}. \tag{A.17}$$

The skill premium depends on aggregate labor supplies N_l and N_h, which in turn depend on individual labor supplies and the composition labor force

$$N_a = \pi_{n,a} n_{n,a} + \pi_{i,a} n_{i,a}.$$

Consider two equilibria $\mathcal{A}$ and $\mathcal{A}'$. We can decompose the change in the skill premium between these equilibria as follows:

$$\begin{aligned}
& SP(N_l', N_h') - SP(N_l, N_h) \\
=& \underbrace{SP(\pi_{n,l} n_{n,l}' + \pi_{i,l} n_{i,l}, \pi_{n,h} n_{n,h}' + \pi_{i,h} n_{i,h}) - SP(\pi_{n,l} n_{n,l} + \pi_{i,l} n_{i,l}, \pi_{n,h} n_{n,h} + \pi_{i,h} n_{i,h})}_{(1)} \\
+& \underbrace{SP(\pi_{n,l} n_{n,l}' + \pi_{i,l} n_{i,l}', \pi_{n,h} n_{n,h}' + \pi_{i,h} n_{i,h}') - SP(\pi_{n,l} n_{n,l}' + \pi_{i,l} n_{i,l}, \pi_{n,h} n_{n,h}' + \pi_{i,h} n_{i,h})}_{(2)} \\
+& \underbrace{SP(\pi_{n,l} n_{n,l}' + \pi_{i,l}' n_{i,l}', \pi_{n,h} n_{n,h}' + \pi_{i,h}' n_{i,h}') - SP(\pi_{n,l} n_{n,l}' + \pi_{i,l} n_{i,l}', \pi_{n,h} n_{n,h}' + \pi_{i,h} n_{i,h}')}_{(3)}.
\end{aligned}$$

Part (1) captures the effects of changing native labor supply, (2) captures the effects of changing immigrant labor supply, and finally (3) captures the effects of a change in the composition of the labor force.

In this decomposition, we start by changing labor supplies and only then change the composition of the labor force. A word of caution is in order, since the effects are not invariant to the order of the decomposition.

B Online Appendix

B.1 Robustness Exercises

We perform different robustness exercises:

1. Decrease both outside options by 5 percent of equivalent consumption;
2. Fix $t = 2000$, and decrease outside options simultaneously until $U_{i,h} = -2.6$
3. Fix $t = 2000$, and decrease outside options simultaneously until $U_{i,h} = -2.8$

B.1.1 Robustness 1

We start by decreasing the outside options in a parallel trend by 5% of equivalent consumption, i.e.

$$\overline{U}'_{i,a} = \overline{U}_{i,a} - \log(0.95) \tag{A.18}$$

for all years.

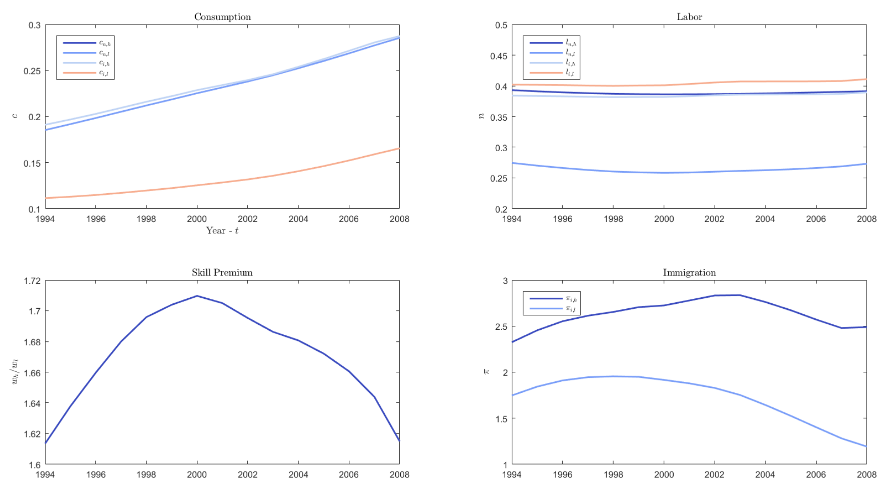

Figure 7: Policy with unrestricted taxes - Robustness 1

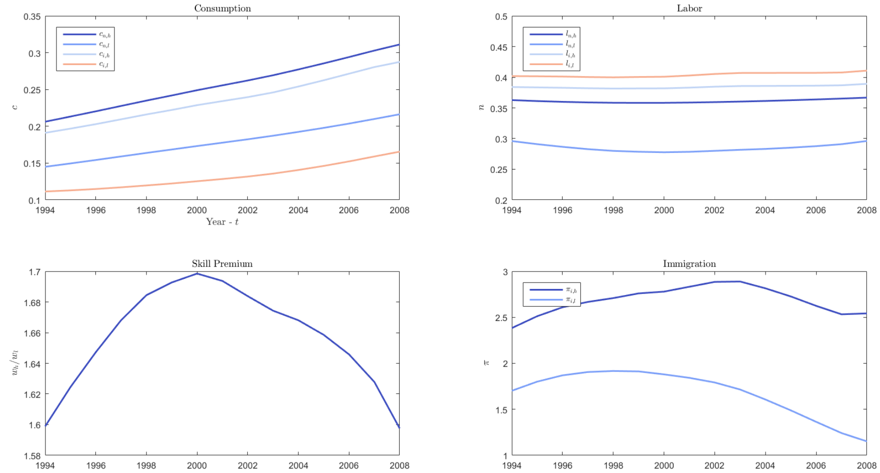

Figure 8: Mirrleesian policy with discrimination - Robustness 1

As one would expect, both the unrestricted taxes and Mirrleesian policy with discrimination look similar to the benchmark case, except for the fact that immigration is now much higher.

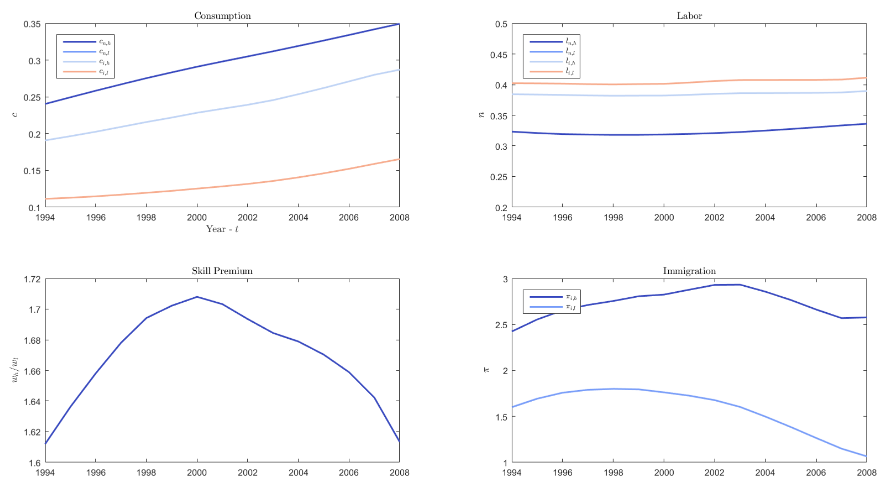

Figure 9: Mirrleesian policy without discrimination - Robustness 1

As shown in the main text, with a lower outside option, high-skill immigrants are now willing to enter in the case without discrimination. The optimal policy features free immigration of high-skill immigrants and fully restricts low-skill immigration.

B.1.2 Robustness 2

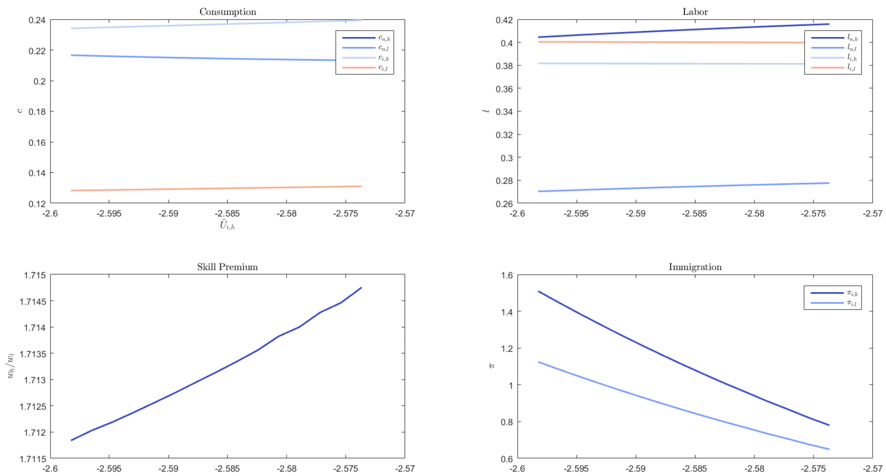

Figure 10: Policy with unrestricted taxes - Robustness 2

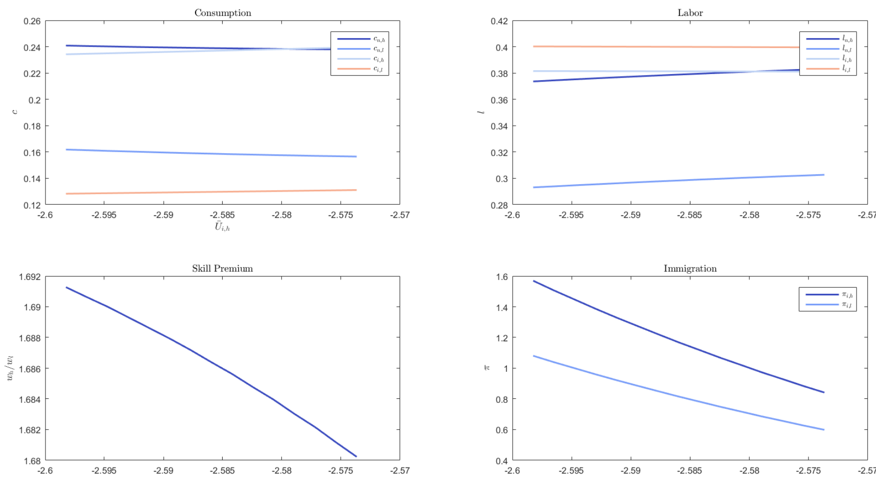

Figure 11: Mirrleesian policy with discrimination - Robustness 2

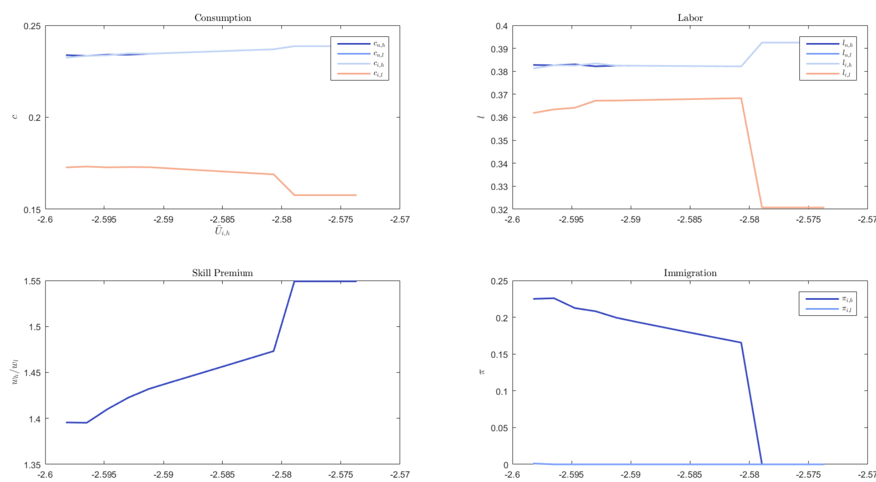

Figure 12: Mirrleesian policy without discrimination - Robustness 2

B.1.3 Robustness 3

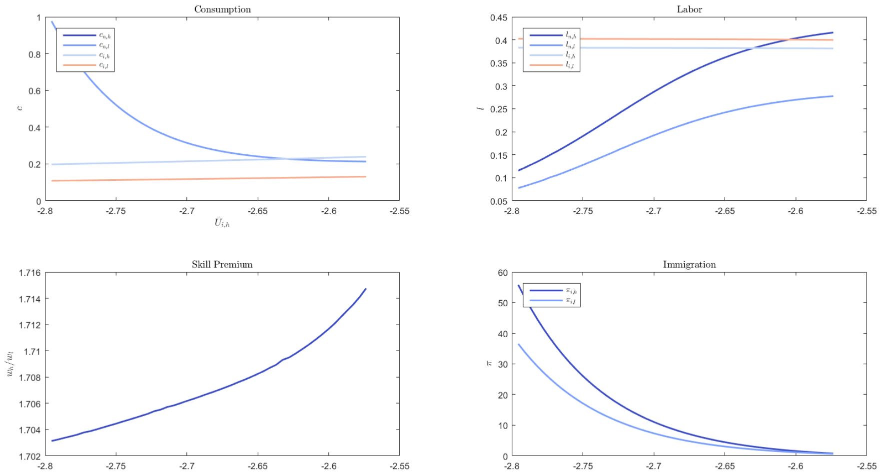

Figure 13: Policy with unrestricted taxes - Robustness 3

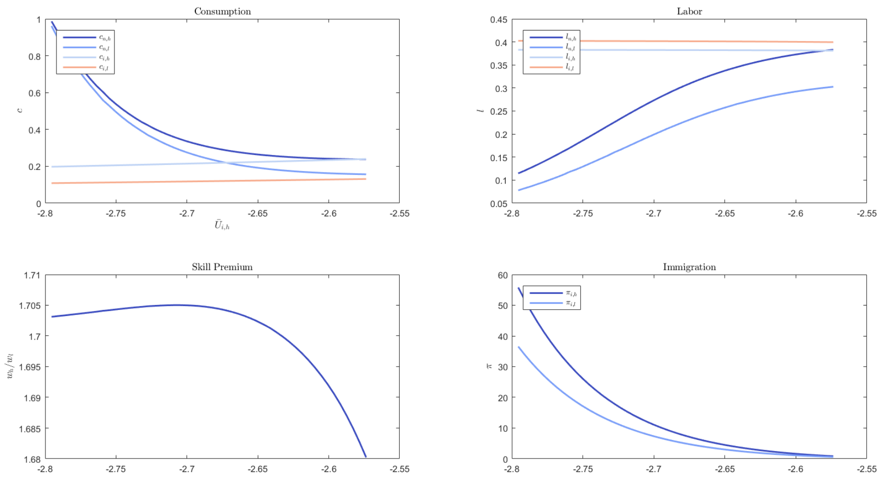

Figure 14: Mirrleesian policy with discrimination - Robustness 3

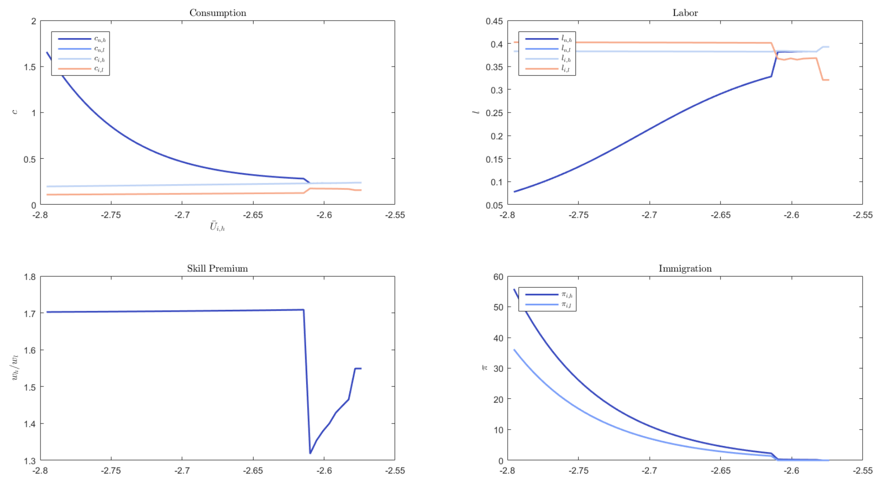

Figure 15: Mirrleesian policy without discrimination - Robustness 3