Choosing and Implementing Optimal Immigration Policies

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Abstract

We formulate immigration as an assignment problem between a destination country and a home country, factoring in the objectives of migrants, natives, and a social planner. We compare government rationing with market-based approaches. We calibrate the model to identify an optimal price for each country, which averages $80,935. At current immigration rates, this would generate $67 billion in annual revenue. Selling visas can reduce tension between capital and labor among natives that leads to accepting fewer than the socially optimal number of immigrants. The model predicts that countries with high income inequality will restrict immigration, consistent with evidence.

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1. Introduction

How many immigrants should a country accept? How should immigration slots be allocated? Which rules or mechanisms are best at turning immigration targets into actual flows? Specifically, how do market mechanisms compare with other allocation methods in allocating scare slots?

Every economic analysis must define the population for which something is maximized. There are a number of possibilities, all of which might seem reasonable ex ante. The most universal concept is to maximize world welfare—that is, to attempt to achieve social efficiency. The global social planner's problem is justifiable when transfers are made not only among individuals within a country but also between countries. For example, suppose that the United States were able to attract the best and brightest from a much poorer country. Even if that maximized total world surplus, it would imply brain drain from the poorer country. If the poorer country could be compensated, all could be made better off. Some compensation happens privately through remittances by migrants to their families still in the home country, but it would be a rare coincidence if the amount of remittances equaled the compensation necessary to treat the entire world as the unit of analysis. Barring inter-country transfers, it is natural to think of the country as the unit of analysis.[1] But some natives—for example, capital owners—may benefit from immigration to the detriment of others, such as substitute labor. Absent within-country compensatory payments, destination country natives will differ in their views on bringing in immigrants.[2]

Considerations of fairness lie outside standard notions of efficiency, and are even more difficult to discuss in unequivocal terms. But some rules or mechanisms might be worth considering. For example, it might be viewed as preferable to have a rule that treats otherwise similarly situated individuals in a way that does not favor one home country over another.[3]

[1] Even in this case, it is necessary to determine whether the relevant population is the native-born population or the population that includes new immigrants.

[2] Lazear (1999) analyzes assimilation and the externalities that might be associated with cultural and language spillovers.

[3] The current system in the United States, and especially the one that preceded it, violates that rule by giving preference based on the national origin of current citizens or, currently, on having relatives in the United States. See Glazer (2020); LeMay (2018); and O'Connor et al. (2019).

Because wages differ so dramatically among countries, it is difficult to avoid the conclusion that social efficiency is served by massive migration that equalizes wages across countries. The typical wage in most countries is well below the wages earned by the poorest Americans.[4] Although there is no reason to expect that any particular destination country chooses policy on the basis of social efficiency, it is also true that a destination country that could engage in compensatory payments would choose levels of immigration that far exceed their current choices.

Market mechanisms that allocate immigration slots by price can implement any desired level of immigration—specifically, that chosen by natives or by social efficiency. However, desirable destination countries like the United States are likely to possess monopoly power and, as a consequence, charge an above-efficient price, thereby restricting immigration in the same way a monopolist restricts quantity. If there were competition among countries for immigrants, such as in parts of Europe today, the competitive price would lie below the monopolist price, and generate less immigration than is socially optimal. To achieve the efficient amount of immigration, a country could price discriminate by offering a price to each potential immigrant, but this would require the capacity to observe their ability.

We calibrate our model with data on the exogenous parameters, and find that the United States could offer an average price for citizenship of $80,935, which would generate $67 billion in revenue annually at current immigration rates. This would be superior to current policy because it would attract high-skilled immigrants, in contrast to the current policy, which is oriented around family reunification and agnostic with respect to skill. The revenue could offset taxes elsewhere, or otherwise lower the federal deficit. Given that US companies already bear large expenses to import technical labor on H-1B visas with long waiting lines, it is conceivable that employers could finance this cost specifically, or else capital markets more generally.

Finally, the existence of highly restricted immigration for countries like the US (we accept only about 1 million of the world's 7.7 billion people per year) can be explained by the fact that within-country transfers from the beneficiaries of more immigration to those harmed by it rarely occurs absent a market mechanism. In fact, the model yields corner solutions, in which

[4] Lazear (2020) uses data from Lahoti et al. (2016) to examine income differences between the rich and poor across countries. In 2015, 63 of 111 countries had median incomes that were below the income of the lowest 10% of Americans.

the natives of a country will prefer either maximal or no immigration, depending on whether the natives receive their income primarily from capital or labor. Under reasonable assumptions, the median voter prefers little or no immigration, which is close to describing the actual situation in the US. The model also predicts that as the skewness of capital ownership in an economy increases, high-ability natives will always prefer to expand immigration, since they receive their income through capital rather than labor. We test this against cross-country data on immigration policies and find support for this prediction. More generally, selling visas can resolve this tension between capital and labor, as the revenue generated can compensate native labor that loses from increased immigration.

The theoretical paper closest in style to ours is Konya (2007), who considers the joint analysis of assimilation and migration. As here, Konya's agents are heterogeneous, and their decisions take the form of a cutoff rule. The chief difference is that Konya's type of agent is two dimensional, since agents vary in their cost of assimilation and their cost of moving. Migrants have the choice of both moving and, if they move, of assimilating. Because of this two-dimensional structure, whether the social planner in Konya can implement the first best depends on the level of income of the home country. Konya considers the implementation of optimal policy based on taxes rather than mechanisms like prices, and also explicitly does not consider migrants of heterogeneous ability, which is the focus of our analysis. Sparber (2018) is one of the few other papers that suggests that allocating H-1B visas based on ability would increase output and wages and result in a $26.5 billion gain for the economy over 6 years. This is in line with the quantitative estimates in this paper.

Borjas (1987) was the landmark study that began the literature on self-selection, building a model of potential migrants who choose to leave their home country based on a comparison of earnings in their destination country. Borjas (1991) deepens this analysis while casting it in the classic Roy (1951) model. Bianchi (2013) also considers the selection decisions of migrants where agents are heterogeneous in skill and face a migration cost. Bertoli, Dequiedt, and Zenou (2016) consider the effect of screening unobservable qualities on decisions of migrants to self-select. Bellettini and Ceroni (2007) consider government rationing and examines the joint determination of wages and migrant selection decisions. Our paper is broadly consistent with this literature on self-selection, as our steering assumption is that migrants rationally choose their location based on their economic opportunities at home versus abroad.

Much of the empirical literature estimates the effect of immigration on wages.[5] Firms and workers can take actions that may blunt the effect of high-skilled immigration on native wages. For example, Glennon (2020) shows that restrictions on H-1B immigration caused multinational companies to increase offshoring. Another example of a firm response is altering trade decisions (i.e., increasing exports in response to increases in immigration). Burstein, Hanson, Tian, and Vogel (2020) show that an increase in immigrants crowds out the employment of natives in non-tradable jobs (like housekeeping) more than in tradable jobs (like working in a textile mill), since the firm can increase or decrease its trade in response to the labor supply shock of immigrants. Another force that minimizes the downward effect of wage competition is occupational choice. Manacorda, Manning, and Wadsworth (2012) find that when natives switch occupations in response to immigration, the negative effects from wage competition are minimized and smaller. Finally, Lewis (2011) shows that US manufacturing plants located where immigrants cluster are less likely to invest in automated machinery than otherwise, suggesting that firms adjust their capital-labor ratios in response to their immigrant labor pool. Peri and Sparber (2009) argue that natives will reallocate their task supply, specializing in more communication/language tasks and less in manual/physical labor tasks in response to increased immigration, which also reduces downward wage pressure. These actions reduce but do not eliminate the negative effect on wages from increased immigration.[6]

[5] Turner (2020) adopts a nested CES model and finds that the wages of native skilled workers fall as skilled immigration increases. In particular, a 10-percentage-point increase in the immigrant-native ratio of the skilled group decreases their relative wages by 1.2%. Bound, Braga, Golden, and Khanna (2015) build and calibrate a dynamic model for computer scientists and finds that skilled immigration leads to a 3.8% decrease in wages for computer scientists and a 7%–13% decrease in employment.

[6] The analysis in this paper will focus primarily on the US as the destination country. Outside the US, the negative wage effect from immigration is muted. For example, Dustmann, Frattini, and Preston (2013) find that in the UK, increases in immigration lead low-skilled wages to decrease, high-skilled wages to increase, and overall wages to slightly increase. Manacorda, Manning, and Wadsworth (2012) also examine data from the UK to find that immigration reduces the wages of other immigrants, mostly high-skilled, rather than natives. Mandelman and Zlate (2019) find that immigration reduces the wage of high-skilled immigrants rather than high-skilled natives without a significant effect on wages of the native born. Finally, Moreno-Galbis and Tritah (2016) examine data from the EU and find that natives' employment rate increases in occupations in sectors that receive more immigrants. All of these explanations essentially assume imperfect substitutability of labor between native and immigrant labor. We assume the neoclassical assumption of perfect substitution.

The paper proceeds as follows. Section 2 lays out the basic model of immigration assignment and solves for the social planner's problem, the migrant's problem, and the destination country's problem under transferable utility. Section 3 discusses the implications of the results, and considers a balanced budget of the destination country. Section 4 surveys current government policies to ration immigration slots. Section 5 treats the pricing of immigration slots, and section 6 calibrates the model. Section 7 solves the model under non-transferable utility when capital and labor within a destination country have opposing views toward immigration, and provides predictions on cross-country differences in immigration policies. Section 8 concludes.

2. Model

Consider a particular destination country like the United States. Both natives and immigrants have ability θ with density and distribution functions $g(\theta)$ and $G(\theta)$ over [0,1].[7]

The goal is to set an admission rule that solves one of a number of the possible maximization problems described in the introduction. The choice comes through the selection of an immigration policy, a subset $\Theta \subseteq [0,1]$ of individuals in the home country who should be located in the destination country, and $\Theta^c \equiv [0,1]/\Theta$ who should stay in their home country. The problem is therefore one of assignment, in which individuals are assigned to different countries based on their comparative advantage.

2.1 *Maximizing world utility*

Maximizing world utility is a reasonable choice when compensatory payments, both within and among countries, can be made. That is the assumption made in this subsection, so that the social planner's choice comes down to comparing value in the home country with value in the destination country and bringing about an optimal assignment of people to countries.

The social value of an individual with ability θ in the destination country is

$$v(\Theta)\theta. \qquad (1)$$

There at two terms: θ, which reflects the individual's raw ability, and $v(\Theta) \geq 0$, which gives the marginal value of that ability in the destination country, given the immigration policy.

[7] Our measure of ability combines quantity equality to a single choice. Because ability is rank ordered, increasing immigration by reducing the policy threshold will bring in more immigrants but also of lower ability. See Chiswick (1989) for a model of the choice of immigrants on separate quantity and quality dimensions.

Assume v is monotonic in the immigration policy, in that policies that bring in more immigrants lead to a smaller marginal value of ability.[8] If the destination country were flooded with immigrants, the value of labor would fall because of the concavity of any standard production function. It is possible that over time the formation of new businesses could eliminate that effect, but the issue of diminishing marginal product of labor is relevant in the short run.[9]

The value of an individual of type θ outside the destination country is given by u. There are two differences between value in the rest of the world and value in the destination country. First, u is a constant and independent of θ. That is a modeling convenience and implies that high-ability individuals have a comparative advantage in the destination country. Second, just as for the destination country, it would be possible to allow the value outside the destination country to vary with the immigration policy, as $u(\Theta^c)$. This is ignored because under most circumstances, migration to the destination country is a small enough fraction of the world's population to have only minimal effects on the value of labor in the rest of the world. Even the US, which is the largest destination country in the world with almost four times as many immigrants as runner-up Germany, issues only about 1 million residency visas per year.

Additionally, because social value in the destination country is increasing in θ, if an immigration policy includes a given ability level, it will include all higher abilities.[10] We can then represent the immigration policy as a threshold θ_{min} where $\Theta = (\theta_{min}, 1]$. Write $v(\Theta)$ as simply $v(\theta_{min})$, and monotonicity implies $v' > 0$. The higher the threshold, the fewer assigned to the destination country.[11]

Let the cost of moving from the home country to the destination country be $c > 0$. Then the social planner's problem of choosing the minimum ability, θ_s, for migration to the destination country is

[8] Formally, for immigration policies Θ_A and Θ_B, if $|\Theta_A| < |\Theta_B|$ then $v(\Theta_A) > v(\Theta_B)$.

[9] The distinction between complements and substitutes is ignored here.

[10] This implicitly assumes that adding a set of measure zero does not change the value of an immigration policy. Formally, if $\theta' \in \Theta$ and $\theta'' > \theta'$ but $\theta'' \notin \Theta$, then $v(\theta'' \cup \Theta)\theta'' = v(\Theta)\theta'' > v(\Theta)\theta'$.

[11] As a practical matter, the assignment problem is a one-directional migration problem—namely, from the rest of the world to the destination country. There are few in the US who would be more productive in other countries, and that reverse flow is ignored. Hanson, Liu and MacIntosh (2017) report that an unskilled worker who moves from Mexico to the US can increase his wages by about $11,000 per year.

$$\max_{\theta_s} \int_0^{\theta_s} ug(\theta)d\theta + \int_{\theta_s}^{1} [v(\theta_s)\theta - c]g(\theta)d\theta. \tag{2}$$

If there is an interior solution, then

$$\theta_s \equiv \frac{u + c + \frac{v'(\theta_s)}{g(\theta_s)} \int_{\theta_s}^{1} \theta g(\theta) d\theta}{v(\theta_s)}. \tag{3}$$

Consider the simple case in which demand for labor in the destination country is perfectly elastic so that $v' = 0$ (and thus $v(\theta_s) = v$, some constant). Then (3) becomes $\theta_s = \frac{u+c}{v}$. Increases in u raise the value of staying in the home country and therefore raise the cutoff ability for socially efficient immigration. Increases in v have the opposite effect, increasing the value of work in the destination country. This lowers the cutoff ability. Finally, lowering c, the cost of migration, raises the efficient amount of migration.

If c is interpreted as the physical costs of moving, then $\frac{u+c}{v}$ implies that the socially efficient amount of migration is very high. A quick search finds a flight from Delhi to New York on a well-known established carrier for $516, which is essentially zero relative to the difference between u and v. Although very poor individuals in a developing country might have difficulty borrowing enough to travel, from a social point of view the move is efficient and almost every person in a low-income country should be permitted to migrate to the rich destination country given the wage difference between the US and low-income countries.[12] Is anything wrong with this logic?

There are three reasons why $\frac{u+c}{v}$ may suggest too low a threshold for the socially efficient amount of migration. First, c, the cost of moving, can entail costs other than the physical cost of transport. Leaving family and friends and setting up a new life in a foreign land, which involves adapting to a new culture and perhaps learning a different language, are costs that must be included in c. Still, this does not seem to be sufficient. For many, especially the young—who are the most likely candidates for migration—the total costs, including implicit ones, are low relative to a career's worth of much higher productivity and earnings in the destination country than in the home country.

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[12] The appropriate rate is the true social cost of financing the move, which is the marginal rate at which funds could be raised. A default on an implicit loan is merely a transfer and not a true social cost (e.g., Wang and Basu (2005)).

Second, bringing in a large wave of immigrants in a short period of time may reduce the productivity of all labor. That effect is incorporated in the $\frac{v'(\theta_s)}{g(\theta_s)}\int_{\theta_s}^{1}\theta g(\theta)d\theta$ term that appears in the numerator of (3). Because $v' > 0$, the lower is θ_s, the lower is $v(\theta_s)$. The average product of the labor of immigrants falls as the amount of labor increases. When θ_s is lowered, there is more migration, which increases the supply of labor. In the short run, that lowers labor's average and marginal product. The United States comprises about 5% of the world's population, so taking a large share of the population from the rest of the world would have significant direct effects on depressing v and on the value of bringing in additional labor. The implications of the effects of immigration on the wages of native workers is explored in more depth later.

If the social planner ignored the effect on the marginal product of labor in the US, θ_s would equal $\frac{u+c}{v}$. The ratio of u to v is best thought of as the ratio of wages in the home country to those in the US. The median income in the US is about four times the median income averaged across other countries in the world.[13] It is also true that over half of China, 90% of India, and at least two-thirds of Indonesia and Brazil, the world's most populous countries outside the US, have wages that are below the wage of the lowest 10% of earners in the US. This suggests a very low level of θ_s even when allowing for the cost of migration. Indeed, from a world welfare point of view, if bringing someone to the US bestows on that immigrant the technology of the US, then to a first approximation the US should accept migrants until wages for workers of a given ability are equalized across countries, meaning that the wage in the US would fall to 25% of its current level.

Finally, bringing in large numbers of immigrants at a point in time creates negative externalities because of the different culture and language issues. Lazear (1999) documents that assimilation, as proxied by learning English, is negatively and strongly related to the number of people in an individual's community who are from his or her native country. Neither the native nor immigrant population takes into account their failure to learn the other community's language or adopt its culture. The larger the immigrant community, the larger the externality.

[13] See Lahoti et al. (2016).

This effect can be mitigated by a balanced approach to immigration, bringing in small numbers of people from any one given country.[14]

Some of these concerns are short run and disappear over time. Immigrant children grow up in the destination country and, as such, acquire both the culture and language of that country, reducing or eliminating any continued externalities that are created by the first generation's immigration. As for the declining average product of labor, having a larger population simply means that the scale of production must increase. If the aggregate production function is homogeneous of degree one, increasing capital in proportion to the increase in labor would leave the marginal and average product unchanged. This can be thought of as simply changing the world in a way that moves people and capital from inferior to superior technology countries, where technology is defined broadly to include government and private institutions. It is technology that makes the destination country more productive than the home country (i.e., $v > u$), and that same technology can be used to create new firms with new capital. If done completely, in the long run, $v' = 0$. The only limiting factor is land, but the US is vast, most people live in cities, and cities like Houston, Denver, and Sacramento can be recreated many times over with minimal use of the virtually vacant land. The scarcity of arable land is an issue, but because food is a tradeable commodity it is world arable land per person that is relevant, and that is not significantly affected by migration. Taken to its logical conclusion, the US should take in many immigrants, enhance our capital stock proportionately, and allow all others to benefit from the superior technology and institutions that enable US productivity to be higher than that of most countries.

2.2 *The migrant's decision*

The marginal migrant is the one for whom the amount received by moving to the destination country just equals wages at home. First, allow t to be the proportion of value generated by an immigrant that is captured by the destination country. Then, $(1 - t)$ is the proportion of that value captured by the immigrant. The interpretation of t is broad. Because an immigrant only receives the marginal product of labor, all inframarginal surplus goes to other

[14] Lazear (1999) shows both theoretically and empirically that balanced immigration facilitates more rapid assimilation and learning the native language and culture by increasing the incentives to assimilate.

factors of production.[15] Those other factors are owned by the native population. Some of the surplus is captured by owners of land as land values increase. Some of the surplus is captured by capital owners because the influx of immigrants lowers wages, which means both a transfer from native labor to capital and a welfare triangle of gain. Additionally, because immigrants pay taxes on their earnings, some of t reflects taxes directly paid by the immigrant.

Let s be the direct cost borne by the native population on each immigrant admitted. This, too, can be interpreted broadly, but the most obvious interpretation takes the form of the social services provided.[16] It is possible to prevent immigrants from receiving some social services, and current US law does that by placing a 5-year residency requirement on some welfare payments. Still, other services are non-excludable and s can be thought of as the cost of those services.[17]

The marginal person who is willing to migrate from the home country to the destination country is the θ_m for whom $(1-t)v(\theta_m)\theta_m + s - c = u$, or

$$\theta_m \equiv \frac{u - s + c}{(1-t)v(\theta_m)}. \tag{4}$$

In the simple case in which v is constant, $\theta_m = \frac{u-s+c}{(1-t)v}$. Compared with the social planner's problem, θ_m differs primarily because the social planner's rule takes into account total value generated by a move without regard to the recipient of that value. For those purposes, s and t are transfers. Additionally, the social planner takes the migrant's effect on the productivity of labor into account, which is reflected in the v' term. The individual migrant, who has (almost) no effect on prices and wages, appropriately ignores this and cares only about that portion of value generated that accrues to the immigrant.

2.3 *The destination country's choices under transferable utility*

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[15] The discussion goes back over a century and traces its roots to Euler's theorem, in which factor payments must add up. This is dealt with explicitly in a later section.

[16] In this context, s can be interpreted as some of the pecuniary externalities imposed on the native population. For example, as a result of increased wealth from migration, the immigrant now competes with the native population for imported goods. That drives up the prices of imports, most of which is a transfer, but it is a transfer to people outside the destination country. Borjas (1999) shows that immigrants are responsive to the receipt of social services, and that those immigrants that are eligible to receive welfare cluster in US states that give greater social service benefits.

[17] Because the transfers are in-kind, it is possible that the value of those transfers to the immigrant does not equal the cost to the native population, especially because the choice of which social services to provide is determined by the native population, whose income may differ from that of immigrants. That distinction is ignored for simplicity. It is assumed that the value to the immigrant equals the cost to the destination society of providing the services, and both equal s.

To determine the ability cutoff the destination country would choose, it is most straightforward to assume that compensatory payments from winners to losers among natives can be made within the country. Thus the problem comes down to accepting any migrant who adds net value, taking into account the effect of altering the migration cutoff on the productivity contribution of the migrants.

Recall that $v(\theta_s)$ is defined as the value of an immigrant in the destination country at the socially chosen cutoff. Externalities aside, every immigrant must bring positive value to the native population for natives to favor the admission of that individual. Given t and s, it is a simple problem to determine the cutoff level, θ_n, that natives in the destination country would choose to maximize the welfare of the native population. The destination country's problem is to choose θ_n to solve[18]

$$\max_{\theta_n} \int_{\theta_n}^{1} [tv(\theta_n)\theta - s]g(\theta)d\theta \,. \tag{5}$$

The first-order condition is

$$\theta_n \equiv \left(\frac{s}{tv(\theta_n)} + \frac{v'(\theta_n)}{g(\theta_n)v(\theta_n)} \int_{\theta_n}^{1} \theta g(\theta) d\theta \right). \tag{6}$$

Threshold θ_n depends on the size of s relative to t—namely direct transfers from natives to immigrants compared with the payoff to the native population received from the immigrants. In the United States, there is heated debate regarding whether immigrants are a fiscal drag, taking the narrow view that t and s reflect direct taxes and transfers. This ignores the part of immigrant output captured by the native population. The fact that H-1B visas are oversubscribed every year suggests that there is value to US firms, above the wages paid, of bringing in immigrants—at least, skilled ones who qualify for H-1B visas.

When t is defined broadly to include all immigrant value captured by the native population, it is highly unlikely that $s > tv(\theta_n)\theta$. Because workers are paid their marginal products, the inframarginal part of the surplus generated goes to other factors of production—namely, capital and complementary labor. But even if a narrower definition of t that is restricted

[18] If θ_n is on net positive to the native population, then $\theta > \theta_n$ is also on net positive to the native population.

to only tax revenues collected from immigrants is used, it is unlikely that $s > tv(\theta_n)\theta$ for a large group of potential immigrants: those with high values of θ.[19]

3. Discussion and implications

3.1 *The optimal number of migrants*

To gain intuition on how the various parameters affect the choice by the social planner, the migrant, and the natives, assume that $v' = 0$ so we can write:

$$\theta_s = \frac{u + c}{v} \tag{7}$$

$$\theta_m = \frac{u + c - s}{(1 - t)v} \tag{8}$$

$$\theta_n = \frac{s}{tv}. \tag{9}$$

These expressions provide a number of insights and comparative statics. First note that the destination country's preferences depend only on the ratio of s to tv. Recall that s is the amount the native population transfers to the immigrant and $tv\theta$ is the amount the native population captures on an immigrant with ability θ. When $s = 0$ and $t > 0$, the natives in the destination country want everyone because there is no cost to having an immigrant and the native population benefits from the immigrant's presence. This implication is consistent with the historical evolution of immigration policy in the United States. Before 1914, the US had a policy of open immigration. At that point, there was no welfare and no government transfers to the immigrant per se, although private individuals, churches, former immigrants from a given home country, and other charity organizations might have made positive transfers. Today, s is positive and substantially so, which has changed the nature of immigration policy, and there is increasing

[19] A large literature discusses the impact of immigrants on natives. Much of this literature is about wages and, for the purposes here, irrelevant. The welfare gains that result from the capture of inframarginal immigrant surplus comes about by lowering the wages of natives. More to the point here is the literature that examines the fiscal effects of immigrants. This literature is also large. One summary of it is found in a study from the National Academies of Sciences, Engineering, and Medicine (2017), which states that the fiscal impacts of immigrants over the long horizon are generally positive at the federal level and negative at the state and local levels, but positive on net. These studies examine the current stock of immigrants under current rules, which is not applicable for this analysis. Because natives are choosing θ_n, the issue is how large must θ_n be to ensure that $s < tv(\theta_n)\theta_n$. More directly relevant is Storesletten (2000), who finds that the discounted net government gain varies substantially across skill levels of new immigrants. The net gain from high skilled-immigrants was \$96,000 while for low-skilled immigrants it was -\$36,000.

political pressure to ensure that an immigrant will not be a drain on society. Thus, as s increases, one would expect θ_n to rise over time and the number of immigrants permitted to decline. Even natives who benefit most from immigration raise their preferred immigration ability cutoff level to ensure that that the net gains to them from immigration are positive. For extremely high s, all natives prefer no immigration.

Higher transfers from immigrants to the native population, as reflected in t, increase the natives' desired number of immigrants and lower θ_n. This implication holds whether the increases reflect inframarginal rents captured by native-owned factors like land or capital or whether they involve direct taxes paid by the immigrant. The socially efficient ability cutoff and number of immigrants is independent of both s and t, which are transfers and do not affect the decision regarding efficient country location.

As is obvious, the migrant's cutoff θ_m, shown in (8), moves in the opposite direction with s. When transfers are high, a potential migrant is more anxious to come and this is true irrespective of the social efficiency of that migration decision. Analogously, increases in t make the potential immigrant less anxious to come because the destination country extracts more of the immigrant's value.

Of much interest is the relation of the socially efficient amount of migration to the destination country's desire for immigrants. Because u, reflected in home country wages, is expected to be low relative to v, the necessary condition whereby the potential migrant must want to come to the destination country is likely to be met even for very low-ability migrants. The United States and other high-wage countries face a large supply of potential immigrants.[20]

When does the destination country prefer more immigrants than are socially optimal and when does the reverse hold? The comparison between (7) and (9) gives the answer. The destination country does not care about the immigrant's alternatives or about the direct costs of migrating (u or c), which affects the socially optimal amount of immigration. Instead, the destination country chooses a higher cutoff ability level than socially optimal when, comparing

[20] The U.S. Department of State reports that in any given year, approximately 1 million immigrants obtain residency status (green cards), but almost 4 million remain on the waiting list. See U.S. Department of State – Bureau of Consular Affairs (2018) and U.S. Department of Homeland Security (2017). The Pew Foundation reports that in 2017 there were 22.4 million applications for entry through the diversity lottery for 50,000 slots, and that the diversity lottery accounts for only about 5% of green cards issued (Connor 2018).

(7) to (9), $\frac{s}{t} > u + c$. When this holds, the destination country prefers to admit fewer immigrants than socially optimal.

It is highly likely that $\theta_n > \theta_s$, so that destination country natives want fewer immigrants than is socially optimal. Using a weighted average of purchasing-power parity per capita GDP in India and China yields $u = \$13{,}181$.[21] Relative to even a one-year difference in earnings, the direct cost of moving, c, is low and even more so relative to differences in lifetime earnings between the US and China or India, so c (at least interpreted strictly as transportation cost) is not a major factor relative to differences in lifetime wealth. Ignoring c, $\theta_n > \theta_s$ if $s > tu$. If t and s are defined narrowly and restricted to only the fiscal transfers through taxes and subsidies, then the average tax rate overall in the US is around 25%, so (0.25)($13,181) is approximately $3,300. Direct expenditures on individuals as transfers equaled 14.3% of GDP, which, on a per capita basis would be almost $9,000.[22] Of course, immigrants are precluded from receiving some benefits for the first years during which they are in the US, but it seems likely that by these calculations, $s > tu$, which implies that $\theta_n > \theta_s$: Natives want fewer than the socially optimal number of immigrants.[23]

3.2 *Balanced budget*

The preference of natives for immigrants depends on the relation of s to t, but s and t are not exogenous. The government of the destination country must tax enough to cover the cost of the transfers to all of its citizens; thus it must adhere to a balanced budget constraint, at least in the long run. This implies a particular relation of s to t.

Having a balanced budget implies that the amount collected in tax receipts must equal the amount spent on all programs (outlays). Let N_{US} be the number of natives and N_i the number of immigrants in the destination country. N_i is the actual number of immigrants, while N_I is the number of *potential* immigrants in the rest of the world. Then, because the native population

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[21] The IMF (2019) reports per capita GDP of $62,606 for the US, $7,874 for India and $18,110 for China, and so $u = [(1.4)18110 + (1.3)7874]/2.7 = \$13{,}181$ (International Monetary Fund 2019).

[22] The Council of Economic Advisers (2019) reports that outlays to individuals were 14.3% of GDP in 2018, so on a per capita basis, transfers average .143*($62,606)=$8952.

[23] Note that u varies by home country. Luxembourg is 1.5 times wealthier than the US on a per capita GDP basis, which means that many fewer of their residents would want to come to the US than would Indians, whose per capita GDP is one-eighth that of the US. This obvious implication is borne out by predicted and observed migration patterns, which are dominated by moves from poor to rich countries rather than from rich to other rich countries. This is the supply side consideration. Equally or more important for actual migration is the immigration policy implemented by the destination country. See Lazear (2020a) and Lazear (2021).

chooses the ability cutoff for immigrants, immigrants come from the part of the ability distribution above θ_n, each producing v. So, the total collected in taxes is

$$\frac{N_i}{1 - G(\theta_n)} \int_{\theta_n}^{1} tvg(\theta)d\theta + N_{US} \int_{0}^{1} tvg(\theta)d\theta. \tag{10}$$

The first term is the conditional expectation of the amount collected in taxes from immigrants times the number of immigrants. The second term is the amount collected in taxes from all natives. The total amount of outlays is $(N_{US} + N_i)s + D$, where D is non-transfer expenditures such as defense.[24] Then the balanced budget constraint is

$$tv\left[\frac{N_i}{1 - G(\theta)} \int_{\theta_n}^{1} \theta g(\theta)d\theta + N_{US} \int_{0}^{1} \theta g(\theta)d\theta\right] \geq (N_{US} + N_i)s + D. \tag{11}$$

Total receipts must (weakly) exceed total outlays. Then we have:

PROPOSITION 1: *Under a balanced budget constraint, the destination country strictly prefers a positive level of immigration ($\theta_n < 1$).*

All proofs can be found in the Appendix. Intuitively, because some of the tax revenues must go to support expenditures other than transfers, the total amount spent on s must be strictly less than the total taken in through taxes. Also, since immigrants are more able than the native population because natives always select a $\theta_n > 0$, the average ability and earnings of immigrants is higher than that of the native population. Thus, the average immigrant pays more in taxes than the typical native and contributes more to revenues than the typical native. Both forces work in the direction of making immigrants a net plus fiscally.

Note that much of the controversy and discussion regarding immigrants' net contribution to the fiscal situation is based on the existing stock of immigrants, not on the immigrants who would come in under an ability-based policy. Indeed, θ_n is chosen specifically to avoid any fiscal drag caused by immigrants. This is reinforced when t is interpreted more broadly to include not only tax revenues, but also immigrant-generated rents that go to native-owned factors of production.

[24] In some sense, D can be thought of as a transfer to both the native and immigrant population, but if D were defense, it might be enjoyed even by those outside the destination country. Furthermore, think of D as a non-excludable public good that is independent of the number of individuals in the destination country so that more admitting immigrants does not imply a higher D.

The most important implication of this section is that some immigration is always desirable. When within-country compensatory payments are allowed, the native population benefits from allowing some immigration. The level depends on the distribution of ability outside the country, but at least some potential immigrants are positive contributors.[25]

4. Rationing immigration slots

In periods and countries when there was not excess demand for immigration slots at the market price—e.g., the US in the 19th century—the market did allocate immigration slots and it was supply driven. All those who found it advantageous to enter with an explicit price of zero ened up doing so. The migrant's threshold θ_m was the determinant of migration because θ_n was implicitly set to zero by the open immigration policy.

4.1. *Current US immigration policy*

Since 1965, the US has given preference to family reunification and a significant majority of permanent resident slots each year are awarded to relatives, immediate or extended, of current residents. Additionally, a fraction of slots are skill-based, while small numbers of slots are awarded to those seeking asylum or allocated on the basis of a diversity lottery. How does the current system, particularly the preference for relatives, conform to the social, native, migrant, and home country thresholds and to notions of fairness?

There are a few ways to deal with these factors formally. The easiest is to boost θ to include the value of being a relative of a resident. Define

$$\theta^* = \theta + \alpha, \tag{12}$$

where $\alpha \geq 0$ captures the value of other attributes. Let $G^*(\theta^*)$ be the distribution over θ^*. Then θ^* replaces θ and G^* replaces G throughout most of the analysis. All implications hold for social, destination country (with transfers), migrant, and home country preferences. But cutoffs refer now to θ^*, which includes the value of other attributes α, not to θ alone. Just as $v\theta$ was interpreted as the total value the immigrant produces in the destination country, now $v\theta^*$ is interpreted as the total value including other attributes produced in the destination country. Then

[25] Bellettini and Ceroni (2007) analyzes government rationing of immigration quotas and solves for the general equilibrium solution of wages and migration problems at once. Their conclusion that increases in the quota, i.e., more immigration, raises national income is consistent with our prediction that both the social planner and destination country prefer more immigration.

t is reinterpreted to be the portion of that total value captured by the native population and $(1 - t)$ as the amount captured by the immigrant. The same argument holds for refugee status, but now α is interpreted as the combined value of bringing in a refugee over another migrant with the same θ who does not need asylum.

First, relative-based preferences are not neutral across source countries and violate social, migrant, native, and home country preferences, as reflected in the threshold ability cutoffs. Using the revised definition of ability $\theta^* = \theta + \alpha$, which includes the additional utility value $\alpha \geq 0$ conferred on an immigrant because she is a relative of a current resident, the social cutoff is now

$$\theta_s^* = \frac{u + c}{v} - \alpha. \tag{13}$$

Because $\alpha \geq 0$, this implies more immigration than would be the case were α ignored. But it also changes the distribution of immigrants. Everyone who would be efficiently moved from the home country to the destination absent a preference for relatives should still be permitted to come. A strong preference for relatives over other high θ migrants can result in inefficiency.

Consider, for example, a rule that precludes anyone who does not have a relative in the US from obtaining an immigration slot, which is not so far from current practice. Social efficiency is decreased by allocating a slot to the relative of a resident with θ_0 and α_0 over a non-relative with θ_1 whenever $\theta_0 + \alpha_0 < \theta_1$. More value is created by moving θ_1 from the home country to the destination country than moving θ_0, even taking into account the utility value of relative immigrants. Thus, distortions and inefficiencies result from a rule that gives strict or strong preference to relatives.

Relative-based preference also may not satisfy basic notions of fairness. First, all source countries are not treated equally. Potential migrants who live in countries where a disproportionate number of their compatriots have already migrated to the destination country are favored over other countries. For example, El Salvador, with a population of about 6.5 million, is highly overrepresented among immigrants in the US, with almost 1 million residents of the US having been born in El Salvador. This means that most Salvadorans have a close relative currently residing in the US. By contrast, Kyrgyzstan has a population of about the same size as El Salvador, but almost no one living in the US today was born in Kyrgyzstan. This means that a current resident of Kyrgyzstan has very little chance of being awarded US residency status.

4.2. *First-come, first-served*

A first-come, first-served allocation system awards slots in a random fashion, although it might favor higher-ability migrants who are better able to navigate the application process. To the extent that it is random, it violates every threshold except the migrant's own, because only migrants $\theta > \theta_m$ would apply for admission. As shown earlier, $\theta > \theta_m$ in no way guarantees $\theta > \theta_s$ because θ_s does not depend on t or s. Thus, a first-come, first-served system bears no relation to efficiency. The same is true with respect to θ_n, which means that those who come in by the first-come, first-served rule are not those the destination country would choose.

4.3. *Point systems*

Some countries, notably Canada, have adopted a point system, in which individuals are given points based on a number of attributes; these might include age, education, occupation, ability to speak the destination country's language, and having a relative in the destination country. A point system is not a price system; it is best thought of as a way to estimate θ. More directly, the total points are a proxy for the potential immigrant's likely contribution to the destination country. A point system, coupled with a minimum threshold number of points necessary to be granted residency, simply recognizes that immigrant ability attributes are multidimensional, and the point system assigns weights to the various attributes. The structure converts a vector of attributes into a scalar index so that the index can be compared with a threshold, or alternatively, so that potential immigrants can be ranked against one another.

5. Pricing immigration slots

Immigration slots can be allocated using quantity-based rules—e.g., the destination country assigns those with abilities greater than a cutoff to migrate.[26] Under the current policy, there is excess demand for limited immigration slots. For example, in the US in 2017, 22.4 million people applied for the diversity lottery for 50,000 slots. Furthermore, the U.S. maintains waiting

[26] Today, rationing slots has led to shortages of skilled labor. The H-1B visa cap reduced the hiring of H-1B workers, as documented by Mayda, Ortega, Peri, Shih, and Sparber (2018) and Mayda, Ortega, Peri, Shih, and Sparber (2020). Moreover, Mayda et al. (2020) find that H-1B employers had reduced sales and profits compared with non-H-1B employers in the face of the H-1B shortages. Giovanni, Shih and Sparber (2015b) find that the H-1B shortages are associated with declines in foreign-born computer-related employment, while native employment falls or remains constant. Sparber (2019) finds that in the face of H-1B shortages, employers shift work to new H-1B workers without advanced degrees rather than to established H-1B workers with advanced degrees.

lists of people who applied but were not issued visas. In 2019, the waiting list for Mexico alone contained 1,229,505 people, compared with the 153,502 Mexicans who obtained lawful permanent residence. Note that this number does not even include Mexican immigrants who applied but were not placed on the waiting list; the U.S. government does not disclose this number. During times of excess demand, the economic solution is to raise the price; the current policy implicitly imposes a price of zero. The question is: What is that price?

To start, consider a destination country that has set a cutoff θ_n and now must find a way to implement that strategy. Recall that θ_n was determined such that natives viewed the contribution from admitting the immigrant to be positive. The condition was simply that $tv(\theta_n)\theta > s$. The threshold chosen by the native population does not take into account the migrant's preferences, but only the value she conveys to the native population after becoming an immigrant. By setting a price for the slot, the destination country can induce the same migration as would occur were the country to enforce a strict ability threshold.

The migrant chooses to come when the net earnings in the destination country minus the cost of migration exceeds what is earned at home:

$$(1-t)v(\theta_m)\theta_m + s - c > u. \tag{14}$$

The destination country may not observe the quality of the immigrant, and because θ_m differs from θ_n, some migrants (those with $\theta_m < \theta < \theta_n$), may not reveal this information truthfully. Prices often induce efficient allocations, and one might expect that prices could do the same with respect to immigration slots. Here, efficiency is not the goal. Does there exist a price the native population could charge for immigration slots that would induce only those immigrants with $\theta > \theta_n$ to pay the price and choose to migrate to the destination country? What implications does using a price system have for efficiency, and how does that relate to notions of fairness? How would this operate in a world where other countries competed for immigrants?

5.1. *Using a price to implement the native's preferred cutoff level*

The destination country would like to implement a cutoff of θ_n where only potential immigrants with $\theta > \theta_n$ would come. Assume for simplicity that $v' = 0$. Now, with an explicit price p_n, the marginal migrant has θ that satisfies

$$(1-t)v\theta - c + s - p_n = u. \tag{15}$$

The goal is to choose a price p_n so that the marginal migrant is exactly the one natives would choose; i.e., set p_n to satisfy

$$(1-t)v\theta_n - c + s - p_n = u. \tag{16}$$

Using (9) for the native's ability cutoff choice and substituting into (16) yields

$$p_n = \frac{s}{t} - u - c. \tag{17}$$

If this price is charged, then only and all potential migrants with $\theta > \theta_n$ will pay the price and migrate to the destination country. This price implements the destination country's desire regarding who should come. It also generates revenue equal to $[1 - G(\theta_n)]N_I p_n$, because $1 - G$ of the N_I potential immigrants would migrate to the destination country.

The pricing function in (17) is intuitive. As s rises, the value of being an immigrant increases. At the same time, the net value of the immigrant to the native population falls. Thus, p_n rises to reduce migration. The converse is true of t, which decreases the value of being an immigrant but raises the value of that immigrant to the native population. Thus, p_n fails to increase migration. The price determined in (17) does not result in efficient immigration—but efficient immigration is not the goal, which is to implement the natives' chosen cutoff θ_n. That cutoff is inefficient from a social viewpoint because the native population does not internalize the migrant's value at home or the cost of moving. Natives' setting of θ_n depends only on what they receive through t and what they lose through s. Other social costs and benefits are irrelevant. If p_n is chosen to implement θ_n and if θ_n is not socially efficient, then p_n does not bring about the socially efficient outcome.

Despite the inefficiency, the advantage of using the price structure is that it implements the natives' desired cutoff target θ_n without requiring the destination country to have specific information on an immigrant's ability level, θ. By setting price p_n, only potential migrants with $\theta > \theta_n$ find it advantageous to buy the immigration slot.[27]

5.2. *Fairness*

[27] Of course, the migrant makes the decision based on an estimate of own ability, which could be incorrect. Still, using the price system induces the migrant to act consistently, given her information.

Efficiency issues aside, is using a price system fair? Many find something morally objectionable in charging for the right to become an American, but the articulation of those objections is generally vague. As a general matter, fairness is difficult to define precisely, but a number of aspects of using prices instead of the current system are worth noting.

Many countries, including some high-income desirable destinations such as Australia, Austria, Canada, Italy, New Zealand, Singapore, the United Kingdom, and even the United States grant residency or citizenship to migrants who invest enough in the destination country.[28] The price is not explicit, but instead based on a capital requirement. Nor is it necessary that the price be paid at once. A destination country could implicitly finance the slot by charging the fee on, say, an annual basis for a period of years until what amounts to a loan for the slot purchase is repaid.

Yet a price system treats residents of all source countries equally. Any potential immigrant who is willing to pay price p_n can become a resident of a destination country. The current system in the US indirectly favors certain countries because their residents are more likely to have a relative in the US, which is the primary channel of entry right now. Before 1965, source countries were given explicit quotas that were based on the number of people in the US from those countries. A straight price mechanism eliminates this form of country-based preference.

Charging for slots that were previously given away free obviously involves a transfer from the immigrant to the native population. To the extent that natives in the destination country are wealthier than the immigrant, this may be viewed as a move in the wrong direction. Perhaps—but two points are worth noting. First, recall that immigrants under the θ_n cutoff are those from the top of the ability distribution and are almost certain to be wealthier than immigrants who enter the US under the current system. Second, even if immigrants are poorer than natives, they are still wealthy compared with those who remain in the home country. If redistribution were desired, a better target would be those left behind in the home country, not those who migrate to the destination country. The immigrants were generally richer than other home country residents before migrating to the destination country and are made even wealthier

[28] In an online appendix, we list several of the existing citizenship-for-sale ("Golden Visa") programs available today and their total fees (converted to USD).

by migration. Using the proceeds of the sale of slots for inter-country transfers might be a preferred strategy.[29]

Third, selling slots places undocumented immigrants who are currently living in the destination country on the same footing as those outside.[30] Just as compatriots who are currently in the home country, those without resident status who live in the destination country would be free to purchase a slot and would do so under the same conditions as someone in the home country.[31]

The immigration price could be paid out over many years. In particular, employers may be willing to pay this price as an investment in top talent. Moreover, capital markets can develop financial products that allow new immigrants to borrow and to pay this entrance fee. Ultimately, the private sector will be better at pricing risk than the government, and just as banks lend to borrowers, so too will financial institutions develop efficient ways of assessing talent and pricing default risk. This would be far superior to the point systems in place today, which rely on uninformed government officials to assess the skill of potential migrants, compared with capital markets that have strong financial incentives to measure risk correctly.[32]

5.3. *Monopoly pricing*

Although it is possible for the natives of a destination country to implement the θ_n cutoff by charging a price p_n, there is no reason to expect that to be the price chosen. Given that slots are now for sale, destination natives might be expected to price as monopolists. Recall that θ_n was determined to be the natives' choice (with intra-country transfers) when natives receive on net $tv(\theta)\theta - s$ from an immigrant with ability θ. But allowing the destination country to charge price p changes the net gain from an immigrant to $tv(\theta)\theta - s + p$. Setting $p = p_n$ to implement

[29] There is no need to restrict inter-country transfers to revenue obtained through the sale of immigration slots. If country transfers were welfare improving, there would be no reason to tie them to slot sales.

[30] Auriol and Mesnard (2016) is one of the few papers that explicitly considers a price mechanism to sell immigration visas. They consider this in the context of illegal immigration and find that a combination of visa sales and repression can control illegal immigration and smuggling.

[31] Orrenius and Zavodny (2020) propose an auction system, and Becker (2011) is indifferent between a price mechanism and an auction mechanism. In such a mechanism, the government selects the quantity and an auction sets the market-clearing price. However, an auction introduces additional complexity regarding potential immigrants. For these reasons we consider the price mechanism in this paper.

[32] Friebel and Guriev (2006) is an early analysis of debt-financed migration, where capital markets could finance migration for wealth constrained migrants. Their analysis focuses on illegal immigration and finds that stricter deportation policies can induce capital markets to increase their financing of immigration, which in turn can actually lead to more, rather than less, illegal migration. This proves there is already academic work that engages the capital markets in assisting with migration, as proposed here.

cutoff rule $\theta = \theta_n$ is no longer optimal, as will be shown below. Also shown below is that when destination natives act as monopolists, the price is chosen so as to result in less than the socially optimal amount of immigration. Just as monopoly pricing results in too little output in standard product market settings, so does monopolistic prices for immigration slots result in too little immigration from the viewpoint of social efficiency.[33]

If the destination country can set the price it desires, it will attempt to act as a monopolist facing a downward-sloping demand curve. A higher price yields more revenue per immigrant, but a lower price induces more potential immigrants to buy the immigration slot.

As above, let $v' = 0$. An individual chooses to buy an immigration entry slot at price p if

$$s + (1-t)v\theta - c - p \geq u, \tag{18}$$

which occurs if

$$\theta \geq \tilde{\theta}(p) \equiv \frac{u + c - s + p}{(1-t)v}. \tag{19}$$

$\tilde{\theta}(p)$ is the skill threshold that results when the destination country sets a price p for the immigration slot. Observe from (19) that the marginal migrant induced by the price, $\tilde{\theta}(p)$, is increasing in the price of an immigration slot. As the price rises, the level of skill necessary to justify paying that price rises. This monotonicity in the threshold with respect to the price is a key feature of the effect of price on the population of migrants. Lowering the price induces a lower threshold for the marginal migrant. With a low price, low-skilled home country residents are now willing to migrate because they can capture enough surplus in the destination country to pay off the entry fee. The population that become immigrants is given by

$$Q(p) \equiv \left[1 - G\left(\tilde{\theta}(p)\right)\right] N_I = \left[1 - G\left(\frac{u + c - s + p}{(1-t)v}\right)\right] N_I. \tag{20}$$

Thus, $Q(p)$ is the quantity of immigration demanded by potential immigrants, N_I, at any given price p and maps a downward-sloping demand curve, since

$$\frac{\partial Q}{\partial p} = -g\left(\tilde{\theta}\right)\frac{1}{(1-t)v} N_I < 0. \tag{21}$$

[33] Bianchi (2013) considers a government that imposes a one-time migration cost that can be paid upfront by the migrant. This is essentially equivalent to a price. Bianchi (2013) finds, similar to us, that natives will restrict immigration at times and that a skill dependent policy can have value, as well as that adjusting this migration cost, (price) affects both the size and the composition of migration.

The destination country will maximize its surplus, which now includes revenue from the sale of immigration rights—i.e., a price p for every migrant θ who immigrates:

$$\max_{p} \int_{\tilde{\theta}(p)}^{1} (p + tv\theta - s)g(\theta)d\theta\,. \tag{22}$$

Solving this yields:

PROPOSITION 2: *The monopoly price chosen by the destination country is:*

$$p_M \equiv s + \frac{1 - G(\tilde{\theta}_M)}{g(\tilde{\theta}_M)} v(1-t) - tv\tilde{\theta}_M, \tag{23}$$

where $\tilde{\theta}_M \equiv \tilde{\theta}(p_M)$*. This results in under-immigration relative to the socially optimal amount* ($\tilde{\theta}_M > \theta_s$).

The cost to the destination country of the marginal migrant is $s - tv\tilde{\theta}$. As is standard in monopoly price setting, the optimal price depends on the price elasticity of demand $\varepsilon \equiv pQ'(p_M)/Q(p_M)$:

$$\tilde{\theta}_M = \frac{1}{v}\left[u + c + \frac{1 - G(\tilde{\theta}_M)}{g(\tilde{\theta}_M)} v(1-t)\right] \tag{24}$$

$$p_M = s - tv\tilde{\theta}_M - \frac{Q(p_M)}{Q'(p_M)} = s - tv\tilde{\theta}_M - \frac{p_M}{\varepsilon}. \tag{25}$$

In this case, marginal cost is interpreted as the net loss on the marginal migrant. This is what drives the inefficiency in the immigration decision, leading to under-immigration. The destination country wants to raise the slot price to increase revenue received per immigrant over the entire pool of immigrants, even at the small loss of those at the margin who are no longer willing to pay the fee. Just like a profit-maximizing monopolist, the destination country balances these two effects, which leads to higher prices and restricted quantities.

When the destination country uses an ability threshold as its policy, there is no reason for the country to concern itself with the outside opportunities of the migrant. Migrants who add positive value net value, given by $tv\theta - s$, are desirable. The destination country takes as many immigrants as it can get with $\theta \geq \theta_n$ and takes none with $\theta < \theta_n$.

When a pricing mechanism is used, the destination country must consider the potential immigrant's outside opportunities, u. The migrant's decision to come depends not only on the price charged but also on the amount the potential migrant can earn at home.[34] When the destination country chooses a monopoly price, it implicitly takes into account the potential migrant's opportunity cost, and it is for this reason that there is an unambiguous ordering between the monopoly-priced number of immigrants and the socially optimal number of immigrants, as stated in Proposition Proposition *2*: The monopoly price chosen by the destination country is:.

5.4. *Competition for immigrants*

Next, suppose that the destination country is one of many countries that can receive immigrants. Therefore, the destination country takes price as given in the market for immigrants. Many of the richer democracies of Western Europe have similar levels of social insurance programs, tax rates, democratic politics, low fertility rates, and high income.[35] The marginal condition for the immigrant's decision is the same as before, expressed in (19). Just as in competitive product markets, assume that a competitive market for immigrants is coupled with the free entry of countries to the immigrant market. Free entry takes the form of a country moving to a price system for allocating slots from a system that currently allocates slots using some method without explicit prices. As in standard product markets, this ensures zero profits in equilibrium and permits solving for the competitive price.

The assumption here is that the destination country sells a slot to any immigrant who is willing to pay the price. Any price that results in positive profits is unsustainable, because other countries will offer immigration slots at lower prices until profits are exhausted.

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[34] Borjas (1987) confirms that the home countries' political and economic conditions matter for explaining the U.S. earnings of immigrants. Therefore, any sensible pricing policy must also condition on these economic opportunities of the home country.

[35] In practice, the countries of Europe may be acting more as an oligopoly than a competitive market. Giordani and Ruta (2013) builds a model of multiple destination countries and finds that any one destination country's immigration policy may lead to coordination failures, leaving all countries in welfare inferior equilibria. We will abstract away from these strategic effects here since they are explored elsewhere.

PROPOSITION 3: *In a competitive market, each destination country charges a competitive price of*

$$p_c \equiv s - tvE\left[\theta | \theta > \tilde{\theta}_c\right], \tag{26}$$

where $\tilde{\theta}_c \equiv \tilde{\theta}(p_c)$*. This price results in more than the socially optimal amount of immigration* $(\tilde{\theta}_c < \theta_s)$.

The threshold for immigration induced by the competitive price is given by

$$\tilde{\theta}_c \equiv \tilde{\theta}(p_c) = \frac{u + c - tvE\left[\theta | \theta > \tilde{\theta}(p_c)\right]}{(1-t)v}. \tag{27}$$

Substituting θ_s from (8) into (19) yields $p_s \equiv s - t(u + c)$. There are now three prices that implement three cutoffs: p_M, p_c, and p_s. As must be the case, the monopoly price exceeds the competitive price. Competition among nations for immigrants places downward pressure on prices. The immigrant response function is represented by $\tilde{\theta}(p)$, which is increasing in price. As price increases, the ability cutoff for those willing to pay it rises. Because Proposition PROPOSITION *3*: In a competitive market, each destination country charges a competitive price of shows that $\theta_s > \tilde{\theta_c}$, it also follows from (19) that $p_s > p_c$. Analogously, from Proposition PROPOSITION *3*: In a competitive market, each destination country charges a competitive price of, $\theta_s < \theta_m$, so $p_s < p_m$.

Summarizing, there is strict ordering of the immigration policies: $\tilde{\theta}_c < \theta_s < \tilde{\theta}_M$ with $p_c < p_s < p_m$.[36] A destination country that acts as a monopolist facing a demand curve picks prices that maximize profits, leading to higher prices and lower quantities. Competition among countries induces lower prices, but this generates its own inefficiency. Prices are driven down to the point where the marginal immigrant should not come. This is because the destination country earns rents on inframarginal migrants, but competition forces those rents to vanish. There is only one price, given in Proposition PROPOSITION *4*: The destination country can choose an ability-specific pricing function, $p(\theta)$, that implements the efficient immigration policy., with which to accomplish that.

[36] As before, it is impossible to rank $\tilde{\theta}(p_c)$ to θ_n or equivalently, p_c to p_n. That is clear because $\tilde{\theta}(p_c)$ does not depend on s and θ_n does not depend on u or c. It is possible to increase θ_n to 1 by choosing a high enough s or lowering it to zero by choosing $s = 0$.

The country loses on the marginal immigrant with ability $\tilde{\theta}_c$, but the ability of the average immigrant is high enough to satisfy the breakeven condition. Countries can only charge a single price, determined competitively, and that price induces too much immigration. This differs from the standard competitive case because here, quantity (which is really quality) decisions are made by the potential migrants, not by the destination country, and the destination country has no independent control over price. The country takes price as given (because it operates in a world of Bertrand competition) but also does not set quantity or quality. It sells immigration slots to anyone who is willing to pay the competitive price. The consequence is that the amount of immigration exceeds the social optimum because the market price is below the breakeven level on the marginal migrant.

5.5. *Price discrimination*

The inefficiencies that result from a single price (monopoly or competitive) might be eliminated were countries able to price discriminate, whereby different immigrants could be charged different prices. Price discrimination can be sustained when the seller has monopoly power and can prevent resale. In this case, the resale of slots from the purchaser to other potential immigrants is clearly impossible, but it is important to ensure that the equilibrium is sustainable in that no one country can undercut the pricing strategy of another country by picking off those who are charged a high price.

For now, let us ignore those considerations and assume that countries can vary the price based on the characteristics of the potential immigrant (θ). As a general matter, price discrimination can be used to generate an efficient outcome, and that is true here as well:

PROPOSITION 4: *The destination country can choose an ability-specific pricing function, $p(\theta)$, that implements the efficient immigration policy.*

This mirrors the classic economic result that full price discrimination leads to efficiency, because the pricing function can extract all of the surplus from each migrant. Since each migrant is held to his reservation utility, the country will pick the threshold to maximize total surplus. This leads to the efficient threshold.[37]

Although the United States does not price residency permits per se and as such does not vary the price with the characteristics of the immigrant, it does vary the likelihood of being admitted to the country based on the immigrant's characteristics. For example, students who graduate from US universities, particularly in technical fields, have a greater chance of remaining in the US and eventually obtaining permanent residency than those without technical skills. Similarly, the H-1B visa is available to those who have a US company sponsor and generally high levels of technical skills.[38] Relatives of current US residents are also given priority over their compatriots without relatives in the US.

5.6. *Golden Visa programs and implementation through taxes*

A handful of countries offer citizenship-for-sale programs: however, those countries are either very small or are major economies but attract a small number of actual migrants to these programs. The analysis assumes that the price for citizenship is a transfer from the migrant directly to the government.[39] But most of the existing citizenship-for-sale programs today require additional investment in other forms, such as property, business, or government bonds.

For example, Singapore requires an investment of $1,834,054 in one of its businesses to qualify for permanent residence. Alternatively, some countries require investment in real estate and property. Portugal grants a temporary visa for a $554,175 investment in real estate. Some countries allow the investment to take the form of government bonds, and return the principal without interest to the migrant after a set number of years. For example, Bulgaria grants citizenship for a $566,519 deposit in a government bond portfolio for 5 years. Some countries require a mix of investments. Malta requires a real estate investment ($387,905 for a purchase or

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[37] In a more complex version of this problem, we could imagine that θ is not contractible, but that migrants communicate messages $\hat{\theta}$ around θ. The pricing function would need to be both individually rational and incentive-compatible, meaning that the migrant needs incentives to tell the truth. Such an analysis is standard in the private information economics literature. We focus on the simpler assumption that θ is contractible in order to focus on novel issues specific to immigration.

[38] The H-1B visa program itself has several flaws aside from the random lottery. Because employers must seek government approval for the visa, an outdated government wage schedule allows employers to pay below-market wages for their H-1B candidates, as documented in Costa and Hira (2020) and Hira (2016). The H-1B waiting list remains long, which proves demand for American citizenship even at these lower wages; this suggests that there is excess demand for immigration slots and a possibility to clear the market with higher prices.

[39] For example, Dominica charges a nonrefundable $100,000 fee for a single citizenship applicant, which is a direct transfer to the government. Similarly, Saint Kitts and Nevis charges $150,000.

an annual rental of $17,732), plus an investment of $166,245 in government bonds, a $5,500 fee paid to the government, and either proof of income of at least $110,830 per year or assets of at least $554,150.

What matters to the destination country is how much of the price the country actually collects. We can generalize this by replacing the price with a scaled price $\lambda_p p_j$. In the case of pure cash payment, $\lambda_p = 1$, in which case all of the transfer accrues to the government. If the destination country requires investment in business (as the U.S. does), then the country will earn tax revenue from those businesses in the future, so likely $\lambda_p < 1$ and similarly with property. The parameter λ_p will scale how much of the fee accrues to the destination country, and this will naturally affect its pricing function in a monotonic way.

To get some insight into the scale of these programs, the U.S. offered 9,947 EB-5 visas in fiscal year 2016, a small fraction of the total pool of 1,800,000 migrants who immigrated to the U.S. that year.[40] Even at an investment level of $500,000, these 9,947 visas would generate $4.97 billion in private investment—still only around 1% of the $457.1 billion total foreign direct investment in the U.S. in 2016. Thus, even though the U.S. has the largest investor visa program, it is tiny in both number of visas offered and dollars generated.[41]

Some countries use the tax system to implement a price of citizenship. For example, Italy offers a 15-year substitute tax in which immigrants pay no Italian taxes on income earned in Italy but pay a flat $110,830 fee on all foreign income, regardless of amount. Italy also has a 4-year exemption of 90% of income for professors and researchers who relocate to Italy. However, this is a more restricted category than the substitute tax, which applies to anyone willing to pay the $110,830 fee. In this sense, a substitute tax τ takes the place of the price, and the tax rate for these immigrants on income in the destination country is zero. Thus we can use the same analysis as above, substituting an optimal substitute tax level τ in place of the price of citizenship p, and taking the destination country tax rate to be $t = 0$. The optimal substitute tax rate is therefore

[40] The U.S. EB-5 program grants a conditional green card for 2 years, convertible to full permanent residence if the migrant invests $900,000 in a targeted low-employment area (or $1.8 million elsewhere) in a business that creates at least 10 full-time jobs.
[41] Note that this number is an investment in the U.S. and therefore not direct government revenue. The government revenue share of this would be much smaller, which it would collect through distortionary corporate and individual taxes.

$$\tau^* = s + \frac{1 - G\left(\tilde{\theta}(\tau)\right)}{g\left(\tilde{\theta}(\tau)\right)} v. \tag{28}$$

As before, this induces under-immigration in a profit-maximizing country, since in this example $\tilde{\theta}(\tau) = \theta_s + \frac{\tau - s}{v} > \theta_s$. Therefore, the general analysis earlier can apply to a specific implementation of the price through the tax, as Italy has done through their substitute tax to attract wealthy immigrants from abroad.[42]

6. Calibration

We now seek to calibrate the model using data to provide guidance on what these optimal prices should be. To fix ideas, consider a uniform distribution of ability, so $G(\theta) = \theta$ is the CDF and $g(\theta) = 1$ is the PDF. This will allow for closed-form solutions for many of the equations throughout the paper. Assume a linear value function, $v(x) = vx$.[43] We can solve for the optimal thresholds and pricing functions in closed form under these new assumptions:

PROPOSITION 5: *Under a linear value function, the optimal immigration thresholds are:*

$$\theta_s = \sqrt{\frac{2(u+c)+v}{3v}}, \theta_m = \sqrt{\frac{u-s+c}{(1-t)v}}, \theta_n = \sqrt{\frac{2s+tv}{3tv}}, \text{ and } \tilde{\theta}(p) = \sqrt{\frac{u+c-s+p}{(1-t)v}}. \tag{29}$$

The optimal monopoly price is:

$$p_M = s - u - c + \frac{1-t}{9(2-t)^2}\{8v(1-t)^2 + 3(2-t)(2u + 2c + tv) + 4(1-t)\sqrt{4(1-t)^2 v^2 + 3v(2-t)(2u + 2c + tv)}\}. \tag{30}$$

The optimal competitive price is

[42] Burda and Wyplosz (1992) considers two-directional migration both to and from a home country and destination country in the context of migration across eastern and western parts of Europe. They find that in order to maximize total world surplus, citizens in the high income country should receive a subsidy to migrate to the low income country, while citizens in the low income country should face a tax to migrate to the high income country. While we do not consider migration outside of the U.S., the tax can be interpreted as a price, as in our analysis.

[43] The true shape of the value function may not be linear, but likely has some curvature. For example, as the influx of immigrants begins to approach the number of new births in the U.S. population at 4 million people per year, it's possible that the hit to marginal productivity is larger than at current levels. This concavity in the value function will lead to different estimates, though we impose linearity for simplicity and in the belief that at current immigration rates the value function is linear.

$$p_c = s - u - c + \frac{(1-t)\left[t^2 v + 4(2-t)(u+c) - t\sqrt{t^2 v^2 + 8(2-t)v(u+c)}\right]}{2(2-t)^2}. \quad (31)$$

Calibration of the model will require some admittedly subjective choices for the exogenous parameters in the model. The goal here is not exact certainty, but rather a ballpark estimate that can provide guidance.

The analysis that follows will generate the optimal immigration prices specific to the relationship between the US and each country, so prices that implement an immigration policy for one country will differ from those of another country. For notation, a hat over each variable denotes an empirical estimate. The social safety net annually per person in the US is $\hat{s} =$ $8,157,[44] and the average tax rate in the US is $\hat{t} = 25\%$. We take gross national income (GNI) per capita from the World Bank as the measure of u, and the transit cost c to include current immigration fees and estimated travel cost as airfare between the capital city of the home country and Washington D.C. as the port of entry.

The parameter v, the marginal value of an immigrant, is more difficult to measure. Recall that the social value of an immigrant of type θ, given an immigration policy threshold θ_{min}, is $v(\theta_{min})\theta$. Therefore, the value function $v(\theta_{min})$ is the marginal product of labor (MPL). If the value function is linear, then $MPL = v(\theta_{min}) = v\theta_{min}$. Thus the parameter v captures a change in marginal product for a given change in immigration threshold ($v = \frac{\partial MPL}{\partial \theta_{min}}$). In competitive labor markets, wages approximate marginal products, so we can estimate v by examining how changes in immigration policy impact wages.

To calculate this, we measure wages as household income from 1974 to 2019 from the US Census. For changes in immigration policy, calculate immigration percent—the percentage of persons obtaining lawful permanent residence from the Department of Homeland Security as a proportion of N_I, the world's population outside the US—for each year 1974-2019. We regress immigration percent on current median household income. We can interpret the OLS coefficient as a marginal increase in immigration (0.001% of the world's population outside the U.S., or

[44] Social safety nets are what the Congressional Budget Office calls mandatory spending, which includes Medicare, Medicaid, and Social Security, as well as other benefits programs. Federal mandatory spending in 2019 was $2.7 trillion, or $8,157 per American.

73,000 extra immigrants into the US) that leads to a marginal decrease in median household income of $270.[45]

We can insert these calibrated values of the model parameters into PropositionProposition *5*. Table 1 calculates the optimal price for every country for which the U.S. admitted a positive number of immigrants in 2019. The prices range from a low of $46,707 for Switzerland to a maximum price of $91,578 for Syria. In general, the lower the income in the home country, the higher the induced demand will be for a given price, and hence the optimal price is higher to prevent large inflows of immigrants. The average monopoly price in the sample is $80,935.[46] Bear in mind the following caveats: First, this is a fixed amount that can be collected over time. Second, a pricing policy must be accessible to anyone who is willing to pay the price, and therefore a sufficiently high price guarantees that the destination country will not be flooded with immigrants it does not want. Third, estimation of the underlying demand curve is critical in setting this price, and in future research we will expand this analysis to structurally estimate the elasticity of immigration demand, which can yield more precise estimates of the optimal monopoly price.[47]

Of course, the population of migrants who want to come to the US for free under a family reunification policy will differ from migrants with skill willing who are to pay an entrance fee. For instance, it is likely that current immigration rates and the existing family reunification policy deters large numbers of Mexican immigrants from even considering applying for immigration, and that a fee that anyone can pay for entry could induce many more applicants. Thus the revenue generated from future immigrants is likely to be an underestimate of the true revenue raised.

To estimate revenue generated, it is important to estimate the take-up rate, $(1 - G(\tilde{\theta}(\rho_M)))N_I$. While it is tempting to consider the entire home country population as N_I,

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[45] The sign of the coefficient is positive in our regression because the independent variable measures $1 - \theta_{min}$, the percentage of immigrants admitted to the US. We seek to measure a marginal increase in θ_{min}, which is equivalent to a marginal decrease in $1 - \theta_{min}$.

[46] Becker and Lazear (2013) propose a price of $50,000 per person. While this universal price for any potential immigrant is simple, it does not consider the differing home country opportunities. Low-income-country immigrants will have a stronger incentive to migrate than high-income-country immigrants, and therefore the optimal price must adjust to this higher demand.

[47] Without a structural estimation, calculating the number of immigrants who will pay the entry fee (i.e. the take-up rate) is difficult.

realistically not everyone in the home country will want to immigrate (the elderly, children, those involved in home country family businesses, etc.). Rather than speculate on a measure of N_I, we anchor on current immigration rates. Table 1 also lists the number of visas the U.S. issued per country in 2019. At this level, the optimal pricing schedule will generate $67 billion in annual revenue. The model with a linear value function assumes that there will be sufficient demand at these prices to fill all slots, even at multiple times the current immigration rates. For example, were the U.S. to increase immigration uniformly to match the number of new births in the U.S., admitting 4 million immigrants to the U.S., (a number the U.S. could easily absorb), this could generate $268 billion in revenue that, in turn, could significantly reduce the U.S. budget deficit.

7. Capital and labor conflicts over immigration

Destination country natives have a common preference for the number of immigrants only when within-country compensatory payments (transfers) are permitted. Under those circumstances, any immigration that increases the total wealth of current and future natives taken together is preferred by all. More realistically, for political and economic reasons, it may be difficult to pay natives who lose from immigration enough to offset them for their losses, absent a market mechanism like selling visas.

7.1 *Destination country choices under non-transferable utility*

When winners from immigration fail to compensate losers from immigration, there is a clear tension between natives who benefit from immigration and those who do not. Because $v' > 0$ in the short run, immigrants push down the marginal product of labor and consequently lower the wages for the part of the native population that is substitutable for immigrant labor. Capital has a different view. When wages fall, there is a direct transfer and welfare triangle of gain that goes to capital. All of this occurs at the expense of those who only compete with immigrant labor and do not own complementary factors of production. As a practical matter, this issue of substitution is relevant even for highly skilled labor. Technical workers who come in on H-1B visas put downward pressure on the wages of native technical workers.[48] Indeed, if there were a minimum skill cutoff for immigrants, as reflected in θ_n, and if workers with different levels of θ

[48] Gunadi (2019) finds that native STEM workers with high amounts of education experience low wage gains. He also finds that the increase in STEM labor supply from 2000–2015 through high-skilled immigration slowed the growth of wages among native STEM workers. This suggests that skilled immigration benefits capital, which then passes some of those benefits on to workers. Nonetheless, competition renders native workers worse off.

were not perfect substitutes for one another, increased immigration would more likely result in downward pressure on the wages of the highly skilled workers, not those natives with low values of θ.[49]

Most research finds that the negative effects of immigration on the wages of native-born substitutes is minimal, but this happens at least partly because the flows are very small relative to the size of the native workforce.[50] Were large immigration flows considered, the total gains to the native population from immigration would be larger, but the distributional effects would also be larger. Still, it is clear that there is tension between the preferences of natives who benefit from immigration and those who are harmed by it. That is modeled here by emphasizing how the distribution of capital and labor income affects immigration preferences.

Suppose that the economy follows a production function $f(K, L)$, where K is the amount of capital in the economy and L is the amount of labor.[51] Assume the production function has the standard properties—i.e., is increasing and concave in both capital and labor—and that capital and labor are complements. Suppose that all workers are perfectly substitutable for one another, but have different productivities as indexed by θ, as is standard in human capital models.[52] Let N_{US} be the number of people in the US. Define θ_{n^*} as the cutoff level chosen by a native of ability θ through some political equilibrium when within-country transfers are not permitted. The immigration problem involves selecting θ_{n^*} given by the total labor stock

$$L_1 \equiv N_{US} \int_0^1 \theta dG + N_I \int_{\theta_{n^*}}^1 \theta dG, \tag{32}$$

[49] In this model, different types of labor are not modeled explicitly. The structure here is akin to that in standard human capital theory, with the more able simply modeled as having more units of human capital that sells or rents at some market-determined rate.

[50] Perhaps the landmark study is that of Ottaviano and Peri (2012), who find that from 1990 to 2006 immigration had a small but nonzero effect on the wages of native workers with no high school degree between 0.6% and 1.7%, but a substantial negative effect of -6.7% of the wages of previous immigrants in the long run. This is broadly consistent with our own regression. See also Council of Economic Advisers (2008); Card (2001); LaLonde and Topel (1990); Leubsdorf (2017); and Ottaviano and Peri (2006).

[51] We assume that while labor by immigrants is mobile, capital is fixed. If capital were also mobile, we would expect the wage differences between the home country and the destination country, (i.e., u and v in in this model if $v' = 0$) to be even larger, which is consistent with the analysis in Gerking and Mutti (1983).

[52] Ottaviano and Peri (2005) argue that US and foreign workers are imperfectly substitutable, and therefore overall immigration could generate a large positive effect on average wages. While this may be true with small immigrant flows, it cannot be true over a large influx of immigrants since it would be optimal to allow the whole world to enter the US, equivalent to arguing that the $v' < 0$. We will see later that even with $v' > 0$, optimal immigration is much larger than current practice.

where N_I is the number of potential migrants to the US. In competition, a worker of ability θ receives wages

$$W(\theta, L_1) = \theta\lambda(L_1), \tag{33}$$

where $\lambda(L_1)$ is a scalar determined such that all wages exhaust the total wage bill and is equal to the amount that $\theta = 1$ receives. To economize on notation, the fiscal components of s and t are ignored.

Capital is complementary with labor and owned by the native population, but not necessarily evenly. High-skilled individuals own more of the capital than less skilled ones, so let the relative fraction of capital owned by an individual with ability θ be given by θ^{β}. If $\beta = 0$, capital is distributed on a per capita basis. If $\beta = 1$, natives get dividends in proportion to their θ. More realistically, $\beta > 1$ so capital is disproportionately owned by the most able. In what follows, assume that $\beta \geq 1$. As β goes to infinity, all capital is owned by the single highest-θ native. The amount each individual of type θ receives in rents from capital is then

$$R(\theta, L_1) = \theta^{\beta}\gamma(L_1), \tag{34}$$

where $\gamma(L_1)$ is a scalar determined such that all payments from capital exhaust the total payments to capital.[53] Immigrants of ability θ receive $W(\theta, L_1)$ but nothing from capital, because all capital is owned by the native population.[54]

Assume that capital is fixed in the short run, which implies $\lambda'(L_1) < 0$ and $\gamma'(L_1) > 0$. Wages fall when the number of immigrants increases, but payments to capital rise. A native of ability θ faces a trade-off in choosing a preferred number of immigrants. More immigrants mean lower wages, but more immigrants also mean higher returns to capital. Because natives have different preferences on θ_{n^*} because of their own θ, write $\theta_{n^*}(\theta)$ instead of θ_{n^*}. The problem for a native of ability θ is then to choose $\theta_{n*}(\theta)$ to maximize total income

$$W(\theta, L_1) + R(\theta, L_1). \tag{35}$$

[53] Because K is fixed, K is already embedded in $\gamma(L_1)$ and it is unnecessary to think in terms of per unit capita, as was done above with labor where $\lambda(L_1)$ is explicitly multiplied by L_1, which is variable, to exhaust total payments to labor.

[54] Giovanni, Shih and Sparber (2015a) find that increases in the supply of H-1B visa programs lead to increases in native college-educated wages. They argue that the increase in foreign STEM workers increases the total factor productivity (TFP) growth of the US, and some of that growth translates into higher wages. This is equivalent to the benefits of accruing to capital.

The solution to this program leads to the following result:

PROPOSITION 6*: The optimal threshold $\theta_{n*}(\theta)$ a native of type θ prefers is decreasing in θ and β for sufficiently high θ.*

Thus, as the skewness of capital in the economy increases, capital becomes more concentrated and the θ-native prefers more immigration to less. Highly able natives prefer more immigration because they receive more of their income from capital than labor. When the ownership of capital becomes increasingly skewed, this effect increases, and so high types are more likely to hold more of their income from capital than labor, and therefore they will prefer more immigration than less. This accords with the conflicting preferences of capital and labor with respect to immigration. The next question, however, is what the optimal level of immigration will be under non-transferable utility, with capital and labor holding different preferences toward immigration.

Consider the class of CES production functions, $f(K, L) = (aK^{\rho} + bL^{\rho})^{\frac{1}{\rho}}$ with $\rho \in [-1, 1]$. We will assume that the parameters of this production function are such that the production function is still increasing and concave in both of its arguments. We can solve for the optimal immigration level for this broad class of production functions:

COROLLARY 1: Under CES production, a native of type θ prefers either full or no immigration ($\theta_{n^*}(\theta) \in \{0,1\}$).

If a native owns enough capital, he ignores the lower wages that result from immigration and takes his income in returns to capital. Natives who own little or no capital care only about wages, so every addition to the stock of US labor affects them adversely. The structure makes native and immigrant labor perfect substitutes but makes (all) labor and capital complements. The total stock of labor, L_1, is the sum of native and immigrant labor whereby each person contributes her own θ to the stock of labor. Allowing more immigration lowers wages but raises returns to capital. Higher-ability, and therefore higher-wage, natives own a larger share of the capital stock. Those who receive most of their income through capital tend to favor immigration, whereas those who receive most of their income in wages tend to oppose immigration. The starkest result from Corollary 1 is that there is no interior solution, only corner solutions. Therefore, an arbitrary θ-native will either prefer one extreme or the other: maxiuml immigration or no immigration.

7.2 *Median voter example*

A common way to resolve the heterogeneity in preferences among natives is to allow the median voter to determine the outcome.[55] Nothing in the analysis is specific to using the median voter to determine outcomes, and any combination of preferences among percentiles could be used; the conclusions are unchanged. It is necessary, however, to select a rule for weighting the varying preferences of different members of society.[56]

The median native's preference for immigration depends on β. If β is very high, so that the median native owns very little capital, the preference is for no immigration. If β is very low, the preference is for maximum immigration. Under reasonable parameterizations, the no-immigration solution is the one preferred by the median voter, which is close to the actual situation in the US today where the stock of immigrants in the US is less than 1% of the world's 7.7 billion people.

Consider an example using a special case of CES, the Cobb-Douglas production $f(K,L) = L^{\alpha}K^{(1-\alpha)}$ for $\alpha > 0$ and $G(\theta) = \theta$ for $0 \leq \theta \leq 1$. The median individual maximizes $R(.5, L_1) + W(.5, L_1)$, as a function of β, the skewness of capital ownership. The maximum amount of labor in the world in this illustration is 525. There are 50 US natives and 1,000 potential immigrants (similar to the proportion in the US relative to the world's population) but because the expectation of θ in both populations is ½, maximum L_1, which adjusts for quality, is $\frac{1050}{2} = 525$. Capital benefits and labor loses as immigration increases. In panel (a) of Figure 1,

[55] If G is uniform, the median voter is the person of ability θ_{med} such that $G(\theta_{med}) = 0.5$.

[56] There is a cluster of papers that consider the political economy of aspects of immigration in greater detail. Benhabib (1996) is an early analysis that postulates that natives will have different immigration preferences based on their wealth level, as we assume here, and solves for the optimal immigration policy under majority voting. Dolmas and Huffman (2004) considers the joint problem of immigration policy and redistributive tax policy, as immigrants will vote on future tax policy. Razin, Sadka, and Swagel (2002) considers how taxes affect migration, and finds that because migrants pay taxes, low skilled immigration can lead to lower taxes and lower redistribution. These papers are broadly consistent with our analysis of capital and labor tension over immigration, though they go into more detail on the specific political economy mechanisms than we do.

$\beta = 10$. When β is that high, the median gets about 1/1000 as much of the capital returns as the top capital owner. Because the median receives so little income from capital, the primary concern regards the wage part of income, which falls monotonically in L_1 for all values of L_1 below the world's population. Thus, with $\beta = 10$, capital income is too unimportant to induce the median to prefer the corner of maximum immigration over the corner of zero immigration.

The other extreme is shown in panel (b). There, $\beta = 0$, which means that every native gets a per capita share of the total payout to capital. When $\beta = 0$, the median prefers the corner of maximum immigration. In this case, the gains from returns to capital are the same for all persons and the positive effect of immigration on capital income dominates the negative wage effect.

The more informative case is one with $\beta = 4.85$, which implies that if the top capital owners (with $\theta = 1$) owned \$10 million in capital, the median voter would own about \$350,000. This is shown in panel (c), in which β is chosen so that both corner solutions, maximum and zero immigration, yield the same income to the median voter. Because $.5^{4.85} = .035$, the median voter would need to own 3.5% of the capital stock to make her indifferent between zero and maximum immigration. Any less than that and the median prefers no immigrants.

The result is intuitive. It is unrealistic to expect the median voter, who owns a small share of total capital, to favor wage-lowering immigration. Note that the median native prefers that more capital comes into the destination country, which is the opposite of that preferred by capital. Because the median's capital ownership is low, bringing in more capital—which lowers native capital's return—has only minor negative effects on the median's income. The loss is swamped by the positive effects of more capital on wages. The introduction of more capital lowers the return natives receive on their capital, but the capital raises the productivity of labor, thereby raising wages. In this example, increasing capital by 50% while leaving labor unchanged increases the median's total income by about 13%, even though the capital component of the median's income falls. The reverse is true of natives who receive most of their income from capital.

The unevenness of capital ownership creates a tension between the richest natives and those closer to the median. Because of the adverse consequences to wages and because the median native receives the majority of income in wages, middle wage earners prefer the corner solution of zero immigration, which is approximately where the US is today relative to the number of immigrants the US could have were it to open its borders. The richest members of society, with $\theta = 1$, are in the opposite situation. They receive the majority of their income from capital, meaning that they care more about how immigration affects the returns to capital than they do about how immigration affects wages.

As discussed earlier, during the 19th century the US had open immigration. What was different? Government transfers, s, were lower, but even absent any transfers, in this example, the median still prefers zero immigration. It is possible that capital ownership was more evenly distributed during earlier centuries, particularly when the primary source of capital ownership (the family farm and agriculture) benefited from a steady flow of labor. The existence of indentured servitude, which brought in labor from abroad, suggests that there may be some validity to this hypothesis.[57]

7.3 *Cross-country differences in immigration policies*

Some countries and time periods are more welcoming to immigrants than others. But at any point in time, countries differ on immigration rules and the number and composition of those admitted.

One major reason the desired number of immigrants differs between countries relates to the distribution of capital ownership. Income inequality, at least in the upper tail of the distribution, is likely to relate to capital ownership rather than to human capital. The US is likely a high β country, in that the ownership of capital is highly concentrated. As such, the model predicts that a few Americans want high immigrant flows to improve the value of their capital. Most, who own little of the capital stock, prefer no immigration. In countries with more equal income distributions, capital is likely to be distributed more evenly, implying a lower β. The prediction is that the median voter in a low β country is more likely to favor immigration.

Although the logic is indirect, the implication is that countries with high inequality, measured by the Gini coefficient, would admit fewer immigrants as a proportion of the population than low-inequality countries. Table 2 lists 21 of the top 25 countries defined by

[57] An alternative is that the median voter mechanism used to close the model here was less appropriate in earlier times. Before universal suffrage, it is quite possible that the rich played a greater role in determining immigration policy—and because of the disproportionate ownership of capital, they pushed open immigration, which enhanced the capital portion of their incomes.

having the largest number of immigrants in the population. Only 19 had data on current immigrant flows and on the Gini coefficient. A regression shown in Table 3 of the number of immigrants admitted per year as a proportion of the population on the Gini coefficient yields a statistically significant negative coefficient. More unequal countries accept fewer immigrants relative to the size of their population, as the theory suggests.

Of course, it is possible that the Gini coefficient picks up a general taste for immigration among the entire population, not merely the preferences of the median voter that come from capital ownership. It could be that societies with less income disparity are also more open to immigration. Sweden (not included in Table 2), which has low inequality and an explicit policy of offering asylum to a large number of refugees, is an obvious case in point. Detailed information on the distribution of capital ownership within these countries might help disentangle the two explanations.

Selling visas can resolve this tension between capital and labor identified here. The government could redistribute the revenue generated from the visa sales to native labor that suffers from increased immigration. Since the government collects the visa fees on entry, the ex-ante fee will not distort effort and investment decisions of immigrants, unlike taxation. This redistribution would be welfare improving because native labor would then encourage the skilled immigration that capital owners prefer, and the best immigrants would capture more surplus in their destination rather than home country.

8. Conclusion

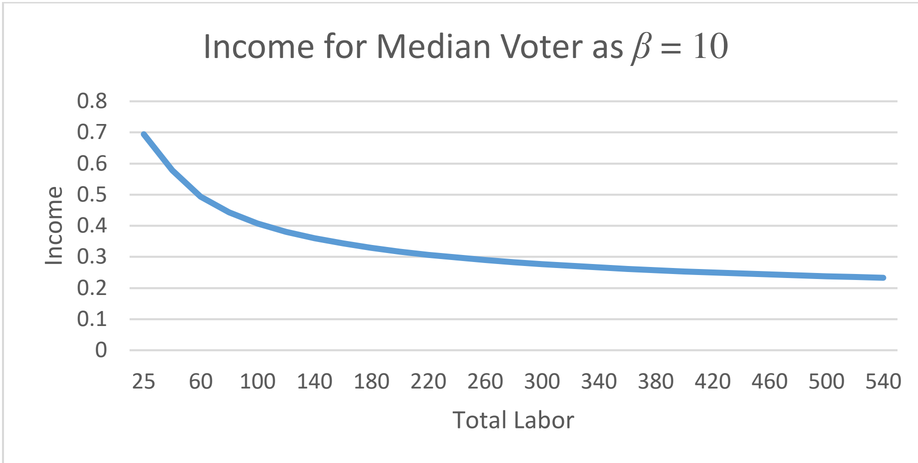
While actual immigration policies chosen by countries emerge organically through political processes, this paper argues, based on economic principles, what an optimal immigration policy should be. We formulate the problem as assignment between a high-productivity and low-productivity country. In such a model, our result on the optimal level of immigration depends on whether the winners of immigration in an economy can compensate the losers. If they can, efficiency requires a high amount of immigration. If they cannot, we would expect to see little to no immigration, provided that the median voter receives a sufficient portion of his income through labor rather than capital. Market mechanisms are effective ways of inducing these optimal immigration policies and are often superior to government rationing, which are the traditional methods used globally aside from small Golden Visa programs. We calibrate an optimal immigration price, whereby the destination country is able to price as both a monopolist and a competitive firm. Selling visas can reduce conflict between capital and labor on immigration, as the revenues generated can compensate native labor that suffers from increased immigration.

Future research can extend this analysis in several ways. First, taxation is assumed to be proportional to the immigrant's output. It would be possible to allow the tax rate to depend on ability θ, which would correspond more closely to the progressive tax system that characterizes most destination countries. Second, immigrants of a given ability may produce a different amount in the destination country than a native of that ability. It is likely that there are adjustment costs and that immigrants will be under-placed relative to their ability. Third, political considerations could be modeled more explicitly. For instance, Democrats might favor one origin country and Republicans another because of historical patterns of voting by new citizens who originate in those countries; tension between political parties over immigration rules and number of immigrants often reflect concerns over changing the future electorate. Fourth, immigrants may have other preferences that differ from those of the native population. Knowing that, the native population might resist immigration because they fear the changing character of the country. This form of nativism may be part of the reason why high levels of immigration are opposed by many.[58] Fifth, it would be worthwhile to consider illegal immigration and how setting a price for entry would encourage or deter more illegal immigration.[59] Finally, the per-person transfer is assumed to be the same for all, but immigrants, in part because of laws restricting their eligibility, may receive less than the typical transfer amount. These questions would be fruitful avenues for further research in this important area.

[58] See Lazear (1999) for a discussion of assimilation and imposing native culture and language, efficiently or inefficiently, on immigrant groups.
[59] We do not consider the problem of illegal immigration, which has its own literature, such as Ethier (1986); Grossman (1984); and Hillman and Weiss (1999). In particular, Djajić and Vinogradova (2019) examines how various policy instruments affect illegal immigration, with the deportation rate more effective than border controls and employer sanctions. We leave for future work a comprehensive analysis of optimal illegal immigration and implementation through prices or rationing.

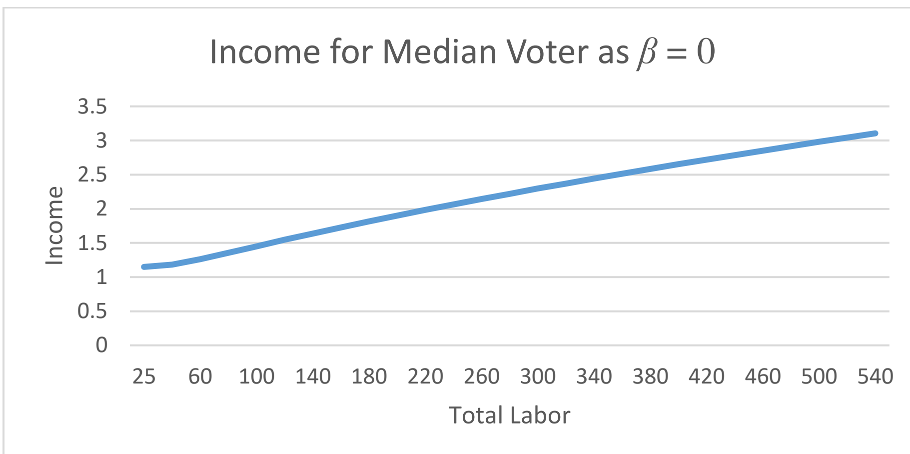
Figure 1

a.



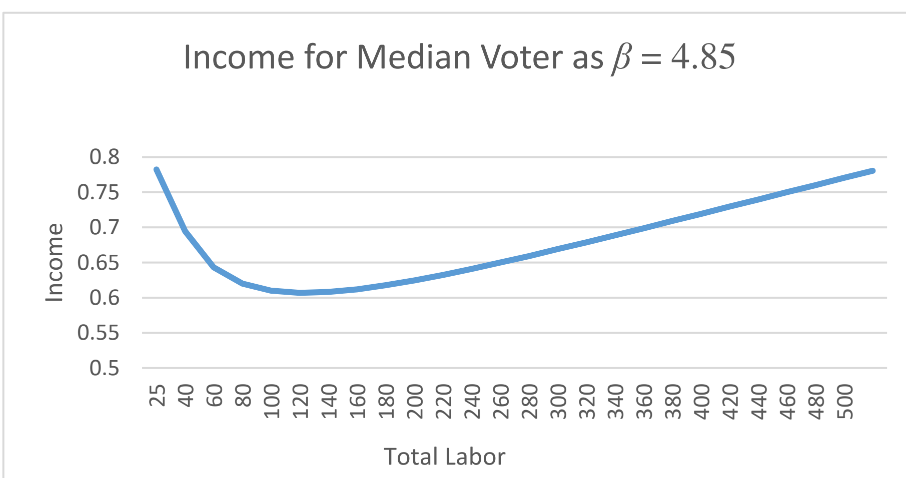
Income for Median Voter as $\beta = 10$
Income
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
25 60 100 140 180 220 260 300 340 380 420 460 500 540
Total Labor

b.



Income for Median Voter as $\beta = 0$
Income
3.5
3
2.5
2
1.5
1
0.5
0
25 60 100 140 180 220 260 300 340 380 420 460 500 540
Total Labor

c.



Income for Median Voter as $\beta = 4.85$
Income
0.8
0.75
0.7
0.65
0.6
0.55
0.5
25 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500
Total Labor

Appendix

PROOF OF PROPOSITION 1: Assume the opposite. Then $\theta_n = 1$ and $N_i = 0$ so (11) becomes

$$tv\left[N_{US}\int_0^1 \theta g(\theta)d\theta\right] \geq N_{US}s + D. \tag{36}$$

Because $D > 0$ and the integral is merely the unconditional expectation of θ, this implies that

$$tv > \frac{s}{E(\theta)}, \tag{37}$$

and because $E(\theta) < 1$, that $tv > s$, or $\frac{s}{tv} < 1$. But from (9), $\theta_n = \frac{s}{tv}$, which implies that $\theta_n < 1$. This contradicts the starting assumption that $\theta_n = 1$. QED.

PROOF OF PROPOSITION 2: Differentiating (22) with respect to price p gives

$$-\left[\left(p + tv\tilde{\theta} - s\right)g\left(\tilde{\theta}\right)\right]\frac{\partial\tilde{\theta}}{\partial p} + \int_{\tilde{\theta}}^{1} g(\theta)d\theta = 0, \tag{38}$$

where $\tilde{\theta} = \tilde{\theta}_M$. Rearranging the equation above yields

$$p_M = s + \frac{1 - G\left(\tilde{\theta}\right)}{g\left(\tilde{\theta}\right)}v(1-t) - tv\tilde{\theta}. \tag{39}$$

Recall from (19) that the potential migrant's threshold off a migrant's sorting decision is $\tilde{\theta}(p)$. Combining (19) and (39) gives

$$\tilde{\theta} = \frac{\left[u + c + \frac{1 - G\left(\tilde{\theta}\right)}{g\left(\tilde{\theta}\right)}v(1-t) - tv\tilde{\theta}\right]}{(1-t)v}, \tag{40}$$

or

$$\tilde{\theta} = \frac{1}{v}\left[u + c + \frac{1 - G\left(\tilde{\theta}\right)}{g\left(\tilde{\theta}\right)}v(1-t)\right]. \tag{41}$$

Using the definition of θ_s and substituting into (41) yields

$$= \theta_s + \left\{\frac{1 - G\left(\tilde{\theta}\right)}{g\left(\tilde{\theta}\right)}(1-t)\right\}, \tag{42}$$

where the second equality follows from the definition of θ_s given by (8). Since the second term in braces is positive, $\tilde{\theta} > \theta_s$. QED.

PROOF OF PROPOSITION 3: As long as there are multiple equally attractive destination countries, no country can charge a price that yields positive surplus on an immigrant or a rival country could attract all potential immigrants by lowering the price until all rents are driven to zero. Thus, defining $\tilde{\theta} = \tilde{\theta}(p)$, each destination country's payoff charges a price p that satisfies the zero-profit condition.

$$\int_{\tilde{\theta}}^{1}(p + tv\theta - s)g(\theta)d\theta = 0. \tag{43}$$

Separating terms and rearranging gives

$$(p-s)\left[1-G(\tilde{\theta})\right]+tv\int_{\tilde{\theta}}^{1}\theta g(\theta)d\theta=0\,. \tag{44}$$

Dividing the equation by $1-G(\tilde{\theta})$ gives

$$p-s+tv\int_{\tilde{\theta}}^{1}\theta g\left(\theta|\theta>\tilde{\theta}\right)d\theta=0\,. \tag{45}$$

Solving this for price gives

$$p_c\equiv s-tvE\left[\theta|\theta>\tilde{\theta}(p_c)\right]. \tag{46}$$

To show that this price induces more than the optimal amount of immigration, assume the opposite—namely, that $\tilde{\theta}(p_c)\geq\theta_s$, which would imply fewer immigrants with the competitive price than is socially optimal. Then from (19) and (8),

$$\tilde{\theta}(p_c)=\frac{u+c-s+p_c}{(1-t)v}\geq\frac{u+c}{v}=\theta_s, \tag{47}$$

or $p_c\geq s-t(u+c)$. So from (46),

$$s-tvE\left[\theta|\theta>\tilde{\theta}(p_c)\right]\geq s-t(u+c). \tag{48}$$

Rearranging,

$$\theta_s\equiv\frac{u+c}{v}\geq E\left[\theta|\theta>\tilde{\theta}(p_c)\right]>\tilde{\theta}(p_c), \tag{49}$$

which contradicts the supposition that $\tilde{\theta}(p_c)\geq\theta_s$, implying that $\tilde{\theta}(p_c)<\theta_s$. QED.

PROOF OF PROPOSITION 4: Let $p(\theta)$ be the pricing function for any given θ. The payoff for a migrant type θ is

$$U(\theta)\equiv s+(1-t)v\theta-c-p(\theta). \tag{50}$$

Set $p(\theta)$ to make each potential immigrant indifferent between remaining in the home country and migrating to the destination country, then

$$p(\theta)=s+(1-t)v\theta-c-u. \tag{51}$$

The profit for the country on any given migrant of type θ is

$$\pi(\theta)\equiv p(\theta)+tv\theta-s=v\theta-c-u. \tag{52}$$

The destination country implicitly sets a minimum threshold θ_{pd}, by charging a price $p(\theta)>s-(1-t)v\theta-u$ for $\theta<\theta_{pd}$ to preclude anyone with $\theta<\theta_{pd}$ from purchasing a slot. Then think of part of the destination country's pricing process as choosing θ_{pd} to solve with the first-order condition

$$\max_{\theta_{pd}} \int_{\theta_{pd}}^{1} \pi(\theta)g(\theta)d\theta \tag{53}$$

$$\pi(\theta_{pd})g(\theta_{pd}) = 0. \tag{54}$$

Substituting (52) into (54) yields

$$\theta_{pd} = \frac{u+c}{v} = \theta_s. \tag{55}$$

QED.

PROOF OF PROPOSITION 5: Now, $v(x) = vx$, and $v'(x) = v$. Since $g(\theta)$ is a uniform distribution, $g(\theta)$ is constant and $\int_0^1 g(\theta)d\theta = 1$. So, we have $g(\theta) = 1$. Therefore:

$$\int_x^1 \theta g(\theta)d\theta = \int_x^1 \theta d\theta = \frac{1-x^2}{2}. \tag{56}$$

The social planner's optimal threshold is

$$\theta_s = \frac{u + c + \frac{v'(\theta_s)}{g(\theta_s)}\int_{\theta_s}^1 \theta g(\theta)d\theta}{v(\theta_s)}. \tag{57}$$

Plugging $v(x) = vx$ and (56) into (57) gives:

$$\theta_s = \frac{u + c + v\cdot\frac{1-\theta_s^2}{2}}{v\theta_s}. \tag{58}$$

Solving (10) for θ_s gives:

$$\theta_s = \sqrt{\frac{2(u+c)+v}{3v}}. \tag{59}$$

The migrant's optimal threshold is

$$\theta_m = \frac{u-s+c}{(1-t)v(\theta_m)}. \tag{60}$$

Plugging $v(x) = vx$ into (60) gives:

$$\theta_m = \frac{u-s+c}{(1-t)v\theta_m}. \tag{61}$$

Solving (61), we have:

$$\theta_m = \sqrt{\frac{u-s+c}{(1-t)v}}. \tag{62}$$

The native's optimal threshold is

$$\theta_n = \frac{s}{tv(\theta_n)} + \frac{v'(\theta_n)}{g(\theta_n)v(\theta_n)}\int_{\theta_n}^1 \theta g(\theta)d\theta. \tag{63}$$

Plugging $v(x) = vx$ and (56) into (63) gives:

$$\theta_n = \frac{s}{tv\theta_n} + \frac{v(1-\theta_n)}{v\theta_n}\frac{1+\theta_n}{2}. \tag{64}$$

Solving (64) gives:

$$\theta_n = \sqrt{\frac{2s+tv}{3tv}}. \tag{65}$$

If a destination country offers a price, p, the induced threshold is:

$$\tilde{\theta}(p) = \frac{u+c-s+p}{(1-t)v\left(\tilde{\theta}(p)\right)}. \tag{66}$$

Plugging $v(\theta) = v\theta$ into (66) gives

$$\tilde{\theta}(p) = \frac{u+c-s+p}{(1-t)v\tilde{\theta}(p)}. \tag{67}$$

So, we have:

$$\tilde{\theta}(p) = \sqrt{\frac{u+c-s+p}{(1-t)v}}. \tag{68}$$

Then we have:

$$\begin{aligned} \frac{\partial\tilde{\theta}(p)}{\partial p} &= \frac{1}{2\sqrt{\frac{u+c-s+p}{(1-t)v}}}\frac{1}{(1-t)v} \\ &= \frac{1}{2\sqrt{(u+c-s+p)(1-t)v}}. \end{aligned} \tag{69}$$

The monopolist setting a price p solves:

$$\max_p \int_{\tilde{\theta}_p}^{1} [p + tv\left(\tilde{\theta}(p)\right)\theta - s]g(\theta)d\theta. \tag{70}$$

Solving for optimal $p = p_M$:

$$\begin{aligned} p_M = s - tv\left(\tilde{\theta}(p)\right)\tilde{\theta}(p) + (1-t)\frac{1-G\left(\tilde{\theta}(p)\right)}{g\left(\tilde{\theta}(p)\right)}\left[\tilde{\theta}(p)v'\left(\tilde{\theta}(p)\right) + v\left(\tilde{\theta}(p)\right)\right] \\ + \frac{tv'\left(\tilde{\theta}(p)\right)}{g\left(\tilde{\theta}(p)\right)}\int_{\tilde{\theta}(p)}^{1}\theta g(\theta)d\theta. \end{aligned} \tag{71}$$

Plugging (8) and $G\left(\tilde{\theta}(p)\right) = \tilde{\theta}(p)$ into (71) gives:

$$\begin{aligned} p = s - tv\tilde{\theta}(p)\tilde{\theta}(p) + (1-t)\left(1-\tilde{\theta}(p)\right)\left[\tilde{\theta}(p)v + v\tilde{\theta}(p)\right] \\ + tv\frac{1-\left[\tilde{\theta}(p)\right]^2}{2}. \end{aligned} \tag{72}$$

Rearranging gives:

$$p_M = s + \frac{tv}{2} + 2v\tilde{\theta}(p_M)\big(1 - \tilde{\theta}(p_M) - t\big) + \frac{1}{2}tv\big[\tilde{\theta}(p_M)\big]^2 \qquad (73)$$

Plugging (68) into (73):

$$p = s + \frac{tv}{2} + 2v\sqrt{\frac{u+c-s+p}{(1-t)v}}\left(1 - \sqrt{\frac{u+c-s+p}{(1-t)v}} - t\right) + \frac{1}{2}tv\left(\sqrt{\frac{u+c-s+p}{(1-t)v}}\right)^2$$

$$= s + \frac{tv}{2} + 2v\sqrt{\frac{u+c-s+p}{(1-t)v}} - 2v\frac{u+c-s+p}{(1-t)v} - 2vt\sqrt{\frac{u+c-s+p}{(1-t)v}} + \frac{1}{2}tv\frac{u+c-s+p}{(1-t)v} \qquad (74)$$

$$= s + \frac{tv}{2} + 2v(1-t)\sqrt{\frac{u+c-s+p}{(1-t)v}} + u(\frac{1}{2}t - 2)\frac{u+c-s+p}{(1-t)v} \qquad (75)$$

$$= s + \frac{tv}{2} + 2\sqrt{v(1-t)(u+c-s+p)} + \frac{(t-4)(u+c-s+p)}{2(1-t)}. \qquad (76)$$

Let $x = u + c - s + p$, so $p = x - u - c + s$. Then we have:

$$x - u - c + s = s + \frac{tv}{2} + 2\sqrt{v(1-t)x} + \frac{t-4}{2}\frac{x}{1-t}. \qquad (77)$$

Rearranging (77) gives:

$$\left[\frac{t-4}{2(1-t)} - 1\right]x + 2\sqrt{v(1-t)x} + u + c - s + s + \frac{tv}{2} = 0 \qquad (78)$$

$$\frac{3(t-2)}{2(1-t)}x + 2\sqrt{v(1-t)x} + u + c + \frac{tv}{2} = 0. \qquad (79)$$

Multiply by $2(1-t)$

$$3(2-t)x - 4\sqrt{v(1-t)^3}\sqrt{x} - \left(u + c + \frac{tv}{2}\right)2(1-t) = 0 \qquad (80)$$

$$3(2-t)x - 4\sqrt{v(1-t)^3}\sqrt{x} - (2u + 2c + tv)(1-t) = 0. \qquad (81)$$

Use root function

$$\sqrt{x} = \frac{4\sqrt{v(1-t)^3} \pm \sqrt{16v(1-t)^3 + 12(2-t)(2u+2c+tv)(1-t)}}{6(2-t)} \qquad (82)$$

$$= \frac{2\sqrt{v(1-t)^3} \pm \sqrt{4v(1-t)^3 + 3(2-t)(2u+2c+tv)(1-t)}}{3(2-t)}. \qquad (83)$$

Since $\sqrt{x} > 0$

$$x = \frac{1}{9(2-t)^2}\{4v(1-t)^3 + 4v(1-t)^3 + 3(2-t)(2u+2c+tv)(1-t) + 4\sqrt{4v^2(1-t)^6 + 3v(2-t)(2u+2c+tv)(1-t)^4}\} \quad (84)$$

$$= \frac{1}{9(2-t)^2}\{8v(1-t)^3 + 3(2-t)(2u+2c+tv)(1-t) + 4\sqrt{v(1-t)^4\,(4(1-t)^2v + 3(2-t)(2u+2c+tv))}\} \quad (85)$$

$$= \frac{1-t}{9(2-t)^2}\{8v(1-t)^2 + 3(2-t)(2u+2c+tv) + 4(1-t)\sqrt{v[4(1-t)^2v + 3(2-t)(2u+2c+tv)]}\}. \quad (86)$$

Since $x = u + c - s + p$, we can solve for p_M

$$p_M = s - u - c + \frac{1-t}{9(2-t)^2}\{8v(1-t)^2 + 3(2-t)(2u+2c+tv) + 4(1-t)\sqrt{4(1-t)^2v^2 + 3v(2-t)(2u+2c+tv)}\}. \quad (87)$$

A competitive firm will set a price p_c that satisfies:

$$\int_{\tilde{\theta}(p)}^{1}\left(p_c + tv\left(\tilde{\theta}(p)\right))\theta - s\right)g(\theta)d\theta = 0. \quad (88)$$

Rewriting this becomes:

$$(p_c - s)\left(1 - G\left(\tilde{\theta}(p)\right)\right) + tv\left(\tilde{\theta}(p)\right)\int_{\tilde{\theta}(p)}^{1}\theta g(\theta)d\theta = 0. \quad (89)$$

Plugging $G(x) = x$ and (56) into (77):

$$(p_c - s)\left(1 - \tilde{\theta}(p)\right) + tv\tilde{\theta}(p)\frac{1 - \left[\tilde{\theta}(p)\right]^2}{2} = 0. \quad (90)$$

Rearranging gives:

$$p_c = s - \frac{1}{2}tv\tilde{\theta}(p)\left(1 + \tilde{\theta}(p)\right). \quad (91)$$

Plugging (65) in gives:

$$p_c = s - \frac{1}{2}tv\sqrt{\frac{u+c-s+p_c}{(1-t)v}}\left(1 + \sqrt{\frac{u+c-s+p_c}{(1-t)v}}\right). \quad (92)$$

Add $(u + c - s)$ to both sides:

$$u + c - s + p_c = u + c - \frac{1}{2}tv\sqrt{\frac{u+c-s+p_c}{(1-t)v}}\left(1 + \sqrt{\frac{u+c-s+p_c}{(1-t)v}}\right). \quad (93)$$

Multiply $\frac{1}{(1-t)v}$ to both sides:

$$\frac{u+c-s+p_c}{(1-t)v}=\frac{u+c-\frac{1}{2}tv\sqrt{\frac{u+c-s+p_c}{(1-t)v}}\left(1+\sqrt{\frac{u+c-s+p_c}{(1-t)v}}\right)}{(1-t)v}. \quad (94)$$

Let $x=\frac{u+c-s+p_c}{(1-t)v}$, we have:

$$x=\frac{u+c-\frac{1}{2}tv\sqrt{x}\left(1+\sqrt{x}\right)}{(1-t)v}. \quad (95)$$

Rearranging gives:

$$\frac{(2-t)v}{2}x+\frac{tv}{2}\sqrt{x}=u+c. \quad (96)$$

Let $y=\sqrt{x}$, we have:

$$\frac{(2-t)v}{2}y^2+\frac{tv}{2}y=u+c. \quad (97)$$

According to the root function of the quadratic equation of one known $(a\beta^2+b\beta+c=0)$:

$$\beta=\frac{-b\pm\sqrt{b^2-4ac}}{2a}, \quad (98)$$

where $y=\beta$, $a=\frac{(2-t)v}{2}$, $b=\frac{tv}{2}$, $c=-(u+c)$.

So, we can solve for y:

$$y=\frac{-\frac{tv}{2}\pm\sqrt{\left(\frac{tv}{2}\right)^2-4\frac{(2-t)v}{2}(-u-c)}}{2\frac{(2-t)v}{2}} \quad (99)$$

$$=\frac{-\frac{tv}{2}\pm\sqrt{\frac{t^2v^2}{4}+2(2-t)v(u+c)}}{(2-t)v}. \quad (100)$$

Since $y=\sqrt{x}>0$,

$$y=\frac{-\frac{tv}{2}+\sqrt{\frac{t^2v^2}{4}+2(2-t)v(u+c)}}{(2-t)v}=\sqrt{x}. \quad (101)$$

Then, x can be obtained:

$$x=\left[\frac{-\frac{tv}{2}+\sqrt{\frac{t^2v^2}{4}+2(2-t)v(u+c)}}{(2-t)v}\right]^2 \quad (102)$$

$$=\frac{\frac{t^2v^2}{4}+\frac{t^2v^2}{4}+2(2-t)v(u+c)-tv\sqrt{\frac{t^2v^2}{4}+2(2-t)v(u+c)}}{(2-t)^2v^2} \quad (103)$$

$$=\frac{t^2v^2+4(2-t)v(u+c)-2tv\sqrt{\frac{t^2v^2}{4}+2(2-t)v(u+c)}}{2(2-t)^2v^2}. \quad (104)$$

Since $x=\frac{u+c-s+p}{(1-t)v}$, and plugging it into the equation, we have:

$$\frac{u+c-s+p}{(1-t)v} = \frac{t^2v^2 + 4(2-t)v(u+c) - 2tv\sqrt{\frac{t^2v^2}{4} + 2(2-t)v(u+c)}}{2(2-t)^2v^2}. \tag{105}$$

Multiply $(1-t)v$ by both sides:

$$u+c-s+p = \frac{(1-t)\left[t^2v^2 + 4(2-t)v(u+c) - 2tv\sqrt{\frac{t^2v^2}{4} + 2(2-t)v(u+c)}\right]}{2(2-t)^2v}. \tag{106}$$

Then, p_c can be solved:

$$p_c = s-u-c+\frac{(1-t)\left[t^2v + 4(2-t)(u+c) - 2t\sqrt{\frac{t^2v^2}{4} + 2(2-t)v(u+c)}\right]}{2(2-t)^2}. \tag{107}$$

Simplify:

$$p_c = s-u-c+\frac{(1-t)\left[t^2v + 4(2-t)(u+c) - t\sqrt{t^2v^2 + 8(2-t)v(u+c)}\right]}{2(2-t)^2}. \tag{108}$$

QED.

PROOF OF PROPOSITION *6*: Therefore, the solution to this program leads to the following result: Recall that the amount of labor imported into the country as a function of the threshold $\theta_{n^*}(\theta)$ is

$$L_1 = N_{US}\int_0^1 \theta dG + N_I\int_{\theta_{n^*}(\theta)}^1 \theta dG. \tag{109}$$

Observe that there is a one-to-one (inverse) relationship between $\theta_{n^*}(\theta)$ and L_1. Formulate the problem in terms of L_1.

The economy is subject to a production function $f(K,L)$. The optimal amounts of capital and labor are given by

$$\max_{K,L} f(K,L) - wL - rK, \tag{110}$$

where w and r are the prices for labor and capital, respectively. The total wage and capital expense is, therefore,

$$wL = (f_L)L \tag{111}$$

$$rK = (f_K)K. \tag{112}$$

The first constraint is that the total amount of wage payments must equal the total wage bill:

$$N_{US}\int_0^1 W(\theta, L_1)dG + N_I\int_{\theta_{n^*}}^1 W(\theta, L_1)dG \tag{113}$$

$$= N_{US}\int_0^1 \lambda(L_1)\theta dG + N_I\int_{\theta_{n^*}}^1 \lambda(L_1)\theta dG \tag{114}$$

$$= \lambda(L_1)\left[N_{US}\int_0^1 \theta\, dG + N_I\int_{\theta_n}^1 \theta dG\right] = wL_1. \tag{115}$$

Inserting (109) and (111) for $L = L_1$, we can write this as $\lambda(L_1) = f_L(K, L_1)$. The marginal product of labor equals $\lambda(L_1)$. Given that production is concave in labor, we have

$$\lambda'(L_1) = f_{LL}(K, L_1) < 0. \tag{116}$$

Similarly, the payments to all natives who receive capital must equal the total payments to capital:

$$N_{US} \int_0^1 \theta^\beta \gamma(L_1) dG = rK. \tag{117}$$

Let $Z \equiv \int_0^1 \theta^\beta dG$. Inserting (112), we can write this as

$$\gamma(L_1) = \frac{f_K(K, L_1)K}{ZN_{US}} > 0. \tag{118}$$

Because of complementarity between capital and labor, $f_{KL} > 0$, so

$$\gamma'(L_1) = \frac{f_{KL}(K, L_1)K}{ZN_{US}} > 0. \tag{119}$$

From equations (116) and (119), we see that as immigration (L_1) increases, the returns to capital increase, but the returns to labor decrease. The individual of type θ maximizes his wage and capital income. Let $\overline{L_1} \equiv (N_{US} + N_I)\bar{\theta}$ be the upper bound for L_1, which occurs when $\theta_{n^*}(\theta) = 0$. Therefore, he chooses L_1 to maximize $EU(\theta, L_1)$, or

$$\max_{L_1 \in [0, \overline{L_1}]} W(\theta, L_1) + R(\theta, L_1). \tag{120}$$

Recall that

$$W(\theta, L_1) = \theta\lambda(L_1) \tag{121}$$

$$R(\theta, L_1) = \theta^\beta \gamma(L_1). \tag{122}$$

Substituting in equations (121) and (122) into (120) and differentiating,

$$\theta\lambda'(L_1) + \theta^\beta \gamma'(L_1) = 0. \tag{123}$$

Plugging in equations (116) and (119), this becomes

$$\theta f_{LL}(K, L_1) + \left(\frac{\theta^\beta}{Z}\right) f_{KL}(K, L_1)k = 0, \tag{FOC}$$

where $k \equiv \frac{K}{N_{US}}$. The second-order condition is

$$\theta f_{LLL}(K, L_I) + \left(\frac{\theta^\beta}{Z}\right) f_{KLL}(K, L_I)k < 0. \tag{SOC}$$

Differentiate the first-order condition with respect to β:

$$\frac{d}{d\beta}\left(\frac{\theta^\beta}{Z}\right) f_{KL}(K, L)k. \tag{124}$$

This is positive if

$$\frac{d}{d\beta}\left(\frac{\theta^\beta}{Z}\right) = \frac{Z(\ln\theta)\theta^\beta - \theta^\beta(\int_0^1 (\ln\theta)\theta^\beta dG)}{Z^2} > 0, \tag{125}$$

or if

$$\theta > \exp\left(\frac{1}{Z}\int_0^1 (\ln\theta)\,\theta^\beta dG\right). \tag{126}$$

By the implicit function theorem, $\frac{\partial L_1}{\partial\beta} > 0$ if θ is sufficiently high. Similarly, differentiate the first-order condition with respect to θ to get

$$f_{LL}(K, L_1) + \frac{\beta\theta^{\beta-1}}{Z} f_{KL}(K, L_1)k. \tag{127}$$

Observe that this expression is positive if

$$\theta > \left(\frac{-f_{LL}(K, L_1)}{f_{KL}(K, L_1)}\left(\frac{Z}{\beta k}\right)\right)^{\frac{1}{\beta-1}}. \tag{128}$$

By the implicit function theorem, $\frac{\partial L_1}{\partial\theta} > 0$ if θ is sufficiently high. Since L_1 and $\theta_{n^*}(\theta)$ vary inversely, this means $\frac{\partial\theta_{n^*}(\theta)}{\partial\beta} < 0$ and $\frac{\partial\theta_{n^*}(\theta)}{\partial\theta} < 0$ if θ is sufficiently high.

QED

LEMMA 1: The L_1 that satisfies (FOC) is a local min of the objective function.

PROOF OF LEMMA 1: Wish to show (SOC) fails when $\rho < 1$, or

$$\theta f_{LLL} + \left[\frac{\theta^\beta K}{ZN_{US}}\right] f_{KLL} > 0 \text{ when } \rho < 1. \tag{129}$$

Inserting expressions for f_{LLL} and f_{KLL},

$$\theta\left[-K^\rho L^{\rho-3}ab(aK^\rho + bL^\rho)^{\frac{1}{\rho}-3}(\rho-1)(2aK^\rho + bL^\rho - a\rho K^\rho + b\rho L^\rho)\right] + \left[\frac{\theta^\beta K}{ZN_{US}}\right]\left[K^{\rho-1}L^{\rho-2}ab(aK^\rho + bL^\rho)^{\frac{1}{\rho}-3}(\rho-1)(aK^\rho - a\rho K^\rho + b\rho L^\rho)\right] > 0. \tag{130}$$

Move to the other side and cancel terms that are always positive:

$$\theta[-K^\rho L^{\rho-3}(\rho-1)(2aK^\rho + bL^\rho - a\rho K^\rho + b\rho L^\rho)] > -\left[\frac{\theta^\beta K}{ZN_{US}}\right][K^{\rho-1}L^{\rho-2}(\rho-1)(aK^\rho - a\rho K^\rho + b\rho L^\rho)]. \tag{131}$$

This becomes

$$\theta[-K^\rho L^{\rho-3}(\rho-1)(2aK^\rho + bL^\rho - a\rho K^\rho + b\rho L^\rho)] > -\left[\frac{\theta^\beta K}{ZN_{US}}\right][K^{\rho-1}L^{\rho-2}(\rho-1)(aK^\rho - a\rho K^\rho + b\rho L^\rho)]. \tag{132}$$

Combine K's and cancel:

$$\theta[-L^{\rho-3}(\rho-1)(2aK^\rho + bL^\rho - a\rho K^\rho + b\rho L^\rho)] > -\left[\frac{\theta^\beta}{ZN_{US}}\right][L^{\rho-2}(\rho-1)(aK^\rho - a\rho K^\rho + b\rho L^\rho)]. \tag{133}$$

Rewriting,

$$-\theta[L^{\rho-3}(\rho-1)(2aK^\rho + bL^\rho - a\rho K^\rho + b\rho L^\rho)] > \tag{134}$$

$$-\left[\frac{\theta^{\beta}}{ZN_{US}}\right][L^{\rho-2}(\rho-1)(aK^{\rho}-a\rho K^{\rho}+b\rho L^{\rho})].$$

Rewrite $L^{\rho-2}$ as $L^{\rho-3}L$. Thus,

$$-\theta[(\rho-1)(2aK^{\rho}+bL^{\rho}-a\rho K^{\rho}+b\rho L^{\rho})]> \\ -\left[\frac{\theta^{\beta}}{ZN_{US}}\right][L(\rho-1)(aK^{\rho}-a\rho K^{\rho}+b\rho L^{\rho})]. \tag{135}$$

Cancel L^{p-3}:

$$-\theta(\rho-1)(2aK^{\rho}+bL^{\rho}-a\rho K^{\rho}+b\rho L^{\rho})> \\ -\left[\frac{\theta^{\beta}}{ZN_{US}}\right][L(\rho-1)(aK^{\rho}-a\rho K^{\rho}+b\rho L^{\rho})]. \tag{136}$$

Factor and divide by θ:

$$-(\rho-1)[aK^{\rho}(2-\rho)+bL^{\rho}(1+\rho)]> \\ -\left[\frac{\theta^{\beta-1}}{ZN_{US}}\right][L(\rho-1)\{aK^{\rho}(1-\rho)+b\rho L^{\rho}\}]. \tag{137}$$

Move back to the other side,

$$-(\rho-1)[aK^{\rho}(2-\rho)+bL^{\rho}(1+\rho)] \\ +\left[\frac{\theta^{\beta-1}}{ZN_{US}}\right][L(\rho-1)\{aK^{\rho}(1-\rho)+b\rho L^{\rho}\}]>0. \tag{138}$$

Substituting FOC: $L=ZN_{US}\theta^{1-\beta}$, we have

$$-(\rho-1)[aK^{\rho}(2-\rho)+bL^{\rho}(1+\rho)]+[(\rho-1)\{aK^{\rho}(1-\rho)+b\rho L^{\rho}\}]>0. \tag{139}$$

Simplifying,

$$-(\rho-1)[aK^{\rho}(2-\rho)+bL^{\rho}(1+\rho)]+(\rho-1)\{aK^{\rho}(1-\rho)+b\rho L^{\rho}\}>0. \tag{140}$$

Expanding the interior,

$$-(\rho-1)[2aK^{\rho}-a\rho K^{\rho}+bL^{\rho}+b\rho L^{\rho}]+(\rho-1)\{aK^{\rho}-a\rho K^{\rho}+b\rho L^{\rho}\}>0. \tag{141}$$

Expanding again,

$$[-3a\rho K^{\rho}+2aK^{\rho}+bL^{\rho}]+[2a\rho K^{\rho}-b\rho L^{\rho}-aK^{\rho}]>0. \tag{142}$$

Combine like terms to get

$$-a\rho K^{\rho}+aK^{\rho}+bL^{\rho}-b\rho L^{\rho}>0. \tag{143}$$

Factoring,

$$aK^{\rho}(1-\rho)+bL^{\rho}(1-\rho)>0, \tag{144}$$

which holds for $\rho<1$. QED.

PROOF OF COROLLARY 1: Let $M\equiv aK^{\rho}+bL^{\rho}$. Then $f(K,L)=M^{\frac{1}{\rho}}$. Observe that the derivatives of this production function are

$$f_L=\frac{1}{\rho}M^{\left(\frac{1}{\rho}-1\right)}[b\rho L^{\rho-1}]=M^{\frac{1}{\rho}-1}bL^{\rho-1} \tag{145}$$

$$f_K = \frac{1}{\rho} M^{\left(\frac{1}{\rho}-1\right)} [a\rho K^{\rho-1}] = M^{\frac{1}{\rho}-1} aK^{\rho-1} \tag{146}$$

$$f_{KL} = \left(\frac{1}{\rho} - 1\right) M^{\left(\frac{1}{\rho}-2\right)} (b\rho L^{\rho-1}) aK^{\rho-1} \tag{147}$$

$$= (1-\rho) M^{\frac{1-2\rho}{\rho}} bL^{\rho-1} aK^{\rho-1} \tag{148}$$

$$f_{LL} = b\left[\left(\frac{1}{\rho} - 1\right) M^{\frac{1}{\rho}-2} (b\rho L^{\rho-1}) L^{\rho-1} + M^{\frac{1}{\rho}-1} (\rho - 1) L^{\rho-2}\right] \tag{149}$$

$$= b\left[(1-\rho) M^{\frac{1}{\rho}-2} bL^{2\rho-2} + M^{\frac{1}{\rho}-1} (\rho-1) L^{\rho-2}\right] \tag{150}$$

$$= b(1-\rho)\left[bM^{\frac{1}{\rho}-2} L^{2\rho-2} - M^{\frac{1}{\rho}-1} L^{\rho-2}\right] \tag{151}$$

$$\begin{aligned} f_{KLL} = (1-\rho)(b)(aK^{\rho-1}) \Big[(\rho-1) L^{\rho-2} (aK^\rho + bL^\rho)^{\frac{1}{\rho}-2} \\ + L^{\rho-1}\left(\frac{1}{\rho} - 2\right)(aK^\rho + bL^\rho)^{\frac{1}{\rho}-3} (b\rho L^{\rho-1})\Big] \end{aligned} \tag{152}$$

$$\begin{aligned} f_{LLL} = b(1-\rho)\Big[-(\rho-2) L_1^{\rho-3} \left(aK^\rho + bL_1^\rho\right)^{\frac{1}{\rho}-1} + \left(-L_1^{\rho-2}\right)\left(\frac{1}{\rho} - 1\right)\left(aK^\rho + bL_1^\rho\right)^{\frac{1}{\rho}-2} \left(b\rho L_1^{\rho-1}\right) \\ + b(2\rho-2) L^{2\rho-3} \left(aK^\rho + bL_1^\rho\right)^{\frac{1}{\rho}-2} + bL_1^{2\rho-2}\left(\frac{1}{\rho} - 2\right)\left(aK^\rho + bL_1^\rho\right)^{\frac{1}{\rho}-3} \left(b\rho L_1^{\rho-1}\right)\Big]. \end{aligned} \tag{153}$$

Plugging into the first-order condition generates

$$0 = \theta\left\{b(1-\rho)\left[bM^{\frac{1}{\rho}-2} L^{2\rho-2} - M^{\frac{1}{\rho}-1} L^{\rho-2}\right]\right\} + \frac{\theta^\beta K}{ZN_{US}} [(1-\rho) M^{\frac{1-2\rho}{\rho}} bL^{\rho-1} aK^{\rho-1}. \tag{FOC}$$

Rearranging and simplifying, the unique L_1 that satisfies (FOC) is

$$L_1^* \equiv ZN_{US} \theta^{1-\beta}. \tag{154}$$

Substituting the first-order condition into the (SOC) and simplifying,

$$\begin{aligned} \left[-(\rho-2) L_1^{\rho-3} M + bL_1^{2\rho-3} (\rho-1) + b(2\rho-2) L_1^{2\rho-3} + \frac{b^2 L_1^{3\rho-3} (1-2\rho)}{M}\right] \\ < -\left[\frac{\theta^{\beta-1} K^\rho}{ZN_{US}}\right]\left\{(\rho-1) L_1^{\rho-2} + \frac{L^{2\rho-2} (1-2\rho) b}{M}\right\}. \end{aligned} \tag{SOC}$$

Now, the marginal product $\mathrm{MP}_L \equiv f_L$, so

$$\mathrm{MP}_L' \equiv f_{LL} = b(1-\rho)\left[bM^{\frac{1}{\rho}-2} L^{2\rho-2} - M^{\frac{1}{\rho}-1} L^{\rho-2}\right]. \tag{155}$$

Now $bM^{\frac{1}{\rho}-2} L^{2\rho-2} < M^{\frac{1}{\rho}-1} L^{\rho-2}$ since $bL^\rho < M = aK^\rho + bL^\rho$. So $\mathrm{MP}_L' < 0$ if $\rho < 1$. Similarly,

$$\mathrm{MP}_K' \equiv f_{KK} = M^{\left(\frac{1}{\rho}-1\right)} a(\rho-1) K^{\rho-2} + \left(\frac{1}{\rho} - 1\right) M^{\left(\frac{1}{\rho}-2\right)} (a\rho K^{\rho-1}) aK^{\rho-1} \tag{156}$$

$$= M^{\frac{1}{\rho}-1} a(\rho-1) K^{\rho-2} - (\rho-1) M^{\frac{1}{\rho}-2} a^2 K^{2\rho-2} < 0, \tag{157}$$

iff

$$M^{\left(\frac{1}{\rho}-1\right)} (\rho-1) K^{\rho-2} < (\rho-1) M^{\left(\frac{1}{\rho}-2\right)} aK^{2\rho-2}, \tag{158}$$

iff $(\rho-1)M<(\rho-1)aK^{\rho}$. This holds iff $\rho<1$. Thus $\mathrm{MP}_K'<0$ if $\rho<1$. Now the average products are:

$$\mathrm{AP}_K=\frac{f(K,L)}{K}=\frac{M^{\frac{1}{\rho}}}{K} \tag{159}$$

$$A\mathrm{P}_k'=\frac{\partial A\mathrm{P}_K}{\partial K}=\frac{K\dfrac{1}{\rho}M^{\left(\frac{1}{\rho}-1\right)}(a\rho K^{\rho-1})-M^{\frac{1}{\rho}}}{K^2}<0, \tag{160}$$

iff $M^{\frac{1}{\rho}-1}aK^{\rho}<M^{\frac{1}{\rho}}$, iff $aK^{\rho}<M$, which always holds. And $A\mathrm{P}_L=\frac{M^{\frac{1}{\rho}}}{L}$, so

$$A\mathrm{P}_L'=\frac{L\dfrac{1}{\rho}M^{\left(\frac{1}{\rho}-1\right)}(b\rho L^{\rho-1})-M^{\frac{1}{\rho}}}{L^2}<0, \tag{161}$$

iff $M^{\frac{1}{\rho}-1}bL^{\rho}<M^{\frac{1}{\rho}}$, iff $bL^{\rho}<M$, which always holds. Now $M\mathrm{P}_i=f_L<A\mathrm{P}_L$ iff

$$M^{\frac{1}{\rho}-1}bL^{\rho-1}<\frac{M^{\frac{1}{\rho}}}{L}, \tag{162}$$

iff $bL^{\rho}<M$, which is always true. Similarly $\mathrm{MP}_K=f_K<A\mathrm{P}_K$ iff

$$M^{\frac{1}{\rho}-1}aK^{\rho-1}<\frac{M^{\frac{1}{\rho}}}{K}, \tag{163}$$

iff $aK^{\rho}<M$, which is always true.

For f to be concave, we require $\rho<1$. By Lemma 1, L_1^* from (154) that satisfies (FOC) and $\rho<1$ gives a local min, hence fails (SOC). L_1^* in (154) is unique, so there is no other L_1 that satisfies (FOC) and (SOC) for a local max. Because f is a smooth and continuous function, the max value over $[0,\overline{L_1}]$ must occur at either endpoint. Observe that there is a one-to-one, inverse relationship between the total amount of immigration labor, L_1, and the immigration threshold θ_{n^*}, governed by the equation

$$L_1^*=N_{US}\int_0^1\theta dG+N_I\int_{\theta_{n^*}}^1\theta dG. \tag{164}$$

Therefore, optimizing over immigration labor L_1 is equivalent to optimizing over the immigration threshold θ_{n^*}. Thus $L_1\epsilon\{0,\overline{L_1}\}$ iff $\theta_n^*(\theta)\epsilon\{0,1\}$. QED.

Table 1—Optimal Prices based on existing immigration flows to the U.S. in 2019

Country	Visas Issued	GNI per capita ($)	Airfare ($)	Optimal Price ($)	Revenue ($MM)
Argentina	3,753	11,130	391	86,025	323
Australia	3,823	55,100	898	62,870	240
Belgium	765	48,030	254	66,989	51
Belize	817	4,480	211	89,428	73
Bolivia	1,425	3,520	556	89,731	128
Brazil	19,607	9,130	352	87,046	1,707
Bulgaria	1,697	9,570	448	86,778	147
Chile	1,817	15,010	300	84,116	153
China	60,029	10,410	699	86,231	5,176
Colombia	18,715	6,510	171	88,441	1,655
Costa Rica	2,466	11,700	127	85,871	212
Cuba	39,580	7,480	274	87,908	3,479
Czechoslovakia	1,200	21,940	333	80,573	97
Denmark	467	63,950	249	58,453	27
Dominican Republic	49,815	8,080	159	87,666	4,367
Ecuador	11,189	6,090	337	88,567	991
Egypt	10,415	2,690	461	90,188	939
El Salvador	24,326	4,000	138	89,701	2,182
Ethiopia	10,109	850	661	90,994	920
Finland	523	50,010	537	65,785	34
France	5,009	42,450	258	69,943	350
Germany	5,276	48,580	503	66,564	351
Greece	1,537	19,750	333	81,692	126
Guatemala	13,111	4,610	140	89,398	1,172
Guyana	4,837	6,630	248	88,343	427
Haiti	16,991	1,330	154	91,008	1,546
Honduras	15,543	2,390	246	90,441	1,406
Hong Kong	2,377	50,800	620	65,319	155
Hungary	1,046	16,500	244	83,390	87
India	51,139	2,120	522	90,438	4,625
Iran	4,463	5,300	527	88,865	397
Ireland	1,912	64,000	184	58,461	112
Israel	4,702	43,110	370	69,535	327
Italy	4,072	34,530	262	74,099	302

Jamaica	21,337	5,320	212	89,011	1,899
Japan	4,897	41,710	539	70,185	344
Jordan	7,442	4,410	689	89,226	664
Korea	18,120	33,790	499	74,361	1,347
Liberia	3,419	580	938	90,991	311
Mexico	153,502	9,480	144	86,975	13,351
Morocco	3,659	3,190	419	89,962	329
Netherlands	1,348	53,100	327	64,247	87
New Zealand	979	42,760	1,151	69,307	68
Nicaragua	3,689	1,890	578	90,524	334
Norway	349	82,500	258	48,322	17
Panama	1,135	14,950	281	84,156	96
Paraguay	435	5,520	618	88,711	39
Peru	9,873	6,740	183	88,321	872
Philippines	43,478	3,850	581	89,556	3,894
Poland	4,561	15,350	368	83,910	383
Portugal	959	23,200	256	79,967	77
Romania	2,532	12,630	390	85,271	216
Russia	10,006	11,260	209	86,051	861
South Africa	3,337	6,040	663	88,430	295
Spain	3,465	30,390	165	76,304	264
Suriname	149	5,420	467	88,835	13
Sweden	1096	55,780	294	62,830	69
Switzerland	730	85,500	189	46,707	34
Syria	1708	1,820	no data	91,578	156
Taiwan	5770	no data	562	--	--
Turkey	9135	9,690	341	86,771	793
United Kingdom	12951	42,220	262	70,062	907
Uruguay	1063	16,230	737	83,277	89
Venezuela	15159	13,080	465	85,007	1,289
Vietnam	38944	2,590	651	90,143	3,511
Yugoslavia	5065	no data	349	--	--

Table 2: Immigration statistics for major destination countries

Country	International migrant population (2017)	Number of immigrants accepted per year	Immigrant acceptances as percent of population	GINI (2015)
Australia	7,036,000	530,000	2.1%	0.348
Canada	7,861,000	310,000	0.8%	0.336
France	7,903,000	220,000	0.3%	0.326
Germany	12,165,000	1,370,000	1.7%	0.315
Italy	5,907,000	310,000	0.5%	0.349
Jordan	3,234,000	45,000	0.5%	0.508
Kazakhstan	3,635,000	17,000	0.1%	0.446
Kuwait	3,123,000	58,000*	1.4%	N/A
Malaysia	2,704,000	100,000**	0.3%	0.461
Russia	11,652,000	400,000	0.3%	0.332
Saudi Arabia	12,185,000	470,000 $^{\gamma}$	1.4%	N/A
Singapore	2,623,000	40,000 $^{\beta}$	0.7%	0.401
South Africa	4,037,000	200,000 $^{\delta}$	0.3%	0.662
Spain	5,947,000	750,000	1.6%	0.365
Switzerland	2,506,000	140,000	1.6%	0.314
Thailand	3,589,000	240,000 $^{\alpha}$	0.3%	0.511
Turkey	4,882,000	460,000	0.6%	0.458
Ukraine	4,964,000	3,200	0.007%	0.425
United Arab Emirates	8,313,000	150,000 $^{£}$	1.6%	0.325 (2014)
United Kingdom	8,842,000	640,000	1%	0.333
United States	49,777,000	1,140,000	0.3%	0.409

* Average of yearly growth in residences granted for first time (excluding temporary residence) from 2016 to 2019
**Average growth of non-citizens from 2010 to 2019
$^{\gamma}$ Non-Saudi population change between 2017 and 2016
$^{\beta}$ Average growth in resident and non-resident populations from 2010 to 2019
$^{\delta}$ According to the 2011 South African census, "there were just over 2,1 [*sic*] million international migrants in 2011…Just less than half of international migrants (47%) entered South Africa recently between 2006 and 2011, bearing in mind that Census only asked about their last move into South Africa" (Statistics South Africa, 2011). 47% of 2.1 million is 987,000, which averaged over 5 years becomes a little less than 200,000
$^{\alpha}$ According to the 2019 Thailand Migration Report, "the non-Thai population in the country now stands at an estimated 4.9 million, a substantial increase from 3.7 million in 2014" (United Nations Thematic Working Group on Migration in Thailand, 2019). The difference between the two averaged over 5 years is 240,000
$^{£}$ Average growth from 1995 to 2005 of non-Emirate population

Note: Immigration slot numbers (excluding Jordan, Kazakhstan, Russia, and the annotated estimates) are averages of the three most recent years rounded to the 10,000. The populations used in the third column are 2018 figures from the World Bank. The estimates were calculated when clear immigration numbers were not available and should be noted to be estimations rather than actual figures. Hong Kong, India, Iran, and Pakistan, though all major destination countries, could not be estimated because of recent negative net migration rates.
Sources: Migration Policy Institute; Migration Data Portal using OECD (2017) data; Immigration/Statistical offices for Australia, Canada, France, Germany, Italy, Kuwait, Malaysia, Saudi Arabia, Singapore, South Africa, Spain, Ukraine, United Arab Emirates, United Kingdom, and the United States; Prague Process; World Bank

Table 3—Regression of immigrant proportion on Gini coefficient: (weighted by population (2) and unweighted (1)).

	Dependent variable:	
	proportion of population	
	(1)	(2)
Gini2015	-0.037^{**}	-0.053^{***}
	(0.014)	(0.018)
Constant	0.022^{***}	0.032^{***}
	(0.006)	(0.007)
Observations	19	19
R^2	0.275	0.340
Adjusted R^2	0.233	0.302
Residual Std. Error (df = 17)	0.006	0.0005
F Statistic (df = 1; 17)	6.455^{**}	8.777^{***}
Note:	$^{*}p < 0.1^{**}p < 0.5^{***}p < 0.01$	

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