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Immigration quotas and skill upgrading

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Abstract

A reason why immigration policy is such a contended issue is that often immigrants end up obtaining the right to vote and, hence, may affect future policies. This paper offers a dynamic, general equilibrium model of immigration policy. In each period, a heterogeneously skilled population chooses an immigration policy by majority vote. Voters anticipate that immigration affects the skill premium and the skill composition of the electorate. The main insight is the existence of a trade-off between skill complementary immigration and the resulting shift in political power. I argue that a reasonably parameterized version of the model is consistent with the main features of US immigration.

JEL classification: F22; I2; J62
Keywords: Migration; Mobility; Skills; Political economy

1. Introduction

College graduation rates across cohorts in the US have grown substantially over the last century. The changing composition of the skills of the US population has created a demand for immigration to fill up unskilled jobs. In 2000, 21.6% of the (non-citizen) foreign-born workforce in the US was employed in services and 6.2% in farming, fishing or forestry.

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While, respectively, only 13.2% and 2.1% of US-born workers were employed in these sectors.[1]

Nevertheless, immigration policy remains a highly controversial topic. Some of the issues are common to discussions of trade policy and have to do with the unequal distribution of the benefits from immigration among the native population. One distinct feature of immigration policy is that often immigrants stay in the country and eventually gain voting rights, and hence the potential to influence future policies. This paper offers a dynamic, general equilibrium, political economy model of immigration policy. In the model, voters are aware that current immigration affects future immigration policy and, in the absence of immigration, the skills of the labor force improve over time (skill upgrading). I provide a simple characterization of the Markov perfect equilibria of the model.

The main insight of the analysis is that immigration poses a trade-off. In each period, the native population chooses the size and skills of immigration, from an exogenously given pool that contains a large quantity of both skilled and unskilled immigrants. Voters realize that immigration policy can be used to affect the skill premium. Each voter also notices that immigrants with complementary skills will vote against her in the future. When the political effects of immigration are important, immigration restrictions (quotas) arise endogenously. In this type of equilibrium, immigration flows are unskilled and their size is proportional to the rate of skill upgrading in the economy. Evidence is presented that, despite its simplicity, that a reasonably calibrated model captures the main features of US immigration.

This paper is closely related to several strands of literature. It contributes to the growing body of research that studies the political economy of immigration policy. In a way, the present work provides an extension of Benhabib (1996) to a dynamic setup where voters are foresighted and altruistic with their offspring. Other contributions to this literature include Dolmas and Huffman (2000, 2003).

My analysis complements the literature on the effects of immigration on dynamic competitive economies. In these models, immigration flows are exogenously given and economic agents adjust their labor supply and saving decisions. Some excellent contributions to this literature are Storesletten (2000), which investigates how to use immigration policy to maximize the derived fiscal gains, and Ben-Gad (2004a,b), which study the effects of immigration on the dynamics of capital accumulation and factor prices.

The model I present is also related to the recent literature on the dynamics of government. Krusell et al. (1997) and Krusell and Rios-Rull (1999) provide a framework for the analysis of foresighted voting in dynamic general equilibrium models, which requires the use of numerical methods. Hassler et al. (2002, 2003) provide an analytically tractable framework, which requires particular functional form assumptions on preferences and technology.

The dynamic considerations of voters in the present model are also present in models of franchise extension. Voters take into account that current decisions regarding immigration policy will affect the composition of the future electorate. Important contributions in this

[1] The figures are reported by Schmidley (2001), based on CPS data.

literature are Acemoglu and Robinson (2000), Lizzeri and Persico (2004) and Jack and Lagunoff (2003).

The plan of the paper is as follows. Section 2 presents the model, Section 3 characterizes the equilibrium, Section 4 explores the empirical implications of the model, and Section 5 offers a simple calibration exercise. Section 6 concludes and discusses promising venues of future research. Appendix A gathers all proofs.

2. The model

2.1. The economy

There are two skill levels in the economy. Low skill (unskilled) workers are indexed i=1 and high skill (skilled) workers are indexed i=2. Let $N_i(t)$ denote the number of *native* workers with skill level i. Correspondingly, $(N_1(t), N_2(t))$ is the distribution of skills of the native population at time t. Each agent lives for two periods. In the first period, childhood, her skill type is not yet determined and the agent makes no decisions. In entering the second period of life, adulthood, the agent draws her skill type, votes over immigration, in the labor markets, together with the recent immigrants, and has one child.

Production is undertaken by a competitive firm that hires both types of labor and transforms their services into a consumption good. The firm's technology is given by a continuous and differentiable constant returns to scale production function $F(L_1, L_2)$ that satisfies the following standard assumptions: $F_i>0$, $F_{ii}<0$, for i=1, 2, and $F_{12}>0$, that is both types of labor are complementary in production. Assume also that for any $T>0$, $F_2(T, T)\geq F_1(T, T)$, that is when the number of workers of each type is the same, the marginal product of skilled workers is higher than that of unskilled workers.

Agents' preferences depend on own consumption and on the welfare of their children. The utility derived from own consumption is described by $u(c)$, a continuous, strictly increasing and concave function. Agents are uncertain about the skill level of their children, which is stochastically determined, and discount their children's expected utility with a factor $\beta\in[0,1)$.

Workers inelastically supply one unit of labor. In contrast to unskilled workers, skilled workers have the choice to work (full time) either as skilled or as unskilled. This assumption will guarantee a non-negative skill premium in equilibrium. I shall say that the labor market is *stable* if no skilled worker is receiving less than an unskilled worker or than any other skilled worker. In addition, I assume that there are no bequests. As a result, agents maximize utility by consuming their labor income and can only affect their children's welfare through voting on immigration policy.

Immigrants are assumed to be adult when they arrive into the country. They participate in the labor markets on arrival and remain in the country thereafter. There is a large pool of potential immigrants, containing both skilled and unskilled immigrants. Immigrants face a settle down cost of $C>0$ that they need to pay out of their (first period) labor income; no previous savings or loans against future income are available. It follows that no (unskilled) immigrants are willing to enter the country unless the unskilled wage is sufficient to cover the settle down cost. This assumption will guarantee a bounded skill premium in equilibrium. Let $(I_1(t), I_2(t))$ denote the immigrants that join the economy at time t. The economy's labor supply is then given by

$$L_i(t) = N_i(t) + I_i(t), \text{ for } i = 1, 2.$$

It will be convenient to define the skilled-to-unskilled factor ratio *before* and *after* immigration, denoted respectively by

$$n_t = \frac{N_2(t)}{N_1(t)} \text{ and } k_t = \frac{L_2(t)}{L_1(t)}.$$

The first skilled ratio summarizes the skill distribution of the native population, while the second summarizes the skill distribution of the labor force, which includes native and immigrant workers.

The skill type of children, irrespective of the country of birth of their parents, is determined as follows. The child of an unskilled worker has a probability p of being skilled while, for simplicity, each skilled worker has a child of her own type with probability one. I shall assume $p<0.5$ so that skills are *positively correlated*, between parents and children (intergenerational persistence). Finally, the draws for the types of children are assumed to be independent across all agents.

Given period t's labor force, which includes natives and immigrants, period t+1's electorate (native population) is given by

$$\begin{aligned} N_1(t+1) &= (1-p)L_1(t) \\ N_2(t+1) &= pL_1(t) + L_2(t), \end{aligned}$$

where a law of large numbers has been invoked. Observe that there is no aggregate uncertainty in the economy since agents know the exact fraction of unskilled adults who will have skilled children. Additionally, p provides a measure of the rate of *skill upgrading* between two consecutive generations. It will be useful to define a mapping m from the current *after-immigration* skilled ratio, k_t, to next period's *before-immigration* skilled ratio, n_{t+1}. It is straightforward to show that for any $p<1/2$,

$$n_{t+1} = m(k_t; p) = \frac{p + k_t}{1 - p} \geq k_t.$$

We shall refer to m as the *skill upgrading mapping*. Define Φ as the factor ratio such that if $k_t=\Phi$, then $n_{t+1}=m(\Phi; p)=1$. I shall refer to Φ as the *tie factor ratio* and it is easy to show that $\Phi(p)=1-2p$.

2.2. Exogenous immigration

We are now ready to define an 'economic equilibrium', that is, a competitive equilibrium for a given sequence of immigration. In short, in every period, the consumers and the firm take optimal actions given prices and market clearing. Clearly, in any competitive equilibrium, agents' consumption levels are given by marginal products evaluated at the after-immigration factor ratios. Before stating this result more formally, let us define skilled ratio $\hat{k}$ by $F_1(1, \hat{k})=F_2(1, \hat{k})$, that is, the ratio at which the skill premium is zero.

Lemma 1. *Let immigration flows be exogenously given by* $\{(I_1(t), I_2(t))\}_{t=1}^{\infty}$ *and suppose that* $\frac{N_2(1)+I_2(1)}{N_1(1)+I_1(1)}<\hat{k}$, *that is the initial labor force is relatively unskilled. In any competitive equilibrium,* $\{n_t, k_t, c_1(t), c_2(t)\}_{t=1}^{\infty}$, *with a stable labor market:*

(i) in all periods,

$$n_t = \frac{N_2(t)}{N_1(t)} \text{ and } k_t = \frac{N_2(t)+I_2(t)}{N_1(t)+I_1(t)}.$$

(ii) For a finite number of periods, $c_i(t)=F_i(1, k_t)$, *for* $i=1, 2$. *Beyond that, consumption is given by* $c_1(t)=c_2(t)=F_1(1, \hat{k})$, *for* $i=1, 2$ *and* x_t *skilled workers perform unskilled jobs, where* x_t *is the solution to*

$$\frac{N_2(\mathrm{t})+I_2(\mathrm{t})-x_t}{N_\mathrm{t}(\mathrm{t})+I_1(\mathrm{t})+x_t} = \hat{k}.$$

The rest of the paper describes the dynamics of the economy when immigration is democratically chosen by the native population period after period.

2.3. Endogenous Immigration

Each generation of natives chooses an immigration policy by majority vote. In doing so, voters take into account that immigrants will affect current wages and that their children will be citizens with full voting rights. This section describes how voters form their preferences over immigration policies. I will assume that in ranking alternative policies voters are altruistic, foresighted and lack the ability to commit the votes of their offspring. Voters need to form beliefs about the future consequences of their current political choices. The current immigration policy affects utility through current wages, and hence, consumption. On top of that, current immigration policy affects the skill distribution of next period's electorate and, thus, future policies. As common in the literature, I shall restrict attention to Markov perfect equilibria where the state is the ratio of skilled to unskilled in the native population.[2]

2.3.1. The voter's problem

Let agents' beliefs be summarized by a triplet consisting of a state space, a policy rule and a law of motion, respectively, (Ω, K, Ψ). In any period, the state $\pi_t \in \Omega$ summarizes the skill distribution of the electorate, before choosing the contemporaneous immigration policy. Policy rule $K(\pi)$ denotes the skilled ratio in the labor force *after immigration* expected in future state π. This policy rule reflects the fact that voters only care about the

[2] See Hassler et al. (2002, 2003).

sequence of skilled-to-unskilled ratios in the labor force, rather than the actual sequence of immigration vectors. This follows from the assumptions of constant returns to scale in production, majority vote and only two types of voters. Finally, function Ψ maps pairs of current labor force skilled ratio and state into states one period ahead, that is $\pi_{t+1}=\Psi(k_t, \pi_t)$. Beliefs are equilibrium objects.

Let us describe the set of *feasible immigration policies*, or equivalently, skilled ratios in the labor force. Suppose that n_t is the current skilled ratio in the electorate and recall that the supply of immigrants of both types is assumed to be large relative to the size of the native population. What is the least skilled labor force that can be attained by means of immigration? As unskilled immigrants are admitted, the value of k_t falls and so does the marginal product of unskilled labor. Once the marginal product equals C, the settle down cost, no more unskilled immigrants are willing to enter the country. Hence, there is a lower bound on k_t, given by the solution to $F_1(k_a)=C$. Likewise, what is the most skilled labor force that can be attained by means of immigration? As skilled immigrants enter the economy, the skill premium shrinks. Recall that since skilled workers can also take on unskilled jobs, a lower bound on the skill premium (zero) and an upper bound on the marginal product of skilled labor is reached at $\hat{k}$, which can easily be shown to be larger than 1. I shall assume that the upper bound on feasible skilled ratios for the labor force is given by $k_b=\hat{k}$. The justification is as follows. Only an unskilled majority might want to choose k_b in equilibrium. Given that for skilled ratios above $\hat{k}$ the unskilled wage is constant, there is no incentive to attempt to reach a higher skilled ratio and if there were any cost of issuing visas to immigrants, $\hat{k}$ would dominate any higher skilled ratio.

The above arguments show that the set of feasible skilled ratios for the labor force in any given period (k_t) does not depend on the actual skilled ratio in the native population for that period (n_t). This observation, and the fact that there are only two types of voters, suggests restricting the analysis to a two-point *state space*:

$$\Omega = \{\pi_1, \pi_2\}. \tag{1}$$

If $\pi_t=\pi_i$, skill group i chooses immigration policy at time t. Define the *law of motion* for the state of the economy as follows:

$$\pi_1 + 1 = \Psi(k_t, \pi_t) = \begin{cases} \pi_1 \text{ if } k_t<\Phi \\ \pi_2 \text{ if } k_t>\Phi \\ \pi_1 \text{ if } k_t = \Phi \text{ and } \pi_t = \pi_1 \\ \pi_2 \text{ if } k_t = \Phi \text{ and } \pi_t = \pi_2 \end{cases}. \tag{2}$$

Essentially, immigration policy is chosen in each period by the group in the majority and if there is ever a tie, the group who made the last policy decision chooses the policy once again. It will be useful to define payoff functions $w_i(k)=u[F_i(1, k)]$, for i=1, 2. Observe that w_1 is an *increasing* function of k while w_2 *decreases* in k, and both are continuous.

To define voters' preferences over immigration policies, we shall proceed in two steps. First, we shall define the *value* that each type of worker assigns to *each* *state*. For a given policy rule K, let the value of state π to an i-type voter be given by[3]

$$V_i(\pi|K) = w_i(K(\pi)) + \beta E[V(\Psi(K(\pi),\pi))|i]. \tag{3}$$

We can now define the value of a current after-immigration skilled ratio. Given K, V_1 and V_2, let $W_i(x|\pi_i, K)$ denote the *value* of an immigration policy inducing a skilled ratio x to an agent of type i in state π_i. That is,

$$W_i(x|\pi_i, K) = w_i(x) + \beta E[V(\Psi(x,\pi_i))|i],$$

where notice that V_i is used to evaluate the future consequences of the current policy. We can now define each agent's utility-maximizing policy for a given policy rule.[4]

Definition. Let agent i's preferred policy given K be

$$x_i(\pi_i, K) = \arg\max\{W_i(x|\pi_i, K)\}\text{s.t.}\, x\in[k_a, k_b].$$

2.3.2. Politico-economic equilibrium

In equilibrium voters' beliefs are required to be correct. That is, if a voter believes that a type-i majority will impose a given policy, it must be the case that such a policy is utility-maximizing for i-type voters.

Definition. $X^*=(x_1^*, x_2^*)$ is said to be *an equilibrium policy rule if*

$$x_i(\pi_i, X^*) = x_i^*, \text{for } i = 1, 2.$$

It is straightforward to generate the equilibrium sequences of factor ratios, before and after immigration, for a given equilibrium policy rule $X^*=(x_1^*, x_2^*)$. Given initial state π_1^*, equilibrium sequence $\{k_t^*, n_t^*, \pi_t^*\}_{t=1}^{\infty}$ satisfies

$$k_t^* = \begin{cases} x_1^* \text{ if } \pi_t^* = \pi_1 \\ x_2^* \text{ if } \pi_t^* = \pi_2 \end{cases},$$

$$\pi_{t+1}^* = \Psi(k_t^*, \pi_t^*) \text{ and}$$

$$n_{t+1}^* = m(k_t^*; p).$$

[3] $E[V(\pi'|1]=(1-p)V_1(\pi')+pV_2(\pi')$ and $E[V(\pi')|2]=V_2(\pi')$.

[4] It follows from the assumptions that the argmax set in the definition is in fact a singleton. Note also that agent i's preferred policy in state π_j, for $j\neq i$, is irrelevant.

3. Equilibrium characterization

It is clear that voters' preferences over alternative immigration policies depend on the resolution of a *dynamic trade-off*. For a voter of a given type, admitting immigrants of the *other* type delivers a high level of current consumption. This policy, however, results in an increase in the political power of the *other* skill group. On top of that, unskilled voters' political preferences are affected by their children's prospects of upward mobility, as in Benabou and Ok (2001).

Some feasible policy choices are clearly dominated. Consider, for instance, the decision problem of an unskilled voter. Among all immigration policies that lead to a *skilled majority* in the next period, that generating the highest skilled ratio dominates all the rest; it yields the highest current consumption to unskilled workers. Similarly, among all immigration policies leading to an *unskilled majority*, that which generates the highest skilled ratio—that is, Φ—dominates all others. The following lemma formalizes this intuition.

Lemma 2. *Given state space $\Omega=\{\pi_1, \pi_2\}$, for any policy rule K, voters' preferred policies can only take the following values: $x_1(\pi_1, K)\in\{\Phi, k_b\}$ and $x_2(\pi_2, K)\in\{k_a, \Phi\}$.*

This lemma implies that there are only four candidate equilibrium policy rules: $K_0=(\Phi, \Phi)$, $K_1=(\Phi, k_1)$, $K_2=(k_\mathrm{b}, \Phi)$ and $K_c=(k_\mathrm{b}, k_\mathrm{a})$. I shall refer to the first three policy rules as *quota equilibria* and to the last one as the *cycle equilibrium*, for reasons that will become clear shortly.

Let us turn next to examine the main question of the paper: what is the equilibrium immigration policy for a given rate of skill upgrading?

3.1. Cycle equilibrium

Protectionism against international flows of goods and factors appears to have a cyclical pattern in history. The high levels of trade and international migration registered in the 19th century came to an abrupt end with the wave of protectionist policies of the 1920s and 1930s. Both trade and international migration remained very low until well after World War II. In contrast, we have witnessed impressive growth in both variables in the postwar period. The analysis of immigration policy in Benhabib (1996) suggests that cyclical behavior in immigration policy may be an inevitable outcome.[5]

As the next proposition demonstrates, cycles in immigration policy may be an equilibrium outcome in the present model. In this equilibrium, unskilled voters support k_b and skilled voters support k_a, which implies that the decision power alternates between the two skill types provided that $k_a<\Phi(p)<k_b$. Intuitively, this is the case when voters' decisions are dominated by short-run concerns.

[5] Borjas (1999), Martin and Midgley (2003) and Hanson et al. (2002) contain excellent and concise accounts of the history of American immigration policy. Goldin (1994) and Timmer and Williamson (1998) study immigration policy before World War II.

Proposition 1. *Suppose that $k_a<\Phi(p)<k_b$. In this case, $K_c=(k_b, k_a)$ is an equilibrium policy rule if and only if*

$$\begin{cases} w_2(k_a) - w_2(\Phi) \geq \beta[w_2(\Phi) - w_2(k_b)] \text{ and} \\ w_1(k_b) - w_1(\Phi) \geq \beta\left((1-p)[w_1(\Phi) - w_1(k_a)] + \dfrac{p}{1+\beta}[w_2(\Phi) - w_2(k_a)]\right) \end{cases}. \tag{4}$$

In both expressions, the left-hand side captures the net utility gains that each voter type could obtain by means of (complementary) immigration. In contrast, the right-hand side quantifies the expected discounted utility cost from *losing control over future policies* and engaging in a policy cycle. These conditions state that a cycle equilibrium requires both types of voters being willing to 'cooperate' in sustaining it. Note that when $\beta=0$ the two conditions are satisfied, essentially Benhabib's result of the inevitability of policy cycles. However, the previous proposition demonstrates that these political dynamics are possible *even when voters are altruistic and foresighted*. Later on, we shall explore the implications for immigration flows of this type of equilibrium.

Obviously, it is always the case that $\Phi=1-2p\leq k_b$ but, what is the equilibrium when $\Phi<k_a$, that is when the tie skilled ratio is not feasible? In that case, Lemma 2 implies that $x_1(\pi_1, K)=k_b$ and $x_2(\pi_2, K)=k_a$, irrespective of K. Trivially, in this case, one group is always in the majority and the only equilibrium policy rule is K_c. In what follows, I will assume that Φ is feasible.

3.2. Equilibrium with immigration quotas

Virtually, all rich countries impose limits (quotas) on immigration, sometimes setting different quotas for immigrants with different skill levels. As we shall now see, voters' dynamic political concerns can give rise to constraints on the size of immigration, which can be interpreted as quotas. In these equilibria, the group in the majority is willing to limit the amount of skill-complementary immigration (and thus forego present consumption) in order to *retain control over future policies*. Immigration restrictions arise in these equilibria and their size depends on the rate of skill upgrading in the economy. Consider, for instance, a situation where the unskilled majority wants to retain control over immigration policy indefinitely. Obviously, intergenerational skill upgrading requires admitting unskilled immigrants. In equilibrium, a limited amount of unskilled immigrants are admitted. Proposition 2 provides necessary and sufficient conditions for the existence of quota equilibria.

Proposition 2. *Suppose that $k_a<\Phi(p)<k_b$. The following conditions are necessary and sufficient for each type of equilibrium with quotas:*

(i) A skilled-majority equilibrium, $K_2=(k_b, \Phi)$, arises if and only if

$$w_2(k_a) - w_2(\Phi) \leq \beta[w_2(\Phi) - w_2(k_b)]. \tag{5}$$

(ii) An unskilled-majority equilibrium, $K_1=(\Phi, k_a)$, arises if and only

$$w_1(k_b) - w_1(\Phi) \leq \beta((1-p)[w_1(\Phi) - w_1(k_a)] + p[w_2(\Phi) - w_2(k_a)]). \tag{6}$$

(iii) There is no equilibrium with policy rule $K_0=(\Phi, \Phi)$.

First of all, observe that two types of equilibrium with quotas are possible, depending on the skill group that stays in office. In any quota equilibrium, it has to be the case that short-run gains from choosing a policy that delivers the highest current wage are offset by the costs of losing decision power over future policies. The rate of skill upgrading in the economy plays a double role in the evaluation of this trade-off: it determines the position of $\Phi(p)$ relative to k_a and k_b, and it affects the prospects of upward mobility of the children of unskilled voter.[6]

Quite interestingly, all quota equilibria share an identical immigration policy, *regardless* of the type who holds the majority. In these equilibria, *immigration is (mostly) unskilled*, in the sense that $k_t \leq n_t$, and the size of immigrant cohorts increases in the rate of skill upgrading. When there is a skilled majority, we can interpret this immigration policy as being the *maximum* unskilled immigration that the skilled majority can 'afford' without losing control over immigration policy. In contrast, when the majority is unskilled, it is the *minimum* unskilled immigration needed to 'replenish' the pool of unskilled voters and offset skill upgrading. Section 4 examines the empirical implications of both types of equilibria.

4. Empirical implications for immigration

The analysis so far suggests two alternative interpretations for changes in immigration policy. In a cycle equilibrium, immigration policy changes when there is a switch in the majority. In a quota equilibrium, shifts in immigration policy reflect changes in the rate of skill upgrading. These two approaches differ in their empirical implications along two dimensions: the characteristics of immigration flows and voters' views over immigration. This section compares the empirical implications of each equilibrium to US data.

4.1. Immigration flows

Consider measuring the size of immigration flows by the difference between the skilled ratios before and after immigration, that is, $\sigma_t=|n_t-k_t|$, and say that period t's immigration

[6] Observe also that, while the first equation in Proposition 2 is the opposite of the first equation in Proposition 1, that is not exactly the case for the second equation when $p>0$.

flow is *unskilled* if $n_t \geq k_t$, that is when the labor force (which includes immigrants) is less skilled than the native population.[7]

Likewise, I shall say that immigration was *skilled* in a given period if $n_t < k_t$. Recall from before that the skill upgrading (or mobility) mapping is given by

$$n_{t+1} = m(k_t; p) = \frac{k_t + p}{1 - p} \geq k_t.$$

In a cycle equilibrium, pair (n_t^*, k_t^*) alternates between $(m(k_a), k_b)$, which involves *skilled* immigration, and $(m(k_b), k_a)$, which involves *unskilled* immigration. Denote the size of immigration flows implied by $(m(k_a), k_b)$ by σ_2^c. Likewise, let σ_1^c be the size of immigration flows implied by pair $(m(k_b), k_a)$. Assuming positive skill upgrading (and Φ interior), it is easy to show that

$$k_a < m(k_a) < k_b < m(k_b),$$

implying that $\sigma_1 = m(k_b) - k_a > \sigma_2 = k_b - m(k_a)$.[8] That is, in a cycle equilibrium periods of large unskilled immigration alternate with periods of small skilled immigration. The reason for the asymmetry in the sizes of immigration flows in the two phases of the cycle is quite intuitive. When immigration policy is used to increase the skilled ratio, skill upgrading and immigration go in the same direction. When used to decrease the skilled ratio, immigration has to compensate for skill upgrading.

In contrast, in quota equilibria, immigrant flows are always unskilled and their size is given by $\sigma^q = n_t^* - k_t^* = 2p$, which increases in skill upgrading. Recall that immigration flows are identical in all equilibria with quotas.

4.2. Individual preferences over immigration

In a cycle equilibrium, unskilled voters' favorite policy is given by $x_1^* = k_b$ (highly skilled labor force) and skilled voters' is $x_2^* = k_a$ (low skilled labor force). Let us now consider the answer that voters would give to the question "Do you think immigration should be reduced, left unchanged or increased?" In addition, let us assume that the inflows of skilled voters are given and only unskilled immigration can be adjusted. In this case, skilled voters in a cycle equilibrium would support increasing immigration and unskilled voters would support reducing it.

Voters' preferences over immigration differ across quota equilibria. In an *unskilled-majority equilibrium*, $(x_1^*, x_2^*) = (\Phi, k_b)$, that is, unskilled voters want to maintain the level of immigration unchanged while skilled voters support increasing it. However, in a skilled-majority equilibrium, $(x_1^*, x_2^*) = (k_a, \Phi)$, that is, unskilled voters support reducing immigration and unskilled voters prefer leaving it unchanged. Note that the skilled-

[7] Implications for the levels of immigration can be derived by assuming that to go from n_t to k_t, voters unanimously agree to do so with the *minimum* total number of immigrants. For instance, this might be the case if it is costly to issue work permits. Then, to increase (decrease) the skilled ratio only skilled (unskilled) immigrants would be admitted. An *alternative* approach consists in taking as given the inflow of immigrants of one type and attain the desired ratio by adjusting the size of the immigration quota of the *other* type.

[8] Recall that $k_b \geq 1$ and Φ interior implies that $m(k_a) < 1$.

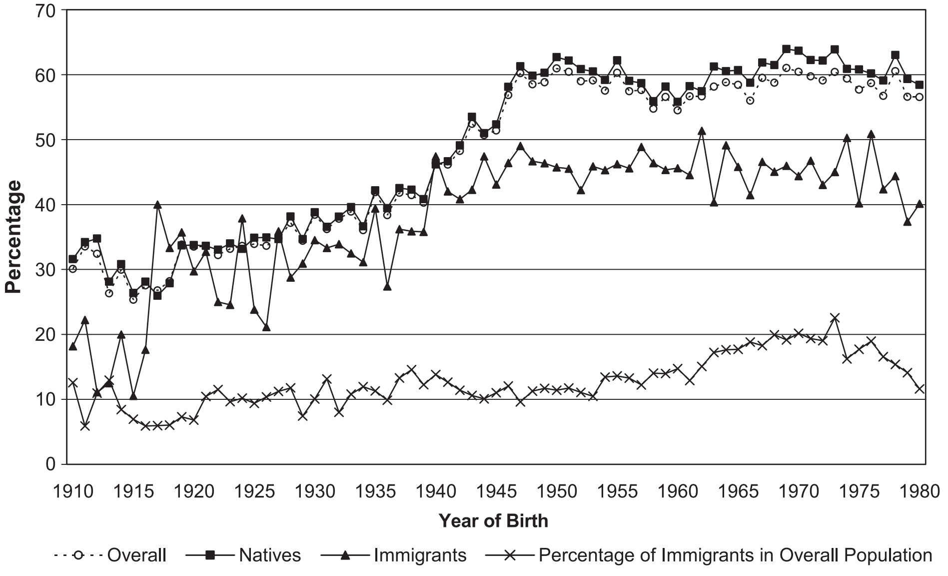

Fig. 1. College participation rates by year of birth (Carniero and Heckman, 2004).

majority equilibrium is the only equilibrium where both types of voters support restrictions on (unskilled) immigration.

4.3. The US immigration experience

4.3.1. Immigration flows

Let us now turn to data on the size and skills of immigrant flows in the US over the 20th century. Fig. 1 reproduces the calculations of Carneiro and Heckman (2004) based on the 2000 Current Population Survey. The figure plots college participation rates by nativity and year of birth from 1910 to 1980, as well as the fraction of the population who is foreign-born (immigrant).

Two features stand out. First, there has been a surge in immigration in the last five decades. More specifically, the fraction of immigrants in the population was fairly constant (around 10%) until birth cohort 1955. Then, it increased rapidly during the period 1955–1973, reaching 20% of the cohort.[9] Secondly, college attendance rates among the foreign-born have almost always been lower than for the US-born in the same birth cohort.[10] Up until 1944, the difference in college participation rates between the two groups remained

[9] Their data shows a *decline* in the share of the population that is foreign born for the cohorts born after 1973. This feature is at odds with other measurements of the size of US immigration (Hanson et al., 2002, Martin and Midgley, 2003). It simply reflects that many immigrants born in the 1970s probably entered the country only after year 2000. When this is taken into account, the share of immigration in the population continues on the upward trend.

[10] Exceptionally, this was not the case for the cohorts born in 1917–1919 and in 1924, which may reflect the exodus of highly qualified people from Europe to the US as a result of World War II.

small (less than 3 percentage points). But for the cohorts born since 1945, there has been a difference of over 10 percentage points. Data on high-school dropout rates by nativity and year of birth confirm this picture.

In summary, throughout the 70 years considered, immigration has been (mostly) unskilled and there has been a substantial increase in the size of (unskilled) immigration for the cohorts born after 1955.

4.3.2. Individual preferences over immigration

Scheve and Slaughter (2001) use individual-level survey data to analyze public opinion over immigration in the US. Their results are based on a question in the National Election Survey: "Do you think that, compared to current levels, immigration should be reduced a lot", reduced, left unchanged, increased or increased a lot? The main conclusion of the study is that low-education individuals are more likely to support immigration restrictions than highly educated individuals. Furthermore, their estimates reveal (and direct calculations from the National Election Survey confirm) that in fact most college-educated respondents *also* support immigration restrictions.

Combining all the evidence, the US immigration experience has been characterized by a long period of unskilled immigration (relative to the educational attainment of the native population) and both skilled and unskilled voters support immigration restrictions. One of the equilibrium above shares these features: the *skilled-majority quota equilibrium*. However, is this interpretation of the data consistent with the surge in immigration for the cohorts born after 1955?

4.3.3. The Second great migration

Borjas (1999) has labelled the wave of immigration in the last few decades as the Second Great Migration. Immigration experts tie the surge in immigration to the 1965 Amendments to the US immigration law. Despite its profound effects, what determined the policy change in 1965 remains unclear.[11]

The analysis above suggests an explanation. Suppose that the US economy was on a skilled-majority quota equilibrium and experienced. And now suppose that the economy experienced an increase in the rate of skill upgrading. In that case, we would expect an increase in unskilled immigration: the skilled majority could now "afford" to admit more unskilled immigrants and still retain control over future immigration policies.

Next, I construct estimates of skill upgrading over the period considered. Consider the fraction of skilled people in an age-30 cohort and in the cohort of the same age thirty years later.[12] The measure I propose is, roughly speaking, the *difference* between the skilled

[11] It has been argued that the suspension of the National Origins quotas by the 1965 Amendments was the result of the Civil Rights movement. Although the connection is very likely, the consolidation of the National Origins quotas effectively raised the number of unskilled immigrants that could be admitted, arguably benefiting skilled Americans.

[12] These are data on aggregates in the sense that it is not explicit how many, say, skilled children were born in unskilled families and how many in skilled families. Hence, the CPS can be used for these calculations.

fraction in a cohort and the skilled fraction in the cohort born 30 years before. Or, equivalently, the difference between the fraction of skilled in the age-30 cohort for a given year and the fraction of skilled in the age-60 cohort *measured in the same year*. More specifically, it will be helpful to measure skill upgrading using the *skill upgrading*

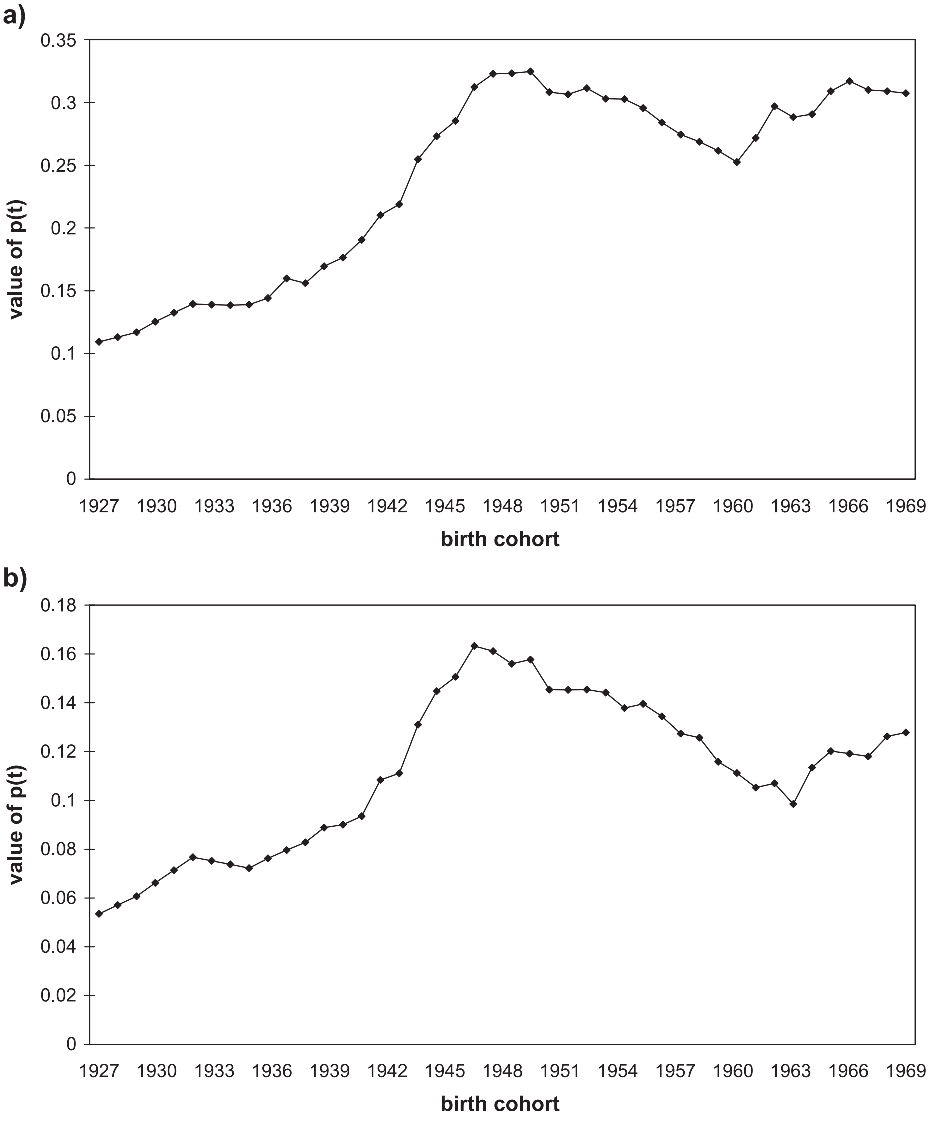

Fig. 2. (a) Skill upgrading in US labor force (skilled if some college, CPS 1957–2000). (b) Skill upgrading in US labor force (skilled if college degree, CPS 1957–2000).

mapping defined earlier. This function maps the after-immigration factor ratio in a given period, k_t, into next generation's pre-immigration factor ratio, n_{t+30}:[13]

$$n_{t+30} = m(k_t; p_t) = \frac{p_t + k_t}{1 - p_t}.$$

Clearly, given information on k_t and n_{t+30}, it is possible to back out p_t, the rate of skill upgrading at time t (or the degree of upward mobility experienced by the children of unskilled families when assuming that all skilled families have skilled children). It is easy to see that p_t is increasing in n_{t+30}, the skilled ratio of the age-30 cohort (the children), and decreasing in k_t, the skilled ratio of the age-60 cohort (the parents). Fig. 2a plots the rates of skill upgrading for the period 1927–1970, when taking as skilled workers those with at least some college education. As a robustness check, I also calculate $\{p_t\}$ taking as skilled workers those with a college degree (Fig. 2b).

Fig. 2a shows a steep increase in the rate of skill upgrading for the cohorts born between 1927 and 1947.[14] With the normalization in the model, the children from unskilled families in 1927 had a 10% probability of becoming skilled (that is, attending college). By 1951, that probability had increased by a factor of 3 and remained at that level thereafter.[15] In summary, the increase in skill upgrading illustrated by Fig. 2a and b is consistent with the explanation for the increase in (unskilled) immigration based on a skilled-majority quota equilibrium.

5. A simple calibration

The goal of this exercise is twofold. First, it offers an alternative approach to assess what is the "realistic" equilibrium for the US. In particular, I use estimates of the parameters from US data to check the existence conditions for each type of equilibrium. The second goal of the calibration exercise is to illustrate the connection between the rate of skill upgrading in the model and the resulting equilibrium.

5.1. Technology

Let us restrict to the family of constant returns to scale, CES production functions:

$$F(L_1, L_2) = A(L_1^\theta + L_2^\theta)^{\frac{1}{\theta}}$$

with $A>0$ and $\theta \in (-\infty, 1]$. Recall that the elasticity of substitution between the two inputs is given by $1/1-\theta$, and that for $\theta=1$, this is a constant returns to scale Cobb–Douglas

[13] Since we are going to use annual data from the Current Population Survey, it will be more convenient to change notation and denote next generation's pre-immigration factor ratio by n_{t+30} instead of n_{t+1}.

[14] To fix ideas, let us see how p_{1970} is constructed. Using the fraction of skilled of the age-30 and age-60 cohorts, say, in year 2000, we can obtain the skill upgrading rate (or upward mobility) experienced by the age-30 individuals who had been born in 1970.

[15] When using college graduate as the definition of skilled, the probability of becoming skilled doubled for the cohorts considered.

production function. Also observe that for all $\theta<1$, $F_{12}>0$ and $F_{22}<0$, consistent with the earlier assumptions on technology. The estimation of parameter θ has received a large attention in the literature on income inequality and technological change. Katz and Murphy (1992) report an estimate of 0.3, a smaller elasticity of substitution than Cobb–Douglas production functions. Krusell et al. (2000) estimate θ to be 0.4. I will set $\theta=0.35$.

I will set A to the value that makes the steady state unskilled hourly wage equal to 5 dollars, roughly the unskilled wage for young workers with little experience in 1990 (Heckman et al., 1998).[16] This value turns out to be 13.15.

5.2. Preferences

I will assume that the utility function is CRRA, that is, $u(c)=\frac{c^{1-\sigma}}{1-\sigma}$ with $\sigma=4$. And given that one period amounts to 40 years in the model, I shall take the discount factor to be $\beta=0.985^{40}=0.546$.

5.3. Feasible skilled-to-unskilled ratios

The technology above implies that the skill premium is

$$\frac{F_2(k)}{F_1(k)}=\left(\frac{1}{k}\right)^{1-\theta}.$$

Given that we assumed k_b to be the skilled ratio at which the skilled wage equals the unskilled wage, it follows that $k_b=1$. Let us turn now to parameter k_a. What is the lowest unskilled wage that can be reached by means of immigration? I will assume that this is given by the *minimum wage* in the US. One interpretation is that the settle down cost is roughly equal to the income earned by getting minimum wage during one period.[17] In the early 1990s, the minimum hourly wage was 4.25 dollars. Solving $F_1(k_a)=4.25$ yields $k_a=0.212$. Table 1 summarizes the values chosen for the calibration and Fig. 3a plots the wage functions for the calibrated production function over the set of feasible policies.

We shall now compute the equilibrium at skill upgrading rates ranging from 0 to 0.30. At each value of p, I evaluate the existence conditions for each type of equilibrium. Fig. 3b through 3d present the results.

Fig. 3b plots the existence conditions for the cycle equilibrium. Two lines are plotted, the incentive constraints for each type of voters. Specifically, I define

$$ic_1(p;K_c)=w_1(k_b)-w_1(\Phi)-\beta\left((1-p)[w_1(\Phi)-w_1(k_a)]+\frac{p}{1+\beta}[w_2(\Phi)-w_2(k_a)]\right) \tag{7}$$

$$ic_2(p;K_c)=w_2(k_a)-w_2(\Phi)-\beta[w_2(\Phi)-w_2(k_b)]. \tag{8}$$

[16] Recall that in steady state, the skilled ratio in the labor force is given by $F(p)=1\text{-}2p$. I will take $p=0.30$, roughly the value for cohorts born after 1945.

[17] Alternatively, we can interpret that if unskilled immigration were so high as to bring the equilibrium unskilled wage down to the minimum wage, social unrest would oppose further immigration.

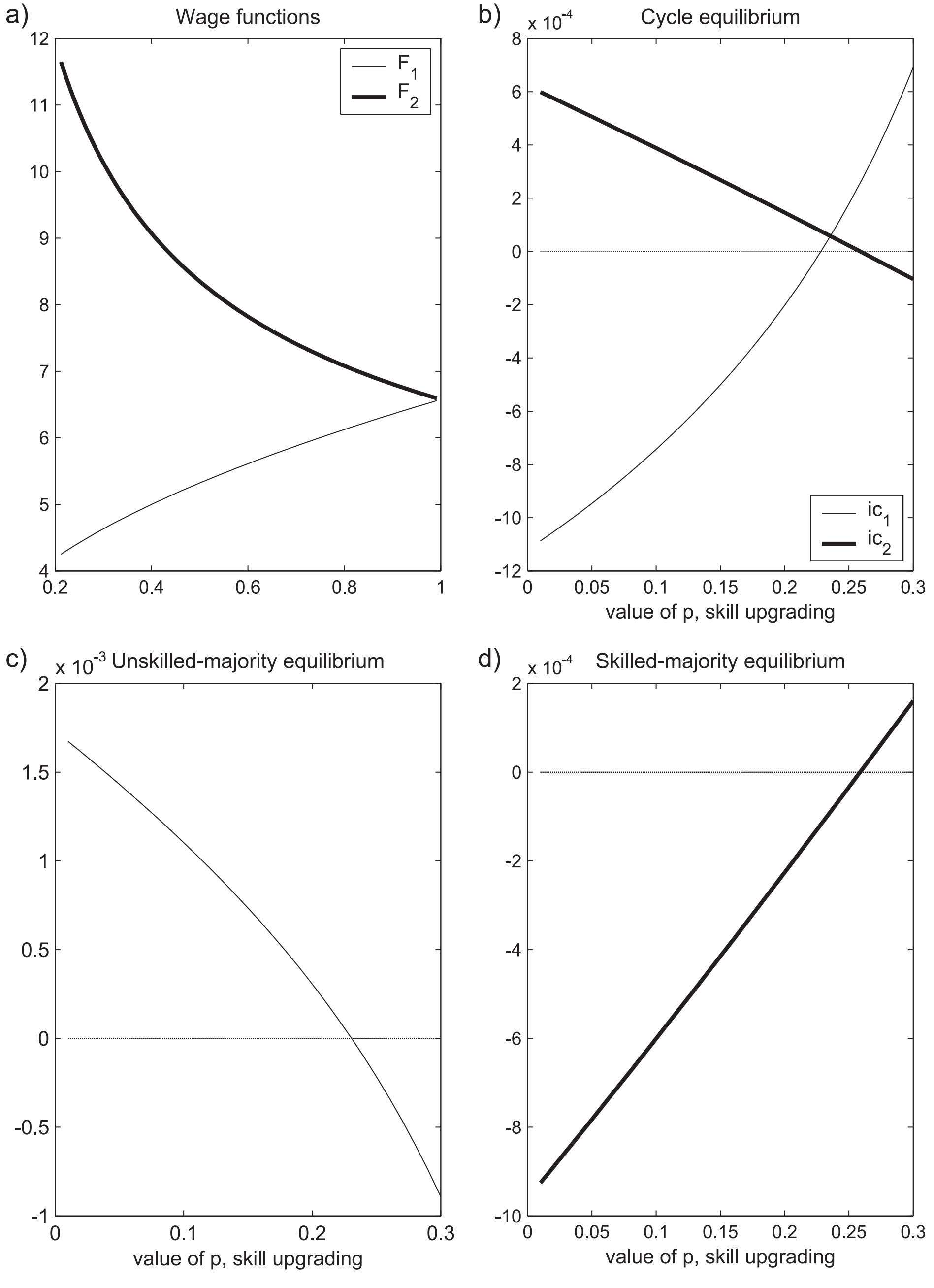

Fig. 3. Equilibrium in the calibrated model for different rates of skill upgrading. (a) Wage functions, (b) cycle equilibrium, (c) unskilled-majority equilibrium, (d) skilled-majority equilibrium.

Table 1
Calibrated parameters

θ	A	β	σ	k_a	ϕ	k_b
0.35	13.15	0.546	4	0.212	0.4	1

It follows from Proposition 1 that when both $ic_1(p, K_c)$ and $ic_2(p, K_c)$ are positive there exists a cycle equilibrium. Fig. 3c and d plots, respectively, the conditions for existence of the unskilled-majority equilibrium and the skilled-majority equilibrium:

$$ic_1(p;K_1) = \beta((1-p)[w_1(\Phi) - w_1(k_a)] + p[w_2(\Phi) - w_2(k_a)]) - w_1(k_b) + w_1(\Phi) \tag{9}$$

$$ic_2(p;K_2) = \beta[w_2(\Phi) - w_2(k_b)] - w_2(k_a) + w_2(\Phi) = -ic_2(p;K_c). \tag{10}$$

Again, positive values of the incentive constraints imply that an equilibrium of that type exists.[18] As the figures illustrate, for levels of skill upgrading below 0.23, the only equilibrium is the unskilled-majority quota equilibrium. Likewise, for values of p above 0.26, the only equilibrium is the skilled-majority quota equilibrium. This provides additional support for suggested interpretation of the US data. Finally, at intermediate values, p between 0.23 and 0.26, there is a cycle equilibrium.

6. Concluding remarks

I have presented a dynamic political economy model aimed at exploring the determinants of immigration policy in countries that face a large supply of potential immigrants. The main feature of the model is that voters face a trade-off between factor complementarity and the political effects of immigration. The dynamics of immigration policy depend on which of the two forces dominates. A reasonably calibrated version of the model shares many features of US immigration data. In particular, both in the model and in the data, there appears to be a positive relation between the rate of skill upgrading in the economy and the level of (unskilled) immigration.

The model is highly stylized and has the potential to be extended in a number of interesting directions. Throughout the paper, I have assumed that there is a large supply of immigrants of both types. This may be a reasonable assumption for small countries but in some cases it is unrealistic to assume that there are many skilled potential immigrants. Formally incorporating restrictions on the supply of immigrants requires a richer state variable, such as the fraction of skilled voters, which might yield more smooth dynamics. The extreme case where only unskilled immigrants are available is easily analyzed. In that case, the only equilibrium involves an unskilled majority. Intuitively, an unskilled majority

[18] Note that at no values of p can a skilled-majority equilibrium *and* a cycle equilibrium exist simultaneously. At low levels of p, the same is *roughly* true for the unskilled-majority equilibrium and the cycle equilibrium.

has the incentive to retain control over immigration policy because unskilled voters anticipate a large cost from losing control over policy. A skilled majority would substantially (and temporarily) raise the skill premium by admitting a large contingent of unskilled immigrants. In contrast, a skilled majority has no incentive to remain in power. There is no cost to opening the door to unskilled immigration. Even if the decision power over policy switches to the unskilled, the new (unskilled) majority cannot induce a lower skill premium since no skilled immigrants are available.

Another interesting extension consists of endogenizing skill acquisition. The model could then be used to study questions related to the educational attainment and the economic assimilation of second generation immigrants, a very important policy issue in many countries. Technically, the analysis would require enriching the optimization problems of workers. As long as the resulting model retains the feature of intergenerational persistence in skills, the main trade-off survives, suggesting that the main results might still hold. A large body of empirical work finds a substantial positive correlation between the education levels of parents and children. See, for instance, Keane and Wolpin (2001), Carneiro and Heckman (2004) and Ortega and Tanaka (2004).

Finally, a very promising research question involves the study of the interaction between immigration and the welfare state. In the present model, the only economic effects of immigration, as opposed to political effects, operate through changes in the skill premium. Some empirical work, however, finds little evidence that immigration affects wages. In that case, it would be interesting to study a situation where voters are mainly concerned about the effects of immigration on income redistribution. After all, a very widely spread view maintains that unskilled immigration leads to higher government spending and higher taxes, that is, to greater income redistribution. In such an environment, the complementarity gains for skilled natives from unskilled immigration might very well be offset by the increase in income redistribution from rich to poor. This is a very important policy issue that demands further research on the political economy of immigration.

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Appendix A. Proofs

Proof Lemma 1. Profit maximization, utility maximization and market clearing conditions at each period, together with constant returns to scale in production. □

Proof Lemma 2. Suppose we are in state π_1 and consider the value that an unskilled voter attaches to a feasible policy $x \in [k_a, k_b]$, that is $W_1(x; \pi_1, K)$. Suppose that at the given value of p, $\Phi(p)$ is not feasible, i.e. $\Phi(p) < k_a$ or $\Phi(p) > k_b$. This means that next period's state is independent of current policy x. Given that w_1 is an increasing function, it is obvious that $W_1(x;\pi_1,K)$ is also increasing in x. Therefore, $x_1(K)=\{k_b\}$. Suppose now that $\Phi(p)$ is feasible and pick any feasible policies x, x' such that $x<x'\leq\Phi$. Clearly, both policies imply the same state for the next period, namely π_1. Again given that w_1 is an increasing function we have $W_1(x;\pi_1,K)<W_1(x';\pi_1,K)$. Similarly, for any two feasible policies such that $\Phi<x<x'$, we have $W_1(x;\pi_1,K)<W_1(x';\pi_1,K)$. Therefore, the voter needs only compare policies Φ and k_b. As a result, for any K, $x_1(K)\in\{\Phi,k_b\}$. A symmetric argument shows the result for skilled voters. □

Proof Proposition 1. Let $K_c=(k_b,k_a)$ be the policy rule. Then, $X^*=K_c$ if and only if $W_1(\Phi;\pi_1,K_c)<W_1(k_b;\pi_1,K_c)$ and $W_2(k_a;\pi_2,K_c)>W_2(\Phi;\pi_2,K_c)$. Expanding these expressions using the policy rule and the law of motion yields

$$W_2(\Phi;\pi_2,K_c)=w_2(\Phi)+\beta V_2(\pi_2;K_c)$$

$$W_2(k_a;\pi_2,K_c)=V_2(\pi_2;K_c)$$

$$W_1(\Phi;\pi_1,K_c)=w_1(\Phi)+\beta[(1-p)V_1(\pi_1;K_c)+pV_2(\pi_1;K_c)]$$

$$W_1(k_b;\pi_1,K_c)=w_1(k_b)+\beta[(1-p)V_1(\pi_2;K_c)+pV_2(\pi_2;K_c)].$$

Thus,

$$W_2(k_a;\pi_2)-W_2(\Phi;\pi_2)=(1-\beta)V_2(\pi_2)-w_2(\Phi)\text{ and} \tag{11}$$

$$\begin{aligned}W_1(k_b;\pi_1)-W_1(\Phi;\pi_1)=w_1(k_b)-w_1(\Phi)+\beta\{(1-p)[V_1(\pi_2)-V_1(\pi_1)]\\+p[V_2(\pi_2)-V_2(\pi_1)]\},\end{aligned} \tag{12}$$

where the explicit dependence of V_i and W_i on K_c has been omitted just to simplify notation.

By combining the policy and the law of motion, we can derive the following system, which defines the value functions:

$$V_1(\pi_1)=w_1(k_b)+\beta[(1-p)V_1(\pi_2)+pV_2(\pi_2)]$$

$$V_1(\pi_2)=w_1(k_a)+\beta[(1-p)V_1(\pi_1)+pV_2(\pi_1)]$$

$$V_2(\pi_1)=w_2(k_b)+\beta V_2(\pi_2)$$

$$V_2(\pi_2)=w_2(k_a)+\beta V_2(\pi_1).$$

Combining the last two equations delivers

$$V_2(\pi_2) = \frac{w_2(k_a) + \beta w_2(k_b)}{1-\beta^2}$$

$$V_2(\pi_1) = \frac{w_2(k_b) + \beta w_2(k_a)}{1-\beta^2},$$

which in turn yields

$$V_2(\pi_2) - V_2(\pi_1) = \frac{w_2(k_a) - w_2(k_b)}{1+\beta} > 0. \tag{13}$$

Define $z{:=}V_1(\pi_1){-}V_1(\pi_2)$. The first two equations of the system can be combined as

$$z = w_1(k_b) - w_1(k_a) - \beta(1-p)z + \beta p(V_2(\pi_2) - V_2(\pi_1)).$$

Plugging in Eq. (13) and solving for z yields

$$V_1(\pi_1) - V_1(\pi_2) = \frac{[w_1(k_b) - w_1(k_a)] + \frac{\beta p}{1+\beta}[w_2(k_a) - w_2(k_b)]}{1+\beta(1-p)}. \tag{14}$$

Plugging Eqs. (13) and (14) into Eq. (12) and performing some rearrangements yields that

$W_1(k_b;\pi_1) > W_1(\Phi;\pi_1)$ if and only if

$$w_1(k_b) - w_1(\Phi) > \beta\{(1-p)[w_1(\Phi) - w_1(k_a)] + \frac{p}{1+\beta}[w_2(k_b) - w_2(k_a)]\}. \quad \square$$

Proof Proposition 2. Let us start with point ii.

ii. Let $K_1{=}(\Phi,\ k_a)$ be the policy rule. Then, $X^*{=}K_1$ if and only if $W_1(\Phi;\ \pi_1,\ K_1) \geq W_1(k_b;\ \pi_1,\ K_1)$ and $W_2(k_a;\ \pi_2,\ K_1) > W_2(\Phi;\ \pi_2,\ K_1)$. Observe first that, using the policy rule and the law of motion, we can write

$$W_2(\Phi;\pi_2,K_1) = w_2(\Phi) + \beta w_2(k_a) + \beta^2 V_2(\pi_1;K_1)$$

$$W_2(k_a;\pi_2,K_1) = w_2(k_a) + \beta w_2(\Phi) + \beta^2 V_2(\pi_1;K_1).$$

Therefore,

$$W_2(k_a;\pi_2,K_1) - W_2(\Phi;\pi_2,K_1) = (1-\beta)[w_2(k_a) - w_2(\Phi)] > 0.$$

Similarly, for unskilled voters, we can write

$$W_1(\Phi;\pi_1,K_1) = w_1(\Phi) + \beta[(1-p)w_1(\Phi) + pw_2(\Phi)] + \beta^2\{(1-p)^2V_1(\pi_1) + (1-p)pV_2(\pi_1) + pV_2(\pi_1)\}$$

$$W_1(k_b;\pi_1,K_1) = w_1(k_b) + \beta[(1-p)w_1(k_a) + pw_2(k_a)] + \beta^2\{(1-p)^2V_1(\pi_1) + (1-p)pV_2(\pi_1) + pV_2(\pi_1)\}.$$

Observe that the term accompanying β^2 cancels out and hence

$$W_1(\Phi;\pi_1,K_1) - W_1(k_b;\pi_1,K_1) \geq 0 \text{ if and only if}$$

$$w_1(k_b) - w_1(\Phi) \leq \beta\{(1-p)[w_1(\Phi) - w_1(k_a)] + p[w_2(\Phi) - w_2(k_a)]\}.$$

Or, in other words, $R_1(p, K_1)\geq 1$.

i. Let $K_2=(k_b, \Phi)$ be the policy rule. Then $X^*=K_2$ if and only if $W_1(\Phi;\ \pi_1, K_2)<W_1(k_b;\ \pi_1, K_2)$ and $W_2(k_a;\ \pi_2, K_2)\leq W_2(\Phi;\ \pi_2, K_2)$. Mimicking the expansions in (i), we obtain the desired expression.

iii. Let now $K_0=(\Phi, \Phi)$ be the policy rule. Then, $X^*=K_0$ if and only if $W_1(\Phi;\ \pi_1, K_0)\geq W_1(k_b;\ \pi_1, K_0)$ and $W_2(k_a;\ \pi_2, K_0)\leq W_2(\Phi;\ \pi_2, K_0)$. Observe that

$$W_2(\Phi;\pi_2,K_0) = w_2(\Phi) + \beta V_2(\pi_2;K_0)$$

$$W_2(k_1;\pi_2,K_0) = w_2(k_a) + \beta V_2(\pi_1;K_0).$$

Furthermore, since $K_0=(\Phi, \Phi)$, we have $V_2(\pi_1;\ K_0)=V_2(\pi_2;\ K_0)$. It is then obvious that $W_2(k_a;\ \pi_2, K_0)>W_2(\Phi;\ \pi_2, K_0)$ given that Φ is feasible. □

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