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Illegal Immigration, Crimes, and Unemployment

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Abstract

A search-theoretic model of illegal immigration is presented to examine the effect of deportation and other policy measures on unemployment, crimes and immigration flows. It is found that deporting immigrants who commit crimes lowers the unemployment rate and causes an increase in native labor force. However, if hiring immigrants is more profitable than hiring natives, deportation increases the immigrant population and the number of crimes they commit. Anti-crime policy and higher minimum wages generate similar effects.

Keywords: Illegal immigration, deportation, unemployment, crimes, minimum wages

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1 Introduction

According to Pew Research Center estimates, there were 10.5 million illegal (undocumented) immigrants living in the United States in 2021, constituting roughly 4.6 percent of the U.S. labor force. In some industries they had much higher representations; 18 percent in agriculture and 13 percent in construction, for example. In the E.U. as many as 4.8 million unauthorized immigrants were living in 2017. In both the U.S. and the E.U., recent years have seen a policy shift toward stricter border control and deportation of immigrants, especially when they commit crimes. The main objective of this paper is to analyze the effect of deportation and other related policy measures on unemployment, crimes, and flows of undocumented immigrants.

Decisions to deport immigrants are generally up to local authorities (state governments in the U.S., and member countries in the E.U.). Furthermore, the attitudes towards undocumented immigrants vary greatly from one jurisdiction to another - witness the existence of more than 300 sanctuary cities (and counties) in the United States, which refuse to comply with U.S. federal immigration laws to deport illegal immigrants, even the ones who commit crimes. Thus, the present paper intends to investigate the effect of local government policy changes, given the federal immigration policy.

To incorporate unemployment into our analysis, we assume that all jobs are created by random matching between job seekers and employers so that unemployment arises as an equilibrium phenomenon (Pissarides 2000). Employed native workers receive the minimum wage, but immigrants must negotiate wages continuously with the employers. All unemployed workers stumble upon opportunities to commit crimes and are arrested with some probability (Burdett, Lagos and Wright 2003). Arrested immigrants face deportation risks.

Our main findings can be summarized as follows. An increased effort to deport illegal immigrants who commit crimes results in a lower unemployment rate and a lower incidence of crime by natives. However, it causes the immigrant labor force to grow and the number of crimes committed to rise, if hiring immigrants is more profitable than hiring natives. We also examine the effect of crime-fighting policy (catching more criminals and sentencing them to longer prison terms) and minimum wage hikes, finding similar results.

We now briefly review the literature. The present paper extends the line of research on illegal immigration that originates from Ethier (1986), who compared the effect between two alternative immigration policies: border control and employer sanctions, in the presence of unemployment due to wage rigidity. Ethier's model spawned numerous extensions; e.g., see Djajić (1987), Bond and Chen (1987), and Woodland and Yoshida (2006). Subsequent authors came to utilize the notion of equilibrium (search) unemployment instead of that arising from wage rigidity.[1] Liu (2000) studied such a model, assuming that natives negotiate wages with employers and illegal

[1]See Rogerson, Shimer and Wright (2005) for a review of this literature. Carter (1998) applied the Shapiro-Stiglitz efficiency-wage model to generate unemployment.

immigrants receive the given fraction of the equilibrium wage native workers receive. Unlike those early works, where flows of immigrants are determined exogenously, Liu (2000) was interested in the effect of an exogenous influx of immigrants. However, how the wage gap between native and immigrants is determined was left unanswered. Chassamboulli and Palivos (2014) and Battisti et al. (2017) adopted an approach similar to Liu's (2000) but treated all immigrants legal and examined the income distribution effect of an exogenous inflow of immigrants under unequal substitutability for capital between natives and immigrants.[2] In contrast, Miyagiwa and Sato (2019) considered endogenous immigration flows in the setting in which immigrants have multiple destinations and characterized the Nash equilibrium of the game in which the destination countries choose their immigration policy independently and simultaneously. The present paper is closely related to Miyagiwa and Sato (2018) but differs in its incorporation of criminal activities into the analysis. It is noted that, to the best of our knowledge, this is the first paper to explore the relationship between immigration and crimes.

The remainder of the paper is organized in three sections. The next section presents the model. Section 3 investigates the effect of policy changes. The last section concludes.

[2] The last three studies also contain calibration results based on the data from the U.S. (Liu 2000, Chassamboulli and Palivos 2014) and from multiple countries (Battisti et al. 2017).

2 Model

2.1 Migration decisions

Suppose that a typical foreign-born worker contemplates to migrate to another country, which we call the destination country. He incurs the travel cost τ during the journey that takes him to the frontier of the destination country. When trying to cross the border, with probability $\beta \in (0, 1)$ he is apprehended by border guards and sent back home. If he successfully enters the destination country, he settles down in some region (or jurisdiction) j of that country and looks for a job. Let U_{mj} denote his intertemporal welfare while he is looking for a job in region j of the destination country and F be his welfare when he stays in his native country. Then, an immigrant's expected welfare from migration equals $\beta F + (1 - \beta)U_{mj} - \tau$. This welfare must equal his stay-at home welfare F in an interior equilibrium. Thus, $\beta F + (1 - \beta)U_{mj} - \tau = F$. Moreover, since immigrants choose to settle in the region that gives them the highest expected welfare, the preceding equation must hold for any region as long as there are immigrants living there. We can thus drop the subscript j in the above equation and rewrite it as

$$U_m = F + \tau/(1 - \beta). \tag{1}$$

Note that in this formulation U_m depends only on the travel cost and the tightness of border control, which is the federal government's responsibility.

Thus, we take U_m as a parameter in the subsequent sections.

2.2 Search

The following analysis focuses on a representative regional economy, in which immigrants compete with local (native) workers for unskilled jobs in an industry or a group of industries. We let N_m and N_n denote the immigrant and native population of unskilled workers, respectively, in the region in question (henceforth, the subscript m refers to immigrants and n refers to natives). N_n is assumed exogenous but N_m is determined endogenously.

All jobs are created through random matching between job seekers (immigrants and natives) and firms with vacancies to fill. Assuming continuous time, let job seekers be matched with employers at the rate $a(v)$ and let employers be matched with job seekers at the rate $q(a)$ per instant, where ν denotes the number of vacancies per job seeker. These two rates are related by $\nu q(\nu) = a(\nu)$ due to the homogeneity of the underlying matching function (Pissarides 2000). We can express this relationship as $q = q(a)$ and require that it satisfy

Assumption 1:

(i) $q(a)$ is differentiable with $dq/da = q'(a) < 0$ for $a > 0$.

(ii)$\lim_{a\to 0} q(a) = \infty$ and $\lim_{a\to\infty} q(a) = 0$

The negative relation between the two rates is standard in the literature. The limit requirements ensure that N_m is positive and finite.

2.3 Firms

All firms with vacancies are symmetric ex ante and have the asset value V. Spending the search cost c, they are matched with job seekers at the rate $q(a)$ per instant. Firms do not know beforehand whether they will be matched with a native or an immigrant, but do know that with probability $\mu \in (0,1)$ they will be matched with immigrants. After matching, firms learn the type of their employees. Suppose that when matched with a type-i worker, firms get the asset values J_i. Then those three asset values can be related by the following Bellman equation:

$$rV = -c + q(a)[\mu(J_m - V) + (1-\mu)(J_n - V)],$$

This is in the standard form in financial economics. Holding the asset V yields the "dividends" $(-c)$ per instant and the "capital gains" $(J_i - V)$ with the Poisson rate $q(a)$. In a stationary equilibrium, the sum of these values must equal the flow value of holding the asset, rV, where r is the interest rate. If we assume free entry, competition drives the asset value V to zero and simplifies the above equation to:

$$\mu J_m + (1-\mu)J_n - c/q(a) = 0. \tag{2}$$

This equation is referred to as the job-creation equation.

We next calculate the asset values J_i. Assume that firms produce y_i units of output when matched with a worker of type i. Assume also that a minimum wage law is in place, requiring firms to pay the wage $\underline{w}$ when matched with native workers. By contrast, firms hiring undocumented immigrants are assumed to be able to circumvent the minimum wage law and negotiate the wage w_m directly and continuously with immigrants. As a result, firms receive the flow profit $y_n - \underline{w}$ when matched with native workers and $y_m - w_m$ when matched with immigrants. Further, all active firms are assumed to go bankrupt with the Poisson rate λ. Thus, we have the Bellman equation

$$rJ_n = (y_n - \underline{w}) + \lambda(V - J_n)$$

if firms employ natives and

$$rJ_m = (y_m - w_m) + \lambda(V - J_m),$$

if they employ immigrants. With $V = 0$, these equations yield

$$J_n = (y_n - \underline{w})/R \tag{3}$$

$$J_m = (y_m - w_m)/R, \tag{4}$$

where we set $R \equiv r + \lambda$.

There is empirical evidence showing that illegal immigrants are paid much lower than native workers, even after controlling education and skill differences. For example, Kossoudji and Cobb-Clark (2002), examining the impact of the 1986 Immigration Reform and Control Act (IRCA) in the U.S., find the wage penalty for being unauthorized to range from 14 % to 24 %. Thus, it is reasonable to assume that $w_m < \underline{w}$. [3]We show, in Appendix 1, that this condition is satisfied when $y_n$is sufficiently greater than $\underline{w}$.

2.4 Crime and punishment

There is convincing evidence that higher unemployment causes more crimes (e.g., Raphael and Winter-Ebmer 2001). Our analysis incorporates this evidence and focuses on the equilibrium in which workers commit crimes only when they are unemployed. To be more specific, following Burdett et al. (2003), we assume that unemployed workers stumble on opportunities to commit crimes at some rate θ per instant. When they commit crimes, they get the immediate gain $g > 0$ but with probability $\alpha \in (0, 1)$ they are apprehended and sent to prison, where their welfare falls to P_i. If they are not caught, their (post-crime) welfare equals U_i. Thus, committing a crime yields the expected welfare $g + \alpha P_i + (1 - \alpha)U_i$. On the other hands, if they walk away from the opportunity without committing a crime, they secure the welfare U_i. Thus, unemployed workers commit crimes if and only if

$$g + \alpha(P_i - U_i) \geq 0$$

which we assume.

[3]Otherwise, native workers would prefer to negotiate wages instead of getting paid the minimum wage, thereby rendering the minimum wage ineffective.

To calculate P_i, we assume that convicted criminals serve time in prison for the period $1/\phi$ on average. This assumption is equivalent to saying that convicts are released from prison at the Poisson rate ϕ per instant. The random prison time reflects the uncertainty in sentencing in court.[4] When released from prison, native workers return to the unemployment pool and look for jobs. Assuming that convicts receive zero welfare, we can relate P_n and U_n by the Bellman equation $rP_n = \phi(U_n - P_n)$, which gives us $P_n = \phi U_n/(r + \phi)$.[5] The case for immigrants is similar except that when released from prison they face the risk of deportation $\delta \in [0, 1]$. If deported, their welfare falls to his stay-at-home welfare F. If they do not get deported, they return to the unemployment pool like natives, receiving the welfare U_m. Thus, the "capital gain" for immigrants has the value $[\delta F + (1 - \delta)U_m] - P_m$, giving us the Bellman equation:

$$rP_m = \phi[\delta F + (1 - \delta)U_m - P_m].$$

Solve this equation, we get

$$P_m = \phi[\delta F + (1 - \delta)U_m]/(r + \phi). \tag{5}$$

Note that P_m is exogenous because U_m is by (1).

[4] Our results are not affected even if we assume a fixed prison term.

[5] This equation is not needed for finding the equilibrium and hence is ignored below. Appendix 1 gives the equilibrium values of P_n and U_n.

2.5 Determination of the immigrants' wage

As already mentioned, the wage w_m is determined by Nash bargaining between immigrant and employer. It is well known that the Nash bargaining solution yields

$$E_m - U_m = \gamma_m(E_m - U_m + J_m - V).$$

Here, $\gamma_m \in (0,1)$ denotes an immigrant's relative bargaining power vis-a-vis his employer and E_m denotes the immigrants' welfare when they are employed. The above equation says that in equilibrium γ_m determines a worker's share of the total surplus,$(E_m - U_m + J_m - V)$, generated by a match. Setting $V = 0$, we can write the above equation as

$$(1 - \gamma_m)(E_m - U_m) = \gamma_m J_m \tag{6}$$

We know the asset value J_m from (4). To compute the value $E_m - U_m$, note that employed immigrants receive the wage w_m per instant but lose their jobs at the rate λ (when their firms bankrupt) with the concomitant welfare loss $(U_m - E_m)$. Immigrants are also assumed to fall victim to crimes at the rate v and suffer the welfare loss l_v. This suggests the following Bellman equation for employed immigrants

$$rE_m = w_m - \kappa + \lambda(U_m - E_m), \tag{7}$$

where $\kappa \equiv vl_v$ denotes the expected welfare loss from victimization. On the other hand, unemployed immigrants acquire jobs at the rate a, realizing the capital gain $E_m - U_m$ and also run into an opportunity to commit a crime at the rate θ, obtaining the "capital gain" $g + \alpha(P_m - U_m) > 0$. They also fall victim to crimes, suffering the expected welfare loss κ. Thus, the Bellman equation for unemployed immigrants is given by

$$rU_m = -\kappa + a(E_m - U_m) + \theta[g + \alpha(P_m - U_m)]. \tag{8}$$

Subtracting (8) from (7), we get

$$E_m - U_m = \frac{w_m - \theta C}{R + a}, \tag{9}$$

where

$$C \equiv g + \alpha(P_m - U_m).$$

Now we can substitute (9) and (4) into (6) to derive:

$$w_m = \frac{\gamma_m(R + a)y_m + (1 - \gamma_m)R\theta C}{R + \gamma_m a}. \tag{10}$$

Substitution of this wage expression into (4) and (9) yields

$$J_m = \frac{(1 - \gamma_m)(y_m - \theta C)}{R + \gamma_m a} \tag{11}$$

$$E_m - U_m = \frac{\gamma_m(y_m - \theta C)}{R + \gamma_m a}. \tag{12}$$

Straightforward differentiation of the last three equations gives us

Lemma 1: (i) $\partial w_m/\partial a > 0$, $\partial J_m/\partial a < 0$, $\partial(E_m - U_m)/\partial a < 0$.

(ii) $\partial w_m/\partial C > 0$, $\partial J_m/\partial C < 0$, $\partial(E_m - U_m)/\partial C < 0$.

To see why a higher C increases the immigrants' wage, recall that when employed, immigrants give up the opportunities to commit crimes. Thus, C is part of the opportunity cost of accepting employment, an increase of which must be compensated for by a higher wage.

2.6 Unemployment

We next determine the unemployment rates, u_i. If L_i denotes the size of the labor force of type-i workers, then there are $u_i L_i$ unemployed workers and $(1 - u_i)L_i$ employed workers of type i per instant. Hence, at each instant, $au_i L_i$ of unemployed workers of each type find jobs while $\lambda(1 - u_i)L_i$ of the employed lose their jobs. In a steady state, these two numbers must be equal, giving us

$$u_i = \lambda/(\lambda + a) = u; \qquad (13)$$

thus, natives and immigrants are unemployed at the same rate u. As a result, the proportion of immigrants in the unemployment pool equals

$$(u_m L_m)/(u_m L_m + u_n L_n) = L_m/(L_m + L_n).$$

By the law of large numbers, this ratio must equal the probability μ with which firms are matched with immigrants:

$$\mu = L_m/(L_m + L_n). \tag{14}$$

Furthermore, $\theta u L_i$ of unemployed workers of each type commit crimes, of whom $\alpha\theta u L_i$ are arrested and sent to prison. On the other hand, if I_i type-i workers serve time in prison, ϕI_i of them are released per instant.[6] In a steady state, these two numbers are equalized: $\phi I_i = \alpha\theta u L_i$. Hence

$$I_i = \alpha\theta u L_i/\phi. \tag{15}$$

Substitute the above into the definition $N_i = L_i + I_i$, we get the size of the labor force

$$L_i = \frac{\phi}{\phi + \alpha\theta u} N_i. \tag{16}$$

2.7 Equilibrium

We now look for a rational-expectations equilibrium of the model. To close the model we need to determine the equilibrium job-acquisition rate a^* and the equilibrium probability μ^* with which firms are matched with immigrants. To that end, we first substitute (12) to rewrite (8) as

[6] This holds true for immigrants.

$$H(a) \equiv \frac{a\gamma_m y_m + R\theta C}{R + \gamma_m a} - \kappa - rU_m = 0 \tag{17}$$

Here we treat κ as a parameter. This is justified if the industry in our analysis is a small part of the local regional economy. In this interpretation, since crimes happens to everyone living in the region, if the total population $N_m + N_n$ is sufficiently small relative to the the entire region's population, the victimization rate is insensitive to the umber of unemployed immigrants uL_m. Equation (17) continuously holds because immigrants are free to choose which jurisdiction to live in. Solving it, we get

$$a^* = \frac{R[(\kappa + rU_m) - \theta C]}{\gamma_m y_m - (\kappa + rU_m)}$$

By (8), $(E_m - U_m) > 0$ implies $(\kappa + rU_m) > \theta C$. Thus, $a^* > 0$ if y_m is large enough to make the denominator positive.

We next turn to the job-creation equation (2). Substituting for J_m and J_n from (11) and (3), we can rewrite it as

$$G(a, \mu) \equiv \frac{\mu(1-\gamma_m)(y_m - \theta C)}{R + \gamma_m a} + \frac{(1-\mu)(y_n - \underline{w})}{R} - c/q(a) = 0. \tag{18}$$

This equation is also assumed to hold continuously due to free entry and exit of firms. Differentiating it, we get

$$da/d\mu = -G_\mu/G_a$$

where

$$G_a = -\frac{\mu\gamma_m J_m}{R+\gamma_m a} + cq'/q^2 < 0, \tag{19}$$

$$G_\mu = J_m - J_n = \frac{(1-\gamma_m)(y_m - \theta C)}{R+\gamma_m a} - \frac{y_n - \underline{w}}{R}. \tag{20}$$

To determine the sign of $G\mu$, let $a_1 > 0$ solve the equation $G(a_1, 1) = J_m(a_1) - c/q(a_1) = 0$, and let $a_0 > 0$ solve the equation $G(a_0, 0) = J_n - c/q(a_0) = 0$. That is, a_1 (resp. a_0) is the job acquisition rate when $\mu \to 1$ (resp. $\mu \to 0$) in (18). Under assumption 1, a_0 and a_1 are unique, and

Lemma 2: (i) If $a_0 > a_1$, $G_\mu = J_m - J_n < 0$.

(ii) If $a_0 < a_1$, $G_\mu = J_m - J_n > 0$.

(iii) if $a_0 = a_1$,$G_\mu = J_m - J_n = 0$.

The proof of lemma 2 is found in the appendix.

In case (i) of lemma 2, the graph of (18) is downward-sloping like the curve G in the left panel of figure 1. (17) gives us the horizontal line H at the height a^* since a^* does not depend on μ. Therefore, if $a_0 > a^* > a_1$, the two curves intersect at some $\mu \in (0, 1)$, which is the equilibrium μ^*. In case (ii) of lemma 2 the curve G slopes upward as in the right-hand panel of figure 1. If $a_0 < a^* < a_1$, the two curves intersect to give us the equilibrium $\mu^* \in (0, 1)$. Finally, in case (iii) the graph of (18) is also horizontal, so there is no interior

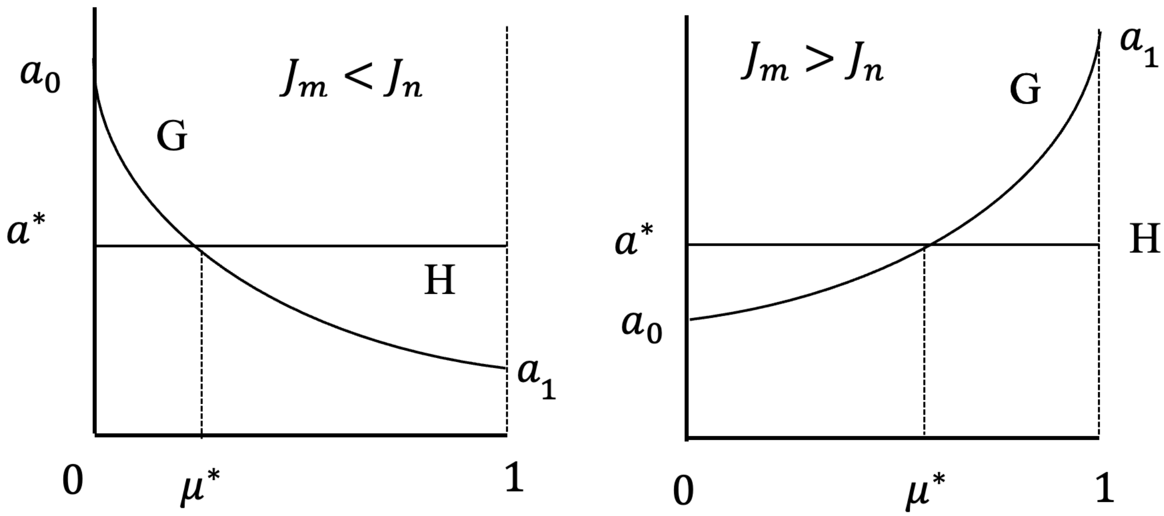

Figure 1:

equilibrium μ^* or there is an infinity of equilibria. In the remainder of the analysis we ignore the last case.

With a^* and μ^* uniquely determined, the other equilibrium values readily follow. The immigrant's equilibrium wage depends only on a^* by (10).

$$w_m^* = \frac{\gamma_m(R+a)y_m + (1-\gamma_m)R\theta C}{R+\gamma_m a^*} \tag{21}$$

So does the unemployment rate:

$$u^* = \lambda/(\lambda + a^*). \tag{22}$$

Substituting u^* into (16), we get the equilibrium native labor force

$$L_n^* = \frac{\phi}{\phi + \alpha\theta u^*} N_n. \tag{23}$$

The number of natives in prison follows from (15):

$$I_n^* = \left(\frac{\alpha\theta u^*}{\phi + \alpha\theta u^*}\right) N_n. \tag{24}$$

Substituting L_n^* from (23) and μ^* into (14), we get the equilibrium immigrant labor force

$$L_m^* = \frac{\mu^*}{1-\mu^*}\left(\frac{\phi}{\phi + \alpha\theta u^*}\right) N_n. \tag{25}$$

The number of immigrants who are in prison follows from (15):

$$I_m^* = \frac{\mu^*}{1-\mu^*}\left(\frac{\alpha\theta u^*}{\phi + \alpha\theta u^*}\right) N_n. \tag{26}$$

The total immigrant population equals

$$N_m^* = L_m^* + I_m^* = \frac{\mu^*}{1-\mu^*} N_n. \tag{27}$$

3 Policy experiments

This section begins with the following observation (the proof is in the appendix):

Lemma 3. $a^*$and μ^* are always in a steady state and jump to their new steady-state values following changes in parameters.

3.1 Deportation policy

This subsection examines the impact of enforcement of stricter deportation policy. In our model, that is represented by an increase in δ, the probability of deportation verdict in court. Notice that δ affects only the welfare P_m, which in turn affects (17) and (18) only through $C = g + \alpha(P_m - U_m)$. Since $dC/d\delta = (dC/dP_m)(dP_m/d\delta) < 0$ by (5), adoption of tougher deportation policy is equivalent to a decrease in C.

Differentiating (17) with respect to C, we get

$$da^*/dC = -H_C/H_a = -\theta/(E_m - U_m) < 0,$$

with the partial derivatives

$$H_C = \frac{\theta R}{R + \gamma_m a} > 0$$

$$H_a = \frac{R\gamma_m(y_m - \theta C)}{(R + \gamma_m a)^2} = \frac{R(E_m - U_m)}{R + \gamma_m a} > 0,$$

(the second equality in H_a follows from (12)). Thus, $da^*/d\delta > 0$. Recalling that the unemployment rate, the immigrant's wage, and the size of the native labor force depends only on a^*, the next results follow immediately from lemma 1:

Proposition 1. $da^*/d\delta > 0$, $du^*/d\delta < 0$, $dL_n^*/d\delta > 0$ and $dw_m^*/d\delta < 0$.

In words, stricter deportation policy increases the job-acquisition rate a and decreases the unemployment rate. The native labor force grows because with a lower unemployment rate, fewer natives are committing crimes and dropping out of the labor force. The effect on the immigrants' wage also has an intuitive explanation. With a higher deportation risk, crimes pay less, i.e., C falls. With a fall in the opportunity cost of being employed, immigrants accept lower wages.

By (15) the number of individuals in prison is proportional to the number of crimes they commit. Since the unemployment rate falls, (24) implies

Corollary 1: $dI_n^*/d\delta < 0$**.**

That is, natives commit fewer crimes because more of them are employed.

Next, we ascertain the effect of deportation policy on μ^*. Differentiating (18), we get

$$G_C + G_a \partial a^*/\partial C + G_\mu \partial \mu^*/\partial C = 0,$$

where $G_a < 0$ by (19) and

$$G_C = -\frac{\theta\mu(1-\gamma_m)}{R+\gamma_m a} < 0.$$

Substituting $\partial a^*/\partial C = -H_C/H_a$, we get

$$d\mu^*/dC = -(G_C + G_a da^*/dC)/G_\mu = \frac{H_C G_a - G_C H_a}{H_a G_\mu}, \qquad (28)$$

Substituting for the derivatives, we get

$$\underset{(+)\,(-)}{H_C G_a} - \underset{(-)\,(+)}{G_C H_a} = \left(\frac{R\theta}{R+\gamma_m a}\right)\left(-\frac{\mu\gamma_m J_m}{R+\gamma_m a} + cq'/q^2\right) - \left(-\frac{\theta\mu(1-\gamma_m)}{R+\gamma_m a}\right)\left(\frac{R(E_m-U_m)}{R+\gamma_m a}\right)$$

$$= \left(\frac{R\theta}{R+\gamma_m a}\right)\left(\frac{cq'}{q^2}\right) < 0. \tag{29}$$

where the second equality follows from (6). Since $H_a > 0$, we have $d\mu^*/dC \gtreqless 0$ if $G_\mu \lesseqgtr 0$. Recalling that $dC/d\delta < 0$, we conclude

Proposition 2. (i) $d\mu^*/d\delta < 0$ if $G_\mu = J_m - J_n < 0$.

(ii) $d\mu^*/d\delta > 0$ if $G_\mu = J_m - J_n > 0$.

Figure 2 illustrates proposition 2. The left panel illustrates case (i) and the right panel case (ii). In both cases, the dotted curves correspond to a smaller C (i.e., a higher δ) and the prime denotes the corresponding new equilibrium values. Intuitively, since $da^*/dC = -H_C/H_a < 0$, a decrease in C (stricter deportation policy) shifts up the H line. Partial differentiation of (18) at μ^* gives us $\partial a^*/\partial C|_{d\mu^*=0} = -G_C/G_a < 0$, so the G curve also shifts upward. Comparing the magnitudes of shift, we get $H_C/H_a - G_C/G_a = (H_C G_a - G_C H_a)/(H_a G_a) > 0$, where the inequality holds due to (29) and the fact that $H_a G_a < 0$. Thus, the H curve shifts up more than the G curve at μ^*as illustrated in figure 2, verifying the results in proposition 2.

By proposition 2, the effect of deportation on μ^* depends on the asset values of firms employing two types of workers. To have a better understanding

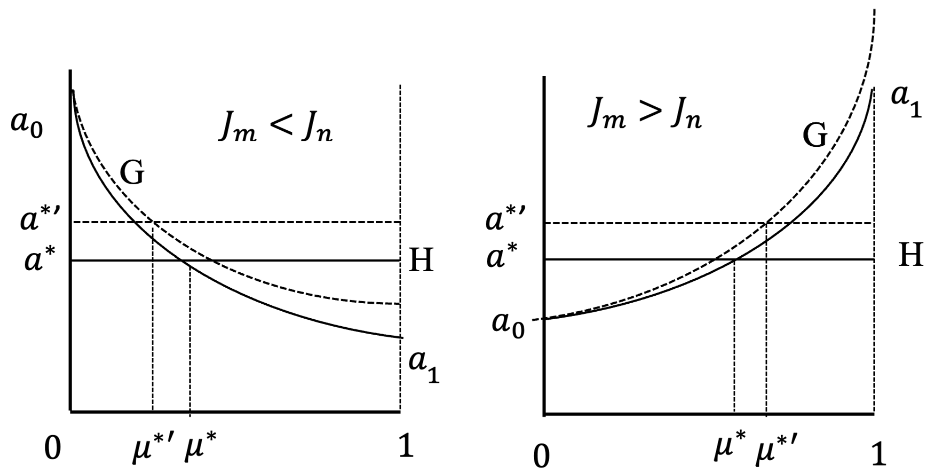

Figure 2:

of it, we rewrite (18) as

$$\mu(1-\gamma_m)\left(\frac{y_m}{R+\gamma_m a} - \frac{R\theta C}{R(R+\gamma_m a)}\right) + \frac{(1-\mu)(y_n - \underline{w})}{R} = c/q(a).$$

and (17) as

$$\frac{R\theta C}{R+\gamma_m a} = \kappa + rU_m - \frac{a\gamma_m y_m}{R+\gamma_m a}.$$

Then substituting the latter into the former, we get, after simplifying:

$$\mu\frac{(1-\gamma_m)(y_m - \kappa - rU_m)}{R} + (1-\mu)\frac{(y_n - \underline{w})}{R} = c/q(a^*). \qquad (30)$$

In this equation, the first term on the left-hand side representing the asset value of firms employing immigrants is independent of the job acquisition rate a^*, and

$$J_m \lesseqgtr J_n \Longleftrightarrow (1-\gamma_m)(y_m - \kappa - rU_m) \lesseqgtr (y_n - \underline{w}).$$

This implies that regions tend to fall into case (ii), if natives are relatively less productive than immigrants, immigrants have a weaker bargaining power in wage determination, and/or the minimum wages are higher. In such regions deportation has the unexpected consequence of increasing the immigrant population and the number of crimes by immigrants.

Let us examine the implications of proposition 2 more closely. As we saw, an increase in deportation probability raises a^*, which increases the "effective" search cost $c/q(a)$ on the the right-hand side of (30). In equilibrium, the rise in effective search cost is offset by an increase in the expected value of entry under the condition of free entry and exit. In case (i), we have $J_m < J_n$ so (30) implies that a fall in μ^* is needed to increase the expected value of entry. Although a fall μ^* signifies a smaller fraction of immigrants in the unemployment pool, however, it is compatible with a larger immigrant labor force because the native labor force is larger by proposition 1. However, a fall in μ^*, via (27), implies a smaller immigrant population. As for crimes, with both $u^*$and μ^* decreased, (26) implies a lower incidence of crime by immigrants. Since fewer natives commit crimes (corollary 1), the total number of crimes is also lower.

In case (ii), $J_m > J_n$ so a rise in μ^* is required to offset the increase in the effective search cost. A higher μ^* signifies a relative increase in the number of immigrants in the unemployment pool. With an increase in the native labor force, an increase in μ^* implies an even greater growth of the immigrant labor force than the native labor force. The total immigrant population also grows by (27). As for the effect on crimes, a lower unemployment rate tends to decrease the number of crimes committed by immigrants; however, a larger labor force can increases the number of unemployed immigrants and hence the number of crimes they commit. As a result, the number of crimes by immigrants is indeterminate and so is the total number of crimes. We summarize these results in

Proposition 3: (i) If $J_m < J_n$, then $dN_m^*/d\delta < 0$ and $dI_m^*/d\delta < 0$.

(ii) If $J_m > J_n$, then $dL_m^*/d\delta > 0$, $dN_m^*/d\delta > 0$ and $dI_m^*/d\delta > 0$.

3.2 Anti-crime policies

The government can fight crime by catching more criminals (increasing the arrest rate α) and/or meting out longer prison sentences (lowering ϕ). Note that these variables affect the two schedules (17) and (18) only through the term C. Since $dC/d\alpha = P_m - U_m < 0$ and $dC/d\phi = r[\delta F + (1-\delta)U_m]/[r + \phi)^2 > 0$, those anti-crime measures produce the effects qualitatively the same as enforcement of tougher deportation policy.

Proposition 4. Stricter anti-crime policy enforcement (an increase in α or a decrease in ϕ) and stricter deportation policy yield the qualitatively identical results.

3.3 Raising minimum wages

In recent years, many local governments (city, state) in the United States have raised or plan to raise minimum wages. Thus, it is of some interest to find how a minimum wage increase affects the equilibrium of our model. We begin by noticing that the minimum wage $\underline{w}$ is absent in equation (17), implying that the equilibrium job-acquisition rate a^* is immune to minimum wage changes. It is because in our model immigrants can always move to another jurisdiction to get the utility U_m, implying that the immigrant population continuously adjusts to keep a^* invariant. Then, the unemployment rate, the size of the native labor force (L_n^*), the number of jobs natives hold $(1-u^*)L_n^*$ and the number of crimes they commit ($\theta u^* L_n^*$) are unaffected by a minimum wage hike.

Proposition 5. (a) An increase in minimum wage has no effect on the job-acquisition rate, the unemployment rate, the native labor force and the number of crimes by natives; that is,

$$da^*/d\underline{w} = du^*/d\underline{w} = dL_n^*/d\underline{w} = dI_n^*/d\underline{w} = 0.$$

An increase in $\underline{w}$ only affects the job-creation equation. Differentiating (18), we get

$$d\mu^*/d\underline{w} = -G_{\underline{w}}/G_\mu = \frac{1-\mu^*}{R(J_m - J_n)},$$

so the effect on μ^* depends on the sign of G_μ. In case (i) of proposition 2, we have $J_m < J_n$, implying $d\mu^*/d\underline{w} < 0$. Given $dL_n^*/d\underline{w} = 0$, a decrease in μ^* implies $dL_m^*/d\underline{w} < 0$; a minimum wage hike causes the immigrant labor force to shrink. This and the fact that there is change in the unemployment rate imply that there are fewer immigrants in the unemployment pool and hence a drop in the number of crimes they commit. In case (ii), the opposite results: we have $d\mu^*/d\underline{w} > 0$, so a minimum wage hike results in a larger immigrant labor force and an increase in the number of crimes by immigrants.

Proposition 6. In case (i) of proposition 2 (i.e., $J_m < J_n$), the immigrant labor force and the number of crimes committed by immigrants decrease ($dL_m^*/d\underline{w} < 0$) and ($dI_m^*/d\underline{w} < 0$). The immigrant population also declines. In case (ii) of proposition 2 (i.e., $J_m > J_n$), the above results are reversed.

It is interesting to note in passing that in case (ii) we have $d(1-u^*)(L_n^* + L_m^*)/d\underline{w} = (1-u^*)dL_m^*/d\underline{w} > 0$; that is, raising the minimum wage creates more jobs (cf., Card and Krueger 1994).

4 Concluding remarks

We present a model of a local economy with the following features: native workers and illegal immigrants compete for unskilled jobs through random matching with employers. When employed, native workers receive the minimum wage while immigrants continuously negotiate wages with employers. Unemployed workers stumble on opportunities to commit crimes. Immigrants who commit crimes are deported with some probability, our policy variable

Our analysis shows that stricter deportation policy decreases the unemployment rate and the number of crimes committed by natives. It decreases the immigrant population and the number of crimes by immigrants only if employing natives is more profitable than employing immigrants. If hiring immigrants is more profitable, then deportation results in a larger immigrant population and a higher incidence in crime by immigrants, and may increase the size of the immigrant labor force. Raising minimum wages and stricter anti-crime policies yield similar results but the former has no effect on the unemployment rate and the size of native labor force.

Some extensions suggest themselves. For example, this paper assumed worker homogeneity in the attitude towards crimes. One extension is to introduce worker heterogeneity in compunction about committing crimes. In this extension, only those having lower degrees of compunction than the equilibrium cutoff level end up committing crimes. Another possible extension is to explicitly incorporate the social welfare programs such as unemployment insurance into the analysis because of the concern that such program creates incentives for immigration. Lastly, this paper does not address the incidence of crimes by gangs and other criminal organizations but increases in the number of serious crimes they commit are important factors in reconsideration of the existing immigration policy in many countries. Addressing those issues is left for future research.

Appendices

Appendix 1: Native workers

The relevant Bellman equations for native workers are

$$rE_n = \underline{w} - \kappa + \lambda(U_n - E_n).$$

$$rU_n = -\kappa + a(E_n - U_n) + \theta[g + \alpha(P_n - U_n)]$$

The net gain from a crime can be written

$$g + \alpha(P_n - U_n) = g - \xi U_n,$$

where $\xi \equiv \frac{r\alpha}{r+\phi}$. These equations can be solved for

$$E_n(a) = [(r + a + \theta\xi)\underline{w} + \lambda\theta g - (R + a + \theta\xi)\kappa]/[R(r + \theta\xi) + ra].$$

$$U(a) = [a\underline{w} + R\theta g - (R + a)\kappa]/[R(r + \theta\xi) + ra].$$

If native workers negotiate their wages with employers, an appeal to Nash bargaining yields

$$w_n(a) = \frac{(1-\gamma_n)[R(r+\theta\xi)+ra]y_n + \gamma_n R\theta(rg+\xi\kappa)}{R(r+\theta\xi)+(1-\gamma_n)ra}$$

where γ_n is the relative strength of a native in bargaining. We assume this negotiated wage is less than the minimum wage, or $w_m < \underline{w}$. This inequality can be written as

$$r(1-\gamma_n)(y_n-\underline{w})a > R\left((r+\theta\xi)[\underline{w}-(1-\gamma_n)y_n]-\gamma_n\theta(rg+\xi\kappa)\right).$$

The above inequality holds for all $a > 0$, if y_n is large enough to satisfy $(1-\gamma_n)y_n \geq \underline{w}$, which we assume in our analysis.

Appendix 2: Proof of Lemma 2.

Proof: (i) Since $J_m(a)$ is decreasing and $c/q(a)$ is increasing in a, $a_0 < a_1$ implies $J_m(a_1) > J_n$. Since $J_m(a) - c/q(a)$ is decreasing in a, for any $a \in (a_0, a_1)$ we have$J_m(a) - c/q(a) > J_m(a_1) - c/q(a_1) = 0$. Then $G(a,\mu) = J_m(a)+(1-\mu)(J_n - J_m(a)) - c/q(a) = 0$ implies $J_n < J_m(a)$ for any $a \in (a_0 a_1)$ and $\mu \in (0,1)$, as desired. (ii) $a_0 > a_1$ implies $J_m(a_1) < J_n$. If there is an $a > a_0 > a_1$, then $J_m(a) - c/q(a) < J_m(a_1) - c/q(a_1) = 0$ and $J_n - c/q(a) < J_n - c/q(a_0) = 0$. Therefore, $G(\mu,a) = \mu(J_m(a) - c/q(a)) + (1-\mu)(J_n - c/q(a)) < 0$ for any $a \in (a_0, a_1)$ and $\mu \in (0,1)$. Therefore, $G(\mu, a) = 0$, implies $a_0 > a > a_1$. If $J_m(a) > J_n, J_m(a) - c/q(a) > J_n - c/q(a) > J_n - c/q(a_0) = 0$. Therefore, $G(\mu, a) > 0$. This contradiction implies $J_m(a) < J_n$. $\square$

Appendix 3: Out-of-steady-state dynamics

When the economy moves out of steady-state values, the equation for the asset values of a firm employing an immigrant is modified to

$$rJ_m = y_m - w_m + \lambda(V - J_m) + \dot{J}_m, \tag{31}$$

where the dot indicates time derivatives ($\dot{x} = dx/dt$). The equations for the welfare of an employed and an unemployed immigrant undergo similar changes:

$$rE_m = w_m + \lambda(U_m - E_m) - \kappa + \dot{E}_m \tag{32}$$

$$rU_m = a(E_m - U_m) + \theta C - \kappa + \dot{U}_m. \tag{33}$$

These three equations combine to yield

$$(r+\lambda)(E_m - U_m + J_m - V) = y_m - \theta C - a(E_m - U_m) + \dot{J}_m + \dot{E}_m - \dot{U}_m \tag{34}$$

If we let Σ_m denote the total surplus from a match, i.e.,

$$\Sigma_m \equiv E_m - U_m + J_m - V$$

then

$$\dot{\Sigma}_m = \dot{E}_m - \dot{U}_m + \dot{J}_m - \dot{V}.$$

Since firms can enter freely and that immigrants can move freely across jurisdictions at any date, we can put $V = \dot{V} = 0$ and $\dot{U}_m = 0$ while U_m is given by (1). Substituting these values, we can rewrite (34) as

$$R\Sigma_m = y_m - \theta C - a(E_m - U_m) + \dot{\Sigma}_m$$

where $R = r + \lambda$ as defined in the text. Nash bargaining implies that $E_m - U_m = \gamma_m \Sigma_m$. Substituting this, we can rewrite the above equation as

$$(R + \gamma_m a)\Sigma_m = \dot{\Sigma}_m + y_m - \theta C. \tag{35}$$

Letting $R + \gamma_m a(t) \equiv P(t) > 0$ and $y_m - \theta C \equiv z > 0$, the above equation is written:

$$\dot{\Sigma}_m(t) - P(t)\Sigma_m(t) + z = 0$$

This differential equation has the general solution

$$\Sigma_m(t) = e^{\int_0^t P(x)dx} \int_0^t z e^{-\int_0^x P(v)dv} dx + K e^{\int_0^t P(x)dx}$$

where K is a positive constant. Regardless of $a(t)$, $P(x) > 0$ and hence $\Sigma_m(t)$ does not converge. Thus (35) holds only if $\dot{\Sigma}_m = 0$; that is,

$$\Sigma_m = \frac{y_m - \theta C}{R + \gamma_m a}$$

is stationary. This implies that when the economy is disturbed, a jumps immediately to its new steady-state value. This reflects all agents' forward-looking behavior (rational expectations) and is standard in the equilibrium unemployment models (Pissarides 2000). The absence of transition dynamics implies that the number of jobs and the immigrant's wage also jump immediately to their stationary values. Since $V = \dot{V} = 0$, the job-creation equation

$$\mu J_m + (1-\mu) J_n - c/q = 0.$$

holds at any date. The surplus-sharing rule gives us $J_m = (1-\gamma_m)\Sigma_m$ and hence the job-creation equation implies $\dot{\mu} = 0$. Thus, μ also jumps immediately to its stationary value, forcing L_m to do the same. In contrast, the unemployment rate adjusts according to the equation $\dot{u} = -(\lambda + a)u + \lambda$, converging to the steady-state rate $u^* = \lambda/(\lambda + a)$. This indicates that the number of immigrants in prison changes according to the differential equation $\dot{I}_m = \theta\alpha u(t) L_m - \phi I_m$. (Although immigrants with criminal records are deported with probability δ when released prison, they are immediately replaced by new arrivals. Thus, if we do not care about the identities of individual immigrants, the equilibrium outcome is as if all immigrants move to unemployment when released from prison.)

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