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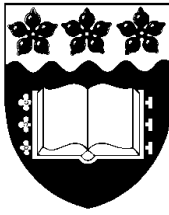
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Abstract: This paper develops a lean-against-the-wind rule for setting low-skill immigration quota. The construction of this rule takes into account the factors governing the supply of and demand for low-skill immigrants, illegal immigration, border enforcement and the host-country's level of unemployment.

Key words: Economics, low-skill immigration, immigration quota, illegal immigration, unemployment, lean-against-the-wind policy rules.

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1. Introduction

Illegal immigration is a major social and economic problem in many technologically advanced countries. The immigration policies pursued by these countries have usually taken the form of annual quotas enforced by border control. Immigration quotas exist due to excess supply of candidates. This excess supply is the source of illegal immigration.

Two types of immigrants are commonly observed: a relatively small number of early, skilful workers and a relatively large number of following low-skill workers. The immigration of skilful workers is triggered by large positive income-differentials between the technologically advanced country of destination and the less technologically advanced countries of origin. Although skilful immigrants can be perceived to be the “scouts” who pave the immigration path for their low-skill compatriots, their immigration is not restricted due to a small domestic supply of, and a large demand for, their skills in certain industries in the technologically advanced country.

The immigration of low-skill people is triggered by a wage-differential and facilitated by capable “family-and-friends” in the host country. Due to the rigidities that lead to relatively high wages in the technologically advanced countries for low-skill workers¹ and to the large number of low-skill workers in the less technologically advanced countries, the quantity supplied of low-skill immigrants is much larger than the quantity demanded by the technologically advanced country. The excess supply of low-skill immigrants feeds the number of illegal immigrants and increases the technologically advanced country’s level of unemployment.

This paper refines Levy’s (2002) leaning-against-the-wind rule on immigration for minimizing the adverse, unemployment effects of immigration on the host-country by

¹ For instance, a minimum wage that is higher than the internationally open-market-clearing wage.

distinguishing between skilful and low-skill immigrants, focusing on the management of low-skill immigration and incorporating border enforcement. Section 2 analyzes conceptually the relationships between illegal immigration, low-skill immigration, skilled immigration, job-vacancies, border control and unemployment. Section 3 derives the conditions for, and intensity of, leaning-against-the wind of low-skill immigration. Section 4 displays the lean-against-the-wind rule for setting the low-skill immigration's optimal quota. The paper is concluded in section 5 with a discussion of the optimal investment in border-enforcement and computational remarks.

2. Supply and demand determinants of low-skill immigrants

The flow of low-skill immigrants from a less technologically advanced country of origin i to a technologically advanced country (F_i) is taken to be random, yet positively related to the low-skill-wage differentials (\tilde{w}_i) between the latter and the former and to the number of skilful veteran immigrants from the less technologically advanced country i living in the technologically advanced country (S_{it-1}). Hence, the current aggregate supply of low-skill immigrants (L_t^s) to the technologically advanced country is given by

$$L_t^s = \sum_{i=1}^N F_i(\tilde{w}_i, S_{it-1}) \quad (1)$$

where $i = 1, 2, 3, \dots, N$ less technologically advanced countries of origin and $\partial F_i / \partial \tilde{w}_i$ and $\partial F_i / \partial S_{it-1}$ are positive.

The admittance of low-skill immigrants might aggravate the host-country's unemployment problem.² The current increase (Δ) in the technologically advanced country's unemployment level (U) is given by:

$$\Delta U_t = L_t^d + V_t - B_t - J_t \quad (2)$$

where, L_t^d is the number of low-skill immigrants who legally enter the technologically advanced country at t , $V_t = \sum_{i=1}^N F_i(\tilde{w}_{it}, S_{it-1}) - L_t^d$ is a random variable indicating the number of illegal immigrants (endowed with low skills) who attempt entering this country at t , B_t is a random variable denoting the number of illegal immigrant apprehended and detained at t , and J_t is a random variable representing the number of low-skill jobs generated, or become vacant, at t , which might be positively related to the number of earlier skilful immigrants.

Suppose that the technologically advanced country's government is aware of the adverse effect of low-skill immigration on its level of employment and sets the number of low-skill immigrants to be admitted so as to minimize the expected loss from the actual rise in the unemployment level beyond a desired increment. Consistent with Levy (2002) and the common practice in the macroeconomic-stabilization literature, the loss function (ℓ) is taken to be quadratic.³ Suppose, further, that the technologically advanced country's desired increase in the unemployment level is equal to zero. Then its loss function is

² Agiomirgianakis and Zervoyianni (2001) focus on the impact of illegal immigration on social welfare. They show that illegal immigration reduces the inflationary bias associated with expansionary policies and thus has a positive overall impact on 'social welfare' in the economy.

³ Despite the undesired property of equal treatment of positive and negative deviations from targets, quadratic loss functions have been extensively used in economics in general and macroeconomics in particular (see the seminal papers by Poole, 1970; and Sargent and Wallace, 1976).

$$\ell = E[\Delta U_t]^2. \quad (3)$$

In setting the expected-loss-minimizing quota of low-skill immigrants, a lean-against-the-wind rule supported by border enforcement and alleviated by the moderating effect of border enforcement on the size of the illegal immigration is considered.⁴ That is, the technologically advanced country's demand for new low-skill immigrants at t is given by

$$L_t^d = g_0 - g_1 [L_{t-1}^d + V_{t-1} - B_{t-1}] \geq 0 \quad (4)$$

where, $L_{t-1}^d + V_{t-1} - B_{t-1}$ is the increase in this country's stock of low-skill immigrants during the previous period, g_0 is the maximum quota of low-skill immigrants per period, and g_1 is a feedback coefficient reflecting the intensity of the policy-maker's reaction to the increase in the stock of low-skill immigrants during the previous period.

3. The conditions for, and intensity of, leaning against the wind of low-skill immigration

The parameters of the technologically advanced country's lean-against-the-wind rule are found by minimizing the long-run (i.e., steady state) expected loss from the squared increase in the unemployment level, which is equivalent to minimizing the stationary variance of the change in the unemployment level. By considering equations (4), (2) and (3)

⁴ See Karlson and Katz (2003) for a policy mix involving border control.

$$\begin{aligned}
g_1^* = \arg \min \{ & \ell = g_1^2 [\text{var}(V) + \text{var}(B) - 2 \text{cov}(V_{-1}, B_{-1})] \\
& - 2g_1 [\text{var}(V) + \text{var}(B) + \text{cov}(V, V_{-1}) - \text{cov}(B, V_{-1}) - \text{cov}(J, V_{-1}) - \text{cov}(V, B_{-1}) + \text{cov}(B, B_{-1}) \\
& + \text{cov}(J, B_{-1})] + [\text{var}(V) + \text{var}(B) + \text{var}(J) - 2 \text{cov}(V, B) - 2 \text{cov}(V, J) + 2 \text{cov}(B, J)] \}
\end{aligned}
\tag{5}$$

where all the variances and covariances are stationary.

The first-order condition for minimum implies

$$g_1^* = \frac{\text{var}(V) + \text{var}(B) + \text{cov}(V, V_{-1}) - \text{cov}(B, V_{-1}) - \text{cov}(J, V_{-1}) - \text{cov}(V, B_{-1}) + \text{cov}(B, B_{-1}) + \text{cov}(J, B_{-1})}{\text{var}(V) + \text{var}(B) - 2 \text{cov}(V_{-1}, B_{-1})}
\tag{6}$$

The second-order condition for minimum requires that the denominator in the right-hand side of equation (6) should be positive. Recalling that $\text{var}(V) > 0$ and $\text{var}(B) > 0$, the second-order condition for minimum is satisfied and the denominator in equation (6) is positive as long as $\text{cov}(B, V) < 0.5[\text{var}(V) + \text{var}(B)]$. There may be a flow-catch effect -- the larger the flow of illegal immigrants the easier the catch. Hence, it can be expected that $\text{cov}(B, V) > 0$. The second-order condition for minimum requires that the sum of variations in the number of illegal immigrants and in the number of those apprehended and detained should be at least twice as large as the flow-catch association.

Furthermore, leaning against the wind requires that $g_1^* > 0$. That is, the numerator in equation (6) must be positive for the technologically advanced country to adopt a lean-against-the-wind low-skill immigration policy. The following assumptions are made:

- i. $\text{cov}(V, V_{-1}) > 0$ and reflecting, by virtue of equation (1), the *persistence* of positive low-skill wage differentials between the technologically advanced country and the less

technologically advanced countries and the support provided by veteran, skilled immigrants to their low-skill compatriots;

ii. $\text{cov}(V, B_{-1}) < 0$ and reflecting the *deterrent* effect of past success in border enforcement on the current number of attempts to enter the technologically advanced country illegally;

iii. $\text{cov}(B, V_{-1}) > 0$ and reflecting a positive *stock* effect of the past flow of illegal immigrants on the present number of apprehension and detention;

iv. $\text{cov}(B, B_{-1}) > 0$ and reflecting a positive *experience* effect in border enforcement;

v. $\text{cov}(J, B_{-1}) > 0$ and reflecting a *vacancy* effect – as some of the illegal immigrant apprehended in the previous period had entered the technologically advanced country earlier and had been employed, their detention has created vacancies; and

vi. $\text{cov}(J, V_{-1}) < 0$ and reflecting a *job-exhaustion* effect of the past number of illegal immigrants on the number of new low-skill jobs.

In view of the above assumptions, if $\text{cov}(B, V_{-1})$ is smaller than

$$\text{var}(V) + \text{var}(B) + \text{cov}(V, V_{-1}) + \text{cov}(B, B_{-1}) + \text{cov}(J, B_{-1}) + |\text{cov}(V, B_{-1})| + |\text{cov}(J, V_{-1})|$$

then $g_1^* > 0$. The intensity of leaning against the wind is moderated by the stock effect and the variations in the number of illegal immigrants and the number apprehensions and detentions, but increased by: 1. the persistence of wage differentials and the support extended by veteran, skilled immigrants, 2. the successful experience in border control, 3. the low-skill jobs that become vacant due to recent apprehension and detention of illegal immigrants who entered the technologically advanced country earlier, 4. the deterrent factor, and 5. the job-exhaustion effect of the past number of illegal immigrants.

4. The optimal lean-against-the-wind of low-skill immigrants

Using equation (2) for formulating the stationary expectation of ΔU and setting it to be equal to the desired zero increase in the level of unemployment,

$$E(L^d) + E(V) - E(B) - E(J) = 0 \quad (7)$$

where all the means are stationary. By taking the stationary expectation of both sides of equation (4) and recalling that in steady state the mean of the lagged variable is equal to the mean of the variable,

$$E(L^d) = g_0^* - g_1^* [E(L^d) + E(V) - E(B)] \quad (8)$$

which implies

$$E(L^d) = [g_0^* / (1 + g_1^*)] - [g_1^* / (1 + g_1^*)] [E(V) - E(B)]. \quad (9)$$

By substituting the right-hand side of equation (9) into equation (7) for $E(L^d)$ and collecting terms, the technologically advanced country's optimal maximum quota of low-skill immigrants is

$$g_0^* = (1 + g_1^*) E(J) - [E(V) - E(B)]. \quad (10)$$

By substituting this expression into equation (4), it is optimal for the technologically advanced country to set the quota of low-skill immigrants in period t by using the following formula:

$$L_t^{d*} = [E(J) - E(V) + E(B)] - g_1^* [L_{t-1}^d + V_{t-1} - B_{t-1} - E(J)] \quad (11)$$

where g_1^* is given by equation (6). The optimal quota depends on the effort invested in border control.

5. Border-control effort and computational remarks

It is proposed that the number of illegal immigrants to be apprehended and detained (B) will be set so as to minimize the technologically advanced country's combined costs of border control (or enforcement) and increased unemployment

$$y = C(B) + q\ell(B) \quad (12)$$

where, C is a convex function representing the costs of border control and q denotes the shadow value of the increased variation in the unemployment change $\ell(B)$. As depicted by equation (5), the explicit form of $\ell(B)$ is

$$\begin{aligned} \ell = & (g_1^*)^2 [\text{var}(V) + \text{var}(B) - 2 \text{cov}(V_{-1}, B_{-1})] \\ & - 2g_1^* [\text{var}(V) + \text{var}(B) + \text{cov}(V, V_{-1}) - \text{cov}(B, V_{-1}) - \text{cov}(J, V_{-1}) - \text{cov}(V, B_{-1}) + \text{cov}(B, B_{-1}) \\ & + \text{cov}(J, B_{-1})] + [\text{var}(V) + \text{var}(B) + \text{var}(J) - 2 \text{cov}(V, B) - 2 \text{cov}(V, J) + 2 \text{cov}(B, J)] \end{aligned} \quad (13)$$

with g_1^* given by equation (6).

The combined-cost-minimizing border-enforcement level (i.e., $B^* = \arg \min y$) is found by solving the necessary condition $C'(B^*) = -q\ell'(B^*)$ as long as the second-order condition $C''(B^*) > -q\ell''(B^*)$ is satisfied. Otherwise, B^* is equal to zero, when $y(B=0) < y(B=V)$, or to the stationary number of illegal immigrant V , when $y(B=V) < y(B=0)$. Subsequently, the optimal quota of low-skill immigrants is found by substituting B^* into equation (11).

For practical purposes, q can be approximated by the periodical unemployment payment per person in the host-country, and the cost of border enforcement by $C = cB^a$, whose coefficients $c > 0$ and $a > 1$ denote, respectively, the minimum cost for apprehending an illegal immigrant and the elasticity of the border-control costs with

respect to the number of illegal immigrants apprehended. These minimum cost and elasticity reflect how porous the country is physically (e.g., due to a large size, long borders, difficult topography and dense flora) and socially (e.g., due to a large and ethnically diversified population) and their estimation should take into accounts these factors.

The complexity of the explicit form of g_1^* , ℓ and y implies that the computation of the optimal stationary number of illegal immigrants apprehended and detained and the optimal low-skill immigration quota is not an easy task. In addition to the estimation of the aforementioned parameters of the border-control-cost function, the computation of B^* and L_t^{d*} requires an estimation of the stationary means, variances and covariances of V , B , B_{-1} and J and assessment of the effects of border-control on the stationary variances and covariances.

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