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UNEMPLOYMENT AND FEEDBACK APPROACH TO THE MANAGEMENT OF IMMIGRATION BY THE HOST COUNTRY

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ABSTRACT

This paper presents a broad approach to the analysis of immigration by combining aspects of both supply of immigrants and demand for immigrants. Immigration is assumed to be motivated by lack of economic and noneconomic opportunities; and, correspondingly, immigrants are classified as early immigrants, late immigrants and refugees. An optimal immigration quota's policy, which is based on a linear feedback rule and aimed at stabilizing the host-country's unemployment level, is developed. The optimal feedback coefficient is found to be dependent upon the correlations of the number of legal immigrants in the previous period with the current numbers of illegal immigrants and vacant jobs, and upon the variances of these variables. The consequences of the feedback policy on the numbers of early immigrants, late immigrants, and illegal immigrants are discussed under the assumption that early immigrants and late immigrants generate rational expectations about incomes in the host country. This conceptual framework is applied to the United States in order to assess its immigration policy.
The traditional economic literature on migration focuses on the supply of immigrants and explains incidences of migration by combining two well-known ideas. One of these ideas is the location choice hypothesis raised by Schultz (1962) and Sjaastad (1962) which suggests that a difference in the discounted net present value of pecuniary and non-pecuniary income streams between two places precipitates migration. The other hypothesis introduced by Kuznets and Thomas (1958) proposes that special human capital characteristics enhance migration. That is, the migrants come from selective groups endowed with a high capacity to adapt themselves to unfamiliar environments and, are dynamic and risk-taking beings. Both hypotheses are concerned with the migrants’ consideration and regard migration as permanent.

In contrast, an interesting new approach, which emphasises the demand for immigrants, has been suggested by Ethier (1985, 1986). This approach focuses on the host-country’s perspective, views the migration as temporary, and takes the supply of migrant labour as unlimited at predetermined terms. It treats migration symmetrically with international labour mobility into a standard factor-endowment model of international trade. In the centre of this model are factors such as the elasticity of demand for the host-country exports, and the correlation between conditions in the export market and in the migrant labour market. These factors, it is suggested, imply that native labour fluctuations can be moderated by a combination of commodity dumping and migrant dumping.

Whether labour migration can be viewed as temporary or permanent, and whether the host-country welfare considerations should be confined to the native population or expanded to take into account the well-being of migrant workers and their accompanying families are open issues for debate. The rate of return of the international labour force varies significantly with regard to the migrants’ countries of origin and destination. On the one hand, we find that the majority of workers migrating from the Asian and Pacific countries to the oil-producing Middle-East countries go on contract for a specified period of time and return at the end of the contract. On the other hand, guest workers in West-European countries, who arrived following the labour shortage created by the economic boom of the late 1950s and the early 1960s, tended to remain despite the recession of the 1970s. Moreover, it appears that these guest workers have become a permanent part of the population and the labour supply of the West-European countries. This development is
due to several factors: 1. needs that cannot be satisfied in the countries of origin have been developed in the host countries, 2. labour surplus in the source countries have been increased by the repercussion effects during the 1970s, and 3. there is a growing awareness of the migrant workers' civil rights in the host countries. Consequently, the economic gains to the West-European countries have been replaced by severe social problems of unemployment and tension between natives and immigrants. Whether these problems can be resolved by dumping migrant workers is a delicate issue that involves important ethical and moral aspects. This issue is beyond the scope of the present paper.

The present paper provides a conceptual analysis of the optimal management of immigration by the host country which takes into account aspects on both the supply of immigrants and the demand for immigrants. The analysis presents strong lines of similarity to well known macroeconomic analyses of stabilisation policy of the rational expectations' school, and assumes that for moral and ethical reasons migrants should not be dumped. The supply of migrants to the host country is classified in section I into three distinct groups: early immigrants and late immigrants who are motivated by economic reasons, and refugees. All immigrants are assumed to be endowed with identical stocks of human capital, but face different opportunities in their country of origin. Early immigrants are discriminated in their homeland's labour market, and refugees are persecuted on political, ethnic, or religious grounds. The demand for immigrants is derived in section II by minimising the expected loss from an increase in the unemployment level subject to a linear feedback rule. The extent of early immigration, late immigration and excess supply of immigrants (i.e., illegal immigration) is analysed in section III under the assumption that early immigrants and late immigrants generate their expectations about incomes in the host country rationally. Possible trajectories of immigration to the host country are described in section IV. This conceptual analysis is applied in section V to the United States in order to assess its immigration policy during the 1970s and 1980s. Finally, the paper is concluded in section VI with a brief summary.
I. SUPPLY OF IMMIGRANTS

The supply of immigrants to the host country at period t is assumed to be from a single source and comprising three distinct groups. The members of the first group are those who at the end of the period t-1 perceived their expected income in the host country to exceed their income in the country of origin, and hence migrated at the beginning of period t. We refer to them as early migrants (EM) and present them in our model by the linear equation:

\[ EM_t = \alpha (t_{-1}W_t^h - W_t^o) \]  \hspace{1cm} (1)

where \( t_{-1}W_t^h \) is the expectation, taken at the end of period t-1 of the income in the host country at t, \( W_t^o \) is the income at t in the country of origin which is assumed to be known at t-1; and \( \alpha \) is a positive parameter denoting the propensity of the first group of potential migrants to migrate.

The second group of immigrants includes those individuals who at the end of period t-1 believed that their income in the country of destination will not exceed that in the country of origin, and hence did not immigrate immediately. These are individuals who enjoy higher incomes in the country of origin than their early immigrant counterparts. However, once realising that their expectations about incomes in the country of destination were underestimated, they migrate during the t-th period. We refer to them as late migrants (LM), and assume that their number increases with the expectations' error as described by the following equation:

\[ LM_t = \beta(W_t^h - t_{-1}W_t^h) \]  \hspace{1cm} (2)

where \( W_t^h \) is the average income in the country of destination at t, and \( \beta \) is the propensity of the second group of potential migrants to migrate.

The third group of immigrants consists of individuals who are motivated by nonpecuniary reasons such as persecutions on religious, ethnic and political grounds. We call them refugees. Since persecutions in the country of origin might continue for more than one period, a positive correlation (\( \theta \)) between immigrations of refugees in two successive periods is very likely. Thus, we describe the stream of refugees (R) to the host country by a first-order autoregressive process.

\[ R_t = \theta R_{t-1} + \epsilon_t \]  \hspace{1cm} (3)
where $\epsilon_t$ is a white noise having zero mean and finite variance.

Summing up, the supply of migrants to the host country is given by

$$M^s_t = EM_t + LM_t + R_t.$$  \hspace{1cm} (4)

II. DEMAND FOR IMMIGRANTS

The distinction between the various groups of immigrants, and in particular between early and late immigrants, might have important implications on the host-country's level of unemployment, output and income distribution and hence on its demand for immigrants. For instance, if earning opportunities were equally distributed in the country of origin and income were directly related to possession of human capital, one could deduce from the supply equations 1 and 2 that early immigrants are endowed with less human capital than late immigrants. On the one hand, the host country should be aware that in this case a substantial share of the host-country's immigrant quota could be first exploited by less talented and able people, unless a screening policy is implemented. On the other hand, a screening policy should take into account that, in contrast to late immigrants who are endowed with more human capital, early immigrants do not necessarily compete with the native population in the labour market, but are rather engaged in employment occupations which are considered to have low status. Thus, the greater the share of early immigrants in the total immigrant population, the lower the tension between the host-country's native population and immigrants.

In contrast to the above description, the host-country's demand for immigrants will be derived under the alternative assumptions that human capital is distributed equally in the country of origin and that income inequality is predominantly due to unequal distribution of opportunities. These assumptions imply, in terms of the supply equations specified above, that early immigrants are more severely discriminated at their homeland's labour market than late immigrants. Since all immigrants are assumed to be identical with regard to potential performances in production, the host country should be indifferent between early immigrants and late immigrants, and apply nondiscriminating immigration policy against early immigrants. In this case it seems reasonable that the host country should only be concerned with the effect of immigration on the domestic level of unemployment.
Immigration increases the host-country's supply of labour. Hence, we postulate that the host country's demand for migrants is found by minimising the expected loss from an increase in unemployment above a desired level. The increase in the host country unemployment level (U) at period t is given by:

\[ U_t = M_t - J_t + V_t \]  \hspace{1cm} (5)

where \( M \) is the number of migrants who legally entered the host country at \( t \), \( J \) is the number of vacant jobs at \( t \), and \( V \) is the number of illegal immigrants who successfully enter the host country at \( t \). Since a successful illegal immigration at one period might encourage further illegal immigration at the following period, we specify \( V \) as a stochastic first-order autoregressive process:

\[ V_t = \phi V_{t-1} + \varepsilon_2 \]  \hspace{1cm} (6)

where \( \phi \) is the correlation coefficient between illegal immigrations in two successive periods, and \( \varepsilon_2 \) is a white noise having zero mean and finite variance \( \sigma_2^2 \).

We assume that the host-country immigration authorities are aware of the adverse effect of immigration on the domestic level of unemployment as presented in equation 5, and hence admit a certain number (\( M \)) of immigrants that minimises the expected loss from an increase in the unemployment level. We shall inquire into the optimality of the widely practiced "lean against the wind" immigration strategy by considering the linear feedback rule:

\[ M_t = g_0 - g_1 M_{t-1} \geq 0 \]  \hspace{1cm} (7)

where the parameters \( g_0 \) and \( g_1 \) indicate the maximum periodical number of immigrants admitted and the immigration feedback coefficient, respectively; and are chosen to minimise the expected loss function. As is frequently practiced in stabilisation macroeconomic studies (e.g., Poole, 1970; Chow, 1970; Sargent and Wallace, 1976), we specify the expected loss function to be quadratic in its argument, and set the stationary mean of the increase in the level of unemployment to be equal to the desired level. Therefore, the host-country's decision problem can be rendered equivalently as minimising the stationary variance of the increase in the unemployment level by an appropriate choice of \( g_1 \).
By substituting 7 in 5 for \( M_t \) we can demonstrate that the stationary variance of the increase in the unemployment level is:

\[
\text{var} (U) = g_1^2 \text{var}(M) + 2g_1[\text{cov}(M_{t-1}, J) - \text{cov}(M_{t-1}, V)] + 2\text{cov}(J, V) + \text{var}(J) + \text{var}(V). \quad (8)
\]

Hence, the necessary condition for minimum \( \text{var}(U) \) implies that the optimal feedback coefficient is given by

\[
g_1 = \frac{\text{cov}(M_{t-1}, V) - \text{cov}(M_{t-1}, J)}{\text{var}(M)}.
\]

(9)

Given that \( \text{var}(M) > 0 \), the second-order condition for minimum \( \text{var}(U) \) is satisfied.

Equation 9 indicates that the optimality of a migration policy based on a feedback rule depends crucially on the existence of a difference between the stationary covariances of the lagged number of legal migrants with the current numbers of vacant jobs and illegal immigrants. It seems reasonable to assume that the more restrictive the immigration quota in the past, the larger the illegal immigration in the present, i.e., negative correlation between \( M_{t-1} \) and \( V \). It also seems reasonable to assume that the more restrictive the immigration quota in the past, the greater the number of vacant jobs in the host country in the present, i.e., negative correlation between \( M_{t-1} \) and \( J \). Thus, the "lean against the wind" setting of immigration quotas (i.e., \( g_1 > 0 \)) is optimal if \( \text{cov}(M_{t-1}, J) \) is greater than \( \text{cov}(M_{t-1}, V) \) in absolute value, or equivalently if

\[
| \text{cor}(M_{t-1}, J) \text{sd}(J) | > | \text{cor}(M_{t-1}, V) \text{sd}(V) | .
\]

(10)

That is, the likelihood that a "lean against the wind" strategy of immigration certificates' allocation will be optimal:

(1) increases with the standard deviation (sd) of the number of vacant jobs in the host country,
(2) increases with the correlation (cor) between one-period lagged number of legal immigrants and current number of vacant jobs in absolute value,
(3) decreases with the standard deviation of the number of illegal immigrants, and
(4) decreases with the correlation between one-period lagged number of legal immigrants and current number of illegal immigrants in absolute value.
Equation 9 also indicates that the immigration feedback coefficient should also be inversely related to the variance of the number of legal immigrants'.

When \( \text{cov}(M_{t-1}, V) \) and \( \text{cov}(M_{t-1}, J) \) are equal, the maximum quota, \( g_o \), is optimal. In order to find \( g_o \), let us compute the stationary expectation of \( U \) from equation (5) and (6), and set it to be equal to the desired increase in the level of unemployment \( U^* \):

\[
E(U) = g_o - g_1E(M) - E(J) + \phi V_{t-1} = U^*. \quad (11)
\]

By substituting (9) for \( g_1 \) in (11) we obtain that

\[
g_o = U^* + \left( \frac{\text{cov}(M_{t-1}, V) - \text{cov}(M_{t-1}, J)}{\text{var}(M)} \right) E(M) + E(J) - \phi V_{t-1}. \quad (12)
\]

The host-country's demand for legally new immigrants (\( M^d \)) can now be found by substituting equations (9) and (12) for \( g_1 \) and \( g_o \), respectively, in the feedback rule (7):

\[
M^d_t = U^* + E(J) - \phi V_{t-1} - \left( \frac{\text{cov}(M_{t-1}, V) - \text{cov}(M_{t-1}, J)}{\text{var}(M)} \right) [M_{t-1} - E(M)], \quad (13)
\]

provided that the right-hand-side (r.h.s.) of this equation is nonnegative. That is, the host-country's demand for immigrants is equal to its desired increase in the level of unemployment and the number of vacant jobs minus the expected number of illegal immigrants and the product of the optimal feedback coefficient and the deviation of the number of immigrants admitted in the previous period from the stationary number. Note, however, that when the r.h.s. of equation 13 is negative, \( M^d_t \) is set to be zero because of our postulate that migrants should not be dumped. In the following sections we assume that the r.h.s. of equation 13 is nonnegative.
III. DISEQUILIBRIUM AND THE NUMBER OF IMMIGRANTS UNDER RATIONAL EXPECTATIONS

Many of the preferred countries of destination, in particular the West-European and North-American countries, suffer from the problem of illegal immigration. This problem is a reflection of a permanent excess supply of immigrants. Recalling equations 1 to 4, which specify the supply of immigrants, and equation 13, which specifies the host country's demand for immigrants, the extent of the illegal immigration at any point of time \( t \) is given by

\[
V_t = \alpha (t_1 W_t^h - W_t^o) + \beta (W_t^h - t_{-1} W_t^h) + R_t - U^* - E(J) + \phi V_{t+1} + \frac{\text{cov}(M, V) - \text{cov}(M, J)}{\text{var}(M)} [M_{t+1} - E(M)].
\]  

Rearranging equation 14 and recalling equation 6, the income in the host country at \( t \) can be expressed as

\[
W_t^h = \frac{1}{\beta} \{ U^* + E(J) - \frac{\text{cov}(M, V) - \text{cov}(M, J)}{\text{var}(M)} [M_{t+1} - E(M)] - \alpha (t_1 W_t^h - W_t^o) + \epsilon_t - R_t \} + t_{-1} W_t^h.
\]  

In what follows we assume that the expectations of the immigrants who are motivated by economic reasons (i.e., early and late immigrants), about their income, in the host country are rational. Considering Muth's (1961) definition of rational expectations, we require that

\[
t_{-1} W_t^h = E_{t-1}(W_t^h).
\]  

Taking the expectations of the r.h.s. of equation 15 and recalling equation 3 and that in steady state \( E(M_t) \) is equal to \( E(M_{t-1}) \) we obtain that

\[
t_{-1} W_t^h = W_t^o + \frac{1}{\alpha} [U^* + E(J) - \theta R_{t+1}].
\]  

Under the assumption of rational expectations, the early immigrants and the late immigrants perceive the expected income differential between the countries of destination and origin to raise with the increase in the desired level of unemployment and with the number of vacant jobs in the
host country, and to decrease with the expected number of refugees. The effects of these factors on the perceived income differential are moderated by the early migrants' propensity to migrate, \( \alpha \). The underlying reason is that, *ceteris paribus*, the greater \( \alpha \) the larger the number of early immigrants and hence the supply of labour at the beginning of period \( t \).

By substituting 17 into 1 we obtain that the number of early immigrants can be expressed as

\[
EM_t = U^* + E(J) - \theta R_{t-1}.
\]  

That is, if the host country applied a linear feedback immigration policy in order to reduce the expected loss from an increase in the unemployment level, and if immigrants' expectations about their income in the host country were rational, then the number of early immigrants would be equal to the sum of vacant jobs and the desired increase in the number of unemployed minus the expected number of refugees.

The substitution of 17 in 15 and the consideration of 3 imply that the income expectations' error can be presented as

\[
W_t^h - t_1 W_t^h = \frac{1}{\beta} \left\{ \frac{\text{cov}(M_{t-1},J) - \text{cov}(M_{t-1},V)}{\text{var}(M)} \right\} [M_{t+1} - E(M)] - \varepsilon_{1t} + \varepsilon_{2t},
\]

In recalling equation 2, the number of late immigrants, i.e., whose prior expectations about the income differential between the countries of destination and origin were underestimated, can be rendered as

\[
LM_t = \left[ \frac{\text{cov}(M_{t-1},J) - \text{cov}(M_{t-1},V)}{\text{var}(M)} \right] [M_{t+1} - E(M)] - \varepsilon_{1t} + \varepsilon_{2t}.
\]

That is, under a linear feedback immigration policy and rational expectations, the number of late immigrants is equal to the product of the optimal feedback coefficient and the difference between the stationary number and previous period's number of immigrants, plus the difference between the random shocks in the current number of illegal immigrants and in the current number of refugees.
Substituting 18 and 20 into 4 and recalling 3, the total number of immigrants to the host country at \( t \), i.e., early immigrants plus late immigrants plus refugees, is given by

\[
M_t = U^* + E(J) + \left[ \frac{\text{cov}(M_{t-1}, J) - \text{cov}(M_{t-1}, V)}{\text{var}(M)} \right] [M_{t-1} - E(M)] + \varepsilon_t \tag{21}
\]

As mentioned above, the excess supply of immigrants reflects the extent of illegal migration into the host country. Equation 6 describes this illegal migration as a stochastic first-order autoregressive process where the autoregression coefficient \( \phi \) can be interpreted as indicating the prospects of entering the country of destination successfully for the potential illegal migrants. Thus, the host-country’s effort in deterring illegal immigration should be aimed at lowering the correlation \( (\phi) \) between illegal immigrations in successive periods. This can be achieved by irregular and surprising investment of effort in border patrols, inspections of suspicious employment places, etc. Note further that the decrease in \( \phi \) also moderates the variance of the number of illegal immigrants as can be seen from the following equation:

\[
\text{var}(V_t) = \frac{\sigma_2^2}{1-\phi} \tag{22}
\]

IV. IMMIGRATION TRAJECTORIES

Equation 21 shows that under a linear feedback immigration policy and rational expectations the immigration into the host country follows a stochastic first-order difference equation. The solution to the deterministic part of this equation gives the instantaneous mean of the total number of immigrants entering the host country:

\[
E(M_t) = U^* + E(J) + [E(M_0) - U^* - E(J)] \left[ \frac{\text{cov}(M_{t-1}, J) - \text{cov}(M_{t-1}, V)}{\text{var}(M)} \right]^t \tag{23}
\]
where $U^*$ plus $E(J)$ (i.e., the sum of the increase in the desired unemployment level and the stationary mean of vacant jobs in the host country) is the stationary mean of immigrants, and $E(M_0)$ is the initial mean of immigrants. This stationary mean of immigrants is asymptotically stable if

$$\left| \frac{\text{cov}(M_{-1}, J) - \text{cov}(M_{-1}, V)}{\text{var}(M)} \right| < 1.$$  \hspace{1cm} (24)

That is, the smaller the difference between the covariances of the one-period lagged number of legal immigrants with the current numbers of vacant jobs and illegal immigrants and the larger the variance of the number of legal immigrants, the greater the prospects of asymptotic stability.

It was argued earlier that the covariances of the number of immigrants admitted a period ago with the current numbers of vacant jobs and illegal immigrants are likely to be negative. Thus, if $\text{cov}(M_{-1}, V)$ is greater than $\text{cov}(M_{-1}, J)$ in absolute value, $[\text{cov}(M_{-1}, J) - \text{cov}(M_{-1}, V)]$ is positive; and given that 24 holds, the instantaneous mean number of immigrants converges gradually to the stationary level from above or below as the initial mean number of immigrants is greater or smaller than the stationary level, respectively. However, in the opposite case where $\text{cov}(M_{-1}, J)$ is greater than $\text{cov}(M_{-1}, V)$ in absolute value, the trajectory of the instantaneous mean number of immigrants displays dampened, or explosive, oscillations around the stationary number provided that 24 is satisfied or not, respectively.

V. IMPLICATIONS FOR THE UNITED STATES

This empirical work follows the theoretical analysis presented in the preceding sections and is concerned with the immigration into the United States after the implementation of the 1965 congressional act. In 1921, the Congress enacted the first numerical ceiling on immigration (357,000 per year) into the United States. This act applied only to the Eastern Hemisphere countries and their dependencies, and required that immigrants be classified to quota and nonquota immigrants. Between 1929 and 1968, quotas were determined by the "national origin" formula. The act of 1965, which became fully effective in July 1968, abolished the quota system and set up
annual limitations of 170,000 immigrants from the Eastern Hemisphere and 120,000 immigrants from the Western Hemisphere, which had been previously unrestricted. After 1968, immigrants were classified as those subject to numerical limitations of the Eastern Hemisphere and of the Western Hemisphere, and those exempt from the numerical limitations. Those exempt included immediate relatives of U.S. citizens and various classes of special immigrants. In October 1978 the separate hemisphere limits were abolished in favor of a worldwide limit of 290,000. This limit was lowered to 280,000 for the fiscal year 1980, and to 270,000 for the fiscal year 1981 and subsequent years.

The data base utilized in the empirical analysis is presented in Table 1 below. It encompasses the fifteen-year period between 1970 and 1984, and comprises annual values of the: 1. total immigration admitted, 2. smuggled aliens apprehended (predominantly Mexicans), 3. border patrol agents on duty, and 4. total unemployed workers.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Immigrants Admitted (M)</th>
<th>Smuggled Aliens Apprehended (SAA)</th>
<th>Border Patrol Agents on Duty (BPA)</th>
<th>Total Unemployed Workers (UWE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>373,326</td>
<td>18,700</td>
<td>1,708</td>
<td>4,088,000</td>
</tr>
<tr>
<td>1971</td>
<td>370,478</td>
<td>19,800</td>
<td>N.A.</td>
<td>4,994,000</td>
</tr>
<tr>
<td>1972</td>
<td>384,685</td>
<td>24,900</td>
<td>N.A.</td>
<td>4,882,000</td>
</tr>
<tr>
<td>1974</td>
<td>394,861</td>
<td>83,100</td>
<td>1,665</td>
<td>5,076,000</td>
</tr>
<tr>
<td>1975</td>
<td>386,194</td>
<td>80,400</td>
<td>1,708</td>
<td>7,929,000</td>
</tr>
<tr>
<td>1976</td>
<td>398,613</td>
<td>82,900</td>
<td>1,193</td>
<td>7,406,000</td>
</tr>
<tr>
<td>1977</td>
<td>642,315</td>
<td>138,800</td>
<td>1,990</td>
<td>6,991,000</td>
</tr>
<tr>
<td>1978</td>
<td>601,442</td>
<td>159,200</td>
<td>2,151</td>
<td>6,202,000</td>
</tr>
<tr>
<td>1979</td>
<td>460,384</td>
<td>172,700</td>
<td>2,051</td>
<td>5,963,000</td>
</tr>
<tr>
<td>1980</td>
<td>530,639</td>
<td>112,600</td>
<td>2,329</td>
<td>7,637,000</td>
</tr>
<tr>
<td>1981</td>
<td>596,600</td>
<td>90,100</td>
<td>2,218</td>
<td>8,273,000</td>
</tr>
<tr>
<td>1982</td>
<td>594,131</td>
<td>80,400</td>
<td>2,186</td>
<td>10,678,000</td>
</tr>
<tr>
<td>1983</td>
<td>559,763</td>
<td>86,700</td>
<td>2,291</td>
<td>10,717,000</td>
</tr>
<tr>
<td>1984</td>
<td>543,903</td>
<td>91,700</td>
<td>2,281</td>
<td>8,539,000</td>
</tr>
</tbody>
</table>

An inspection of the second column of Table 1 indicates that while the officially declared policy since 1968 was contractionary, the policy in practice during the observed period was expansionary. This impression is confirmed by the significantly positive coefficients of the regression of the total immigration admitted onto a time trend $t$:

$$M_t = 329,874 + 2,810t + \text{error}. \quad (25)$$

The numbers in the parentheses indicate the t-ratios, the $R^2$ is 0.751, and the Durbin-Watson test statistic is 1.847.

A major obstacle in pursuing an empirical analysis in the lines of the previous theoretical sections stems from the inavailability of explicit information on the annual number of immigrants who are smuggled into the United States without being apprehended ($V$). However, we shall argue that the annual number of smuggled aliens apprehended (SAA) can serve as a reasonable proxy to $V$. Similarly to studies on renewable resources we assume that SAA is proportional to the annual total number of aliens smuggled into the U.S. (TAS), and that the proportion coefficient ($\gamma$) rises with the border police effort proxied by the annual number of the border patrol agents on duty (BPA):

$$\text{SAA}_t = \gamma(\text{BPA}_t) \cdot \text{TAS}_t. \quad (26)$$

As can be seen from Table 1, while there was a moderate increase in the number of BPA during the last two decades, the number of SAA boosted by 850 percent between 1970 and 1979. This increase in SAA is predominantly due to the unprecedented rise in TAS following the imposition of the numerical limitation on immigration from the Western Hemisphere. Assuming that the BPA's operation methods did not change dramatically, we may consider $\gamma$ to be constant over the observed period. This and the fact that $V$ is equal to the difference between TAS and SAA imply, in turn, that over the observed period $V$ was likely to be proportional to SAA as presented in the following equation:

$$V_t = \frac{1}{\gamma} - 1 \cdot \text{SAA}_t. \quad (27)$$
Given that \( V \) is proportional to SAA, it is possible to proceed with the empirical analysis. First, the important autoregression coefficient \( \phi \) associated with the time-series of the annual number of illegal immigrants crossing the border without being apprehended can be estimated by regressing SAA onto its one year lag. The estimated value of \( \phi \) for the observed period is 0.9925 and is statistically significant at the 0.0001 level. According to the arguments made earlier in section 3, this finding should indicate that during the 1970s and early 1980s the prospects of successfully smuggling illegal immigrants into the United States were very high.

Second, equation 27 implies that by utilising the data on SAA the covariance between \( V \) and \( M_{-1} \), which is essential for evaluating the immigration optimal feedback coefficient \( g_1 \), can be computed up to an unknown proportion:

\[
\text{cov}(M_{-1}, V) = \left(\frac{1}{\gamma} - 1\right) \text{cov}(M_{-1}, \text{SAA}) = \left(\frac{1}{\gamma} - 1\right) 1,526,263,271. \tag{28}
\]

Recalling equation 9, the evaluation of \( g_1 \) also requires the computation of the covariance between the number of vacant jobs and the lagged number of legal immigrants, and the variance of the latter factor. The annual number of vacant jobs is the mirror image of the annual number of unemployed workers (UEW) and hence

\[
\text{cov}(M_{-1}, J) = -\text{cov}(M_{-1}, \text{UEW}) = -119,570,580,860. \tag{29}
\]

The variance of the one-year lagged number of immigrants admitted into the United States for the observed period is found to be

\[
\text{var}(M_{-1}) = 7,819,200,000. \tag{30}
\]

Based on these calculations and equation 9, the optimal feedback coefficient for the immediate period that followed the sample period is given by

\[
g_1 = \left(\frac{1}{\gamma} - 1\right) 0.1951943 + 15.29192, \tag{31}
\]
which implies that \( g_1 \geq 0 \) as \( \gamma \leq -0.0129 \).

Recalling equation 27 and the fact that both \( V \) and \( SAA \) are positive, \( \gamma \) is always positive and hence \( g_1 \) should be positive. In view of the linear feedback rule 7, this result implies that, in contrast to the expansionary policy practiced during the 1970s and early 1980s, the optimal immigration policy for the second half of the 1980s is "leaning against the wind". Furthermore, recalling equation 9 and 23, a positive \( g_1 \) implies that the optimal immigration path for the rest of the 1980s oscillates around the stationary level. The oscillations of the optimal immigration path are most likely to be dampened, unless \( 0.0654 \leq \gamma \leq 0.0752 \).

VI. SUMMARY AND CONCLUSIONS

This paper presents a broad approach to an analysis on immigration by combining aspects on both the supply and demand sides of this phenomenon. Immigrants are assumed to be motivated by lack of economic and noneconomic opportunities in the country of origin relative to those in the country of destination, and are classified as early immigrants, late immigrants and refugees. The paper develops an immigration quota policy which is based on a linear feedback rule and aimed at stabilising the host-country's unemployment level. The optimal feedback coefficient was found to be increasing in the correlation between the previous period's number of legal immigrants and the current number of vacant jobs in absolute value and in the standard deviation of the number of vacant jobs. The optimal feedback coefficient decreases with the correlation between the previous period's number of legal immigrants and the current number of illegal immigrants, with the standard deviation of the number of illegal immigrants, and with the variance of the number of legal immigrants.

The consequences of a feedback policy on the actual number of immigrants and the classification of the immigrant population to early immigrants, late immigrants, and refugees are investigated by taking into account the possibility of excess supply, which is reflected by illegal immigration. The consequences obtained are based on the assumption that the expectations of
early immigrants and late immigrants about their income in the country of destination are rational. The number of early immigrants is shown to be equal to the sum of the mean number of vacant jobs and the desired increase in the number of the unemployed minus the expected number of refugees. The number of late immigrants is found to be equal to the product of the immigration feedback coefficient and the difference between the stationary number of immigrants and the previous period's number of immigrants, plus the difference between the random shocks in the current numbers of illegal migrants and refugees. It is argued that the correlation between illegal immigrations in two successive periods can be interpreted as indicating the prospects of entering the country uncaught. Hence, measures of deterring illegal migration should be based on the element of surprise in order to moderate this correlation. Such measures also reduce the variance of the number of illegal immigrants.

The paper also describes possible trajectories of immigration, and demonstrates that asymptotic stability relies on the covariances of the previous period's number of immigrants with the numbers of current illegal immigrants and vacant jobs, and on the variance of the number of legal immigrants.

Finally, the paper applies this conceptual framework to assess important aspects of the immigration into the United States during the 1970s and 80s. It shows that, in contrast to the expansionary policy practiced during the 1970s and early 1980s, the optimal immigration policy for the second half of the 1980s is "leaning against the wind". The implementation of such a policy could minimise the loss of social welfare from an undue increase in the unemployment level.
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