Immigration and Outsourcing: A General Equilibrium Analysis

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Abstract

This paper analyzes the issues of immigration and outsourcing in a general-equilibrium model of international factor mobility. In our model, legal immigration is controlled through a quota, while outsourcing is determined both by the firms (in response to market conditions) and through policy-imposed barriers. A loosening of the immigration quota reduces outsourcing, enriches capitalists, leads to losses for native workers, and raises national income. If the nation targets an exogenously determined immigration level, the second-best outsourcing tax can be either positive or negative. If in addition to the immigration target there is a wage target (arising out of income distribution concerns), an outsourcing subsidy is required. The analysis is extended to consider illegal immigration and enforcement policy. A higher legal immigration quota will lead to more illegal immigration if skilled and unskilled labor are complements in production. If the two kinds of labor are complements (substitutes), national income increases (decreases) monotonically with the level of legal immigration.

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** The views expressed are those of the authors and do not necessarily represent official positions of the Federal Reserve Bank of St. Louis or of the Federal Reserve System.

1. Introduction[1]

Because of its potential effects on segments of the US economy, outsourcing has become one of the major issues confronting US policymakers. The outsourcing of services, in particular, has taken on increased importance. In a recent contribution, Bhagwati, Panagariya, and Srinivasan (2004) write

> "In the early 1980s, "outsourcing" typically referred to the situation when firms expanded their purchases of manufactured physical inputs...But in 2004, outsourcing took on a different meaning. It referred now to a specific segment of the growing international trade in services . This segment consists of arm's length, or what Bhagwati (1984) called "long-distance" purchase of services abroad, principally, but not necessarily, via electronic mediums such as the telephone, fax and the internet..."[2]

While outsourcing has become more prominent, policies toward both legal and illegal immigrants has continued to occupy a central place in policy debates. Although immigration and outsourcing are interrelated, to our knowledge there has been little work that links them in a formal economic model. In the present paper, we provide a single-good model that allows for a systematic analysis of immigration policy in the context of the outsourcing of services.[3] While the focus in this paper is on the demand side, there are implications of these policies for developing nations like India, who constitute the supply side of this issue. Therefore, this paper seeks to contribute to an area of overlap of the fields of trade, development and labor.

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[1]We would like to thank Bharati Basu and Arvind Panagariya for discussions. We would also like to thank the seminar participants at Central Michigan University and Michigan State University for their comments. The usual disclaimer applies.

[2]The paper also notes that such transactions are categorized as Mode 1 trade in services in WTO terminology.

[3]Let us think of this single good being software. Two factors are used to produce this good, entrepreneurial capital and skilled labor. In short, we may say that this good is produced by capital and labor.

To see the potential links between outsourcing and immigration, consider the software development industry. One of the inputs required in software development is innovation by research engineers cum entrepreneurs in the nation (say, the US) that will own the copyright for the product. Routine programming skills, which can be performed by skilled labor in either the US or in another nation (say India) that has an abundance of skilled labor, also can be used to develop the final product. When hiring programmers, firms in the US can hire US natives, hire Indian immigrants, or outsource the programming by hiring programmers residing in India.[4] When choosing among their three sources of programmers, legal immigration is restricted by quotas (of the temporary immigration varieties, like the H1 visa) determined by the legislative and the executive branches of the government. US firms hire domestic programmers up to the point in which the wage of the domestic workers equals the wage of the immigrant workers. The wage paid to the worker in the foreign country equals the foreign wage rate which is lower than the domestic wage rate. There are limits to the amount of outsourcing that a firm will do because it incurs a rising marginal cost. At the margin, jobs are outsourced to the point where the marginal cost of outsourcing the job to a unit of foreign labor equals the domestic wage rate.

A larger immigration quota raises the ratio of labor to capital. The rise in labor intensity reduces the marginal product of labor, the domestic wage, and, with a given foreign wage, the marginal benefit and the level of outsourcing. It is through this mechanism that immigration and outsourcing are substitutes: A loosening of the immigration quota hurts the native workers but benefits native capital.

[4]To focus on outsourcing and immigration issues as they pertain to the high-tech sector, we abstract in this section from the presence of unskilled labor. We relax this assumption in a later section where we consider the additional issue of illegal immigration.

The gains of this loosening outweigh the losses because the fall in the immigrant wage is a net terms-of-trade benefit (in the factor market) for the nation.

It is well understood that immigration is regulated for economic reasons as well as for social and political considerations. For example, perhaps to maintain social or cultural identity, the government may want to fix the ratio of natives to immigrants for maintaining. In nations where naturalization is allowed, the government may look at the immigrants as potential future citizens and therefore want them to be better assimilated in the society. This may require training costs for the government, such as teaching English, Civics, and History to potential immigrants, which can limit the socially optimal level of immigration.

Because the modeling of all such factors that affect immigration is beyond the scope of this paper, we follow Ethier (1986) and consider an exogenously given policy target for immigration. We show that in the presence of such a target, there are two conflicting effects of levying a tax on outsourcing. The tax will reduce outsourcing, reducing the labor-to-entrepreneurial-capital ratio, and raise the domestic wage. While the rise in the wage paid to immigrants reduces national income, a reduction in outsourcing will reduce the demand for labor in the source nation (India). This reduces the wage at which US firms buy Indian labor and confers a terms-of-trade benefit to the US. The relative strengths of these effects determines whether the optimal policy toward outsourcing is a tax or a subsidy.

The preceding discussion has described how a relaxation of the immigration quota may raise national income. In that scenario, however, wages of native workers fall together with those of the immigrants. Such a policy will face political opposition in the absence of appropriate income redistribution schemes. In light of this, section 3 considers a policy environment which targets a certain acceptable wage for native workers. In the absence of any outsourcing tax (or subsidy), like Ethier (1986) we find that the target wage implies an immigration target (i.e., the two cannot be "unbundled"). With an outsourcing tax (or subsidy) in place, this problem is resolved and a desirable level of immigration that is consistent with the wage target can be attained. Such a policy is not costless, however, because the first-best policy is to have a zero (positive) outsourcing tax if the foreign labor supply is perfectly elastic (upward sloping) with respect to outsourcing. Therefore, an outsourcing subsidy that is required to reduce immigration and raise native wages to its target level must reduce national income.

To consider the problem of illegal immigration of unskilled labor, we extend our model in section 4 to include unskilled labor as a third factor of production. In the model there is a fixed stock of native unskilled workers that is supplemented with unskilled illegal immigrants. Higher US unskilled wages (compared to say Mexico, a source nation of illegal immigrants) leads to this kind of immigration, whose level is endogenously determined through an equilibrium migration process. The government employs both internal and border-detection policies to deter illegal immigration, the level of which adjusts so that the expected wage from migration (for a potential migrant in the source nation) equals the certainty wage available in the source nation.

General equilibrium linkages tie the two types of immigration (legal and illegal) as well as outsourcing. A rise in the legal immigration quota will reduce outsourcing but raise illegal immigration if skilled and unskilled labor are complements in the production process (the reverse is true under substitutability). On the other hand, under complementarity between factors, stricter enforcement of illegal immigration controls will reduce illegal immigration and outsourcing. Thus, depending on the source of the policy change (immigration quota or enforcement) illegal immigration and outsourcing may either be positively or negatively related (in an *ex post* sense). A rise in the legal immigration quota must necessarily raise national income under complementarity but may reduce it under substitutability between skilled and unskilled labor.

The results of section 4 complement the analysis of Jones (2005), which shows that immigration or outsourcing may actually raise the wage rates of the native workers. Although his discussion on outsourcing is somewhat different from our context, the remarks on immigration are closely related. He argues that, although immigration can lower wages in low-dimensional models that ignore heterogeneity, it might actually raise wages of low-skilled natives in models where different skill levels co-exist. We explore this issue at length in our discussion of the coexistence of illegal and legal immigration of different skill types.

The rest of the paper is organized as follows. Section 2 presents the basic model and discusses optimal immigration policy. Section 3 considers immigration and outsourcing in the presence of exogenous targets on immigration and the wage rate, respectively. Section 4 augments the analysis by including unskilled labor and illegal immigration. Section 5 concludes.

2. The Model and Analysis

Let there be two nations, home and foreign. The home nation produces a single good in quantity Q by using inputs T and L. The entrepreneurial capital is measured by T and L is the effective units of labor used in making Q. The production function is CRS and may be described by

$$Q = F(T, L). \tag{1}$$

Let the domestic labor force be $\bar{L}$ while the immigrant labor force is I. The units of labor that the home firm uses in the foreign nation to produce Q is denoted as n (i.e., n is the amount of outsourced labor). Because of the foreign country's inferior infrastructure, employing a foreign worker in the foreign country is more costly than employing the same worker in the home country. This is captured by $\delta(n)$, which converts a unit of foreign labor into its domestic equivalent. Given the fixed costs associated with outsourcing, $\delta(n)$ is assumed to be negatively related to n, suggesting that the marginal productivity of foreign labor declines as outsourcing rises. This is an alternative way to model increasing marginal costs of outsourcing at the firm level. Thus,

$$L = S + I + \delta(n)n, \text{ where } \delta'(n) < 0. \tag{2}$$

Profit of a domestic firm is

$$\pi = F\{T, S + I + \delta(n)n\} - w_T T - w_S S - w_I I - w^* n. \tag{3}$$

The first order conditions of profit maximization are[5]

$$F_1(1, \rho) = w_T;\ \ F_2(1, \rho) = w_S = w_I; \text{ and, } F_2(1, \rho)\{\delta(n) + n\delta'(n)\} = w^*; \text{ where,}$$

$$\rho = \{S + I + n\delta(n)\}/T = \rho(I, n). \tag{4}$$

Relation (4) implicitly defines

$$n = n(I, w^*). \tag{4'}$$

Let Q^* be the quantity of the foreign good that is produced under CRS:

$$Q^* = F^*(T^*, L^*). \tag{5}$$

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[5]Note that while some of the factors of production are given to the industry (and in this model to the nation as well), they are choice variables at the firm level (under perfect competition).

Let the foreign labor force be denoted by $\bar{L}^*$. Profit maximization by foreign producers and the fact that $L^* = \bar{L}^* - I - n$, yields

$$w^* = F_2^*(T^*, \bar{L}^* - I - n) \Rightarrow w^* = w^*(I + n);\ w_I^* = w_n^* = w^{*\prime} = -F_{22}^*(T^*, \bar{L}^* - I - n) > 0. \tag{6}$$

Using (6) in (4), we have

$$F_2[1, \rho(I, n)]\{\delta(n) + n\delta'(n)\} = w^*(I + n). \tag{7}$$

Relation (7) implicitly defines

$$n = n(I). \tag{7'}$$

Since legal immigration is controlled by the government, I is a policy variable. For $I = \bar{I}$, we obtain n from (7′) and w^* from (6). From (4) we can obtain ρ, w_T, w_S, and w_I. From (1) and (5) we obtain the output levels in the two nations. The effect of a change in the immigration quota on the level of outsourcing can be obtained as

$$n'(\bar{I}) = dn/d\bar{I} = [\{\delta(n) + n\delta'(n)\}F_{22}\, \rho_1(.) - w^{*\prime}]/(w^{*\prime} - SOC_n); \tag{8}$$

where, $SOC_n < 0$ (Second Order Condition of profit maximization).

Note from (4) that

$$\delta(n) + n\delta'(n) = w^*/F_2(1, \rho) > 0,\ \rho_1(\bar{I}, , n) = 1/T > 0;$$

$$\text{and, } \rho_2(\bar{I}, n) = \{\delta(n) + n\delta'(n)\}/T > 0 \Rightarrow \rho_2/\rho_1 = \delta(n) + n\delta'(n) > 0. \tag{4''}$$

Using (4″) in (8), $dn/d\bar{I} < 0$. Thus, a rise in the immigration quota will reduce outsourcing. In other words, immigration and outsourcing are substitutes. Total differentiation of ρ yields

$$d\rho/d\bar{I} = \rho_1(\bar{I}, , n)\ [1 + \{\delta(n) + n\delta'(n)\}(dn/d\bar{I})]. \tag{9}$$

It can be shown that a sufficient condition for $d\rho/d\bar{I}$ to be positive is that

$$d\{\delta(n) + n\delta'(n)\}/dn = 2\delta'(n) + n\delta''(n) < 0. \tag{9'}$$

Recall from (4) that the marginal product of outsourcing is $F_2(1, \rho)\{\delta(n) + n\delta'(n)\}$. For a given ρ, the assumption of diminishing marginal product from outsourcing is equivalent to assuming that (9′) holds. Alternatively, this may be thought of as an assumption that captures increasing marginal costs associated with outsourcing. Assuming that (9′) holds, (9) implies that ρ will rise with a rise in the immigration quota. In view of (4), a rise in ρ must reduce w_S ($=w_I$) and raise w_T. This result makes intuitive sense, a larger immigration quota benefits the capitalists, while it hurts the existing immigrants and native workers. In terms of lobbying by different groups, one would then expect support for immigration control from native workers and opposition to such controls from the employers (capitalists). These results do fit the stylized facts regarding support and opposition for immigration of skilled workers to the US.

Let us now explore the effect of immigration policy on the national income (Y) of the home nation. Following the tradition in this literature, we consider the national income of the native population (excluding immigrant income and outsourced labor income). The government realizes that outsourcing is guided by relation (7′) above. Therefore, national income is

$$Y = F[T, S + \bar{I} + \delta\{n(\bar{I})\}n(\bar{I})] - w_I\bar{I} - w^*\{\bar{I} + n(\bar{I})\}n(\bar{I}). \quad (10a)$$

Note from (4) that w_I is a function of $\rho(I, n)$. Using that relationship we can write (10a) as

$$Y(\bar{I}) = F[T, S + \bar{I} + \delta\{n(\bar{I})\}n(\bar{I})] - w_I[\rho\{\bar{I}, n(\bar{I})\}]\bar{I} - w^*\{\bar{I} + n(\bar{I})\}n(\bar{I}). \quad (10b)$$

Differentiating (10b) and using the first order conditions of profit maximization and the $w^*(.)$ function, we get

$$dY/d\bar{I} = -[(IF_{22}\rho_2 + nw^{*\prime})n'(\bar{I}) + (IF_{22}\rho_1 + nw^{*\prime})]. \quad (11a)$$

The optimal immigration level is

$$I_o = -nw^{*\prime}\{1 + n'(\bar{I})\}/[F_{22}\rho_1 \{1 + n'(.)(\rho_2/\rho_1)\}]. \quad (11b)$$

The optimal immigration level exploits the monopsony power in the international labor market, which is reflected in the term $w^{*\prime}$, showing the extent to which a marginal reduction in immigration will influence the foreign wage.[6] Alternately, note that

$$w_I = F_2[1, \rho(I, n)] \Rightarrow dw_I = F_{22}\{\rho_1 + \rho_2 n'(I)\}dI. \quad (12)$$

Using (12), (11a) may be written as

$$dY = -Idw_I - nw^{*\prime}\{1 + (dn/dI)\}dI = -Idw_I - ndw^*. \quad (11c)$$

There are two effects of change in the immigration quota. The first of these is through a change in the wage rate of immigrants. An increase in the immigration quota raises ρ and lowers w_I, the immigrant wage. This wage reduction is a terms of trade gain for the home nation. Further, a rise in I will reduce n, but (n+I) can be shown to rise. Thus, the foreign wage (w^*) will rise as the immigration quota is raised. This leads to a terms of trade loss in the factor market for the home nation. At the optimum immigration level (if one exists without outsourcing being driven to zero) the marginal benefit from a lower immigrant wage is exactly balanced by a marginal loss from a higher wage paid to outsourced labor. Notice that if the foreign labor supply were to be perfectly elastic (i.e., $w^{*\prime}=0$), then

$$dY/dI = -I(dw_I/dI) = -IF_{22}\{\rho_1 + \rho_2 n'(I)\} > 0, \quad (11d)$$

and national income rises monotonically with I (as long as outsourcing and immigration coexist). Of course, if unfettered immigration is allowed it will eventually drive outsourcing to zero and the model will

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[6]It should be noted that (11b) does not hold if the foreign labor supply curve (for immigration or outsourcing) is perfectly elastic (i.e., if $w^{*\prime}= 0$). We discuss that case below.

degenerate to a pure immigration model. In this latter case, immigration will continue unless the foreign labor supply is exhausted or wages are equalized between the host and the source nation.

3. Second Best Policies Under Immigration or Wage Targets

We have already described the first best (from the perspective of the home nation) policies above. It is well understood, however, that immigration is often restricted for noneconomic reasons to achieve social and/or political goals. Immigration reduces native wages and causes a more unequal distribution of income between the native capitalists and workers. This can lead to political tensions that may necessitate support of the domestic wage through controls on immigration and/or outsourcing. In recognition of these realities, this section explores optimal policy in the context of an exogenously given immigration target and discusses wage targets as well as the joint determination of wage and immigration targets.[7]

3.1 Policy Choices Under an Immigration Target

Suppose that there is no wage target but that the government wants to achieve a socially desirable target level of immigration I_T. Suppose also that the government regulates outsourcing through barriers such as requirements that a firm must hire a certain proportion of domestic workers, outsourcing quotas, etc. Here we model barriers to outsourcing in a way that is similar to Bond and Chen's (1987) modeling of barriers to capital flows. If a tax t is levied on each unit of outsourced labor, the profit-maximization condition (4) is becomes

$$F_1(1, \rho) = w_T;\ F_2(1, \rho) = w_S = w_I;\ \text{and},\ F_2(1, \rho)\{\delta(n) + n\delta'(n)\} = w^* + t. \qquad (13)$$

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[7]We have discussed the rationale for such targets in the introduction. For the related literature using such targets, see Ethier (1986) and Bandyopadhyay (2006).

National income in this situation is

$$Y = F[T, S + I_\tau + \delta(n)n] - w_I I_\tau - w^*(I_\tau + n)n$$

$$= F[T, S + I_\tau + \delta(n)n] - F_2[1, \rho(n)]I_\tau - w^*(I_\tau + n)n, \text{ where, } \rho(n) = \{S + I_\tau + n\delta(n)\}/T. \quad (14)$$

Using the first order condition for the choice of national-income-maximizing choice of n in the presence of an outsourcing tax, we have

$$dY = [t - \{I_\tau F_{22}(\delta + n\delta')/T\} - nw^{*\prime}]dn. \quad (15)$$

A rise in outsourcing raises the foreign wage w^*, thus working to reduce welfare for the home nation, and raises ρ, which in turn reduces the immigrant wage w_I and benefits the home nation. If the foreign labor supply is relatively elastic (i.e., if $nw^{*\prime}$is small), national income will rise if outsourcing is subsidized. More generally, (15) suggests that the second-best outsourcing tax is

$$t \text{ (for } I = I_\tau \text{ and flexible w)} = \{I_\tau F_{22}(\delta + n\delta')/T\} + nw^{*\prime}. \quad (16)$$

It is clear from (16) that whether outsourcing should be subsidized or taxed depends on the relative weights of the first and second terms on the right hand side. Given that these terms are weighted by the immigration and outsourcing levels, respectively, one would expect a subsidy to be more likely for a higher target level of immigration (which will be associated with lower n because of their inverse relationship for any given t).

3.2 Policy Choices Under Wage and Immigration Targets

For the sake of exposition, let us first suppose that there is no immigration target but that there is a wage target $\tilde{w}$ for native workers.[8] Using (4) we have

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[8]Note that a given w implies a corresponding factor reward for domestic capital (in a CRS model). Thus there is a trade-off between the two factor rewards. One can think of $\tilde{w}$ as the wage that the

$$F_2(1, \rho) = \tilde{w} \Rightarrow \rho = \tilde{\rho}(\tilde{w}) \Rightarrow \rho(I, n) = \tilde{\rho}. \tag{17}$$

Note that

$$-dI/dn\ (\rho = \tilde{\rho}) = \rho_2/\rho_1 = \delta(n) + n\delta'(n) < 1; \text{ and, } d[-dI/dn]/dn = 2\delta' + n\delta'' < 0. \tag{18}$$

Based on (17) and (18) we trace the n and I combinations that guarantee $\bar{w}$ in Figure 1. Recall that the first order condition for the choice of n requires that

$$F_2(1, \tilde{\rho})\{\delta(n) + n\delta'(n)\} - w^*(I + n) = 0. \tag{19}$$

Using (19) we find that

$$-dI/dn = -[F_2(2\delta' + n\delta'') - w^{*\prime}]/w^{*\prime} > 1. \tag{20}$$

We draw the locus of I and n that satisfy (19) on Figure 1. Note from (18) and (20) that the slopes of both have to be negative and that the schedule defined by (18) has to be flatter than the one defined by (20). The equilibrium combination of n and I is shown on Figure 1. Mathematically, (17) and (19) simultaneously determine

$$\tilde{n} = n(\tilde{w}) \text{ and } \tilde{I} = I(\tilde{w}). \tag{21}$$

This finding is reminiscent of Ethier (1986), where the native wage could not be unbundled from the illegal immigration target. In other words, one cannot have two independent targets for immigration and the native wage in the absence of some other policy instrument. With an outsourcing tax in addition to a wage target $\tilde{w}$, equation (17) still holds. Equation (19) is modified to

$$F_2(1, \tilde{\rho})\{\delta(n) + n\delta'(n)\} - w^*(I + n) - t = 0. \tag{19'}$$

Relations (17) and (19′) simultaneously determine

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government chooses to optimally balance the political pressure from the two groups of natives.

$$\tilde{n}(t) = n(\tilde{w}, t) \text{ and } \tilde{I}(t) = I(\tilde{w}, t). \quad (21')$$

From (21′) it is clear that now we can unbundle wage and immigration by a suitable choice of t, which is shown by Figure 1. The locus defined by (19′) will shift to the right as t is reduced. The outsourcing tax (subsidy) is chosen at t_τ such that it intersects with the locus defined by (17) at the immigration level I_τ.[9]

Let us now turn to the effect on national income of such a wage and immigration targeting policy. Under the outsourcing tax and the wage target we have a modified version of (10b)

$$Y = F[T, S + I + \delta(n)n] - w_I I - w^*(I + n)n = TF(1,\tilde{\rho}) - F_2(1, \tilde{\rho})I - w^*(I + n)n. \quad (22)$$

Differentiating (22) and using (17) and (19′)

$$dY/dt = [t + nw^{*\prime}\{(\rho_2/\rho_1) - 1\}](dn/dt). \quad (23)$$

Note from Figure 1 that an outsourcing subsidy (i.e., $t_\tau < 0$) needs to be used to reduce immigration to the target level. Given that dn/dt is negative and that (ρ_2/ρ_1) is less than unity, (23) implies that $dY/dt > 0$. This implies that the relation between Y and t is monotonic and negative for any value of t that is less than zero. Figure 2 demonstrates this relationship and it is easy to see that national income must go down from Y_0 to Y_τ as t is reduced from zero to t_τ to meet the immigration target.

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[9]Note that the point of this analysis is not to suggest that outsourcing should be subsidized. What it shows is that there is a difficult trade-off for the policy maker. An alternate way of viewing this trade-off is to consider raising the barriers to outsourcing (presumably in response to political pressure from native workers). In that case as t is raised, one cannot maintain the domestic wage target without accepting a higher immigration level.

4. The Model with Illegal Immigration

In this section we augment the model to jointly consider the issues of legal and illegal immigration, borrowing from Ethier (1986) and Bond and Chen (1987). The host country for illegal labor (i.e., the home nation) produces a single good with entrepreneurial capital (T), skilled labor (S), and unskilled labor (L). Skilled labor enters legally and unskilled labor illegally. For simplicity we assume that the immigration quota for unskilled workers is zero (although that can be modified easily). Let λ be the level of illegal immigration, $\bar{L}$ be the domestic labor force, and U be the sum of λ and $\bar{L}$. Let w^* and w_λ^* be the source country wages of skilled and unskilled labor, respectively. For analytical simplicity, we assume that these prices are given.[10]

Border and internal enforcement may both be used to restrict illegal immigration. Internal enforcement takes the form of random checks on firms, which are fined z per illegal worker detected. The probability of internal detection is

$$p_i = p_i(e_i);\ p_i(0)=0,\ p_i'>0,\ p_i''<0, \tag{24}$$

where e_i is the internal enforcement effort. Let Q be domestic output produced through a CRS technology:

$$Q = F\{T,\ S + I + \delta(n)n,\ \lambda + \bar{L}\}. \tag{25}$$

[10]Endogenizing these prices will yield welfare results that depend on exploiting the monopsonistic power in the respective labor markets. Since this issue has already been discussed in the previous section, we focus here on the interlinkage between the two types of immigration for the host nation.

Along the lines of Bond and Chen (1987), we assume that firms can hire illegal labor by paying a wage w_λ. Also, when firms hire a unit of illegal labor they know that with probability p_i that labor unit will be detected and the firm will have to pay a fine z for that unit. Therefore, a firm's profit is

$$\pi = F\{T, S + I + \delta(n)n, \lambda + \bar{L}\} - w_T T - w_S S - w_I I - w^* n - wL - w_\lambda \lambda - zp_i\lambda. \qquad (26)$$

The first order conditions of profit maximization are

$$F_1(.) = w_T;\; F_2(.) = w_S = w_I; \text{ and, } F_2(.)\{\delta(n) + n\delta'(n)\} = w^*; F_3(.) = w = w_\lambda + zp_i. \qquad (27)$$

Now, let us turn to the supply of illegal labor. Let p_b be the probability of border detection

$$p_b = p_b(e_b),\; p_b(0)=0,\; p_b'>0,\; p_b''<0, \qquad (28)$$

where e_b is the border enforcement effort by the host nation. Along the lines of Harris-Todaro (1970) and Ethier (1986), we assume that risk-neutral migrants equate their certainty wage in the source nation to the expected wage from illegal emigration

$$w_\lambda^* = w_\lambda(1-p_b) + p_b(w_\lambda^* - f). \qquad (29)$$

In (29), f is the cost incurred by the illegal immigrant if detected and returned to the source nation. Using (27) and (29),

$$w_\lambda^* = w_\lambda - fp_b/(1-p_b) = w - p_i z - fp_b/(1-p_b) \Rightarrow w = w_\lambda^* + R(e_i, e_b),$$

$$\text{where, } R(e_i, e_b) \equiv p_i(e_i)z + fp_b(e_b)/(\{1-p_b(e_b)\}. \qquad (30)$$

Using (27) through (30), we obtain

$$F_2[T, S + I + \delta(n)n, \lambda + \bar{L}]\{\delta(n) + n\delta'(n)\} = w^*; \text{ and,}$$

$$F_3[T, S + I + \delta(n)n, \lambda + \bar{L}] = w_\lambda^* + R. \qquad (27')$$

Using (27′) and suppressing T, L, S, w^* and w_λ^*, we can define the equilibrium values of n and λ as

$$n = n(I, R) \text{ and } \lambda = \lambda(I, R). \qquad (31)$$

Totally differentiating (27′), and solving using Cramer's rule, we obtain

$$\partial n/\partial I = \{\delta(n) + n\delta'(n)\}\{F_{22}F_{33} - (F_{23})^2\}/D' < 0;$$

$$\partial n/\partial R = \{\delta(n) + n\delta'(n)\}F_{23}/D' \Rightarrow \text{sign}(\partial n/\partial R) = \text{sign}(-F_{23});$$

$$\partial\lambda/\partial I = F_2F_{23}\{2\delta'(n) + n\delta''(n)\}/D' \Rightarrow \text{sign}(\partial\lambda/\partial I) = \text{sign}(F_{23}); \text{ and,}$$

$$\partial\lambda/\partial R = -[F_2\{2\delta'(n) + n\delta''(n)\} + \{\delta(n) + n\delta'(n)\}^2F_{22}]/D' < 0; \text{ where,}$$

$$D' = -\{\delta(n) + n\delta'(n)\}^2\{F_{22}F_{33} - (F_{23})^2\} - F_2F_{33}\{2\delta'(n) + n\delta''(n)\} < 0. \qquad (32)$$

As in the previous section, a larger immigration quota reduces outsourcing. Also, as expected, the effect of stricter enforcement is a reduction in illegal immigration. The cross effects are interesting. A rise in the immigration quota will raise illegal immigration if and only if the two inputs–skilled and unskilled labor–are complements in the production process (i.e., if $F_{23} > 0$). On the other hand, stricter enforcement (through a rise in R) will reduce outsourcing if and only if the two types of labor are complements in production. The intuition is that if the immigration quota is raised for legal immigration, then under complementarity between the labor inputs the marginal product of unskilled labor rises. This will raise the demand for unskilled labor, along with the legal unskilled wage. In turn, through the equilibrium migration condition this will raise the illegal wage w_λ and encourage more illegal immigration. Thus, under complementarity between the two types of labor a rise in the immigration quota I will raise the illegal immigration level λ.

Also, recall that n must fall when I is raised. Thus, we may say that when F_{23} is positive, the flow of legal labor is a complement to the flow of illegal labor, while it is always a substitute for outsourcing. On the other hand, when enforcement is raised (with a given I), λ falls, reducing the marginal product of skilled labor. The resulting decline in the demand for skilled labor leads to a reduction in outsourcing n.[11] Thus, when enforcement is used to reduce illegal immigration, outsourcing declines along with it, unlike the previous case in which illegal immigration and outsourcing move in opposite directions when I is raised.

Turning our attention to national income,[12]

$$Y = F\{T, S + I + \delta(n)n, \lambda + \bar{L}\} - w_I I - w^* n - w\lambda + zp_i\lambda - e_i - e_b. \tag{33}$$

Differentiating (33) and using (30) as well as the first order conditions of profit maximization, we have

$$dY = [\lambda_1(zp_i - IF_{23}) - IF_{22}\{1 + n_1(.)(\delta + n\delta')\}]dI$$

$$+ [\lambda_2(zp_i - IF_{23}) - \lambda - n_2(.)IF_{22}(\delta + n\delta')]dR - de_b - (1\text{-}\lambda zp_i')de_i. \tag{34}$$

Thus,

$$\partial Y/\partial I = \lambda_1(zp_i - IF_{23}) - IF_{22}\{1 + n_1(.)(\delta + n\delta')\} = \lambda_1 zp_i - I[\lambda_1 F_{23} + F_{22}\{1 + n_1(.)(\delta + n\delta')\}] \quad (34')$$

It can be shown that $[\lambda_1 F_{23} + F_{22}\{1 + n_1(.)(\delta + n\delta')\}] < 0$, making the second term on the right hand side of the last equation in (34′) unambiguously positive. If $F_{23} > 0$, then the first term is also positive and a rise in the legal immigration quota must raise national income. On the other hand, if $F_{23} < 0$ the effect is ambiguous. If the first term outweighs the second term, then some immigration restriction on legal immigration may raise national income.

Similar to the previous section, the analysis suggests that a rise in I will reduce w_I and lead to a gain from terms of trade. However, the national income gains may be modified in the presence of illegal

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[11]Note that given I, S+I is fixed. Thus, n has to fall in response to the lower demand for skilled labor.

[12]The expression for national income is somewhat different from that in the previous section. The differences are that we have the costs of two types of enforcement as well as the cost of hiring illegal labor that must be subtracted from Q. Also, the fine collections from internal enforcement ($zp_i\lambda$) must be added in the expression for national income. Note that: $w - zp_i = w_\lambda$. Thus, we may view (33) as the part of national product that goes to the natives only, after allowing for the costs of enforcement.

immigration. The country might gain from having some immigration restrictions on legal immigration, even without market power in the international labor market. This is because a rise in I might reduce illegal immigration (i.e., if $F_{23} < 0$) and lead to a loss in revenue collection from internal enforcement.

5. Conclusion

To our knowledge this is the first paper that addresses immigration (legal and illegal) and outsourcing problems simultaneously in a general equilibrium framework. The model presented in the paper can be easily adapted to address other important policy questions. In future research we can use this model to consider issues in trade policy and how that may interact with immigration and outsourcing policy. For example, Bandyopadhyay and Bandyopadhyay (1998) show that trade and factor mobility can either be complements or substitutes in a multi-good trade model where illegal immigration and trade co-exist. Recognizing the presence of outsourcing and exploring its inter-linkages in a similar context should be a useful line of research. Another direction in which we will like to pursue our research is to consider oligopolistic firms and how they use outsourcing to compete in international markets. The insights developed in this paper should be useful for pursuing these and related lines of inquiry. ■

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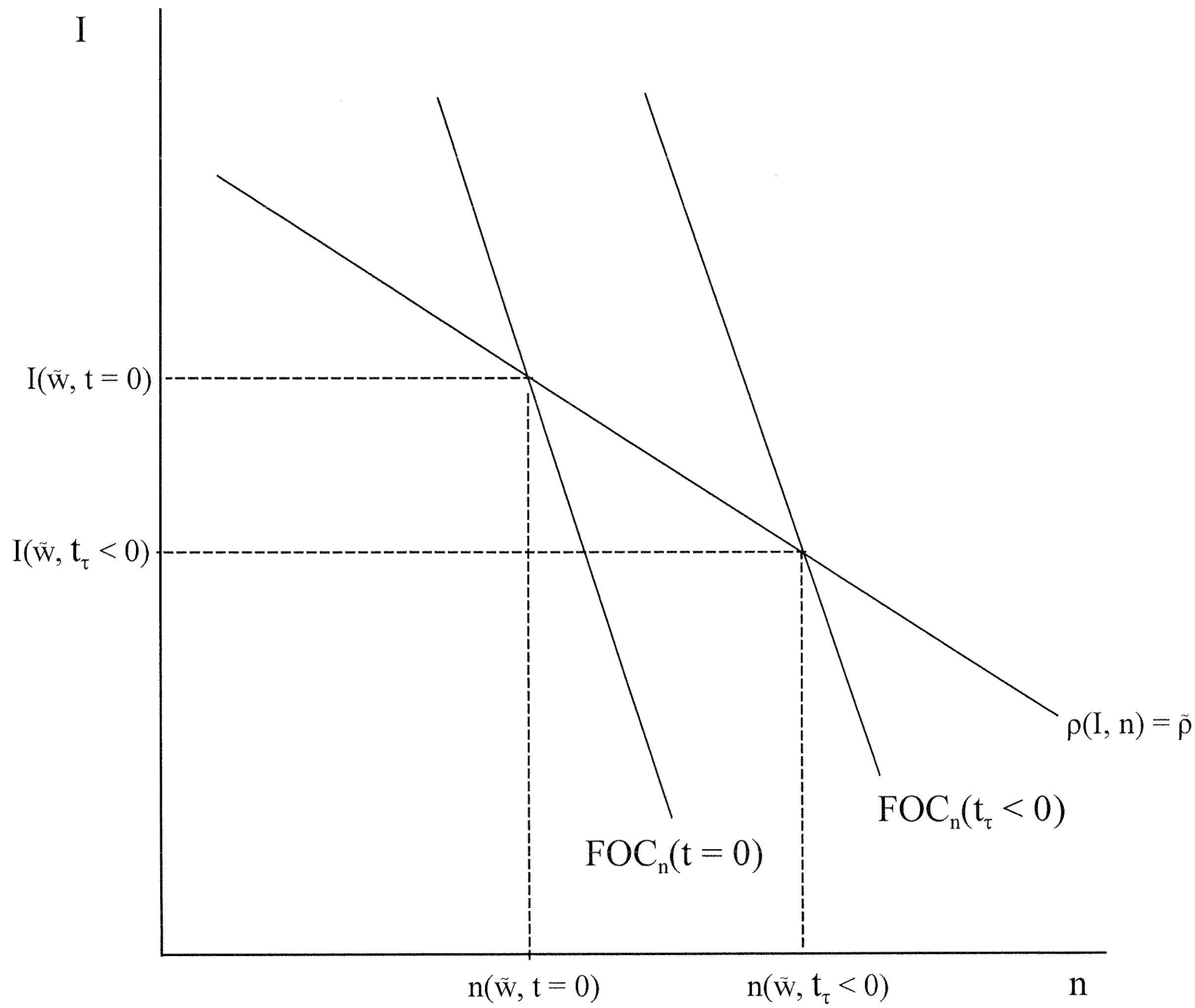

Figure 1

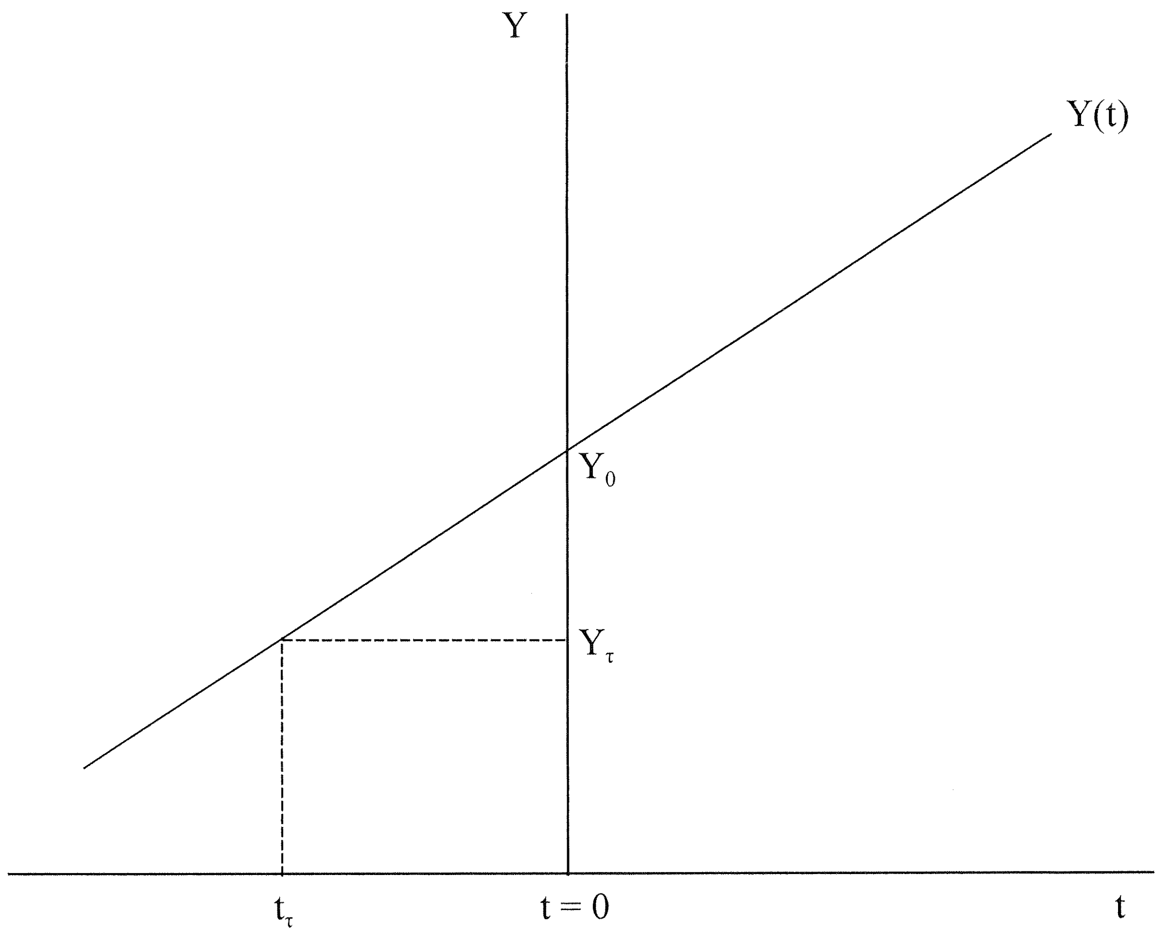

Figure 2