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Immigration and long-run economic outcomes: a note

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Abstract

The paper sets out a simple growth model that assumes imperfect substitutability between immigrants and native workers and posits technological progress as a necessary by-product of the migration process. The paper explores a much-neglected topic of the long-run impact of immigration on a growing economy. The paper shows that, while the short-run impact of immigration on economic outcomes such as capital-per worker, output-per worker and real wages can be negative, the long-run impact of immigration on these variables is not necessarily always adverse. Much depends on the balance between the labor-augmentation effect and the innovation effect of immigration, influences which often work in opposite directions. The paper demonstrates the crucial role of the parameter values of the innovation elasticity in determining the long-run impact of immigration on wages, capital-labor ratio and per capita income.

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1. Introduction

How does immigration affect the long-run economic outcomes in a growing economy? This subject has received scant attention in the economic theoretic literature. Much of the theoretical literature however, is based on static analysis where a good deal of attention has been paid to the issue of the impact of immigration on the real wages of the native workers. This body of research suggests that in a simple static, one-good economy, the inflow of migrants reduces the real wages of native workers (Freeman, 2006). This result has been found to be generally robust in the context of a static two-sector, two-factor model production model with competitive labor market (see, for example, Altonji and Card 1991; Borjas 1995; Friedberg and Hunt 1995; Borjas 2009). The inverse relationship between immigration and real wages also appears to hold in the presence of non-traded goods (Neary, 1989 and Quibria, 1989) and increasing returns to scale in production (Quibria, 1993 and Quibria and Rivera-Batiz, 1989)--even though these more complex models open up possibilities of perverse outcomes. It is of interest to explore how these short-run results hold up in a dynamic context where the economy is subject to capital accumulation and technological innovation. This paper examines this somewhat neglected question, along with the other related economic impacts on the macro economy.

To accomplish the task, this paper sets out a simple, bare-bone Solow-type model that allows for imperfect substitutability between native and immigrant workers and posits technological progress as a by-product of the migration process. This paper derives a number of important results. In particular, it shows that if immigration –presumably because of the education, skills and personal characteristics of immigrants, such as entrepreneurship and risk-taking —brings about new innovations and technological progress, it can have a salutary impact on long-run wages.

The organization of the paper is as follows. Section 2 develops the model and discusses its implications. Section 3 presents conclusion and identifies directions for future research.

2. The Model

In the following, we posit a bare-bone growth model with specific functional forms, which helps to identify some of the important parameters that affect the long-run economic outcomes.

Let us assume that the aggregate production function of the economy can be expressed as a Cobb- Douglas production function:

$Y = AK^b L^{(1-b)}$, where $0 < b < 1$

where Y is output , K is physical capital , L is labor and A is a measure of productivity, which reflects the state of technology in the economy. We will consider both the cases where A is independent of, as well as dependent on, the rate of inflow of migrants. Now, defining $y = Y / L$ and $k = K / L$ as output per worker and capital intensity respectively, the production function can be rewritten as:

$$y = Ak^b \tag{1}$$

The following defines the labor supply functions in the economy:

$P = P_0$ Native labor supply (2a)

$M = M_0 e^{mt}$ Immigrant labor supply (2b)

$L = M^a P^{(1-a)}$ National labor supply (2c)

It is assumed that national labor supply L has two components: native workers P and immigrant workers M.The first and second equations are respectively the supply of native workforce, which is assumed for simplicity to be fixed, and the supply of migrant workforce, which increases at a rate m. Further, the final equation assumes that native and immigrant workers are imperfect substitutes in the "production" of L. For simplicity, it is assumed that total labor supply (in efficiency units) is a Cobb-Douglas function of native and immigrant labor, with $0 \prec a \prec 1$.

It is often presumed, based on a body of empirical work associated with Borjas and his collaborators (see, for example, Borjas, George J., Jeffrey Grogger, and Gordon H. Hanson. 2006; Aydemir, Abdurrahman and George J. Borjas. 2007; Borjas, Grogger and Hanson, 2008), that native and immigrant workers are perfect substitutes. However, , there assumption has been challenged by a set of recent empirical studies , as reviewed by Card (2009), that suggests that domestic and immigrant workers are far from perfect substitutes, even within the *same skill group*. This heterogeneity in skill levels between native and immigrant workers is particularly pronounced at the aggregate economy level. Given this heterogeneity, it seems plausible to assume that there is imperfect substitutability between native and migrant workers at the economy level. For simplicity of analysis, we shall assume that native and migrant workers are imperfectly substitutes with unitary elasticity[1].

Next, by simple algebraic manipulations of the labor supply equations above, we can rewrite L as:

$$L = L_0 \, e^{nt} \tag{2d}$$

where $n \equiv am$ and $L_0 \equiv (P_0)^{(1-a)}(M_0)^a$. Note that n is the rate of growth of national labor supply L, whose initial value is given by L_0.

The capital accumulation equation is given by:

$$I = sY - \delta K \tag{3}$$

It is assumed that the economy saves a constant fraction s of its income Y and loses δ proportion of its aggregate capital stock annually in depreciation. Thus, Eq. (3) states that net investment I is equal to savings. Simple manipulation of the above relations yields the so-called fundamental equation of the neo-classical growth theory:

$$\dot{k} = sAk^b - nk - \delta k \tag{4a}$$

[1] It would however be of interest to explore the sensitivity of results to this assumption. A straightforward way to do so is to posit a CES function for total national labor supply.

where $\dot{k} = dk / dt$. The steady- state solution of Eq. (4a) can be found by solving the following:

$$\dot{k} = sAk^b - nk - \delta k = 0 \tag{4b}$$

Eq. (4b) can be rewritten as :

$$Ak^b = (n+\delta)k / s$$
(4c)

Solving and simple rearranging will yield the following closed-form solution for k :

$$k = \{sA / (n+\delta)\}^{1/(1-b)} \tag{5a}$$

Taking log and rearranging the above, we can derive the following expression:

$$\ln k = \{\ln s + \ln A - \ln(n+\delta)\} / (1-b) \tag{5b}$$

So far, we have not made any assumptions regarding the determinant of A, which is a measure of total factor productivity (TFP) of the economy . We will assume that A is determined by an innovation function, which is essentally the outcome of the migration process. It is assumed that the impact of immigration on innovation and TFP of the economy will be greatly influenced by the quality of immigrants—their education, skills and personal characteristics in terms of entrepreneurship and risk-taking—which in tun will affect the long-run economic outcomes in the economy. If the flow of migrants consists mainly of individuals who are skilled, educated and entreprenurial, it is likley to boost innovations and thus TFP growth. On the other hand, if the flow of migrants consists mainly of individuals who are unskilled, uneducated and lack in entreprenurial abilities, it is likley to impede technological progress and TFP growth.

With the above distinction in mind, we will first consider the case where where immigration is largely limited to skilled migration. In general, most developed countries nowadays restrict immigration to largely skilled and educated workers, who have been an important driver of innovations and technical change. In a recent study, Hunt and Gauthier-Loiselle (2010) note that immigrants in the US patent at double the native rate due to their disproportionately holding science and engineering degrees. Using a 1940–2000 state panel, they show that a 1-percentage point increase in immigrant college graduates' population share increases patents per capita by 9–18 percent. With the above empirical evidence in mind, we posit a simple yet plausible innovation function:

$$A = A(m) \tag{6a}$$

The innovation function is assumed to have the following properties:

$$\partial A / \partial m \geq 0 \tag{6b}$$

$$A(0) = 1 \tag{6c}$$

The first property states that when there is no immigration, TFP remains invariant at the original level that is indicated by unity. The second property states that the inflow of immigrants influences TFP non-negatively. An important implication of the above- posited properties of the innovation function is that the innovation elasticity, μ, which shows the responsiveness of innovation to the rate of growth of immigrants, is non-negative. Thus:

$$\mu \equiv (\partial A / \partial m)(m / A) \geq 0 \tag{6d}$$

Next, we explore the impact of immigration on the steady-state solution of the model. Now substituting Eq. (6a) into Eq. (5b) and differentiating with respect to m, we can derive:

$$\begin{aligned} d\ln k / dm &= \{d\ln A / dm - a / (n+\delta)\} / (1-b) \\ &= \{(\mu / m) - a / (n+\delta)\} / (1-b) \end{aligned} \tag{7a}$$

Eq. (7a) shows that migration has two distinct but opposite effects on capital-intensity : one is the *innovation effect*, denoted by $\mu / m(1-b)$, and the other is the *labor-augmentation effect*, denoted by $a / (n+\delta)(1-b)$.

Let us next consider some specific cases of Eq. (7a):
First, consider the case $\mu = 0$; that is, innovations are independent of the inflow of migrants. This may happen if the immigrants bring no qualitative change in the population in terms of educational traits, skills sets and favorable personality traits. In this case, Eq. (7a) reduces to:

$$d\ln k / dm = -a / (1-b)(n+\delta) < 0 \tag{7b}$$

Eq. (7b) states that with zero innovation elasticity, the steady state k declines as the rate of inflow of immigrant workers increases because of the labor- augmentation effect. In this case, the impact of the labor–augmentation effect on the steady-state solution is analytically equivalent to an increase in the growth rate of labor in the traditional Solow model.
Next consider the case where, $\mu \geq 1$. By simple algebraic manipulation and noting that $n = am$, Eq. (7a) can be rewritten as:

$$d\ln k / dm = [n(\mu - 1) + \delta] / [m(n+\delta)(1-b)] > 0 \tag{7c}$$

Eq. (7c) shows that when the innovation parameter μ is equal to or above unity, the steady state k increases as the rate of immigration increases.

To summarize, it can be seen from Eqs. (7b) and (7c) that (i) $d\ln k / dm \prec 0$ when $\mu = 0$; (ii) $d\ln k / dm \succ 0$ when $\mu = 1$. Given that the steady- state k is a continuous function of m, it can then be shown by simple application of the intermediate -value theorem that there is a $\mu^* \in (0,1)$ where $d\ln k / dm = 0$ and $\mu^* = n / (n+\delta)$

How does the rise in immigration affect long-run wages? The wage rate for the "average" efficiency unit adjusted worker is given by:

$$w = y - rk = (1-b)Ak^b = (n+\delta)(1-b)k/s \tag{8}$$

where, w and r are respectively, the wages rate and the return to capital. The first equality in (8) follows from the accounting identity, the second equality from the marginal productivity condition for the competitive wages, and the third equality from the steady-state condition, denoted by Eq. (4c).

It may be recalled that in our model, the migrant and native workers are assumed imperfect substitutes in production and hence their wages will differ. Furthermore, we have also_ assumed that the labor markets are competitive. By applying the marginal productivity rule, we can derive the wage levels of the migrant and native workers, which are respectively given by: $w^M = a(1-b)k^b$ and $w^N = (1-a)(1-b)k^b$. Note that these wage rates are identical to the average wage w, except for a multiplicative constant. The following analysis applies verbatim to w^M and w^N, as it does to w.

Now, taking log and differentiating (Eq. 8) with respect to m yields:

$$d\ln w/dm = \{a/(n+\delta) + d\ln k/dm\} \tag{9a}$$

When $\mu = 0$, $d\ln k/dm$ is given by Eq. (7b). Substituting (7b) into Eq. (9a) and simplifying, we can find:

$$d\ln w/dm = -ab/(1-b)(n+\delta) < 0. \tag{9b}$$

When $\mu = 1$, Eq. (7c) shows that $d\ln k/dm = \delta/[m(n+\delta)(1-b)]$. Substituting this into Eq. (9a) and simplifying, we can derive:

$$d\ln w/dm = [n(1-b)+\delta]/[(n+\delta)(1-b)m] > 0. \tag{9c}$$

When $\mu = \mu^* \in (0,\ 1)$ i.e., where $d\ln k/dm$ =0, Eq. (9a) reduces to

$$d\ln w/dm = a/(n+\delta)) > 0. \tag{9d}$$

To summarize, Eqs. (9b) and (9d) indicate that (i) $d\ln w/dm \prec 0$ when $\mu = 0$; (ii) $dlnw/dm \succ 0$, when $\mu^* \in (1,0)$. It can then be shown by simple application of the intermediate value theorem that there is a $\mu^{**} \in (0,\ \mu^*)$ where $d\ln w/dm$ = 0. It can be further shown that $\mu^{**} = b\mu^*$.

It can be easily seen that the long-run impact of immigration on steady-state per-capita income follows the pattern of the wage level. The preceding results are summarized in Table 1:

TABLE 1: Sensitivity of economic outcomes to innovation elasticity

	$\mu = 0$	μ **= $bn/n+\delta$	μ*= $n/n+\delta$	$\mu \geq 1$
$d\ln k/dm$	<0	<0	$=0$	>0
$d\ln w/dm$	<0	$=0$	>0	>0
$d\ln y/dm$	<0	$=0$	>0	>0

An important message from the analysis is that while the short-run impact of immigration on wages is generally negative, the long-run impact is not necessarily so, when the innovation effect of immigration is sufficiently strong. This illustrates how the adverse impact of immigration on wages due to the labor augmentation effect can be overturned by the positive innovation effect of immigration.

The above analysis has considered the cases where the flow of immigrants has been such that it is largely limited to skilled and educated migrants or migrants with favorable entrepreneurial traits. If on the other hand, the inflow of migrants is such that it is predominantly unskilled and uneducated, it is conceivable that immigration can act as a barrier to technological innovation and structural change. For example, in their analysis of the impact of international labor migration on structural change in labor-importing East Asian economies, Athukorala and Manning (1999) suggested that in the 1990s, easy availability of unskilled labor acted as a barrier to technological progress for some East Asian countries.

This brings us to the final case where the innovation elasticity μ was such that $\mu \leq 0$. In this case, it can be easily shown-- by following through the algebraic derivations sketched above-- that immigration will depress the long-run capital per worker, output per worker and wages. In this case, there will be a confluence of two negative forces of the labor-augmentation effect and the innovation effect.

3. Conclusion

This paper analyzes the long-run impact of immigration on a growing economy. The paper lays out a simple growth model, which allows for imperfect substitution between native and immigrant workers and posits technological progress as an endogenous outcome of the migration process. The analysis of the paper suggests that if the migrant inflow is largely skilled that induces innovations and productivity growth in the economy, the long-run impact can be significantly different from that of an economy where immigrants are largely unskilled and bereft of entrepreneurial abilities. It shows that if the innovation elasticity of migration is sufficiently positive, the long-run impact of immigration on real wages can be positive, offsetting the effect of diminishing marginal productivity associated with the inflow of migrants[2]. The paper also identifies the parameter values of the innovation elasticity in determining the long-run impact of immigration on wages, capital-labor ratio and per capita income.

The principal findings of the paper in some ways run counter to the conventional wisdom, which is based largely on static models. The main contribution of this paper is to highlight the role of immigration in innovation and technological change, which can have a salutary effect on long-run economic outcomes. The findings of the paper, which have deep policy implications, accord with both intuition and evidence.

It is hoped that the bare-bone model presented in the paper will stimulate further work in this area of great policy import. Future research work should incorporate, among others, various degrees of substitutability between native and immigrant workers; more sophisticated specification of the innovation process; and the existence of non-traded goods.

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[2] If the innovation elasticity is negative –i.e., migrants are indeed barriers to innovations—the wage rates will unambiguously decline.

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