Economics Bulletin

Volume 38, Issue 3

Negative selection migration and education investment: theoretical investigation on the roles of remittances and the prospect of migration

Daichi Yamada
Graduate School of Economics and Business, Hokkaido University

Abstract

This paper theoretically examines the effect of labor migration on education investment in migrant-sending countries, focusing on negative selection migration where unskilled workers migrate. Negative selection migration has two conflicting effects. On one hand, the prospect of children's future migration would reduce education incentives. On the other hand, parents' migration provides remittances and this could encourage education investment. This paper presents a simple model to simultaneously incorporate these two effects. The results show that, in countries where the quality of education is high, the positive effect of parents' remittances outweighs the negative effect of the prospect of future migration. However, in countries with poor education quality, the negative effect of the prospect plays the main role and reduces education investment. Improving the quality of education is vital for obtaining a positive consequence from negative selection migration.

The author is grateful for M. Hiwatari, J. Itaya, and participants in the seminars at Hitotsubashi University and Hokkaido University for their helpful comments. The author also appreciates the insightful comments from anonymous referees.
Citation: Daichi Yamada, (2018) "Negative selection migration and education investment: theoretical investigation on the roles of remittances and the prospect of migration", *Economics Bulletin*, Volume 38, Issue 3, pages 1292-1301
Contact: Daichi Yamada - dyamada@eis.hokudai.ac.jp.
Submitted: April 05, 2018. **Published:** July 18, 2018.

1. Introduction

The role of labor migration on economic development has been widely discussed over the last decades. Among various issues, how labor migration affects education investment or human capital levels in migrant-sending developing countries is one of the central questions. *Brain drain* is the seminal concept on this issue: skilled workers will migrate and human capital will be lost (Bhagwati & Hamada 1974; Kwok & Leland 1982; Miyagiwa 1991). Meanwhile, the *brain gain* literature points out a positive consequence of migration (Beine et al. 2001; Mountford 1997; Stark et al. 1997, 1998). Individuals with the prospect of future migration make large education investment to migrate as skilled workers. Since not all of them do migrate, the prospect still raises the education levels in migrant-sending countries even if some "brains" go abroad. A common assumption in these discussions is positive selection: The migration destinations reward education more highly than the migrant-sending countries do, which encourages skilled workers to migrate.

This paper, conversely, focuses on negative selection migration, where unskilled workers tend to migrate, and theoretically examines its effects on education investment. While positive selection migration is widely recognized (Grogger & Hanson 2011), negative selection migration is also observed in some migration corridors, such as between Central America and the USA, and within the former Soviet Union countries. Relatively equal income distribution in developed countries and asymmetric information on migrants' human capital could make migrants' incomes less dependent on human capital than their incomes in the home countries (Borjas 1987, 2014; Katz & Stark 1987). This would lead to negative selection migration, especially if the initial migration costs and immigration policies in the destinations do not prevent migration of unskilled workers.

This paper addresses two effects of negative selection migration. The first one is the prospect effect. Contrary to positive selection, the possibility of future migration as an unskilled worker provides the opportunities to earn a decent income without high education. Then, children with the prospect of future migration may reduce education investment, choosing to be unskilled migrants instead of skilled workers in the home country. The second effect is the remittance effect. Parents often migrate, leaving their children at the home countries, and share their incomes through remittances. Their remittances or the income effect of their migration are found to encourage education investment for children in the home countries in some empirics (Adams & Cuecuecha 2010, 2013; Yang 2008). Since both these two oppositely directed effects can play roles, whether migration overall encourages or discourages education investment is not clear *a priori*. Answering this question requires a model that simultaneously examines the two effects.

The contribution of this paper is that it sheds light on the theoretical discussions on negative selection, constructs a model to simultaneously examine the two effects of migration, and provides theoretical predictions on the overall effect of negative selection migration on education investment. Compared to positive selection, the previous theoretical discussions have paid relatively little attention to negative selection. Stark and Byra (2012), one of few discussions, apply the *brain gain* framework to negative selection and point out the negative effect of the prospect of future migration. Yet, they abstract the remittance effect as the *brain gain* literature often does. This paper extends their insight but also incorporates the remittance effect by introducing an intergenerational aspect of education investment, which is related to the models of pure or impure altruism in Becker and Barro (1988), Becker and Lewis (1973), and Galor and Weil (2000). This allows us to examine implications of the overall effect of negative selection migration, which would be also relevant for empirics and policy discussions.

The results present two scenarios. In the optimistic one, the remittance effect outweighs the prospect effect. The overall effect of migration raises education investment and encourages children to become skilled workers in the home countries. In the pessimistic scenario, the prospect effect is predominant. The remittances do not greatly encourage education investment. The prospect effect reduces it even if parents are relatively skilled and do not migrate by themselves. The pessimistic scenario is likely to occur if the quality of education is low, the school infrastructure is poor, or the quality of teachers is low, which seemingly match the situations in developing countries. However, this conversely suggests that improving education quality would be vital for obtaining a positive consequence from negative selection migration.

The remainder of this paper proceeds as follows. Section 2 presents the model setting. Section 3 solves the model and presents how the prospect effect works. Section 4 incorporates the remittance effect to derive the overall effect of migration. Proofs for lemmas and a proposition are provided in Appendix.

2. The model setting

Consider a parent in a migrant-sending country who earns income and makes education investment for her child. She derives utility from her own consumption but cares about the future income of her child as well. She also chooses either to work in the home country or to migrate to the foreign country, leaving her child at home. To ignore issues such as quantity-quality trade-off, assume that a household comprises only a parent and a child.

Let h_p be the human capital level of the parent, which is given. The income in the home country is normalized to h_p whereas the net income after migration costs in the foreign country is $\alpha h_p + \mu$. The marginal return to human capital is 1 in the home country and α in the foreign country. μ is the net base wage in the foreign country. Assume $\alpha \in (0, 1)$ and $\mu > 0$. Then, human capital is not highly rewarded in the foreign country but a migrant can earn decent income even if her human capital level is low.[1] Migration costs include opportunity costs, such as foregone earnings during the period of moving and loss of scale economy of household consumption. Assume that the parent prefers migration if it strictly increases the income or, equivalently, $h_p < \mu/(1-\alpha)$. This is consistent to the parent's preference described below.

Given income, $y_p = h_p$ or $\alpha h_p + \mu$, the parent makes an education investment of e for her child. The human capital of the child, h_c, is produced according to

$$h_c = Ah(e), \tag{1}$$

where $h' > 0$, $h'' < 0$, $h(0) = 0$, $h'(0) = +\infty$, and $h(e) \to +\infty$ as $e \to +\infty$. The concavity of $h(e)$ is equivalent to the convexity of the education costs to realize a certain level of h_c. $A > 0$ is the productivity parameter of human capital production. It captures the quality of education, such as the school infrastructure level or teaching quality, or the child's innate learning ability in the sense

[1] A rationale for this type of the income structure is that migrant-receiving developed countries tend to have relatively equal income distribution or pro-poor redistribution (Borjas 1987). μ could be interpreted as the value of lump-sum transfers. Moreover, even if the marginal return in the destination is greater than 1 for the destination natives, this type of the wage equation can show up for migrants. The employers in the destination would offer wages that are fixed to some extent in the presence of asymmetric information on migrants' human capital levels (Katz & Stark 1987). If migrants tend to engage in unskilled jobs because of regulations or stereotypes, then the migrants' incomes would depend less on their skills but would reward their physical labor supplies, which is expressed by μ.

that an increase in A raises the level of h_c produced from the same e. Large A also reduces the cost to acquire large h_c. Assume that the credit market for education investment is absent and that the parent cannot invest more than her income. After making education investment, she consumes the remainder of her income, $y_p - e$.

The child can also choose whether to migrate when she becomes an adult. She treats h_c as given since education investment has already been made by her parent. She faces the same income profile as the parent does, and chooses to migrate if $h_c < \mu/(1-\alpha)$. Note that, while the parent cannot directly decide whether the child migrates, she can control the migration decision of the child by choosing e so that $Ah(e) \gtreqless \mu/(1-\alpha)$.

The preference of the parent is described by the following utility function;

$$U = u(y_p - e) + v(y_c); \tag{2}$$

where $u' > 0$, $u'' < 0$, $u'(0) = +\infty$, $v' > 0$, $v'' < 0$, and $v'(0) = +\infty$. She derives utility from her own consumption, $u(y_p - e)$ for $y_p = h_p$ or $\alpha h_p + \mu$, and from the child's income, $v(y_c)$ for $y_c = h_c$ or $\alpha h_c + \mu$. The condition for the parent's migration, $h_p < \mu/(1-\alpha)$, is consistent to her utility maximization since, with an optimal e, her utility is increasing in y_p by the envelope theorem.

Regarding the model setting, there are three points to be noted. First, the non-linear preference and the absence of the credit market for education investment allow the parent's income to affect education investment. This is vital for incorporating the remittance effect. The framework in the *brain gain* literature and its application to negative selection by Stark and Byra (2012) assume that children make education investment for themselves, financing education costs by loan from perfect credit market. This rules out the possibility that parents' remittances play any role. Second, that the parent cares about the child's income allows the prospect of the child's future migration to play a role. That preference is close to non-dynastic altruism in Galor and Weil (2000) and is also related to warm-glow or impure altruism, as opposed to pure dynastic altruism in Becker and Barro (1988). Although it is common to assume that a warm-glow parent cares about how much to spend in the child's education, it would be reasonable that the parent deriving joy from giving education also cares about how highly their gift will be rewarded, especially if education investment serves as a non-monetary form of bequests.[2] Third, the model focuses on a single pair of the parent and the child since it does not involve any inter-household interaction. We proceed as if we were focusing on a representative household. Nevertheless, the discussion is directly applicable to the cases where the economy comprises various households with heterogeneous levels of h_p.[3]

For the clarity of the discussion, this paper defines the prospect and remittance effects as follows. The prospect effect is the difference between the optimal education investment levels when the parent considers the child's future migration and when migration is impossible, holding the parents' income constant. The remittance effect is the income effect of the parent's migration on

[2] Alternatively, we could assume that the child makes transfers to the parent in the future, which serve as an informal pension, and that the parent makes education investment to receive the transfers. Assuming that the volume of the transfers depends on y_c, we could regard $v(y_c)$ as the parent's utility level after retirement. This view is also noted by Galor and Weil (2000) and formally examined by Cox et al. (1998).

[3] In addition to these three points, an implicit assumption of the model setting is that any person can migrate for certainty. However, in reality, migration may be a risky choice. Some individuals wishing to migrate may fail to obtain visas or work permits. The foreign country may forbid immigration in the future. The author also examined an alternative model where the parent and child wishing to migrate face the risk of failing to migrate. The basic conclusions of this paper are maintained in this alternative model.

the optimal education investment. The sum of these two effects is referred to as the overall effect.[4]

3. The optimization and the idea of the prospect effect

Let us begin with examining the education investment the parent will make after realizing the income of y_p. The optimal education investment maximizes

$$U = u(y_p - e) + (1 - \mathbb{I})v[Ah(e)] + \mathbb{I}v[\alpha Ah(e) + \mu], \tag{3}$$

where $\mathbb{I}$ is the indicator function of the child's migration equal to 1 if $Ah(e) < \mu/(1-\alpha)$, and 0 otherwise. The parent considers the child's future migration and the marginal return of α as long as $Ah(e) < \mu/(1-\alpha)$, but ignores them if $Ah(e) \geq \mu/(1-\alpha)$, since the child will not choose to migrate. This effectively implies that the parent either (i) decides to let her child migrate and chooses e that maximizes (3) with $\mathbb{I} = 1$, or (ii) decides to let her child stay in the home country and chooses e that maximizes (3) with $\mathbb{I} = 0$.

We solve the maximization problem in two steps. First, derive the optimal education investment for $\mathbb{I} = 1$, e_M, and the one for $\mathbb{I} = 0$, e_N. Then, choose either e_M or e_N that gives higher utility.

For $\mathbb{I} = 1$, the parent maximizes $u(y_p - e) + v[\alpha Ah(e) + \mu]$ subject to $Ah(e) < \mu/(1-\alpha)$. The concavity of the problem implies that the unique interior solution, $e^*(y_p)$, is defined by the first-order condition of

$$\frac{dU}{de} = -u'(y_p - e^*) + \alpha Ah'(e^*)v'[\alpha Ah(e^*) + \mu] = 0. \tag{4}$$

The properties of u, v and h assure $0 \leq e^* \leq y_p$ for any y_p with the equalities holding if and only if $y_p = 0$. By the implicit function theorem, $\partial e^*/\partial y_p > 0$. Also, $e^* \to +\infty$ as $y_p \to +\infty$. These imply that the constraint is violated for $y_p \geq y^*$, where y^* is defined as $Ah[e^*(y^*)] = \mu/(1-\alpha)$. Therefore,

$$e_M = \begin{cases} e^*(y_p) & \text{if } \ y_p < y^* \\ \bar{e} & \text{if } \ y^* \leq y_p \end{cases} \tag{5}$$

where $\bar{e}$ is defined as $Ah(\bar{e}) = \mu/(1-\alpha)$.[5]

Meanwhile, for $\mathbb{I} = 0$, the parent maximizes $u(y_p - e) + v[Ah(e)]$ subject to $Ah(e) \geq \mu/(1-\alpha)$. The interior solution, $e^{**}(y_p)$, is defined by

$$\frac{dU}{de} = -u'(y_p - e^{**}) + Ah'(e^{**})v'[Ah(e^{**})] = 0. \tag{6}$$

[4] As suggested in the empirical literature (e.g. McKenzie & Rapoport 2011), parents' migration can have additional side effects on children's education. The parental absence may reduce children's school attendance by forcing them to do housework or through some psychological effects. Parents may provide connection in the destination and this could reduce the costs of children's future migration and affect their migration decisions. However, this paper does not consider these side effects and focuses on the remittance and prospect effects.

[5] Strictly speaking, the parent needs to choose e infinitesimally smaller than $\bar{e}$ for $y_p \geq y^*$. However, treating $\bar{e}$ as the solution here does not affect the final results since the parent chooses neither $\bar{e}$ nor e infinitesimally smaller than $\bar{e}$ in the second step. Therefore, let us treat $\bar{e}$ as the solution for $y_p \geq y^*$.

The properties of e^* with respect to y_p hold for e^{**}. Therefore, the constraint is violated for $y_p < y^{**}$, where y^{**} is defined as $Ah[e^{**}(y^{**})] = \mu/(1-\alpha)$. Also, for $y_p < \bar{e}$, e_N cannot be defined since any $e \le y_p$ cannot satisfy the constraint. Therefore, e_N is defined as

$$e_N = \begin{cases} \bar{e} & \text{if } \bar{e} \le y_p < y^{**} \\ e^{**}(y_p) & \text{if } y^{**} \le y_p \end{cases} \tag{7}$$

Note that e^{**} is also the optimal if migration is impossible. Therefore, e^{**} will be used as the status quo to examine the prospect effect.

These first-step solutions have the following properties.

Lemma 1. *$e^* < e^{**}$ if $y_p < y^*$. Also, $\bar{e} < y^{**} < y^*$.*

$e^* < e^{**}$ is intuitive. The small marginal return in the destination reduces education investment compared to the case where migration is impossible. This forms the basic idea of the prospect effect. $y^{**} < y^*$ implies at least either e_M or e_N is the interior solution for any y_p, and both are for $y^{**} \le y_p \le y^*$.

In the second step, the parent chooses either e_M or e_N. If $y_p < \bar{e}$, then she can choose only $e_M = e^*(y_p)$. For $y_p \ge \bar{e}$, assuming that the parent chooses e_N if she is indifferent between e_N and e_M, the parent chooses e_N if and only if

$$f(y_p) \equiv u(y_p - e_N) + v[Ah(e_N)] - u(y_p - e_M) - v[\alpha Ah(e_M) + \mu] > 0. \tag{8}$$

Proposition 1.
(i) There is unique $\bar{y} \in (y^{**}, y^*)$ such that $f(\bar{y}) = 0$.
(ii) The optimal education investment given y_p is

$$\begin{cases} e^*(y_p) & \textit{if } y_p < \bar{y} \\ e^{**}(y_p) & \textit{if } y_p \ge \bar{y} \end{cases}$$

If $y_p \ge \bar{y}$, then the parent chooses $e_N = e^{**}$ and the child will not migrate. The level of education investment is the same as in the case where migration is impossible. The prospect effect does not show up. If $y_p < \bar{y}$, on the contrary, the parent chooses $e_M = e^* < e^{**}$ and the child will migrate in the future. The parent with small income finds it beneficial to economize education investment, knowing that her child will migrate and earn a decent income even if she does not have large human capital. In this sense, the prospect effect reduces education investment. Since $\bar{y} \in (y^{**}, y^*)$, the optimal education investment is always one of the first-step interior solutions.

Lemma 2. *$d\bar{y}/dA < 0$, $\bar{y} \to 0$ as $A \to +\infty$ and $\bar{y} \to +\infty$ as $A \to 0$.*

The larger A is, the smaller the area of y_p is where the prospect effect shows up. With large A, the parent does not need to sacrifice her own consumption greatly to give the child large human capital. This encourages the parent to choose e^{**}. Conversely, with small A, it is expensive to make education investment so that the child will stay in the home country. This encourages the parent to economize education investment and choose e^*.

4. Incorporating the remittance effect

Now we incorporate the parent's migration and the remittance effect by replacing y_p by h_p or $\alpha h_p + \mu$. If $h_p \geq \mu/(1-\alpha)$, then the parent does not migrate, $y_p = h_p$, and the optimal education investment is either $e^*(h_p)$ or $e^{**}(h_p)$. If $h_p < \mu/(1-\alpha)$, then the parent migrates, $y_p = \alpha h_p + \mu$, and the optimal education investment is either $e^*(\alpha h_p + \mu)$ or $e^{**}(\alpha h_p + \mu)$. Clearly, if migration were impossible, then the optimal education investment would always be $e^{**}(h_p)$.

As we express y_p in terms of h_p, the condition for the prospect effect, $y_p \gtreqless \bar{y}$, also needs to be re-expressed in terms of human capital. Depending on the level of $\bar{y}$, it will be re-expressed in two ways. Note first that a migrant (non-migrant) earns less than (greater than or equal to) $\mu/(1-\alpha)$. Then, suppose $\bar{y} < \mu/(1-\alpha)$. The parent earning $\bar{y}$ is a migrant. The level of her human capital can be expressed as $(\bar{y}-\mu)/\alpha$ (note that $(\bar{y}-\mu)/\alpha < \bar{y} < \mu/(1-\alpha)$ holds if $\bar{y} < \mu/(1-\alpha)$). The prospect effect shows up for $h_p < (\bar{y}-\mu)/\alpha$. Conversely, suppose $\bar{y} \geq \mu/(1-\alpha)$. Then, the parent earning $\bar{y}$ is a non-migrant and has $h_p = \bar{y}$. The prospect effect shows up for $h_p < \bar{y}$.

The condition $\bar{y} \gtreqless \mu/(1-\alpha)$ can be restated in terms of A, which will be vital for the interpretation of the final results.

Lemma 3. *There exists the unique level of A denoted by $\bar{A}$ such that $\bar{y} \gtreqless \mu/(1-\alpha)$ holds if $A \lesseqgtr \bar{A}$.*

The final optimal education investment, $\hat{e}(h_p)$, is summarized as follows.

Proposition 2. *If A is sufficiently large that $\bar{y} < \mu/(1-\alpha)$, then*

$$\hat{e}(h_p) = \begin{cases} e^*(\alpha h_p + \mu) & \text{if } h_p < \dfrac{\bar{y}-\mu}{\alpha} \\ e^{**}(\alpha h_p + \mu) & \text{if } \dfrac{\bar{y}-\mu}{\alpha} \leq h_p < \dfrac{\mu}{1-\alpha} \\ e^{**}(h_p) & \text{if } \dfrac{\mu}{1-\alpha} \leq h_p \end{cases}$$

Meanwhile, if A is sufficiently small that $\bar{y} \geq \mu/(1-\alpha)$, then

$$\hat{e}(h_p) = \begin{cases} e^*(\alpha h_p + \mu) & \text{if } h_p < \dfrac{\mu}{1-\alpha} \\ e^*(h_p) & \text{if } \dfrac{\mu}{1-\alpha} \leq h_p < \bar{y} \\ e^{**}(h_p) & \text{if } \bar{y} \leq h_p \end{cases}$$

Figure 1-a describes the optimal education investment with $\bar{y} < \mu/(1-\alpha)$ (or large A). Figure 1-b describes the case with $\bar{y} \geq \mu/(1-\alpha)$ (or small A). The solid line represents $\hat{e}(h_p)$. For comparison, the gray line starting from the origin represents $e^{**}(h_p)$, the optimal education investment in the case where migration is impossible.[6]

Discuss the case with $\bar{y} < \mu/(1-\alpha)$, first. The parent with $h_p \in [0, (\bar{y}-\mu)/\alpha)$ chooses $e^*(\alpha h_p + \mu)$.[7] Both the remittance and prospect effects work. The difference between the solid and

[6]The exact shapes of those functions are not necessarily linear and depend on the shapes of u, v and h.

[7]The interval $[0, (\bar{y}-\mu)/\alpha)$ is non-empty unless A is extremely large and $\bar{y} < \mu$ holds.

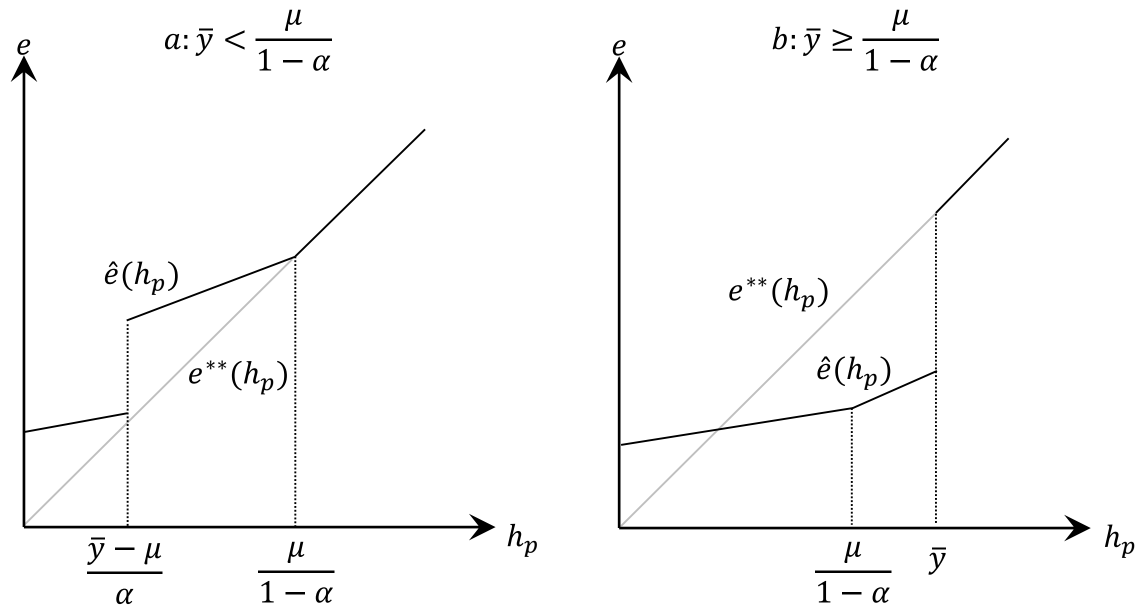

Figure 1 The optimal education investment in Proposition 2.

gray lines, $e^*(\alpha h_p + \mu) - e^{**}(h_p)$, represents the overall effect of migration. It can be decomposed into the two effects by adding and subtracting $e^*(h_p)$ as in the following;[8]

$$e^*(\alpha h_p + \mu) - e^{**}(h_p) = \underbrace{e^*(\alpha h_p + \mu) - e^*(h_p)}_{\text{the remittance effect}} + \underbrace{e^*(h_p) - e^{**}(h_p)}_{\text{the prospect effect}}. \tag{9}$$

For h_p sufficiently close to 0, the remittance effect makes the overall effect of migration positive since only $e^*(\alpha h_p + \mu)$ is positive at $h_p = 0$. However, the sign of the overall effect is ambiguous for h_p sufficiently close to $(\bar{y} - \mu)/\alpha$ if $(\bar{y} - \mu)/\alpha$ is close to $\mu/(1-\alpha)$, since the remittance effect tends to zero as $h_p \to \mu/(1-\alpha)$ whereas the prospect effect remains negative. In this sense, while $\hat{e}(h_p)$ lies above the gray line for any $h_p < (\bar{y} - \mu)/\alpha$ in Figure 1-a, it could lie below the gray line for h_p sufficiently close to $(\bar{y} - \mu)/\alpha$.

The optimal education investment makes a jump at $h_p = (\bar{y} - \mu)/\alpha$. The parent with $h_p \in [(\bar{y} - \mu)/\alpha, \mu/(1-\alpha))$ prefers $e^{**}(\alpha h_p + \mu)$ to $e^*(\alpha h_p + \mu)$ and makes education investment so that the child will not migrate. Only the remittance effect works although its volume tends to zero as h_p tends to $\mu/(1-\alpha)$. Finally, for $h_p \geq \mu/(1-\alpha)$, since neither the parent nor child migrates, migration does not affect education investment.

Overall, the case with $\bar{y} < \mu/(1-\alpha)$ describes an optimistic scenario. Migration mostly encourages education investment. Note that, assuming that the economy comprises various households with heterogeneous h_p, the migration rate among children will be lower than that among parents since the area of h_p where children migrate, $[0, (\bar{y}-\mu)/\alpha)$, is a subset of that for parents' migration, $[0, \mu/(1-\alpha))$.

Then discuss the case with $\bar{y} \geq \mu/(1-\alpha)$ described in Figure 1-b. For $h_p < \mu/(1-\alpha)$, the parent chooses $e^*(\alpha h_p + \mu)$ and both the remittance and prospect effects work. The overall effect

[8] Alternatively, the overall effect can be decomposed into the prospect effect, $e^*(\alpha h_p + \mu) - e^{**}(\alpha h_p + \mu)$, and the remittance effect, $e^{**}(\alpha h_p + \mu) - e^{**}(h_p)$, by adding and subtracting $e^{**}(\alpha h_p + \mu)$.

of migration can be decomposed as in (9). It is positive for sufficiently small h_p, but negative for h_p sufficiently close to $\mu/(1-\alpha)$. If $\mu/(1-\alpha) \leq h_p < \bar{y}$, then only the prospect effect works. The parent is relatively skilled and does not migrate by herself. However, she economizes education investment by choosing e^* and the child will migrate in the future. The prospect effect ceases to work only for $h_p > \bar{y}$. Contrary to the previous case, the case here describes a pessimistic scenario. The prospect effect plays the main role and makes the overall effect of migration negative if the parent has middle-level human capital. The migration rate increases between generations.

A direct implication of these two scenarios is that migration is likely to have a negative overall effect in countries with small A. A would be small if, for example, the school infrastructure is poor or the quality of teachers is low. These features seem to match the circumstances in most developing countries. This conversely implies that policies to raise A, such as public expenditure and aid programs, could make the overall effect of migration positive. A sufficiently drastic increase in A can make the optimal education investment as in Figure 1-a. Even if raising A drastically is not feasible, a slight increase in A still lowers $\bar{y}$ or $(\bar{y}-\mu)/\alpha$ and shrinks the area of h_p where the prospect effect works.

An alternative implication is that the optimistic scenario is likely to occur if the child has large innate learning ability, but that the pessimistic scenario is likely to occur otherwise, since A could also be interpreted as the child's innate learning ability. If the levels of A vary across children, then the two scenarios can show up simultaneously within a country.

Appendix: Proofs

Proof of Lemma 1. Suppose $y_p \leq y^*$. By substituting e^* to the FOC for e^{**}, (6), we have $-u'(y_p - e^*) + Ah'(e^*)v'[Ah(e^*)] > -u'(y_p - e^*) + \alpha Ah'(e^*)v'[\alpha Ah(e^*) + \mu] = 0$, where the inequality follows $v'' < 0$ and $Ah(e^*) < \mu/(1-\alpha)$ and the equality holds since it is the FOC for e^*, (4). This implies $e^{**} > e^*$. Then, consider y^*. Its definition and $e^* < e^{**}$ implies $\mu/(1-\alpha) = Ah[e^*(y^*)] < Ah[e^{**}(y^*)]$. The definition of y^{**}, $Ah[e^{**}(y^{**})] = \mu/(1-\alpha)$, and $\partial e^{**}/\partial y_p > 0$ imply $y^{**} < y^*$. Finally, $\bar{e} < y^{**}$ holds immediately since $e^{**}(y^{**}) = \bar{e}$ and $e^{**} < y_p$ unless $y_p = 0$. □

Proof of Proposition 1. For $y_p \in [\bar{e}, y^{**}]$ where $e_N = \bar{e}$ and $e_M = e^*$, we have $u(y_p - \bar{e}) + v[Ah(\bar{e})] = u(y_p - \bar{e}) + v[\alpha Ah(\bar{e}) + \mu] < u(y_p - e^*) + v[\alpha Ah(e^*) + \mu]$, where the inequality holds since e^* maximizes $u(y_p - e) + v[\alpha Ah(e) + \mu]$. Hence $f(y_p) < 0$. For $y_p \geq y^*$ where $e_M = \bar{e}$ but $e_N = e^{**}$, an analogous logic leads to $f(y_p) > 0$. Since $f(y_p)$ is continuous, there is some $\bar{y} \in (y^{**}, y^*)$ such that $f(\bar{y}) = 0$. Since $f'(y_p) = u'(y_p - e^{**}) - u'(y_p - e^*) > 0$ for any $y_p \in (y^{**}, y^*)$ by the envelope theorem, $\bar{y}$ such that $f(\bar{y}) = 0$ is unique. □

Proof of Lemma 2. Applying the implicit function theorem to $f(\bar{y}) = 0$, we have

$$\frac{d\bar{y}}{dA} = \frac{v'[\alpha Ah(e^*) + \mu]\alpha h(e^*) - v'[Ah(e^{**})]h(e^{**})}{f'(\bar{y})}.$$

Using the FOCs, the numerator can be re-expressed as

$$\frac{u'(y_p - e^*)h(e^*)}{Ah'(e^*)} - \frac{u'(y_p - e^{**})h(e^{**})}{Ah'(e^{**})}.$$

It is clearly negative. Since $f' > 0$, $d\bar{y}/dA < 0$.

As $A \to +\infty$, the definition $Ah[e^*(y^*)] = \mu/(1-\alpha)$ and $h(0) = 0$ imply $e^*(y^*) \to 0$ and $y^* \to 0$. Hence $\bar{y} \to 0$. As $A \to 0$, the definition $Ah[e^{**}(y^{**})] = \mu/(1-\alpha)$ and $h(e) \to +\infty$ as $e \to +\infty$ imply $e^{**}(y^{**}) \to +\infty$. Since $\bar{y} > y^{**} > e^{**}(y^{**})$, $\bar{y} \to +\infty$. □

Proof of Lemma 3. Since $\bar{y} \to 0$ as $A \to +\infty$ and $\bar{y} \to +\infty$ as $A \to 0$, there exists positive A such that $\bar{y} = \mu/(1-\alpha)$. Since $d\bar{y}/dA < 0$, such A is unique. Denoting it by $\bar{A}$, we have $\bar{y} \gtreqless \mu/(1-\alpha)$ if $A \lesseqgtr \bar{A}$. By expressing $f(y_p)$ as $f(y_p, A)$, $\bar{A}$ is implicitly defined as $f[\mu/(1-\alpha), \bar{A}] = 0$. □

References

Adams, R. H., Jr. and A. Cuecuecha (2010): "Remittances, Household Expenditure and Investment in Guatemala." *World Development* **38**, 1626-1641.

——— and ——— (2013): "The Impact of Remittances on Investment and Poverty in Ghana." *World Development* **50**, 24-40.

Becker, G. S. and R. J. Barro (1988): "A reformulation of the economic theory of fertility." *The Quarterly Journal of Economics* **103**, 1-25.

Becker, G. S. and H. G. Lewis (1973): "On the Interaction between the Quantity and Quality of Children." *Journal of Political Economy* **81**, S279-S288.

Beine, M., F. Docquier, and H. Rapoport (2001): "Brain drain and economic growth: theory and evidence." *Journal of Development Economics* **64**, 275-289.

Bhagwati, J. and K. Hamada (1974): "The brain drain, international integration of markets for professionals and unemployment: A theoretical analysis." *Journal of Development Economics* **1**, 19-42.

Borjas, G. J. (1987): "Self-Selection and the Earnings of Immigrants." *The American Economic Review* **77**, 531-553.

——— (2014): *Immigration Economics*. Harvard University Press, Cambridge, MA.

Cox, D., Z. Eser, and E. Jimenez (1998): "Motives for private transfers over the life cycle: An analytical framework and evidence for Peru." *Journal of Development Economics* **55**, 57-80.

Galor, O. and D. N. Weil (2000): "Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond." *The American Economic Review* **90**, 806-828.

Grogger, J. and G. H. Hanson (2011): "Income maximization and the selection and sorting of international migrants." *Journal of Development Economics* **95**, 42-57.

Katz, E. and O. Stark (1987): "International Migration Under Asymmetric Information." *The Economic Journal* **97**, 718-726.

Kwok, V. and H. Leland (1982): "An Economic Model of the Brain Drain." *The American Economic Review* **72**, 91-100.

McKenzie, D. and H. Rapoport (2011): "Can migration reduce educational attainment? Evidence from Mexico." *Journal of Population Economics* **24**, 1331-1358.

Miyagiwa, K. (1991): "Scale Economies in Education and the Brain Drain Problem." *International Economic Review* **32**, 743-759.

Mountford, A. (1997): “Can a brain drain be good for growth in the source economy?” *Journal of Development Economics* **53**, 287-303.

Stark, O. and L. Byra (2012): “A back-door brain drain.” *Economics Letters* **116**, 273-276.

Stark, O., C. Helmenstein, and A. Prskawetz (1997): “A brain gain with a brain drain.” *Economics Letters* **55**, 227-234.

———, ———, and ——— (1998): “Human capital depletion, human capital formation, and migration: a blessing or a “curse”?” *Economics Letters* **60**, 363-367.

Yang, D. (2008): “International migration, remittances and household investment: evidence from Philippine migrants’ exchange rate shocks.” *The Economic Journal* **118**, 591-630.