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A Model of the Brain Drain and Circulation*

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Abstract: To explain the motivation and dynamics of bi- and multi-directional immigration as well as the traditional unidirectional, this paper presents an inter-temporal job search model based on Bellman equations. This model captures three main features of the decision-making problem facing potential immigrants: (1) due to equalization of wages via globalization, immigrants may choose to remain at home or move to gain general human capital (e.g. English) and specific human capital (e.g. technological expertise); (2) an immigrant may leave but her job searches in the host countries often lead to uncertain outcomes since no one is guaranteed a higher wage after immigration; thus decision-making generally depends on expectations; (3) the immigrant's decision-making is state-contingent, which may be adjusted according to updated information obtained in later periods (states). Based on the analysis of my model, I conclude that, although higher expected income will initially induce people to immigrate to the developed host countries, some will return home due to both competitive wages being offered in their home countries and unmet expectations encountered in the host countries. Therefore, brain circulation is a more likely outcome than a pure brain drain.

I. Introduction

Globalization increases the mobility of labour as well as goods, services, technology and capital throughout the world. Under the process of globalization, it is interesting to observe that immigration, especially of the highly educated and highly skilled, is no longer a unidirectional movement from developing countries to developed ones; instead, it turns out to be bi-directional or even multi-directional. Therefore, beyond considering such economic phenomenon as remittances, immigration can be seen as more than a "brain drain/gain" game, since the bi- or multi-directional movement of immigrants can be observed as "brain circulation." That is, the developing country which suffers from a "brain drain" due to emigration of highly skilled workers may reap benefits due to the eventual return of some of those highly skilled workers, which is described as "brain circulation." (Saxenian 2000)

Traditional discussions of the "brain drain" mainly focused on a static comparison of the net income difference caused by information asymmetry (Kwok and Leland 1982), and scale economics (Miyagawa 1991), and as a result, it can not explain the new phenomenon of brain circulation under globalization. Furthermore, though the new issue has been analyzed by many economists (DeVoretz 2006), there is no explicit general model which incorporates both the brain drain/gain and the circulation arguments. The purpose of my paper is to present an inter-temporal job search model to explain the motivation of bi- and multi-directional immigration as well as the traditional unidirectional one. This model has 3 main features:

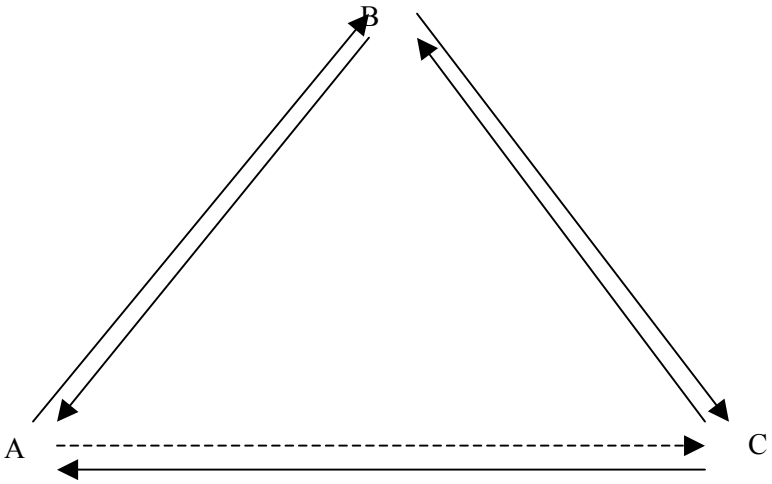
1. Developing countries may also offer some competitive wages due to globalization;
2. A job search leads to uncertain outcomes and no one is guaranteed a higher wage after immigration, thus decision-making generally depends on expectations;
3. Decision-making is state-contingent which may be adjusted according to the updated information obtained in later periods (states).

The Model

Suppose there are 3 countries in the world. Country A is a populated developing country which is a traditional immigrant-sending country; B is a developed country which imposes no restrictions on immigration and will equip the immigrants from A with general human capital (i.e. English); C is also a developed country with a more developed economy than B but only accepts immigrants with general human capital (i.e. only from B) and later equips those immigrants with specific human

capital (i.e. high technology) if they are employed. Furthermore, A's job market is very immature and which can only offer 3 types of wage, $w_1 \prec\prec w_2 \prec\prec w_3$. These wages are respectively offered to those immigrants who lack the general human capital, who have only the general human capital and who also have specific human capital. In addition there is no unemployment in A. Compared to A, B and C have an infinite range of wages from 0~H with the same distribution (i.e. $F_B(w) = F_C(w)$). Workers in these 2 countries draw wages randomly, they will be employed forever once they accept the job offer (but they can choose to quit). If they refuse the offers, they will be given U_B and U_C as unemployment compensation by government of B and C respectively.[1] Thus, we can depict the direction of immigration by Figure 1 shown below (the dotted arrow shows the unfeasible direction).

Figure 1. Immigration Direction Triangle

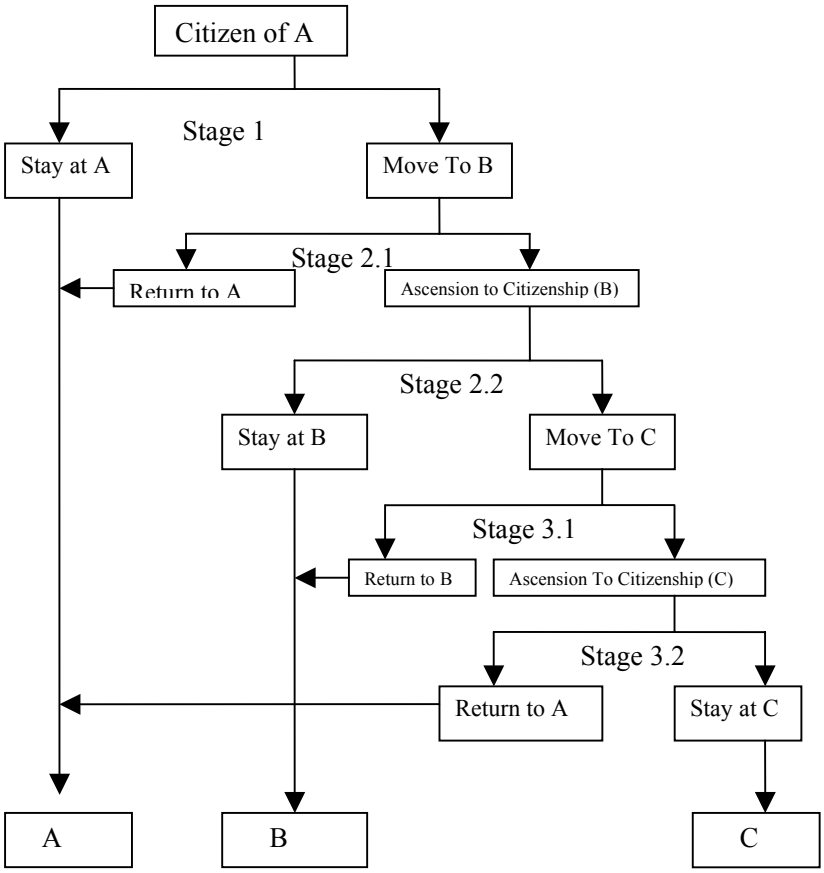


In each country, everyone knows his intelligence (I) which is endowed by Nature and indexed from 0~1 (0 stands for the most naïve while 1 stands for genius) with the same mean (i.e. $E(I_A) = E(I_B) = E(I_C)$). Thus, the traditional "Brain Drain" can be defined by a negative change in the national average intelligence ("Brain gain" vice versa); and "Brain Circulation" can be defined as any fluctuation in the national average intelligence average caused by an outflow and subsequent return to the average intelligence or beyond. Moreover, adding elements of the real world, assume that living costs are the same across countries and people are all risk neutral, then I argue that the cause or motivation to immigrate is owing to the difference in the expected lifetime incomes between countries.

[1] These are the standard assumptions using in job search model.(i.e. McCall, 1970)

In addition, people are assumed to only have one-step forecasting ability, that is, based on current information, they can only forecast the situations in the following period, i.e. they are myopic. In other words, if people in Country A plan to emigrate to B, they are not aware that once they successfully settle in B, they would also have a chance to emigrate further to C which is not feasible when they are in A. This assumption is very important since it excludes the externalities caused by the third country. For example, the motivation for emigrating to B from A is merely due to the relative income advantage in B, and the externalities generated by a chance to move later to C or return to A with general human capital are excluded.

Figure 2. Immigration Decision-Making Tree



Based on the assumptions above, people in A are ready to engage at most in a 3-stage decision-making process illustrated by Figure 2.

Stage 1. Immigration strategies in A

In stage 1, people in A will make a decision on whether or not to emigrate to B based on the lifetime income they can earn in these two countries respectively. If they choose to stay, everyone, no matter how smart they are, will be offered only w_1 in each period, if everyone's discounted factor β is also the same, the lifetime income in A is $\frac{w_1}{1-\beta}$ for all that never emigrate.

However, if one chooses to emigrate to B, s/he will be unemployed at least in the first period while accumulating the essential general human capital, which can be freely acquired by B's immigration integration program. After the second period, she is qualified to join the labour market in B and draw a job (with wage w) randomly and assume w follows the cdf F(w, I) with the property of $\frac{\partial F(w,I)}{\partial I} < 0$, that is, $F(w,I_2)$ is first order stochastic dominant over $F(w,I_1)$ if $I_2 > I_1$. This property captures the fact that smarter people will have a higher probability of obtaining a high wage job. Also note since the wage ranges from 0~H, thus F(0,I)=0 and F(H,I)=1. Once rejecting a current offer, the immigrant will be endowed with U_B as unemployment compensation.

Following the similar method to McCall's Job Search Model (1970), the expected lifetime income to a certain type of potential immigrant with intelligence I will be,

$$V^1 = \beta E(V_B(w,I)) \tag{1}$$

Where $V_B(w,I) = Max\left\{\frac{w}{1-\beta}, U_B + \beta\int_0^H V_B(w',I)dF(w',I)\right\}$.

Then we know there is a reservation wage[2] $\overline{w}_B$, such that

$$\frac{\overline{w}_B}{1-\beta} = U_B + \beta\int_0^H V_B(w',I)dF(w',I) = U_B + \beta E(V_B(w,I)) \tag{2}$$

[2] The reservation wage is the wage offer at which a job hunter is indifferent to accept the offer or reject.

from (2) we can derive $\overline{w}_B = \overline{w}(U_B, I)$, with $\frac{\partial \overline{w}_B}{\partial U_B} > 0$ and $\frac{\partial \overline{w}_B}{\partial I} > 0$ (formal proofs are shown in stage (2.2). Intuitively, it's straight forward to note that higher unemployment compensation implies lower search costs for a job in the next period, thus a higher reservation wage is desired; smarter people have higher probability of finding a job with a good wage, thus the higher expectation also results in a higher reservation wage.

By using the reservation wage in equation (2), we can rewrite equation (1),

$$V^1 = \beta E(V_B(w, I)) = \frac{\overline{w}(U_B, I)}{1-\beta} - U_B \qquad (3)$$

Obviously, the decision on whether or not to emigrate is simple if we compare the "Present Discounted Value" (PDV) of stay $\frac{w_1}{1-\beta}$ versus the value of immigration $\frac{\overline{w}(U_B, I)}{1-\beta} - U_B$. Since $\frac{\partial \overline{w}}{\partial I} > 0$, we know $\overline{w}_B(U,0) \le \overline{w}_B(U,I) \le \overline{w}_B(U,1)$. Therefore, I draw the first conclusion:

Conclusion 1: No one in A will have a motivation to immigrate if $w_1 > \overline{w}_B(U_B,1) - (1-\beta)U_B$, and thus there is no brain drain; All the people in A will have a motivation to immigrate if $w_1 < \overline{w}_B(U_B,0) - (1-\beta)U_B$, and thus there will be a complete brain drain; in the moderate case where $\overline{w}_B(U_B,0) - (1-\beta)U_B < w_1 < \overline{w}_B(U_B,1) - (1-\beta)U_B$, a fraction of population with higher levels of intelligence $1 \ge I \ge I^* = \overline{w}^{-1}(w_1 + (1-\beta)U_B)$ will have a motivation to immigrate, and thus there is a partial brain drain.

Note: equation (2) can also be written as

$$\overline{w}_B(I) - U_B = h_1(\overline{w}, I) = \int_{\overline{w}_B(I)}^{H} (w' - \overline{w}_B(I)) dF(w', I) \qquad (4)$$

Equation (4) simply states that the reservation wage should be the one at which the cost of searching after rejecting the reservation wage(left hand side) will be equal to the PDV of finding a wage offer higher than the reservation wage(right hand side).

For ease of illustration, let U_B=0, so the decision is based on a comparison of w_1 to $\overline{w}_B$. Moreover, by noting the following properties of PDV function $h_1(w(I))$,

(i) $\frac{dh_1(w,I)}{dw} = -\frac{\beta}{1-\beta}(1-F(w,I)) < 0$

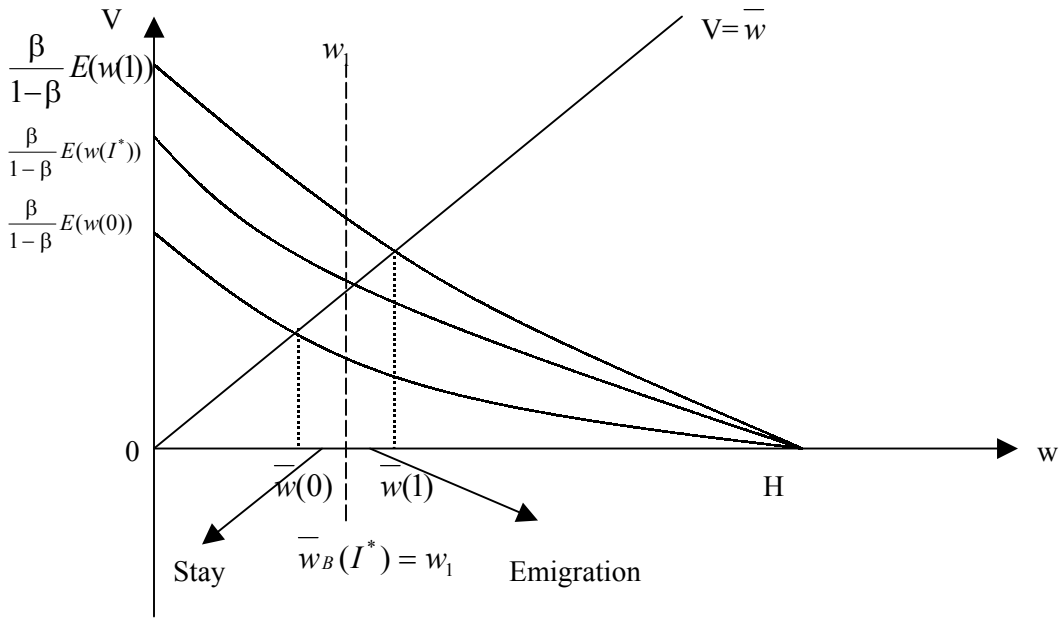
(ii) $\frac{d^2(h_1(w,I)}{dw} = \frac{\beta}{1-\beta}F'(w,I) > 0$

(iii) h(0)=$\frac{\beta}{1-\beta}E(w)$, h(H)=0

(iv) $h_1(w,I_2) > h_1(w,I_1)$, for $1 \geq I_2 \succ I_1 \geq 0, w \neq H$

We can illustrate conclusion 1 in Figure 3: If I focus on the moderate case where $1 \geq I \geq \overline{w}^{-1}(w_1)$, only the upper fraction of people with intelligence $I \geq I^*$ ($I^* = \overline{w}^{-1}(w_1)$) will have a motivation to immigrate and the remaining people's average intelligence level will then decrease. So a brain drain occurs to A in the first stage.

Figure 3. Reservation Wage Determination 1



Stage 2. Immigration strategies at B

From the last section, we know if there are no barriers (physical and political) between A and B, the population with intelligence $I \geq I^*$ will move to B. To avoid ambiguity in my later discussion, I assume $I^* \geq E(I)$, A country's average intelligence level before emigration occurs. And now I am interested in the decision making strategy of this group at the 2nd stage.

Stage 2.1 Return Home or Ascension to Citizenship of B

After immigration, the group of immigrants with $I \geq I^*$ in the 1st period is unemployed (thus no income at all) but equipped with the general human capital. So at the beginning of 2nd period, they are qualified to draw wage offers from B's labour market and to receive unemployment compensation if they reject the offer. Note, alternatively, they can also return home and facing a wage offer of $w_2 (\succ\succ w_1)$ since they have acquired general human capital.

It is apparent that those immigrants who are fortunate to find a job with wage w$\geq w_2$ will choose to stay (even though some of them may reject w since their reservation wage is higher). Since $\frac{\partial F(w,I)}{\partial I} < 0$, we know

$$F(w_2, I_2) < F(w_2, I_1), \text{ if } I_2 > I_1$$

thus the probability of finding a job offer w$\geq w_2$ is given by

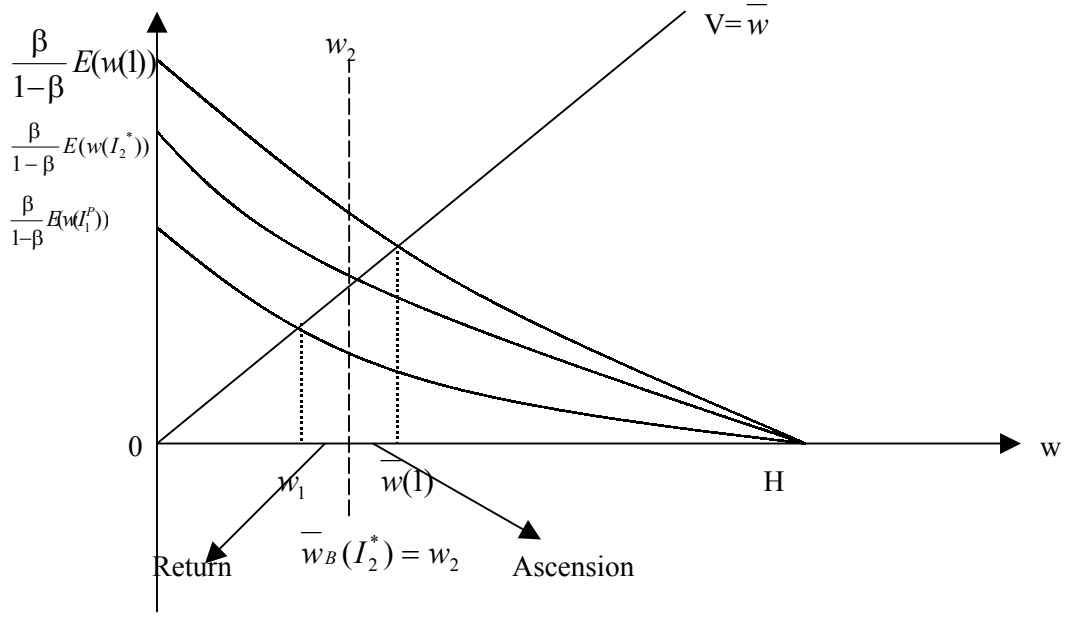
$$1 - F(w_2, I_2) > 1 - F(w_2, I_1) \qquad (5)$$

Inequality (5) states that people having greater intelligence are more likely to draw a higher wage, thus this group of fortunate immigrants have a biased distribution in the upper level of intelligence, that is to say, smarter people are more likely to find a good job and thus choose to stay.

On the contrary, the unfortunate group will distribute a bias to the lower end of the intelligence distribution. For them, they have to decide at the end of the 2nd stage whether to return to A or stay at B. Hence they are facing a very similar situation as in stage 1, that is, to compare w_2 to $\overline{w}_B(U_B,1) - (1-\beta)U_B$.

Conclusion 2: If $w_2 > \overline{w}_B(U_B,1) - (1-\beta)U_B$, all the unfortunate immigrants will return home and only the fortunate group will stay and ascend to citizenship; otherwise, besides the fortunate group, the immigrants have intelligence level $1 \geq I \geq \overline{w}^{-1}(w_2 + (1-\beta)U_B)$ will choose to stay and ascend to citizenship as well, while the remaining unfortunate group ($\overline{w}^{-1}(w_2 + (1-\beta)U_B \geq I \geq \overline{w}^{-1}(w_1 + (1-\beta)U_B)$) will return home as so called "disappointed immigrants". Now A has brain circulation and B has less brain gain.

Figure 4. Reservation Wage Determination 1



Again, let U_B =0, we can easily see, to the fortunate group, who will stay and who will return home on Figure 4.

Stage 2.2 Stay forever at B* vs. *Move Forward to C

After ascension to citizenship, the remaining immigrants at B with the general human capital now can access C's labour market. Since C's economy is assumed to be more flourishing than B, I assume job hunters in C can draw two job offers. Furthermore, assume B opens its job market to C for those experienced workers (work experience either from B or C), yet C's job market is only open to internal job hunters, so job hunters in C can draw both of the wage offers from C or one from C and one from B (if they have working experience in B) within a period, yet one can only draw one in B. For the purpose of simplicity, since the wage distributions are equal, immigrants from B to C will draw one wage offer from B and the other from C if he was ever employed in B. Those without work experience will focus on jobs in C. In any event, no matter what the former employment status was at B, people can always draw a wage w=max $\{w_1, w_2\}$ which means the wage distribution function is,

$$F_c(w,I) = F(w_1 < w, I)F(w_2 < w, I) = F^2(w,I) \tag{6}$$

hence

$$h_C'(w) = -\frac{\beta}{1-\beta}(1-F^2(w)) < 0 \text{, and } h_C''(w) = \frac{\beta}{1-\beta}2F(w)F'(w) > 0$$

i.e. condition (i) and (ii) still hold.

Since cdf $F \leq 1$, therefore we know $F_c = F^2 \leq F$, that is, F_c is first order stochastic dominant over F for any type of I.

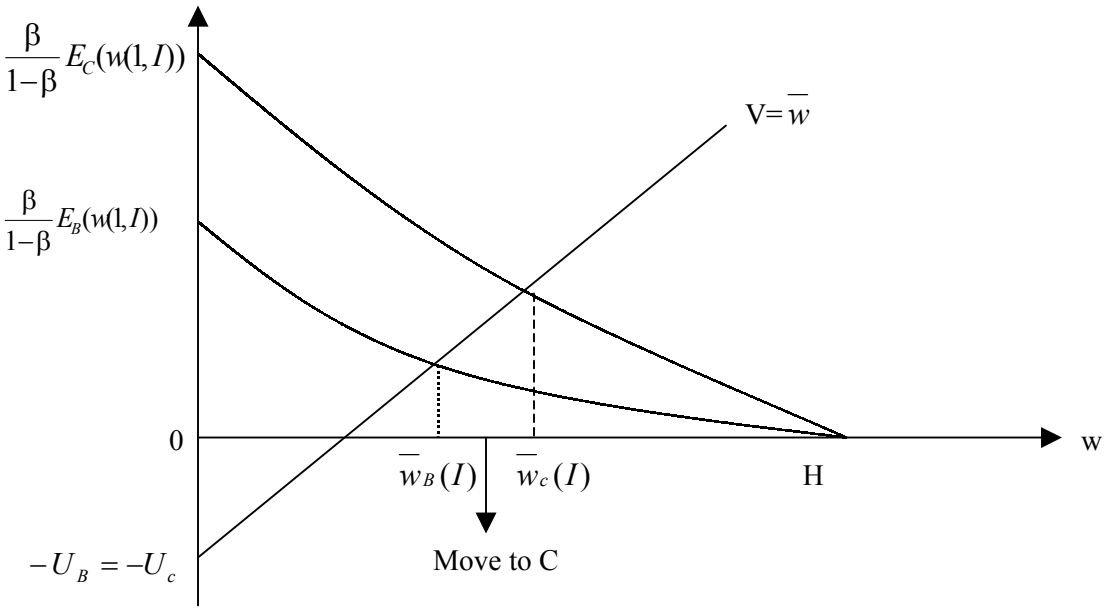
Therefore, analogous to equation (2), the reservation wage for type I people at C's labour market is given by,

$$\frac{\overline{w}_c(I)}{1-\beta} = U_C + \beta E(V_C(w,I)) \tag{7}$$

If this immigrant belongs to the unfortunate group and has not yet obtained a job, then his decision is based on comparison of PDV at B's ($V_B(w,I)$) labour market to C's ($V_C(w,I)$), or alternatively, compare $\frac{\overline{w}_B(I,U_B)}{1-\beta} - U_B$ to $\frac{\overline{w}_c(I,U_c)}{1-\beta} - U_C$.

First of all, let us consider a simple case where $U_B = U_C$, then the decision-making problem can be simplified to a comparison of $\overline{w}_B(I)$ vs. $\overline{w}_C(I)$, and it follows directly that $\overline{w}_C(I) > \overline{w}_B(I)$ since $F^2(w,I)$ is first-order stochastic dominant over F. That is to say, all types of people in the unfortunate group will move forward to C because of the higher expected PDV. Furthermore, fortunate people of type I whose wage is lower than the new reservation wage will also choose to move. This is shown on Figure 5 below.

Figure 5. Reservation Wage Determination 2



However, in general, $U_B \neq U_C$. The analysis here is more complicated.

First of all, let us find the relationship between $\bar{w}(U_B, I)$ and U_B . Take the first derivative with respect to U_B, we get

$$\frac{d\bar{w}(U_B, I)}{dU_B} - 1 = \frac{dh_2(\bar{w}, I)}{d\bar{w}} \cdot \frac{d\bar{w}}{dU_B}$$, where $\frac{dh_2(\bar{w}, I)}{d\bar{w}}$ is shown in condition (i)

If we re-arrange it, we have

$$\frac{d\bar{w}(U_B, I)}{dU_B} = \frac{1-\beta}{1-\beta+\beta(1-F)} = \frac{1-\beta}{1-\beta F} > 0, \quad \text{since } \beta < 1 \text{ and } F \leq 1$$

therefore,

$$\frac{dV_B}{dU_B} = \frac{1}{1-\beta}\frac{1-\beta}{1-\beta F} - 1 = \frac{\beta F}{1-\beta F} > 0 \qquad (8)$$

Hence, we can derive a $U_B^*(I) = U(U_C, I)$ such that $\frac{\bar{w}_B(I, U_B)}{1-\beta} - U_B = \frac{\bar{w}_c(I, U_c)}{1-\beta} - U_C$.

Hence we know that if $U_B^*(I) \le U(U_C, I)$, then everyone of type I in the unfortunate group, would like to move on to C; otherwise, all of them will choose to stay at B forever.

What about the general case for the whole unfortunate group (i.e. $I \in [I^*, 1]$)? The answer relies on the relationship between U_B and I. Mathematically $\frac{dU_B}{dI}$ can be derived from the implicit function of equation (4).

Let $G = \bar{w} - U_B - \int_{\bar{w}}^{H} (w' - \bar{w}) f(w', I) dw'$

Therefore,

$$G_{\bar{w}}' = 1 + \int_{\bar{w}}^{H} f(w', I) dw' \succ 1 \succ 0 \tag{9}$$

and

$$G_I' = -\int_{\bar{w}}^{H} (w' - \bar{w}) \frac{\partial f(w', I)}{\partial I} dw' \prec 0 \tag{10}$$

Hence, we know

$$\frac{d\bar{w}}{dI} = -\frac{G_I'}{G_{\bar{w}}'} > 0 \tag{11}$$

Intuitively, suppose $\bar{w}_B$ is fixed at first, then an increase in I must result in an increase in the expected gain given by $\int_{\bar{w}_1}^{H} (w' - \bar{w}_1) dF(w', I)$ because of the property that F(w,I), which implies that the left hand side of equation (4) is now less then the right hand side. In order to restore the balance, we must increase $\bar{w}_B$. As a result, we can derive that $\frac{d\bar{w}_B}{dI} > 0$. By imposing a regularity condition[3] on F(w,I) such that it can satisfy $\frac{dw(I)}{dI} = \frac{d\bar{w}_c}{dI} - \frac{d\bar{w}_B}{dI} > 0$, we can derive, to keep $V_C = V_B$,

[3] The regularity conditions that I will impose is: the elasticity of reservation wage in C on intelligence is higher than that in B for any $I \ge I^{**}$, where I^{**} is given by $\bar{w}_c(I, U_C) = \bar{w}_B(I, U_B)$. This is, intuitively, given

$$\frac{dU_B}{dI} = \frac{\frac{dV_C}{dI}}{\frac{dV_B}{dU_B}} = \frac{\oplus}{\oplus} \succ 0 \qquad (12)$$

Therefore, we get the following conclusion for the unfortunate group.

Conclusion 3.1 if $U_B \succ U(U_C,1)$, all types of people in the unfortunate group will choose to stay at B forever; if $U_B \prec U(U_C,I^*)$, everyone, no matter what their types, will choose to move on further to C; if $U(U_C,1) \geq U_B \geq U(U_C,I^*)$, the people with $I \in [I_1^{**},1]$ will choose to move since U_B is lower than their desired level, where $I_1^{**} = U^{-1}(U_c,U_B)$

For people in the fortunate group who are paid w, their decision will depend on the comparison of $\frac{w}{1-\beta}$ vs. $\frac{\overline{w}_c(I,U_c)}{1-\beta}$. Note, since $w \geq \overline{w}_B(U_B,I)$ for all types of people accepting w, there will be type I immigrants who quit their current job and move to C if $\overline{w}_c(I,U_C) \succ \overline{w}_B(U_B,I)$. Let us define a functional form as follows,

$$w(I) = \overline{w}_c(I,U_C) - \overline{w}_B(U_B,I) \qquad (13)$$

and we know

$$\frac{dw(I)}{dI} = \frac{d\overline{w}_c}{dI} - \frac{d\overline{w}_B}{dI} > 0, \qquad \text{if regularity condition of F holds}$$

Thus conclusion 3.2 follows:

Conclusion 3.2: if $I_2^{**} > 1$, all people in the fortunate group will choose to stay at B forever; if $I_2^{**} < I^*$, there are some of each type whose wages are smaller than $\overline{w}_c(I,U_C) - (1-\beta)U_C$, choose to move further on to C; if $I^* \leq I_2^{**} \leq 1$, only some immigrants with $I \in [I_2^{**},1]$ will choose

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an appropriate F(w,I), the difference in intelligence would result in even bigger difference in probability of getting a decent job and therefore a bigger difference in reservation wage.

to move further on to C, while everyone with $\in [I_1^*, I_2^{**}]$ will choose to stay at B forever; where I_2^{**} is determined by $\overline{w}_c(I_2^{**}, U_C) = \overline{w}_B(I_2^{**}, U_B)$.

Let us now just focus on the moderate case. First, I note that $I_2^{**} > I_1^{**}$, given U_B and U_C. The proof is quite intuitive: Since the expected PDVs gained in C are the same for people with the same intelligence type, no matter employed or not. However, to those of unemployed immigrants, the opportunity cost of job search in C is just $\frac{\overline{w}_B(I, U_B)}{1-\beta} - U_B$, which is smaller than that of the employed immigrants, $\frac{w}{1-\beta}$, since w $\geq \overline{w}_B(U_B, I)$. Therefore, unemployed immigrants are more likely to move than the employed ones, thus we know $I_2^{**} > I_1^{**}$.

Hence, combining the moderate cases with conclusion 3.1 and 3.2, we can draw conclusion 3.3 as follows:

Conclusion 3.3: for the group of immigrants from Country A, those with I$\in [I^*, I_1^{**}]$, no matter employed or not, will choose to stay at B forever; those with I$\in [I_1^{**}, 1]$ and unemployed will choose to move to C; those employed with I$\in [I_2^{**}, 1]$ but their wage is not sufficiently high (not higher than the expected PDVs in C) so they will choose to emigrate as well.

Therefore, emigration to C is biased to the upper level of intelligent immigrants residing in B, thus B suffers a "brain drain" for this group, since the average intelligence is lower. However, B still enjoys a net brain gain to the whole nation as the remaining immigrant groups are still, on average, smarter than B's average people. Finally there is an obviously a brain gain to C.

Stage 3. Immigration strategies at C

When the subgroup emigrates to C for higher PDVs, they can draw two wage offers in a single period which are both from C if formerly unemployed at B, or one from C and the other from B if formerly employed at B, that is, working experience in B is useless in C but apparently useful in B. After the first searching period in C (the fourth period in total), those who are employed will accumulate the valuable specific human capital and face a wage offer w_3 from A starting in the following period. As in the analysis in B, I will also divide the decision-making process into two sub-stages.

Stage 3.1 Stay at C or Return to B

The decision-making strategy is easy for immigrants from the unfortunate group: if they still can not find satisfying jobs, their situation is exactly like that in stage 2.2. Therefore, they will remain in C and ascend to citizenship in C, and obviously those who find satisfying jobs will do so as well.

What about the decision-making strategy for immigrants from the fortunate group? Analogous to the unfortunate group, those who find satisfying jobs will stay and ascend to citizenship of C. However, those who are now unfortunate will keep on searching. And these immigrants will draw a wage offer from C and another from B. Since the wage distributions are the same, we can conclude that they will return home with a probability $\frac{1}{2}$, which is just the probability of get satisfying jobs in B. Therefore, after the fourth period, the "disappointed" returnees to B will make up the brain drain at the third period to some extent; But C will still have a net brain gain.

Stage 3.2 Return Birth A or Stay at C

To those who are employed at C (no matter how late it is), they will also face a constant job offer w_3 from their Birth Country A. It is straightforward to analyze the decision-making process. We only need compare w_3 with their current employment wage w. If $w_3 \geq$ w, they will return to A; otherwise, they will stay. But we are more interested in the distribution of the intelligence of the returnees. Since it is possible to have returnees with I only if $w_3 \geq \overline{w}_c(I)$. Therefore, I can draw my last conclusion:

Conclusion 4: if $I^{***} \geq 1$, all types of the subgroup will have some guys return to A given their wage is smaller than w_3; if $I^{***} \leq I_1^{**}$, no one will return home since w_3 is even unattractive to the lowest type in this subgroup; if $1 \succ I^{***} \succ I_1^{**}$, there are some immigrants of each type $I \in [I_1^{**}, I^{***}]$ who will choose to return.

Since in the fifth period, there will continuously be returnees from C to A with valuable specific human capital, A then again will experience a brain circulation. C will still end up with an unambiguous net brain grain.

Conclusion and Discussion

Given that the moderate set of conditions are all satisfied, I conclude that immigration causes A country to have a net brain drain. However, the drain is not like the traditional pattern since the initial brain drain will later induce some brain circulation with the returnees equipped with valuable general and even specific human capital if A can offer some competitive wages. Country B will experience a brain gain from A but drain to C. Nevertheless, the final result is still a net brain gain for Country B. Country C will experience a net brain gain.

Even given the net brain drain from the developing Country A, it would be reckless to conclude that immigration is harmful to A, since "good" or "bad" is rather a question of a change in the national human capital stock. It is true that a brain drain is "bad" for the sending country in a traditional environment since unidirectional immigration will definitely reduce the sending country's human capital stock. However, the new phenomenon of "Brain Circulation" as presented here yields an ambiguous effect on Country A's national human capital.

A simple example will make this clearer. Suppose sending Country A has a population of ten with an intelligence level ranging from 1 to 10 respectively, and each of them has 1 unit of human capital. Immigration causes the smartest five residents to leave for B and some to C later, and they will gain 2 more units of human capital in B and 4 more in C. However, brain circulation results in one returning from B and one returning from C. Note that the initial national human capital stock in Country A was 10. But after brain circulation it is now 11! Hence, brain circulation may make developing countries better off even if they still initially suffer from a net brain loss.

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