

Skilled Workers, Immigration Option and Optimal Investment in Human Capital

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Motivation

- Investment in human capital as highly irreversible decision
- Uncertainties about the future pay-off of investment
- Human capital investment and real options: education as a multi stage growth option
- Skilled labor migration as a global problem affecting both developed and developing countries

Immigration

- Froced vs selective immigration
- Immigration only with human/financial capital (the US, Canada, Australia, Germnay) or without this requirement (most of Europe)
- Benefits/costs to both sender and host countries

Our Work

- Impact of immigration option on investing in human capital
- Innovation: two types of human capital, local and global
- Expected results: Immigration option affects rate of investment in global human capital positively and the rate of investment in local one negatively
- Total effect?

Litrature Review

- Real Options and Investment in Human Capital
 - Human capital and exit option: Katz and Rapoport(2005)
 - Higher return on human capital due to the existence of option to wait: Jacobs(2007)
 - Education and option to shutdown: Hogan and Walker(2007)
- Immigration and Investment in Human Capital: Vidal(1998)
- Immigration and Real Options
 - Option value of waiting: Burda(1995)
 - Immigration quotas and option value: Moretto and Vergalli(2008)
 - Uncertainty and option to wait before immigration: Locher(2002)
- Immigrants Human Capital
 - Complementrarity of language: Chiswick and Miller(2003), Berman et al (2002)
 - No positive economic return from homeland education: Hartog and Zorlu(2007)

The Agent and Her Decision Problem

- A risk-neutral skilled person with an option to work abroad
 - Interim vs original country
- Two types skill accumulation
 - Stock of *universal* human capital, $g(t)$

$$dg(t) = u(t)dt \quad (1)$$

- Stock of *local* human capital, $k(t)$

$$dk(t) = q(t)dt \quad (2)$$

- Investment in human capital is costly:

$$c(u, q) = \frac{c_1}{2}u^2 + \frac{c_2}{2}q^2 \quad (3)$$

The Agent and Her Decision Problem

- Tradeoff between universal and local human capital
 - Full transferability of universal human capital
 - Only a portion $\alpha \in [0, 1]$ of local human capital can be put to productive use in the destination country
- Exercise of option leads to a wage gain (destination/host):

$$dw(t) = \mu w(t)dt + \sigma w(t)dz(t) \quad (4)$$

- There is a lump-sum (opportunity) cost of moving of S due, for instance, to losing one's social network, sentiments, permanent residence, any current pension plans etc.

Variations in Modelling

- Finite vs. infinite time horizon
 - Likely to affect the optimal investment policy
 - May not be optimal to accumulate global human capital if "close" to the termination time
 - May not be optimal to migrate if close to the end of career
 - Acknowledge and start with the infinite horizon case
- Ease (probability) of immigration
 - Aim is to capture the immigration policy of destination: friendly or hostile
 - Either add an exogenous probability, p of being able to immigrate or assume that there is some underlying process by which the destination becomes friendlier (eg. a Poisson process)
 - Acknowledge and ignore for the moment

The Payoff of the Agent

- Normalize the wage in the host country to 1
- In the host country, before immigration, the agent's payoff is:

$$\Pi^h(g, k, w) = [g(t) + k(t) - c(u, q)] \quad (5)$$

- After immigration, the payoff is given by:

$$\Pi^d(g, k, w) = w[g(t) + \alpha\bar{k}] - c(u) \quad (6)$$

- Note: after immigration, only investment in global human capital continues, that is:

$$\bar{k} = k_\tau$$

Statement of the Problem

- Before immigration:

$$\left. \begin{aligned} \max_{u,q,\tau} W(g, k, w) &= E_0 \left\{ \int_0^\tau \Pi^h e^{-rt} dt + e^{-r\tau} [V(g, w) - S] \right\} \\ \text{s.t.} &(1), (2), (4) \end{aligned} \right\} \quad (7)$$

- After immigration:

$$\left. \begin{aligned} \max_u V(g, w) &= E \left\{ \int_0^\infty \Pi^d e^{-rt} dt \right\} \\ \text{s.t.} &(1), (4) \end{aligned} \right\} \quad (8)$$

A First Attempt at Solution

Move backwards

- Suppose the option to immigrate has been taken. The Bellman equation is:

$$V = [w(g + \alpha\bar{k}) - \frac{c_3}{2}u^2]dt + (1 - rdt)E[V(g', w + dw)] \quad (9)$$

- Using Itô and optimizing over u yields:

$$u^* = \frac{V_g}{c_3} \quad (10)$$

- Analogous arguments establish that before the immigration decision, the agent accumulates according to:

$$\left. \begin{aligned} u^* &= \frac{W_g}{c_1} \\ q^* &= \frac{W_k}{c_2} \end{aligned} \right\} \quad (11)$$

Characterization of the Value Functions

- Plugging the optimal policies into the Bellman equations we get
 - After immigration

$$\frac{1}{2}\sigma^2 w^2 V_{ww} + \mu w V_w + \frac{1}{2c_3} V_g^2 - rV + w(g + \alpha \bar{k}) = 0 \quad (12)$$

- Before immigration

$$\frac{1}{2}\sigma^2 w^2 W_{ww} + \mu w W_w + \frac{1}{2c_1} W_g^2 + \frac{1}{2c_2} W_k^2 - rW + g + k = 0 \quad (13)$$

Before Immigration

- Distinguish between "assets-in-place" and the option:

$$W(g, k, w) = f(g, k) + h(y) \quad (20)$$

- Assets-in-place have the following structure:

$$f(g, k) = p(g, k) - 0.5u^2 - 0.5q^2 \quad (21)$$

- Optimization yields:

$$\left. \begin{aligned} u^* &= gf_g \\ q^* &= kf_k \end{aligned} \right\} \quad (22)$$

The HJB and the Solution

- The solution depends on the form of $p(g,k)$. Some alternatives:

- Multiplicative

$$p(g, k) = gk \quad (23)$$

- Cobb-Douglas

$$p(g, k) = g^\theta k^\gamma, \theta, \gamma < 1, \theta + \gamma \leq 1 \quad (24)$$

- Additive

$$p(g, k) = g + k \quad (25)$$

Then, conjecture $f(g, k) = f_1(g) + f_2(k)$

$$\left. \begin{aligned} 0.5g^2 \frac{df_1^2}{dg} - rf_1 + g &= 0 \\ 0.5k^2 \frac{df_2^2}{dk} - rf_2 + k &= 0 \end{aligned} \right\} \quad (26)$$

What about the Option Component?

Analogous to an investment option *à la* Dixit&Pindyck

$$\left. \begin{aligned}
 &0.5\sigma^2 y^2 h_{yy} + (\mu + u^*)yh_y - rh = 0 \\
 &s.t. \\
 &h(0) = 0 \\
 &h(y^*) = V(y^*) \\
 &h_y(y^*) = V_y(y^*)
 \end{aligned} \right\} \quad (27)$$

BUT: $u^* = gf_g \Rightarrow$ Not so trivial to solve!

Policy Implications

- An individual immigrant is modeled. What drives her decision?
- Goal: How could countries attract more skilled labor? What are the tools to accomplish that?
 - Providing tax relief?
 - Subsidies (e.g. reducing cost) for integration to the country: ease local human capital investment
 - Pension plans
 - Ease of immigration/bureaucracy
 - Force immigrants to gain local human capital prior to immigrations
 - Make labor market requirements (specially in highly skilled sectors) more international
- Effect of transferability of local human capital: France vs Denmark

Conclusion

- Option based model for skilled workers' human capital investment decision
- Comments on:
 - Is the problem interesting enough?
 - Any idea for analytical solutions?
 - Further insights and policy analysis from the model?