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Real option, human capital investment returns and higher educational policy

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ABSTRACT

This paper incorporates the concept of real option into a modified Harris–Todaro model to investigate the relationship between higher education and unemployment rates. We found that the real option value of waiting to invest in graduate school education will decrease when the expected wage rate of labors with an undergraduate degree becomes relatively lower than that with a graduate degree. As a result, more undergraduate students will decide to go to graduate schools immediately after graduation. As the supply of labors with a graduate degree increases and the job creations fail to meet the increasing demand, those who cannot get a graduate-level job will be willing to accept job offers lower than their education level. Our modified Harris–Todaro model shows that it will lead to an increase in the number of unemployed and underemployed higher educated labors. This explains why the unemployment rates for higher educated labor are relatively high in some developed countries.

1. Introduction

It is widely recognized in the economics of human capital that educational returns are positively correlated with schooling years (e.g., Denny and Harmon, 2001; Hungerford and Solon, 1987; Mincer, 1974; Park, 1999; Silles, 2008). There are basically two schools of thought about the returns to education. One considers wages as educational returns in order to identify sheepskin effects based on various step-function specifications. The other treats education as a signal for employers to recognize individual ability in the labor market. According to the screening theory, diplomas are important for primary matching labor choices in work, however, diploma effects will decline as working experience increases. That is, education demand is negatively correlated with working experience. In contrast to the screening theory, the human capital hypothesis asserts that investments in education can improve labor skills. Therefore, employers are willing to pay more for employees with a higher education diploma than those with a primary or secondary education diploma.

The real options method has attracted significant interests in the fields of individual decision making for the purchase of durable goods, employee hiring, career choices, and human capital investment (see e.g., Ashenfelter et al., 1999; Card, 1999; Harmon et al., 2003; Jacobs, 2007). In comparison with the net present value (NPV) method, the real options method is more capable of incorporating return and cost uncertainties into the individual human capital investment decision-making process (Groot and Oosterbeek, 1992; Hogan and Walker, 2007). Friedman (1962) claims that human capital should be considered as non-liquid assets. That is, individuals can recover their foregone wages and schooling expenditures only after they start working. Therefore, the educational investment is considered an irreversible sunk cost. During the human capital investment decision-making process, individuals can decide when to invest in order to reduce risks in the labor market.

The real options value of educational investment is mainly determined by the current average wage rates, estimated direct and indirect educational expenditures, and expected future wage rates after graduation (Jacobs, 2007; Palacios-Huerta, 2004; Palacios-Huerta and Serrano, 2006). For example, the real options value of higher education investment for an individual with a Bachelor's diploma is the educational risk premium subtracted by sheepskin effects. Because the future wage rate and the probability of obtaining a job after graduation are both uncertain, it is important to take both factors into account in an individual's human capital investment decision-making process.

The issue of relatively high unemployment rate for higher educated labor in some developed countries has been widely studied since the 1990s (see e.g., Groot and van den Brink, 2000). Most previous literatures conclude that overinvestment in higher education could lead to the supply surplus of higher educated labor based on either qualitative analysis or simple quantitative models. There is still lack of a

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theoretical model to investigate the positive relationship between higher education and unemployment rates in some developed countries. In this paper, we try to resolve this important issue by incorporating the concept of real options value into a modified Harris–Todaro model. According to the Harris–Todaro migration model (Harris and Todaro, 1970), the expected wage rate in the urban modern sector plays the key role in the migration decision making process for rural labors. A similar analytical framework is developed in this paper by replacing rural and urban wage rates with undergraduate-level and graduate-level wage rates. However, in addition to expected wage rate, we further incorporate real options value in the decision making process for an undergraduate student choosing between job markets and graduate schools. This implies that the real options value of higher education investment and the re-examination rate (or reapplication rate) will affect the choice between job markets and graduate schools for an undergraduate student. While the Harris–Todaro migration model assumes that the rural labor market will be cleared with urban labor migrations, we assume that unemployment exists for labors with an undergraduate degree. Labors with a graduate degree that accept a job below their educational level are considered as underemployment.

In this paper, we attempt to identify how government's higher education expansion policy affects the relationship between the unemployment rate of labors with an undergraduate degree (undergraduate-level labor), the re-examination/reapplication rate of people who have decided to go to graduate schools but failed to get accepted, and the unemployment rate of labors with a graduate degree (graduate-level labor). According to our analysis, overinvestment in higher education is very likely to cause the increase in the unemployment rate of higher educated labors and the decrease of higher educated labor wage rates. The magnitude of these negative impacts will depend upon the demand of higher educational labor markets. Therefore, our model can be used to explain why there are relatively high unemployment rates for higher educated labor in some developed countries.

The remainders of this paper are organized as follows. Section 2 demonstrates how to incorporate the real options concept into the decision-making process of human capital investment. In Section 3, we develop a modified Harris–Todaro higher education investment model to explain the relationship between unemployment rate, re-examination/reapplication, and unemployment rate of higher educated labor. In Section 4, a graphical analysis is used to explain the impacts of overinvestment in higher education on the unemployment, re-examination/reapplication, and wage rate of higher educated labor. In the last section, we summarize the main conclusions and implications for higher education policy.

2. Education investment and real options

Dixit and Pindyck (1994) point out that there are two strong unrealistic assumptions implicit in the traditional NPV criterion of human capital investment models: reversibility and non-postpone decision making. The former assumes that investment activities would create feedback costs or drawbacks for the individual's original investments if the market condition worsens. The latter assumes that there are only two choices for an individual. That is whether to invest right now or abandon investment forever. Several recent studies have also concluded that the above assumptions are in conflict with the investment decision making process in reality because individual higher education investment decision is deferrable but irreversible (see e.g., Hogan and Walker, 2007; Jacobs, 2007). Therefore, higher educational investment is irreversible and the schooling expenditure and forgone labor earnings should be considered as sunk costs. In general, an individual can decide to invest in higher education immediately (or at later date) or enter the labor market after completing the compulsory levels of education. The decision is highly affected by the direct and indirect costs of education and uncertainties in the labor market. More importantly, real options are present in the irreversible and risky higher education investment because the individual can influence the timing of the investment. As a result, the higher education investment decision making process is more consistent with the concept of real options than traditional NPV method.

The real options of higher education investment can be considered as a put option without a predetermined expiration date. Individuals can influence the timing of the decision and wait for more information about the costs and returns of higher education investment. Therefore, the real options value is derived from the fact that individuals can invest in higher education immediately after graduation or enter the labor market and wait until the expected return is sufficiently large to give up the valuable option. Once individuals decide to invest in higher education, they cannot recover forgone labor earnings and school tuition expenses by selling their human capital asset. As a result, the risk and illiquidity of higher education investment explain why the real option emerges. If individuals decide to give up this valuable real option to wait and decide to invest in higher education, they must be compensated with higher returns. This explains why the wage rate for labors with a graduate degree is in general significantly higher than that for labors with an undergraduate degree.

To calculate the real option value of higher education investment, we assume that the annual forgone labor earnings (indirect costs) is w, the annual school expenses (direct costs) is k, and it takes T years to graduate. For simplicity, we assume that w, k, and T are known to the individual during the investment decision process. The present value of total costs I for higher education investment at the date of graduation ($t=0$) can be calculated as

$$\begin{aligned} &I \equiv \sum_{t=-T}^{0} \frac{w+k}{(1+r)^t} = \omega + \kappa \\ &r : \text{real interest rate} \\ &\omega \equiv \textstyle\sum_{t=-T}^{t=0} \dfrac{w}{(1+r)^t} : \text{present value of gross wages} \\ &\kappa \equiv \textstyle\sum_{t=-T}^{t=0} \dfrac{k}{(1+r)^t} : \text{present value of direct expenditures.} \end{aligned} \tag{1}$$

For simplicity, we assume that the retiring date after graduation is farther enough and thus the time-horizon for future labor earnings can be viewed as infinite. Assume that the expected return right after graduation ($t=0$) is R_0 and it will increase by v with probability q and decrease by δ with probability $(1-q)$ at $t=1$ after all uncertainty is revealed. That is the future expected return from $t=1$ to $t=\infty$ equals $(1+v)R_0$ with probability q and equals $(1-\delta)R_0$ with probability $(1-q)$. The present value of total labor earnings V_0 for higher education investment at $t=0$ can be calculated as

$$\begin{aligned} V_0 &= R_0 + (q(1+v)R_0 + (1-q)(1-\delta)R_0)\sum_{t=1}^{\infty} \frac{1}{(1+r)^t} \\ &= \frac{R_0(1+r+q(v+\delta)-\delta)}{r}. \end{aligned} \tag{2}$$

If the individual has to decide whether to invest in higher education or not immediately after graduation, that is, without the option to postpone the decision, then the decision will be made depending on the net present value (NPV) of the investment. Let Ω_0 represent the NPV of higher education investment without the option to wait, Ω_0 can be defined as

$$\Omega_0 \equiv \max\{V_0 - I, 0\} = \left\{\frac{R_0(1+r+q(v+\delta)-\delta)}{r} - \omega - \kappa, 0\right\}. \tag{3}$$

For simplicity, we assume that the individual will consider to invest in higher education only if Ω_0 is greater than zero. The individual will never consider to enroll in higher education if Ω_0 is equal to zero.