Inducing Human Capital Formation:
How Efficient Is an Education Subsidy?

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Abstract

This paper presents a two-step job ladder model where a skilled individual faces uncertainty in getting a skilled job and an inferior (unskilled) job down the job ladder is the alternative employment opportunity. When the probability of getting the skilled job is low enough, the model suggests the optimal policy to reach the social optimum is taxing rather than subsidizing human capital investment. The paper analyses the conditions when migration can act as a substitute for subsidizing human capital formation by moving the private optimum closer to the social optimum.

Key words: human capital formation; externalities; job uncertainty; education subsidy; migration

JEL classification: F22; H23; I30; J24

1. Introduction

Economists often justify an education subsidy as a socially optimum policy device. The underlying explanations take a variety of forms but mostly concentrate on growth-enhancing effects and other perceived positive external effects of human capital accumulation. Distributional concerns, especially for developing economies, also suggest a policy of subsidizing education from the point of view of a central planner maximizing the social welfare. Stark and Wang (2002) in their model show individuals under-invest in human capital while not taking into account the external effect of their human capital investment. A subsidy for human capital investment induces higher investment levels and brings the private optimum nearer to the social optimum.

The present paper analyses whether an education subsidy is still a social optimum policy when there is a possibility of under-employment of the educated.

Suppose an individual invests in education for a skilled job. The wage structure of this job is solely based on his skill. However, there is uncertainty in getting the targeted job. If the individual is not matched with the skilled job, he has no other option than to accept an inferior job. In this job a nominal fixed payment is made to all irrespective of their skills and a little higher (lower) payment is made to those with above-average (below-average) skills. Here under-employment is represented by meager remuneration or "improper recognition" of his skill in the inferior job. Suppose that, in contrast with the situation for skilled jobs, there is no scope of social interactions and productivity enhancement in the inferior job. Thus the wage in the inferior job is a nominal fixed payment correlated with his skill level net of the attrition or "decay" of skill while working at this menial job. This is similar to the depreciation of skill while remaining unemployed for a long time, widely interpreted as a social cost of unemployment.

Interpreted another way, though accumulation of human capital has no negative externality as such, unemployability of the skilled in a suitable skilled job has. The decay of skills is thus the social-cost of unemployability of the skilled. Quite perceptibly, the higher the average skill level in an economy, the more "decay cost" weighs and the more costly the unemployability of skilled workers. This may be the opportunity cost of the skilled people employed in unskilled jobs (cost forgone for not being able to make productive social interactions), which obviously increases with the average skill level in an economy. One broader implication is: if an economy is unable to generate suitable jobs for the skilled (or the probability of obtaining these jobs is too low), and they have no other choice than accepting unskilled jobs, it is a waste of economic resources in the form of accumulation of skill beyond the desired optimum. This is also verified mathematically that the social optimum skill in this case falls below the private optimum.

Such a negative externality of education acquisition closely resembles the mechanism depicted by Hendel et al. (2005), where education acts as a signal. Educated people join the skilled labor force. The unskilled wage is based on the average ability level of the uneducated pool. When education is costly, lower education implies either lower ability or higher ability with lower financial strength. Policy-induced (subsidized) education acquisition helps the higher ability people to come out of the unskilled pool, thus lowering their average ability, and hence the unskilled wage. Thus more human capital accumulation leads to a fall in income of the unskilled laborers.

Under-employment, apart from educated unemployment, is an open problem, especially in developing countries, where job opportunities for skilled workers are not attuned to the growth rate of the educated pool. Thus employment in an unskilled job becomes a better choice than remaining unemployed. The "overeducation" literature closely resembles this with quite good empirical evidence. Incorporating such a realistic scenario of job uncertainty, this paper contradicts the Stark and Wang (2002) finding that an education subsidy always helps to reach the social optimum level of human capital. The present paper emphasizes that when the probability of getting the targeted job is too low, individuals over-invest in human

capital to increase the expected return from employment, and the suitable policy measure is to tax human capital investment rather than to subsidize it. Some papers show that an educational subsidy is not always beneficial. As explained above, Hendel et al. (2005) show that an education subsidy increases wage inequality when education works as a signal. Caucutt and Kumar (2003) develop a dynamic general equilibrium framework to address the effects of increasing higher education subsidies in the US on inequality and welfare. They conclude that the case for increases in higher education subsidies is grossly overstated.

Section 2 presents the basic model both with and without migration. Then the private and social optimum values of human capital formation are derived, and policy issues including an education subsidy are discussed. Section 3 contains concluding remarks.

2. The Basic Model

2.1 Human Capital Formation without Migration

There are two types of jobs in the economy, a superior skilled job (job type S) and an inferior unskilled job (job type I). One can easily take job I but obtaining job S is uncertain, perhaps due to a fixed number of vacancies. Workers who do not get the superior job S have no choice but to accept the inferior job I.

In the inferior job, tacit labor market competition makes it difficult to get the wage in full recognition of a worker's skills; instead, he is paid commensurate with his skills relative to the average skill level of the labor pool. The wage is flexible upwards and downwards over a fixed payment w in the form of a small incentive (disincentive) wage if his skill is above (below) the average. As a consequence, a skilled worker is compensated less when the general skill level of the labor pool is higher. In contrast, in job S, a skilled worker is remunerated based solely on his own skill level. In contrast with job I, the average skill level of the economy imparts a positive externality similar to that in Stark and Wang (2002) via the scope of social interactions that enhances productivity of workers. However, there is little or no scope for any skill improvement due to poor coordination among the workers in the menial job.

The expected net earnings of a person investing a level θ in human capital is:

$$W(\theta) = p\left[\alpha \ln(\theta+1) + \beta \ln(\bar{\theta}+1)\right] + (1-p)\left[w + (\theta - \bar{\theta})\gamma\right] - k\theta,$$

where p ($0 < p < 1$) is an exogenous parameter representing the probability of getting job S, $\bar{\theta}$ is the average level of human capital in the economy, $k > 0$ is the cost per unit of human capital investment, and α, β, and γ are exogenously given strictly positive constants.

We assume each agent is identical in their private welfare maximization behavior. Each agent maximizes his own expected return W and makes the choice of human capital investment. By the first-order condition of maximization:

$$\frac{dW}{d\theta} = \frac{p\alpha}{\theta+1} + (1-p)\gamma - k = 0.$$

From this we solve for the private optimum value of θ, θ^*, to find:

$$\theta^* = \frac{\alpha p}{k - \gamma(1-p)} - 1. \tag{1}$$

Note that the second-order condition, $d^2W/d\theta^2 = -p\alpha/(\theta+1)^2 < 0$, is satisfied. Let us write the welfare function (i.e., the net earning function) and its value at the private optimum taking $\bar{\theta} = \theta^*$ (since all agents are identical), as:

$$W(\theta^*) = p\left[\alpha\ln\left(\theta^*+1\right) + \beta\ln\left(\theta^*+1\right)\right] + (1-p)w - k\theta^*.$$

Suppose a central planner internalizes the positive externality and maximizes the social welfare function taking into account the marginal gain of a small change in human capital investment on the society. The per worker social welfare function is:

$$W(\theta) = p\left[\alpha\ln\left(\theta+1\right) + \beta\ln\left(\bar{\theta}+1\right)\right] + (1-p)\left[w + \left(\theta - \bar{\theta}\right)\gamma\right] - k\theta$$

or

$$W(\theta) = p\left[\alpha\ln\left(\theta+1\right) + \beta\ln\left(\theta+1\right)\right] + (1-p)w - k\theta$$

using $\bar{\theta} = \theta$. The planner maximizes social welfare on behalf of each agent with respect to the choice of human capital investment, and the first-order condition is:

$$\frac{dW}{d\theta} = \frac{p\alpha}{\theta+1} + \frac{p\beta}{\theta+1} - k = 0.$$

This gives us the social optimum value of θ, $\hat{\theta}$, as:

$$\hat{\theta} = \frac{(\alpha+\beta)p}{k} - 1. \tag{2}$$

Note that $w < (\alpha+\beta)\ln[p\alpha/k - (1-p)\gamma]$ must hold; otherwise, people will always prefer to work in the inferior job. If the planner wants people to invest the social optimum level of human capital, $w < (\alpha+\beta)\ln[p(\alpha+\beta)/k]$ must hold; otherwise no one would prefer job S. Therefore, let us start with the assumption that $w < (\alpha+\beta)\min\{\ln[p\alpha/k - (1-p)\gamma], \ln[p(\alpha+\beta)/k]\}$.

Proposition 1. If $p < \gamma\alpha + \beta(\gamma - k)/\gamma(\alpha+\beta)$, then (i) $\hat{\theta} < \theta^*$ and (ii) $W(\hat{\theta}) > W(\theta^*)$ even if $\hat{\theta} < \theta^*$.

Proof. See Appendix 1.

Proposition 1 shows, when the probability of getting the skilled job is low, the social welfare per worker attained under the social planner's choice is greater than the welfare per worker at the private optimum even if the socially optimum level of human capital is lower than that of the private optimum. This is because, while obtaining the social optimum the planner puts a relatively lower weight on the return from the inferior job whereas, when the probability of getting job S is low enough, agents try to maximize the returns from the inferior job too by choosing a higher education level.

It is interesting to note from Appendix 1 that the lower the value of p, the higher the deviation of welfare per worker at the private optimum from that under the social optimum.

Proposition 2. Education subsidy is not always the desired policy measure to reach the social optimum. A tax might be helpful when the probability of getting a skilled job is low and there is over-investment in human capital by the agents.

It is obvious from Proposition 1(i) that $p < \gamma\alpha + \beta(\gamma - k)/\gamma(\alpha + \beta)$ implies $\hat{\theta} < \theta^*$, i.e., the private optimum is higher than the social optimum or people over-invest in human capital. Again, we have seen that the welfare at the social optimum is higher than that at the private optimum. In this case, to reach the social optimum and hence a higher welfare level, the planner should take the policy measure of taxing investment in human capital instead of subsidizing it.

2.2 Human Capital Formation with Migration

Suppose workers can migrate to a high-technology country, where returns to human capital is higher than that in the domestic country. Following Stark and Wang (2002), a worker's gross earnings in the foreign country is:

$$f(\theta) = c \ln(\theta + 1),$$

where $c > \alpha + \beta$. The worker has probability q ($0 < q < 1$) of getting a skilled job in the foreign country. Then the expected net earnings if he migrates is:

$$W^M(\theta) = q\big[c \ln(\theta + 1)\big]$$
$$+ (1 - q)\big[p\{\alpha \ln(\theta + 1) + \beta \ln(\bar{\theta} + 1)\} + (1 - p)\{w + (\theta - \bar{\theta})\gamma\}\big] - k\theta$$

Each agent maximizes the welfare W^M and by the first-order condition of welfare maximization we get:

$$\frac{dW^M}{d\theta} = \frac{qc + (1 - q)p\alpha}{\theta + 1} + (1 - p)(1 - q)\gamma - k = 0.$$

This gives the private optimum human capital under migration θ^M as

$$\theta^M = \frac{qc + (1-q)p\alpha}{k - (1-p)(1-q)\gamma} - 1.$$ (3)

This sequence yields the following proposition.

Proposition 3. (i) Human capital investment under migration is not always higher than that under no migration. (ii) Equilibrium human capital investment under migration is not always nearer to the social optimum compared to that under no migration. Thus, migration, introduced by the planner to reach the social optimum, is not always a substitute for an education subsidy.

Proposition 3 follows from Lemmas 1 and 2, with proofs in Appendices 2 and 3.

Lemma 1. $d\hat{\theta}/dp > 0$, $d\theta^*/dp > 0$ if $k > \gamma$, and $d\theta^M/dp < 0$ if $k < \gamma[qc/\alpha + (1-q)]$.
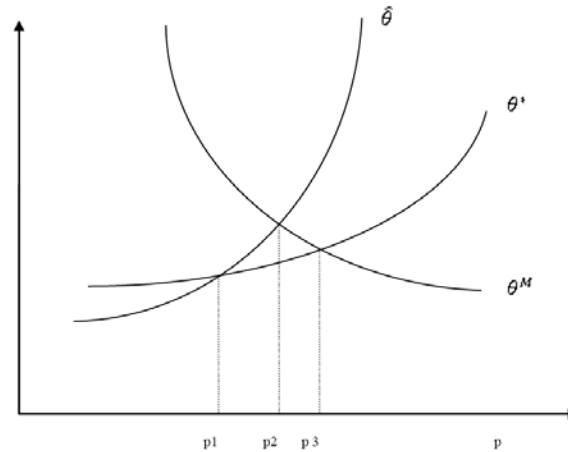
Lemma 2. $\theta^M > \theta^*$ for $p = \gamma\alpha + \beta(\gamma - k)/\gamma(\alpha + \beta)$.

Let us assume that $\gamma < k < [qc/\alpha + (1-q)]$. Using Proposition 1(i) and Lemmas 1 and 2 we can plot θ^* , $\hat{\theta}$, and θ^M against p as shown in Figure 1. Define the points where $\theta^* = \hat{\theta}$, $\hat{\theta} = \theta^M$, and $\theta^* = \theta^M$ hold as p_1, p_2, and p_3 respectively. From Figure 1 we find:

$$\hat{\theta} < \theta^* < \theta^M \quad \text{for} \quad p < p_1 < p_2 < p_3$$

$$\theta^* < \hat{\theta} < \theta^M \quad \text{for} \quad p_1 < p < p_2 < p_3$$

$$\theta^* < \theta^M < \hat{\theta} \quad \text{for} \quad p_1 < p_2 < p < p_3$$

$$\theta^M < \theta^* < \hat{\theta} \quad \text{for} \quad p_1 < p_2 < p_3 < p .$$

Thus, the lower the value of p, the higher the private optimum relative to the social optimum ($\hat{\theta}$) with or without migration. This is because a worker puts a higher weight to the expected return from the inferior job when probability of getting employment in the skilled job is low. Given that the expected foreign skilled wage is higher (a basic necessity for migration to take place), the incentive to acquire skills under migration is obviously more than that under no migration, and thus the skill acquisition is higher under migration. As p increases, the incentive to maximize the return from the inferior job diminishes. For $p = p_1 < p_2 < p_3$ we find the private optimum becomes equal to the social optimum but below the private optimum under migration ($\theta^* = \hat{\theta} < \theta^M$). A further rise in the probability of attaining a skilled job implies that the private optimum (θ^*) falls below the social optimum but the expected foreign skilled wage being high enough to incentivize skill acquisition under migration, the private optimum under migration (θ^M) is still higher than the social optimum ($\hat{\theta}$).

Figure 1

A subsidy on investment in human capital can be a suitable policy measure when the private optimum is less than the social optimum (i.e., when $\theta^* < \hat{\theta}$). It increases the private optimum level of investment closer to the social optimum. Following the same logic, migration acts as a substitute for an education subsidy by nudging the human capital level toward the social optimum only when $\theta^* < \theta^M < \hat{\theta}$. Therefore, comparing the above values of θ^*, $\hat{\theta}$, and θ^M under no migration, a subsidy may be appropriate only when $p > p_1$, and migration acts as a substitute of education subsidy by moving the human capital level toward the social optimum only when $p_1 < p_2 < p < p_3$.

3. Conclusion

An education subsidy is believed to be the social optimum policy when individuals do not take into account externalities created while a worker invests in human capital, which results in a private optimum less than the social optimum level of human capital investment. This paper shows that uncertainty in getting a skilled job might contradict this belief. When the probability of getting a skilled job is low, there is a tendency to over-invest in human capital, and taxing education in that case might improve social welfare.

This paper also finds that, when there is a possibility of migration, workers do not choose a higher level of human capital all the time. For a particular range of values for the probability of becoming employed in a skilled job, migration acts as a substitute for an education subsidy by moving the human capital level toward the social optimum while it might cause an over-investment in human capital for some values of this probability.

Appendix 1: Proof of Proposition 1(i)

$$\theta^* \overset{>}{\underset{<}{=}} \hat{\theta} \quad \text{according as}$$

$$\frac{\alpha p}{k - \gamma(1-p)} - 1 \overset{>}{\underset{<}{=}} \frac{(\alpha+\beta)p}{k} - 1$$

or $(\alpha+\beta)(1-p)\gamma \overset{>}{\underset{<}{=}} \beta k$ (cross multiplying both sides and rearranging terms)

or $(1-p) \overset{>}{\underset{<}{=}} \dfrac{\beta k}{(\alpha+\beta)\gamma}$

or $p \overset{<}{\underset{>}{=}} \dfrac{\alpha\gamma + \beta(\gamma-k)}{(\alpha+\beta)\gamma}$.

Proof of Proposition 1(ii)

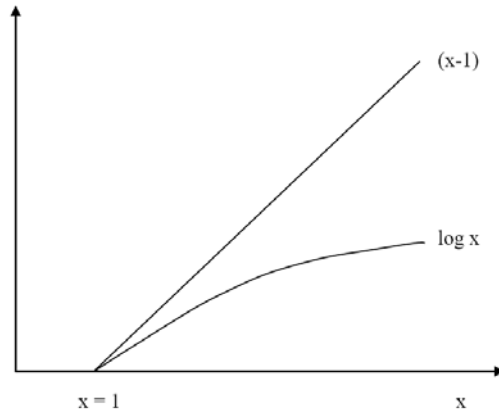Using the expressions for $W(\theta^*)$ and $W(\hat{\theta})$ we get:

$$W(\theta^*) - W(\hat{\theta}) = p\left[\alpha\ln(\theta^*+1) + \beta\ln(\theta^*+1)\right] - p\left[\alpha\ln(\hat{\theta}+1) + \beta\ln(\hat{\theta}+1)\right]$$

$$- k\theta^* + k\hat{\theta}$$

$$= p(\alpha+\beta)\ln\left(\frac{\theta^*+1}{\hat{\theta}+1}\right) - k(\theta^* - \hat{\theta})$$

$$= p(\alpha+\beta)\left[\ln\left(\frac{\theta^*+1}{\hat{\theta}+1}\right) - \left(\frac{k}{p(\alpha+\beta)}\right)\left\{(\theta^*+1) - (\hat{\theta}+1)\right\}\right]$$

$$= p(\alpha+\beta)\left[\ln\left(\frac{\theta^*+1}{\hat{\theta}+1}\right) + 1 - \left(\frac{\theta^*+1}{\hat{\theta}+1}\right)\right]$$

$$= p(\alpha+\beta)\left[\ln x - (x-1)\right],$$

where $x = \theta^*+1/\hat{\theta}+1$. By Proposition 1(i), $x > 1$ if $p < \gamma\alpha + \beta(\gamma-k)/\gamma(\alpha+\beta)$. We first check that $\ln x < x-1$ if $x > 1$. Since $d(\ln x)/dx = 1/x < 1$, $d(\ln x)$ for $x > 1$ and $d(\ln x)/dx = 1$ for $x = 1$. Again, $d^2(\ln x)/dx^2 = -1/x^2 < 0$. Thus, from Figure 2 it is obvious that $\ln x < x-1$ when $x > 1$.

Note that the lower the value of p, the higher x and the higher the deviation of welfare per worker at the private optimum from that under the social optimum.

Figure 2

Appendix 2: Proof of Lemma 1

$$\frac{d\hat{\theta}}{dp} = \frac{(\alpha+\beta)}{k} > 0$$

$$\frac{d\theta^*}{dp} = \frac{(k-\gamma)\alpha}{[k-\gamma(1-p)]^2} > 0 \quad \text{if} \quad k > \gamma$$

$$\frac{d\theta^M}{dp} = \frac{[k-(1-p)(1-q)\gamma](1-q)\alpha - [qc+(1-q)p\alpha]\gamma(1-q)}{[k-(1-p)(1-q)\gamma]^2}$$

$$= \frac{[k-(1-q)\gamma](1-q)\alpha - q(1-q)c\gamma}{[k-(1-p)(1-q)\gamma]^2}.$$

Now, $d\theta^M/dp < 0$ if $[k-(1-q)\gamma]\alpha < qc\gamma \Rightarrow k < [qc/\alpha+(1-q)]\gamma$. Therefore, if $\gamma < k < [qc/\alpha+(1-q)]\gamma$, then $d\theta^M/dp < 0 < d\theta^*/dp$.

Appendix 3: Proof of Lemma 2

$$\theta^M > \theta^*$$

or $\dfrac{qc+(1-q)p\alpha}{k-(1-p)(1-q)\gamma} > \dfrac{\alpha p}{k-\gamma(1-p)}$ (replacing the values of θ^M and θ^*)

or

$qck+(1-q)pk\alpha - q(1-p)c\gamma - p(1-p)(1-q)\alpha\gamma > pk\alpha - p(1-p)(1-q)\alpha\gamma$

or $qk(c-p\alpha) > q(1-p)c\gamma$

or $k(c-p\alpha) > (1-p)c\gamma$ (since $q > 0$)

or $c(k - \gamma) > p(\alpha k - c\gamma)$

or $c(k - \gamma) > (\alpha k - c\gamma)\left[\dfrac{\gamma\alpha + \beta(\gamma - k)}{\gamma(\alpha + \beta)}\right]$ (putting the value of p at $\theta^* = \hat{\theta}$)

or $c\gamma > \left[\alpha\gamma + \beta(\gamma - k)\right]$ (cross multiplying and rearranging terms)

or $k > \dfrac{\gamma(\alpha + \beta - c)}{\beta}$.

This is true since $c > \alpha + \beta$ and $k > 0$. Therefore, $\theta^M > \theta^*$ at $\theta^* = \hat{\theta}$, i.e., at $p = \left[\gamma\alpha + \beta(\gamma - k)/\gamma(\alpha + \beta)\right]$.

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