Mass Higher Education, Investment in Human Capital and Herding: Some Unpleasant Stories

By

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Abstract:

Mass higher education can beget a new type of trade-off for students, the consequences of which are the central focus of this paper. We postulate that a typical student devotes the scarce input "time" to the building of "human capital" as well as to the formation of "educational signals". Time spent on human capital enhances labour productivity in later life while educational signals improve the probability of finding a job for a graduating student. One of the major innovations of this paper is to dichotomise student learning activities into two distinct categories. First, there is core learning that enhances labour productivity in later life and, secondly, there is non-core learning that increases the probability of finding a job in earlier life of a student. Since time is scarce, there thus emerges a trade-off between core and non-core learning activities. From this trade-off, we establish that an expansion of higher education - accompanied by a marked decline in the quality of curriculum - can have strong negative effects on the accumulation and distribution of human capital since students have an incentive to substitute core learning by non-core learning activities. We also find that mass higher education can trigger herd behaviour among students, which can lend fragility to and cause instability and social inefficiency in the formation of human capital.

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1. Introduction

The role of human capital in economic development of nations has always been of critical importance. Davis and Whalley (1989) marshalled evidence to assess that the stock of human capital is about three times larger than the stock of physical capital in the United States. Human capital, as a corollary, has been labelled as "the most important component of national wealth" (Trostel, 1993; p. 327). Lucas (1988) and Rebelo (1991) established that formation of human capital makes a significant contribution to the economic progress of a nation.

In developed countries, the age of globalisation has posed serious challenges for human-capital formation. First and foremost, since the mid-to-late 1970s, wage inequality between low- and highly educated workers has expanded markedly (see Borjas and Ramey, 1994; Sachs and Shatz, 1996 for the US experience). Part of the explanation seems to be a demand shift towards educated workers due to an ever-growing international trade of the developed world with low-wage nations (see Sachs and Shatz, 1994). Given the role played by modern universities as gatekeeper to high-skilled and well-paid jobs, there is a mounting pressure from students, their peers and powerful political constituencies for continuous expansion of the number of university places. We have seen similar scenarios in developing nations in earlier eras (see Wilson, 1996 for the South African experience). Universities have thus confronted severe, somewhat unprecedented, pressure to expand university places. Secondly, the process of globalisation has been accompanied with an onslaught of privatisation and gradual retreat of governments from the domain of economic activities. Budgetary termites and frenetic pursuits of budget surplus have forced governments to reduce their expenditure on merit goods. Universities across the globe respond to these serious budget cuts by expanding their clientele with a marked decline in the quality of their curricula that we call mass higher education. The major concern of this paper is to examine the precise impact of mass higher education on the investment in human capital.

Now it naturally leads to the important question of what determines the accumulation of human capital by a nation. A tentative answer is given in a micro-theoretical model that examines individual decisions to investment in human capital. The principal input of producing human capital is "*time*" (Trostel, 1993) and, hence, the primary cost of producing human capital is the opportunity cost of hourly wage rate and the shadow premium for leisure. The return on investing time in this pursuit is the net wage rate. Therefore, the principal determinant of the accumulation of human capital is the "net wage rate which is then both the return on and the primary cost of human capital investment" (Trostel, 1993; p. 328)[2]. What then possibly drives an individual to invest in human capital? This may be explained by a strong positive (empirical) relationship between labour income (or, net wage rate) and level of education (see the pioneering works of Mincer, 1958 and 1974).

There are two dominant strands of thoughts in explaining such a positive correlation that offers inducements to individuals to obtain higher education, which thereby determines the accumulation of human capital. On the one hand, Schultz (1962, 1971) and Becker (1962, 1975) advanced the "human capital model" in which higher education enhances the productive capacity of an individual in later life. Since employers pay a positive premium on this increase in productivity, the positive correlation between earnings and higher education springs up. On the other hand, Arrow (1973) and Spence (1973, 1974) argued that higher education acts as a screening device to identify certain unobservable "valuable traits" of workers. Though higher education as such does not augment productivity; higher education signals to employers the greater worth of potential employees in terms of their unobserved innate traits. Subsequent finessing by game theorists has further extended this point (Riley, 1975; Mailath, 1987; Cho and Kreps, 1987).

The fundamental premise of these strands of thoughts is the *assertion* that the equilibration mechanism in the market for heterogeneous labour will determine a *wage schedule* and not a single wage. From the *wage schedule* there would emerge "earning functions" such that the earning of an individual is mainly predicated on one's educational attainment. An individual acquires higher

[2]Trostel (1993) compellingly argued that there are other costs associated with the production of human capital, but for our purpose this makes little difference.

education up to the point where the marginal benefits given by the earning functions balance the cost of education at the margin. The compelling common logic of these strands of thoughts is that employers pay a premium for higher education. The above two strands differ mainly in the explanation of why employers pay a premium for higher education. Which one has more empirical corroboration? This is, at best, unclear because both the motivations seemingly guide the decision of an individual to acquire higher education (see early work by Taubman and Wales, 1973; Riley, 1979; Wolpin, 1977; Albrecht, 1974; Kroch and Sjoblom, 1993 among others).

What are the likely outcomes of mass higher education? It is expected that individuals utilise higher education instrumentally to attain an enhanced economic status. In the human capital model, an increased availability of higher education increases the accumulation of human capital and will thereby contribute to economic growth (see Lucas, 1988; Rebelo, 1991; Trostel, 1993). As a result, an economy is expected to gain from the enhanced productivity of the labour force. Signalling models can offer a negative message: mass higher education does not impact on the productivity of the labour force. One may argue that mass higher education results in a larger diversion of resources to rent-seeking activities without productivity gains to the economy (Kroch and Sjoblom, 1993; p. 158-159).

In this paper we develop a mixed model that marries the insights of human capital models with the intuitions of signalling models to examine the consequences of mass higher education. One of the major innovations of this paper is to examine the impact of mass higher education on the allocation of resources/efforts by learners/students. In so doing we dichotomise learning activities into two distinct types of efforts. Firstly, students allocate time for building human capital that enhances labour productivity in their later lives. We call this the core learning. Secondly, students devote the rest of their time to the formation of educational signals, which increases the probability of finding a job in their early careers/lives. We call this the non-core learning. For the sake of tractability we maintain that total time as input is given to an individual and that there is no spillover effects between these two types of learning. Both the assumptions can be relaxed. The main results will be unaltered in the more general setting with appropriate restrictions on the values of the relevant parameters.

The main intuition of this paper is derived from a simple observation that mass higher education and the quality/rigour of academic training bear an inverse relationship. This inverse relationship hinges on the interrelationship between quality of students and academic curriculum (see Brubacher, 1978; p. 56 for an early evidence). Mass higher education naturally compels universities to lower the quality of curriculum in order to expand clientele[3]. As a consequence, less able students can afford to build the same educational signal as more able students will normally do. This is so because mass higher education, by simplifying the curricula, will reduce the marginal cost of acquiring education for less able students given their marginal benefits from higher education. In the light of all this we offer a Cournot-Nash equilibrium that explains the optimal human-capital formation in our model of mass higher education. In this Cournot-Nash equilibrium, we argue, higher education will fail to act as a screening device and can trigger herd-like behaviour in the accumulation of human capital formation that can engender serious social costs. We further argue that this Cournot-Nash equilibrium is characterised by fragility that can further impinge on the quality of this equilibrium in the context of mass higher education.

We then offer a simple dynamic model to establish that mass higher education can trigger herd behaviour among students in the formation of educational signals. As a result, subjective variations in the belief of a group of students can induce all students to alter the allocation of their efforts/resources that will, in turn, impinge on the allocation of accumulation of human capital and thereby drive a nation's prosperity. We will hence argue that herd behaviour can be a terribly important element in the formation of human capital in the context of mass higher education. To our knowledge, this is the first attempt to model herd instincts in the formation of human capital. The upshot is that investment in human capital may not reflect learners' rationally formed expectations and, instead, group psychology and dynamics will characterise the individual investment decision in

[3] Brubacher (1978) aptly summarised this as: "At first, there was anxiety, like that expressed by a Fordham University President (New York Times, 1948), that greatly enlarged enrolments would lead to 'educational inflation.' Paying vast mediocre students into the currency of higher education could lead to its debasement, thus invoking a kind of academic Gresham's law. What was needed, to continue the economic analogy, was a **gold standard** foe admission." (p. 58).

higher education. A nation's prosperity, or a lack of it, can thus derive from simple herding instincts if higher education becomes a commodity of mass consumption. The plan of the paper is the following: Section 2 develops a static model and Section 3 offers a simple model of herding equilibrium and Section 4 draws concluding comments.

2. Mass Higher Education, "Educational Inflation" and Human Capital

2.a. A Simple Story:

The purpose of this section is to develop an intuitive model to capture the adverse effects of mass higher education/"educational inflation". By educational inflation we mean an expansion of higher education along with a marked decline in the quality of curriculum and in the rigour of training (Brubacher, 1978, p. 36). Educational inflation is normally caused by a conscious dilution of the course structure and, hence, we shall interchangeably use these terms in the course of the paper.

To drive the main intuition home let us consider the following example based on the work of Spence (1974) on education as a signalling device. Suppose there are two types of students high ability (I) and low ability (II). Students are employed, after their completion of a degree, by competitive firms. Suppose each student from I has a marginal productivity of 2 while each student from group II has a lower marginal product, say 1. Competitive firms employ workers for 10 years. From a high ability worker (I) competitive firms receive every year $20,000 worth of output and from a low ability worker (II) competitive firms receive every year $10,000 worth of output. In a competitive labour market, with perfect information, the expected wage income of a high ability (I) student is $200,000 during his/her 10 years employment with a competitive firm. Similarly, the expected wage income of a low ability (II) student is $100,000. Suppose, there is a single index Z that summarises all the attributes of higher education, one can view Z as "years of higher education". Since higher education is more costly to less able (II) students, we assume the marginal cost of acquiring education for more able student is $25,000 and that for a less able student is $40,000 for each year spent in higher education. The optimal higher education for a more able student is

Z*=200,000/25,000=8. The optimal higher education for a less able student is Z**=100,000/40000=2.5. As long as competitive employers offer a higher salary of $200,000 to a worker with higher education Z such that 2.5<Z<8, higher education acts as a screening device.

Now let us see how mass higher education can create problems for higher education as a screening device. Since academic inflation is accompanied by a dilution of the course structure, higher education adds little value to students regardless of their types (high ability, or low ability). Since the rigour is not there in the coursework, anyone can get a degree. An employer therefore expects an average productivity, say $15,000 (0.5*10,000+0.5*20,000), from a student. The expected wage income for each student is $150,000. Due to a simplification of the course structure (some kind of dumbing down) the marginal cost of each type of student is also very low, say $20,000. The optimal higher education for more able students is Z*=7.5, which is the same for a less able student, Z**=7.5. Higher education fails to act as a screening device.

2.b. The Prototype Model:

For a typical student we first consider the impact of core learning activities on the production of human capital. To simplify the analysis we assume the production function for human capital of a student/learner i (i ∇ 1 to n) to be the Cobb-Douglas type[4]:

$$K_i = Me_i^{\alpha} A_i^{1-\alpha} \qquad (1a)$$

$$A_i = \Phi_i A^* \qquad (1b)$$

where e_i and K_i represent effort to build human capital and human capital of student i respectively while A_i is the innate ability, or simply ability, of student i. We further assume that the vector of abilities of these n students is A that has a prior distribution $\Phi = \Phi_1, \Phi_2.....\Phi_n$ where n is the number of students enrolled in a particular course, and A* is a constant. We impose the following restrictions on the Φ_is: $0<\Phi_i<1$ for all i and if $\Phi_i>\Phi_j$, then student i has higher ability than that of student j. The

[4]This is a static version of the production function commonly known as Ben-Porath type (1967) widely used in the literature on the accumulation of human capital.

ability of a student goes up with increased rigour of training. To simplify, we further set A*=1. Hence, equation (1a) reduces to the following:

$K_i = Me_i^{\alpha}\ \Phi_i^{1-\alpha}$ (1c)

We similarly assume that the formation of educational signals is characterised by the following production function:

$Q_i=NK_i^{1-\beta}\ E_i^{\beta}$ (2a)

Where Q_I and E_i are the educational signals and efforts to build these signals, respectively, by student i. N and are β parameters and K_i is the stock of human capital for student i. Expressing (1c) and (2a) in logs will give us:

$k_i=m+\alpha h_i+(1-\alpha)\phi_i$ (2b)

where k=Log K, m=Log M, Log e=h, Log Φ=ϕ.

$q_i=n+\beta H_i+(1-\beta)k_i$ (2c)

where q=Log Q, n=Log N, Log E=H, Log K=k.

We also express the time constraint as

H_i+h_i =Constant=0 (3a)

Postulate 1: After acquiring higher education every student confronts two dates T and T+1. At date T student i gets a new job which gives him an expected salary of X_i. We posit that the expected salary, X_i, obtained in the new job is a function of examination results/signals, which convey some unobservable traits of students to their employers. The earning at date T+1, Y_i, is due to the human capital K_i and, hence, is a function of accumulated human capital during student life. Thus, the return to higher education/payoff function, R_i, of student i is:

$R_i = X_i + (\text{Log } Y_i/(1+r))$ (3b)

where r is the interest rate which is the discount rate.

Postulate 2: We assume that students have a common opinion, q^A, about the educational signal/result q_i that is necessary to obtain a job. It is important to note, for our model, q^A is some sort of an average result that students think employers use to compare relative performance of students in higher education as a signal of their innate abilities. We hereafter call q^A an average opinion of students.

Postulate 3: We assume that the expected salary X_i is determined by:

$X_i = P_iB$ (3c)

$P_i = [q_i + q_i (q_i-q^A)]$ (3d)

where B is the base salary of a new recruit in the job market and P_i is the probability of obtaining the first job which is given by equation (3d). Equation (3d) incorporates the rat race model: the probability of getting the first job depends on a student's own result q_i and also on the relative performance $(q_i- q^A)$.

Postulate 4: The earning at date T+1, Y_i, depends solely on K_i where Θ is a constant:

$Y_i = \Theta K_i= \Theta M\Phi_i^{1-\alpha}e_i^{\alpha}$ (4a)

$\text{Log } Y_i = \text{Log } \Theta M_i + (1-\alpha) \text{ Log } \Phi_i + \alpha \text{ Log } e_i$ (4b')

$y_i=c_i+(1-\alpha)\varphi_i +\alpha h_i$ (4b)

where $c_i=\text{Log } \Theta M_I$, $y_i=\text{Log } Y_i$, $h_i=\text{Log } e_i$ and $\varphi_i=\text{Log } \Phi_i$.

2.c. The Optimisation Exercise of a Representative Student:

Student i maximises his payoff R_i given the production functions for human capital and educational signals/results. That is,

Maximise $R_i= B[q_i + q_i (q_i - q^A)] + y_i/(1+r)$
{Hi}

Subject to:

$q_i = [n + (1-\beta)m] + H_i (\beta-\alpha(1-\beta) + (1-\beta) (1-\alpha) \varphi_I$ (4c)

$H_i + h_i = 0$ (3a)

We obtain (4c) by substituting (3a) and (2b) into (2c). We substitute (3c) and (3d) into (3b) to yield the above objective function R_i.

Proposition 1: The optimal educational signal, q_i, is the examination result that maximises the payoff R_i of student i and is given by:

$q_i = V + q^A/2$ (5a)

$V = \alpha/[2(1+r)B(\beta-\alpha)(1-\beta)]$ (5b)

Proof: We derive the above from the first order conditions of the constrained optimisation exercise.

2.d. Interdependency in Allocation of Efforts and the Cournot-Nash Characterisation:

The representative student i spends effort H_i to obtain the optimal result/signal q_i. We call H_i the examination-oriented effort/labour. These efforts form the second type of learning. What is interesting is that the optimal result/signal of student i depends on the average result/signal q^A. Thus there is interdependency in the allocation of efforts: if all other students j increase their H_j, then q^A goes up that will in turn increase the optimal effort of student i, H_i, in the formation of results/signals. Hence, as in the rat race, student i is driven by the knowledge that for lower q_i one must share a lower probability, P_i, of finding a job with less able students. Similarly, one is aware that for higher q_i one will enjoy a higher probability of finding job that one will share with students of higher ability. Why does not the student raise the q_i to the maximum feasible level? In our model, the formation of signals is costly because such formation reduces the effort to build human capital. Different students have different costs and the optimal result/signal arises from these costs. If all students behave in this fashion then the equilibrium efforts of a student depend on the expectations of each student about the efforts in signal formation of other students. We summarise these expectations as q^A that, which may be argued, is kind of a market perception.

In the Cournot-Nash characterisation we assume that each student assumes that as one changes one's effort and the efforts of others, and hence q^A, will remain unchanged. This is a well-known assumption of Cournot models. Therefore equation (5a) is the reaction function of student i for allocating one's effort H_i, given the efforts of other students. Based on the reaction functions we shall derive the Cournot-Nash equilibrium in the allocation of efforts between human capital and results/signals. The Cournot-Nash equilibrium effort is such that once reached no student has any incentive to unilaterally deviate from the equilibrium allocation.

2.e. The Cournot-Nash Equilibrium, Fragility and Herd-like Behaviour:

For the sake of tractability we present the equilibrium allocation in the context of two students that can easily be generalised for n students. We hence lose no analytical bite in the special case when there are two, or two groups of, students. We call them Student 1 and Student 2. In order to derive the Cournot-Nash equilibrium allocation we follow two steps. In Step 1 we derive the reaction functions of the students. In Step 2 we derive the optimum allocation of efforts of these students from the equilibrium. To simplify further we express the beliefs of students about the average opinion in the following postulate.

Postulate 5: We define $E_i(q^A)$ as the subjective estimate/belief of student i about the average opinion q^A. We express this as:

$$E_i(q^A) = 2\Psi_i q_j + \eta q_i \qquad (6a)$$

We set $\eta=0$ to simplify calculations. However, there is a twist here: the main intuition is that student i expects/believes that student j has a stronger influence on the average opinion. We establish the result with the assumption that student i thinks s/he has no influence on the average opinion. Thus,

$$E_i(q^A) = 2\Psi_i q_j \qquad (6b)$$

Step 1: From equation (5a) and (6b) we know that the reaction function of student i is:

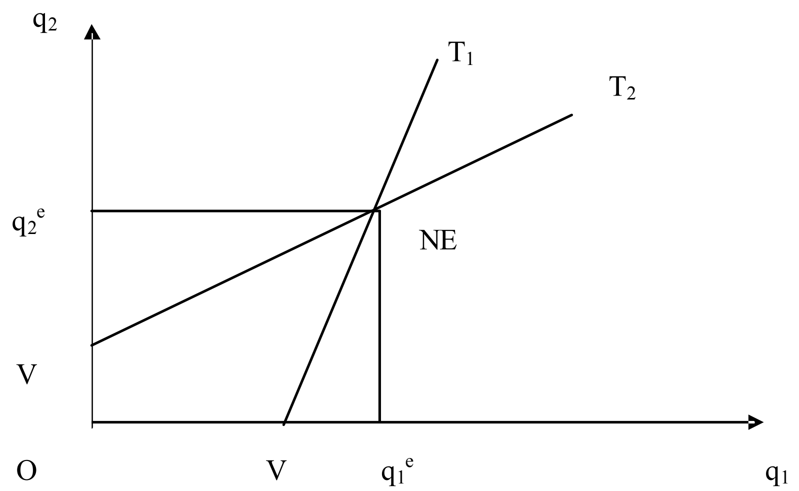
$$q_i = \Psi_i q_j + V \qquad (6c)$$

Step 2: The Cournot-Nash equilibrium is given by the consistency condition and, hence, the solution to the simultaneous equation system (6c). This will give us the equilibrium educational signals q_i^e:

$$q_1^e = V(1+\Psi_2)/[1-\Psi_1\Psi_2] \qquad (6d)$$

$$q_2^e = V(1+\Psi_1)/[1-\Psi_1\Psi_2] \qquad (6e)$$

Diagram 1
The Cournot-Nash Equilibrium with Two Groups of Students



T_1 and T_2 are respectively the reaction functions of students 1 and 2 while NE represents the Nash equilibrium where T_1 and T_2 intersect. The existence of equilibrium is guaranteed if $[1-\Psi_1\Psi_2]>0$. Substituting (6d) and (6e) into (2c) from (3a) we derive the optimal efforts corresponding to the Nash equilibrium as:

$$H_1^e=[q_i^e-n-(1-\beta)k_1]/\beta \qquad (7a)$$

$$h_1^e=[-q_i^e+n+(1-\beta)k_1]/\beta \qquad (7b)$$

One can detect herd-like behaviour in this context by looking at the comparative static properties of the Nash equilibrium:

$$\partial q_i^e/\partial\Psi_i= V(1+\Psi_j)/[(1-\Psi_i\Psi_j)^2]>0 \qquad (7c)$$

$$\partial q_i^e/\partial\Psi_j= [V(1+\Psi_j)\Psi_i+(1-\Psi_i\Psi_j)V]/[(1-\Psi_i\Psi_j)^2]>0 \qquad (7d)$$

$$\partial H_i^e/\partial\Psi_i= V(1+\Psi_j)/[\beta(1-\Psi_i\Psi_j)^2]>0 \qquad (7e)$$

$$\partial H_i^e/\partial\Psi_j= [V(1+\Psi_j)\Psi_i+(1-\Psi_i\Psi_j)V]/[\beta(1-\Psi_i\Psi_j)^2]>0 \qquad (7f)$$

$$\partial h_i^e/\partial\Psi_i= -V(1+\Psi_j)/[\beta(1-\Psi_i\Psi_j)^2]<0 \qquad (7g)$$

$$\partial h_i^e/\partial\Psi_j= -[V(1+\Psi_j)\Psi_i+(1-\Psi_i\Psi_j)V]/[\beta(1-\Psi_i\Psi_j)^2]<0 \qquad (7h)$$

First and foremost, we can see from the reaction functions that q_1 and q_2 are strategic complements. Hence, the decision by one (group) of students to increase (reduce) their effort to build human capital (educational signal) will prompt the other group to increase (decrease) their efforts to build human capital (educational signals). The reason is that an initial shift in efforts in to educational signals by one group of students can expose the other group as under/over investing for building educational signals. This induces the other group to respond by moving in the same direction.

Secondly, decisions concerning human capital are significantly influenced by herd instincts: subjective variations in beliefs of a group (changes in Ψ_1 or Ψ_2) can induce all to change their allocation of their efforts towards human capital formation. One may say that these changes are not triggered by changes in the objective world as these changes take place in the subjective realm of a group of students. The other group, though has unchanged subjective beliefs, yet they decide to go with the flow (herding) in their allocation of efforts in forming human capital (see Palley, 1995 for details). This dependence of the Cournot-Nash equilibrium on the subjective elements makes this equilibrium highly fragile. Simple fluctuations in subjective elements can have far-reaching impacts on the optimal efforts in building human capital. It is recognised that in games involving complementarities, consequences of idiosyncratic shocks get amplified through what is called a *multiplier effect* (see Vives, 2005).

3. Sequential Decisions and Educational Herding

Herd behaviour in capital formation, as opposed to human-capital formation, is a well-received doctrine. Scharfstein and Stein (1990) modelled sequential investment by agents/investors concerned about their reputation as good forecasters. If these agents have correlated signals conditionally on the state of the world, investors will imitate, or copy, the behaviour of the first investor. This kind of modelling has come to be known as *reputation herding*. In models of *statistical herding*, introduced by Banerjee (1992), and Bikhchandani et al. (1992), investors maximise expected profits in a common value environment and have access to conditionally independent private signals of bounded precision, while still watching the behaviour of others. Eventually, the accumulated evidence from observing earlier decisions is sufficiently strong to undermine the private information of a single decision-maker.

The question about the source of herding begs an answer. Herding arises because the observed behaviour of other investors affects the probability belief attached to different states of the world and also the payoff conditional on each state. Banerjee (1992), Bikhchandani et el. (1992) and Welch (1992) and a large number of papers show the significance of informational cascades in modern investment markets. An informational cascade connotes a situation in which subsequent agents, based on the observations of others, makes the same choice independent of their private signals. Informational cascades are argued to engender erroneous mass behaviour and cause fragility in capital formation.

We consider a situation in which students make sequential decisions on their individual efforts to build educational signals. One way of rationalising this sequential decision-making is to assume that every year a new cohort of students arrives who can observe the relevant actions of the past cohorts. To make the model tractable, we simplify by considering the decision making of a representative student from each cohort. Suppose there are N cohorts of students and N periods while the i^{th} cohort makes a decision at date i, i ranging from 1 to N. Cohort 1 gets to choose their effort E_1 first and then Cohort E_2 chooses; and so on and so forth. Student i (representing cohort i) chooses his effort E_I, given the history of effort levels by the previous cohorts, to obtain the optimal results q_i (educational signal). Thus, the decision variable is E_i.

Students do not have a prior knowledge of the average opinion q^A. It is common knowledge that q^A can take either of two values. One can call this q^A as the state of nature. Each cohort receives a signal about this state of nature. Each cohort has two possible optimal actions depending on the two possible states or two possible values of q^A. We state this story by assuming that q^A is chosen from a set of 2 possible values Q={0, 1}. The state of nature, value of q^A, is set randomly at the beginning of the first period before any decision is made. The probability that $q^A=1$ is θ and the probability that $q^A=0$ is $(1-\theta)$. There are N cohorts and each cohort is indexed by the integer t=1,2…N. By construction, cohort t is the cohort at date t. Cohort t (at date t) has one private signal S_t such that Probability $(S_t=j \mid q^A=1)=W$. These private signals are independent and symmetric.

We know from equation (5a), the optimal educational signal of a student is

$q_i=V+q^A/2$ (5a)

Since q^A takes 2 values, the optimal q_i has two possible values q* and q**:

$q^*= V$ for $q^A=0$ (8a)

$q^{**}=V+1/2$ for $q^A=1$ (8b)

The payoff to student i is R_i:

$R_i(q^*) =B(V+V^2)+Y_i/(1+r)$ (8c)

$R_i(q^{**}) =B(1/4+V+V^2)+Y^i/(1+r)$ (8d)

We now introduce fixed costs (F) of building signals to drive our results home:

Assumption 1: $F_i=F_J$ for all i and j. It is assumed that

If $q^A=0$ and $q_i=q^*=V$, $F_i=0$.

If $q^A=1$ and $q_i=q^{**}=V+1/2$, then $F_i=0$.

If $q^A=0$ and $q_i=q^{**}=V+1/2$, then $F_i=F_1$.

If $q^A=1$ and $q_i=q^*=V$, then $F_i=F_2$.

The story is simple: the fixed cost is zero if students correctly read the signals and choose appropriate actions. The fixed cost is positive if and only if cohorts incorrectly interpret signals.

Assumption 2: At any date t, student/cohort t receives a signal S_t such that

Probability $\{S_t=j \text{ for } q^A=j\}=\mu$ (9a)

Assumption 3: At any point in time t the prior probability that $q^A=1$ is θ_t. Students can be of two types: first, students can be *overcautious*. Secondly, students can be *reckless*. We call a student at date t overcautious if s/he receives a signal $S_t=1$. What it means is that the student at date t has received a signal that the average opinion is high and s/he hence chooses a larger (equilibrium) effort in building educational signal. On the other hand, a student at date t is called reckless if s/he receives a signal $S_t=0$. A reckless student receives a signal that the average opinion is of low value and hence s/he chooses a lower (equilibrium) effort to build educational signals. Each student can belong to one of these two types.

Note that a reckless type will update the probability that $q^A=1$ by θ^-:

$\theta^-= \theta(1-\mu)/[\theta(1-\mu)+\mu(1-\theta)]$ (9b)

Similarly, an overcautious student updates the prior as the following:

$\theta^+= \theta\mu/[\theta(1-\mu)+\mu(1-\theta)]$ (9c)

Note that $\theta^-<\theta^+$ (9d)

A reckless student's expected net return from q* is

$E(ri(q^*))= B(V+V^2)+Y/(1+r)-F_2+(1-\theta^-)F_2$ (9e)

Similarly, the expected net return from q** is

$E(ri(q^{**}))= B(V+1/2)\ (V+3/2)+Y/(1+r)-(1-F_2)+\theta^-(1-F_2)$ (9f)

A reckless type will choose q* if

$\theta^->[F_2+B(V+3/4))-1]/[2F_1-1]=L$ (10a)

We define the value of θ as θ^C for which the following condition holds:

$\theta^{-}(1-F_2)= \theta^C(1-F_2)=L$ (10b)

That is

$\theta^C= L\mu/[(1-\mu)+\mu L-L(1-\mu)]$ (10c)

Observation 1: A reckless student chooses q* (the lower level of equilibrium effort) if

$\theta>\theta^C$ (10d)

S/he chooses q** (the higher level of equilibrium effort) if

$\theta<\theta^C$ (10e)

Observation 2: An overcautious student chooses q** if

$\theta<\theta^{CC}$ (10d')

S/he chooses q* if

$\theta>\theta^{CC}$ (10e')

$\theta^{-}(1-F_2)= \theta^{CC}(1-F_2)=L^*$ (10b')

$\theta^{CC}=L^*(1-\mu)/[(1-\mu)-L^*(1-\mu)+L^*\mu]$ (10c')

Observation 3: Suppose the publicly held belief (θ) lies in the following interval,

$\theta^C<\theta<\theta^{CC}$ (11a)

If (11a) holds then student/cohort t will choose q* if the signal is S_t=0 and student/cohort t will choose q** if the signal is S_t=1. Thus, there will be no herding as one's action depends on one's private signals. There is no herding if (11a) holds. On the other hand, herding instincts play a decisive role if $\theta^C>\theta$ because student, cohort, t chooses q* regardless of the private signal that s/he receives. Similarly, herd instincts drive the formation of human capital if $\theta^{CC}<\theta$ because student, cohort, t choose q** regardless of the private signal that s/he receives. We establish, to our knowledge the first time, that formation of human-capital can be driven by herd instincts of Banerjee (1992) and Bhikchandani et el. (1992) type.

4. Concluding Comments

We model higher education as an instrument for advancing human interests: it partially augments the productivity of a student in the later life of a worker. Higher education also acts as a signalling device for a student to secure a job after s/he completes a degree program. In such a mixed model there are two types of learning associated with *mass* higher education: firstly, there is core learning that augments human capital by increasing productivity of labour in the later life of a student. Secondly, there is non-core learning that merely allows students to produce educational signals, which does not augment human capital. Because the principal input for learning activities is time, there is a trade-off between core and non-core learning activities. The decision of a student to devote time to non-core learning activities is shown to depend, *inter alia*, on what s/he expects other students to do. From this interdependency, we derive a game to characterise the decision-making problem concerning non-core learning activities by a representative student. We home in on the relevant Nash equilibrium as a combination of mutually best responses of students in the building of educational signals. In the equilibrium we observe,

- Some kind of rat race drives the equilibrium non-core learning activities. That is, student i is actuated by the knowledge that for the lower educational signal q_i, s/he must share a lower probability (P_i) of finding a job with less able students. Similarly, s/he is aware that for the higher q_i, s/he will enjoy a higher P_i to share with students of higher ability. Every student will behave in this fashion in equilibrium with educational inflation. The equilibrium non-core learning (core learning) will be greater (smaller) than the socially optimal level of non-core learning (core learning). Mass higher education, by lowering individual efforts devoted to core learning, can seriously compromise the formation of human capital and hence economic growth and future prosperity of a nation.
- We also show that mass higher education can lend serious instability and fragility to the equilibrium human-capital formation: decisions to build human capital are significantly influenced by subjective beliefs. Subjective variations in beliefs of a group of students can induce all to change their efforts to the formation of human capital. It is important to note that these changes are not triggered by changes in the objective world as these changes take place in

the subjective realm of a group of students. It is also worth noting that such small changes can cause significant damages to the formation of human capital through the so-called multiplier effect of games with strategic complementarities. This dependence of the Cournot-Nash equilibrium on the subjective elements makes this equilibrium highly fragile. Simple fluctuations in subjective elements can have far-reaching impacts on the optimal efforts in building human capital.

- We further establish the presence of herding instincts in the formation of human capital in the context of mass higher education. The herding instincts in the formation of human capital will adversely impinge on the accumulation and distribution of human capital. As a result, mass higher education may have a large negative impact on the formation of human capital. Fluctuations in the accumulation of human capital are bound to have profound and adverse impacts on the economic fortunes of a nation in the era of globalisation accompanied by budgetary termites, wage inequality and educational inflation.

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