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Early selection and moral hazard☆

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ABSTRACT

The selection of individuals into a school or job or team may be made early based on the expected skills. For instance, children are selected into an academic or a vocational education track at early ages in Germany and other European countries. The paper considers the effects of such early selection on the incentive to make effort.

1. Introduction

The way individuals are selected into a school or a job or a team varies, and this paper considers the timing of selection. For example, children are selected into a general education track or a vocational education track at early ages in Germany and other European countries (Hanushek and Wößmann, 2006; Mühlenweg, 2007). In the US. and UK, the same selection is made much later. In entry-level professional labor markets for new lawyers and medical doctors, labor contracts are signed early before attainment of professional qualifications (Roth, 1984; Roth and Xing, 1994). In other markets, labor contracts are signed much later right before the dates of employment. National Olympic teams are almost selected when their team members are very young in China and Eastern European countries (Riordan and Jinxia, 1996; Yuan and Xueying, 2003). In the US., athletes compete to make the national team later after their skills are known. NASA selects a very few astronaut candidates out of thousands of applicants every two years. Those selected receive a long and intensive training for possible space missions (Overman, 1994; Musson et al., 2004), and astronauts are almost selected at an early stage before training takes place.

A few explanations are possible for early selection (ES). Risk-averse individuals enjoy the benefits of insurance by committing early before the revelation of their qualifications (Li and Rosen, 1998; Li and Suen, 2000). When firms make exploding offers and applicants must decide quickly, unraveling occurs (Niederle and Roth, 2009). Early tracking enables homogeneous grouping, improving efficiency but eliminating possible benefits of peer effects (Mühlenweg, 2007). ES tends to save the cost of training, as it selects fewer individuals to train (Lee, 2006). This paper concerns the effects of ES on effort to train or to increase human capital, the topic that has not been explored. The analysis demonstrates that the effect of ES hinges on the competitiveness of selection.

2. The model

To fix the idea, the model considers early tracking of students as an example, but the analysis and the idea are general. There is a continuum of students, whose size is unity. They are currently at the beginning of secondary school (or end of primary school). Only $n \in (0, 1)$ students will be admitted to college. n is a parameter that measures the competitiveness of college admissions.

A student makes effort β at the beginning of secondary school, called period 1. Effort has an uncertain effect on academic achievement, and the random factor θ unfolds during period 1. Her secondary-school academic achievement s is realized at the end of period 1 and is written as $s = \phi(\beta)+\theta$, where $\phi'(\beta) > 0 > \phi''(\beta)$, and θ is distributed according to a distribution function $F(\theta)$ over the support $(\underline{\theta}, \overline{\theta})$ with $f(\theta) = F'(\theta)$. Students are thus ex ante identical, but their academic achievements differ ex post. Section 4 extends the analysis to heterogeneous students. $f(\theta)$ is assumed to be unimodal and to have thin tails, such that there is $\hat{\theta} \in (\underline{\theta}, \overline{\theta})$ with

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$$f'(\theta) > (=, <) 0 \quad \text{as } \theta < (=, >)\ \hat{\theta},$$

$$\lim_{\theta \to \underline{\theta}} f(\theta) = \lim_{\theta \to \underline{\theta}} f'(\theta) = 0 \quad \text{and} \quad \lim_{\theta \to \overline{\theta}} f(\theta) = \lim_{\theta \to \overline{\theta}} f'(\theta) = 0. \quad (1)$$

During college, called period 2, those admitted to college make second-period effort, γ, building on s. They then graduate from college and become managers. Their wages depend on academic credentials at the end of college, and are written as $w \equiv s + \gamma = \phi(\beta) + \theta + \gamma$.[1]

The analysis compares two systems, ES and Regular Selection (RS), in terms of first-period effort, β. Under RS, college-admissions decisions are made at the end of period 1 after θ and hence s are realized. Those n students with highest achievements are admitted to college. Let s^R be the cut-off achievement, where superscript R denotes RS. The cut-off random factor, given (s^R, β), is

$$\theta^R = s^R - \phi(\beta). \quad (2)$$

θ^R, s^R, and β are all endogenously determined later. Those students with $\theta < \theta^R$ become workers, as opposed to managers, and enjoy the reservation utility x.

Under ES, n students are randomly selected into the academic track (A track), and the remaining $(1 - n)$ students are selected into the vocational track (V track) at the beginning of period 1, given that students are ex ante identical. In general, early selection is made based on expected achievement when individuals differ, as in Section 4. In period 2, those in the A track are automatically admitted to college, and those in the V track become workers and enjoy x. Under ES, college-admissions decisions are then made essentially at the beginning of period 1 before first-period effort β is made (and before the random factor θ and hence academic achievement s are realized).[2]

3. Effort

3.1. Regular Selection (RS)

As usual, the second-period problem is considered first. In period 2, a college student chooses second-period effort γ, given s, to maximize the second-period utility.[3]

$$Q(\beta, \gamma, \theta) \equiv w - \delta(\gamma) = \phi(\beta) + \theta + \gamma - \delta(\gamma),$$

where $\delta(\gamma)$ is the cost of making effort γ. The first-order condition for a maximum of $Q(.)$ is

$$dQ(\beta, \gamma, \theta)/d\gamma = 1 - \delta'(\gamma) = 0, \quad (3)$$

and let γ^* satisfy (3). To have a meaningful analysis, it must be that $Q(\beta, \gamma^*, \theta) \geq x$ for $\theta \geq \theta^R$, so that a participation constraint is satisfied. Since θ^R can take any value between $\underline{\theta}$ and $\overline{\theta}$,

$$Q(\beta, \gamma^*, \underline{\theta}) \geq x. \quad (4)$$

The constraint states that a student admitted to college prefers to graduate from college and become a manager, regardless of her realized random factor θ or secondary-school academic achievement s.

Turning to the first-period problem, a secondary-school student chooses effort β to maximize her lifetime expected utility

$$U^R(\beta, \gamma^*) \equiv F(\theta^R)x + \int_{\theta^R}^{\overline{\theta}} Q(\beta, \gamma^*, \theta) f(\theta) d\theta - c(\beta).$$

The first term shows that a student is not admitted to college with probability $F(\theta^R)$, and in that event she becomes a worker and enjoys x. If admitted, she makes effort γ, graduates, becomes a manager, and enjoys $Q(\beta, \gamma^*, \theta)$ in period 2. In period 1, she only makes first-period effort β, and the cost of effort, $c(\beta)$, is subtracted. Since $\partial\theta^R/\partial\beta = -\phi'(\beta)$ from (2), the first-order condition is

$$dU^R(.)/d\beta = \int_{\theta^R}^{\overline{\theta}} \phi'(\beta) f(\theta) d\theta + [Q(\beta, \gamma^*, \theta^R) - x] \times f(\theta^R)\phi'(\beta) - c'(\beta) = 0. \quad (5)$$

A sufficient condition for the second-order condition, $d^2U^R(.)/d\beta^2 < 0$, is that for all $\theta \in (\underline{\theta}, \overline{\theta})$,[4]

$$f(\theta)\phi''(\beta) - f'(\theta)[\phi(\beta)]^2 \leq 0. \quad (6)$$

It remains to determine s^R and θ^R. Each student is atomistic and takes s^R as given when choosing her β to maximize $U^R(.)$, so that β^R is a function of s^R. In rational expectations equilibrium, $\theta^R = s^R - \phi(\beta^R(s^R))$. In addition, n students are selected and hence $1 - F(\theta^R) = n$. These two equilibrium conditions determine θ^R and s^R, and it is straightforward to verify

$$\partial s^R(n)/\partial n < 0 \quad \text{and} \quad \partial\theta^R(n)/\partial n < 0. \quad (7)$$

Intuitively, as college admissions become less competitive or n increases, it decreases both the cut-off achievement s^R and the cut-off random factor θ^R.

3.2. Early Selection (ES)

A college student, selected into the A track at the beginning of period 1, chooses γ in period 2, given s, to maximize $Q(\beta, \gamma, \theta)$. The first-order condition is identical to (3), and her effort is γ^*.

At the beginning of period 1, the student chooses β to maximize her lifetime expected utility

$$U^E(\beta, \gamma^*) = \int_{\underline{\theta}}^{\overline{\theta}} Q(\beta, \gamma^*, \theta) f(\theta) d\theta - c(\beta),$$

where superscript E denotes ES. A student in the A track is automatically admitted to college, and x does not appear in $U^E(.)$. The utility-maximizing effort, β^E, satisfies the first-order condition

$$dU^E/d\beta = \int_{\underline{\theta}}^{\overline{\theta}} \phi'(\beta) f(\theta) d\theta - c'(\beta) = 0. \quad (8)$$

3.3. Comparison

To compare first-period effort, β^R and β^E, (8) is evaluated at $\beta = \beta^R$ to obtain

$$\int_{\underline{\theta}}^{\theta^R} \phi'(\beta^R) f(\theta)\, d\theta - [Q(\beta^R, \gamma^*, \theta^R) - x] f(\theta^R)\phi'(\beta^R) = \{F(\theta^R) - [Q(\beta^R, \gamma^*, \theta^R) - x] f(\theta^R)\}\phi'(\beta^R). \quad (9)$$

The first term represents the advantage of ES in terms of encouraging effort, because a student selected into the A track is certain to attend college and to be a manager under ES while she may not do so under RS. The remaining term is the disadvantage of ES, as a student in the A track is already admitted to college under ES while she makes effort to increase the probability of being admitted to college under RS. ES then creates a moral hazard problem. The effect of ES is thus ambiguous, and depends on n:

1 If w is formulated generally such as $w = g(s, \gamma)$, as in an earlier version, it does not affect the analysis qualitatively.

2 Section 5 considers a more realistic ES in which students in the A track are screened again for college admissions at the end of period 1. However, this realism turns out to affect the analysis little.

3 Period 2 includes the time period after college.

4 The condition states that the expected marginal product of effort, $f(\theta^R)\phi'(\beta)$, decreases in effort, so that $d[f(\theta^R)\phi'(\beta)]/d\beta = f(\theta^R)\phi''(\beta) - f'(\theta^R)[\phi'(\beta)]^2 \leq 0$. Since θ^R can take any value between $\underline{\theta}$ and $\overline{\theta}$, the last inequality implies (6). Throughout the analysis, (6) is assumed.