Signaling Theory of Education

Returns to Education

- Are more educated workers paid more because
  - education enhances their human capital?
  - education reflects their underlying ability?
- Why does more education reflect higher ability?
  - the education system is a screening device
  - higher ability individuals choose to acquire more education
- Signaling theory is about the latter hypothesis

Self Selection into Education

- A consistent theory of education as a signal for ability requires and environment in which
  - more able workers choose to get more education
  - less able workers choose not to get more education
- As a result, employers' expectation that more educated workers are more productive can indeed be correct—despite the fact that education may not directly enhance productivity

Private Information

- The key assumption of a signaling model is that workers have private information about their own productivity, but employers do not direct observe workers' productivity
- Private information is captured by types:
  - high type: productivity is θ_H
  - low type: productivity is θ_L
- Fraction of high type is λ
- Expected productivity is $\mu = \lambda\theta_H + (1-\lambda)\theta_L$

Pooling

- Why don't employers just pay everybody a wage equal to μ?
- Low types will be happy
- High types will be upset
- High types will try to convince employers that they are productive
- The key challenge is How?
- Talk is cheap
- What can serve as a credible signal for productivity?

Credible Signals

- Signaling is costly
- Credible signals must be differentially costly for different types
- When one type of workers choose to signal while the other type choose not to signal, observing their signaling behavior will allow employers to infer about their types and hence separate one type from another—even though they do not directly observe types

Single-Crossing Condition

- The total cost of getting e years of education is
  - $c_1 e$ for high types
  - $c_2 e$ for low types
- If $c_1 = c_2 = 0$, education is cheap talk
- If $c_1 = c_2 > 0$, we have costly talk, but separation is still not possible
  - whenever $c_1 e$ is greater than the benefit of education, no one chooses to acquire education
  - whenever $c_1 e$ is lower than the benefit of education, low types will mimic high types
- Separation requires $c_1 < c_2$. This is known as the single-crossing condition. This condition may hold because, for example, more able individuals may find that passing exams does not require that much work.

Separating Equilibrium

- Suppose the market expects anyone with e^* years of education is high type
  - employers pay a wage equal to θ_H to those with e^* years of schooling
  - and a wage equal to θ_L to those with less than e^* years of schooling
- For this to be an equilibrium requires
  - high types prefer to choose $e = e^*$ rather than $e = 0$:

$$\theta_H - c_1 e^* \geq \theta_L$$

  - low types prefer to choose $e = 0$ rather than $e = e^*$:

$$\theta_L \geq \theta_H - c_2 e^*$$

- Combining these two inequalities gives

$$\frac{\theta_H - \theta_L}{c_2} \leq e^* \leq \frac{\theta_H - \theta_L}{c_1}$$

Continuous Types

- A worker's type is indexed by $n \in [\underline{n}, \overline{n}]$
- Productivity of type n is βn
- Employers' do not directly observe n. Their expectation of a worker's type is $\hat{n}$. This expectation may depend on the signal chosen by the worker
- The signal is years of schooling z
- Cost of education for type n is z/n
  - marginal cost of education is $1/n$ and is lower for higher types
  - this is the single-crossing condition in the model

Full Separation

- We look for an equilibrium in which each type of worker n chooses a different level of schooling $z(n)$
- As a result, employers can invert the relationship $z(\cdot)$ and infer the type n of a worker by observing his schooling level z
- What determines $z(\cdot)$?

Incentive Compatibility

- Suppose type n_1 worker chooses z_1, and type n_2 (larger than n_1) worker chooses z_2
- Revealed preference implies

$$\beta n_2 - \frac{z_2}{n_2} \geq \beta n_1 - \frac{z_1}{n_2}$$
$$\beta n_1 - \frac{z_1}{n_1} \geq \beta n_2 - \frac{z_2}{n_1}$$

Differential Equation

- Combining the two inequalities gives

$$\beta n_2 \geq \frac{z_2 - z_1}{n_2 - n_1} \geq \beta n_1$$

- z_2 must be greater than z_1: more productive workers choose more schooling
- As $n_2 - n_1 \to 0$, we obtain

$$z'(n) = \beta n$$

- The solution to this differential equation is

$$z(n) = \frac{\beta n^2}{2} + \text{constant}$$

- Boundary condition: the lowest type has no incentive to signal

$$z(\underline{n}) = 0$$

- So the full solution is

$$z(n) = \frac{\beta}{2}\left(n^2 - \underline{n}^2\right)$$

Truth-Telling

- A type n worker wants to maximize his income by choosing a suitable level of schooling
  - in equilibrium he chooses $z(n)$
  - choosing $z' > z(n)$ will allow him to mimic a higher type and get paid more
  - choosing $z' < z(n)$ will save him some education cost
- We can also think of this problem as information manipulation: the type n worker can pretend to be any other type $\hat{n}$ by choosing schooling level $\hat{z} = z(\hat{n})$.
- Equilibrium requires truth-telling, so that employers are not systematically fooled

Check

- Worker of type n chooses $\hat{n}$:

$$\max_{\hat{n}} U(\hat{n}; n) = \beta \hat{n} - \frac{\frac{\beta}{2}(\hat{n}^2 - \underline{n}^2)}{n}$$

- First-order condition is

$$\beta - \frac{\beta}{2}\frac{2\hat{n}}{n} = 0$$

- This implies the optimal $\hat{n}$ is $\hat{n} = n$
- Truth-telling holds given our equilibrium signaling function $z(\cdot)$

Signaling vs. Human Capital

- Signaling is a logically consistent model of education. But is it a reasonable model?
- Some skills are truly learned in school. Few would suggest that the value of medical or legal education lies purely in it signaling function.
- Education is a very expensive; surely there are less expensive signals (tests) available to employers.
- Employers can also offer contingent contracts that reward workers after they are revealed to be good. If it takes 2 years to get an MBA, it probably take less time for employers to observe worker productivity on the site.

Self-Employed Workers

- Kenneth Wolpin finds that self-employed persons (who presumably have less need for signaling) have roughly the same level of education compared to wage and salary workers. The same result remains even after throwing out data on professionals, for whom formal educational attainment is often a legal requirement.
- Similarly there is a large body of research in the development literature which show that more educated farmers are more productive.

Private Information Again

- Do you really know more about your productivity than the person interviewing you?