A Primer on Signaling

Timothy Perri
Appalachian State University

Introduction.

Signaling occurs when the informed side of market wants to communicate information to the uninformed side. Usually sellers (workers in the labor market) are informed. Signaling involves taking an action (the signal) which is costly but which reveals the sender's type. If different types select different signals, they reveal their types.

To be successful, signals must be credible. Credible signals occur if the higher quality/more able sellers have a lower marginal cost (MC) of signaling than do less able sellers.[1]

Conditions for signaling to occur.

If the more able have a lower MC of signaling than the less able, then it is *possible* signaling will occur. Two things are necessary for a *separating equilibrium* in which the more able choose a higher level of the signal than the less able choose.

1st, the level of the signal, y, must be such that, given signaling cost, a) the more able prefer to be correctly viewed as more able, & b) the less able prefer to be correctly viewed as less able----that is, they do not optimally mimic the more able.

2nd, the net payoff for the more able in a separating equilibrium must at least equal their payoff in a *pooling equilibrium* in which both types choose the same level of y.

Simplifying assumptions.

In order to not needlessly complicate the analysis, it is assumed the signal, y, has no direct effect on individual productivity. Thus, in a pooling equilibrium, all would set $y = 0$. Also, it is assumed the signal is obtained immediately, & work occurs for one period (so present value analysis can be ignored).

Employer beliefs.

To analyze signaling, 1st ignore the possibility of pooling. Assume employers believe those with at least some level of the signal, call it y^*, are more able (call them *Smart*), & those with $y < y^*$ are less able (call them *Dumb* workers). Firms will ultimately learn individual productivity & thus will see if their beliefs have been confirmed.

Since y does not affect productivity, in a separating equilibrium, Smart individuals set $y = y^*$ & Dumb individuals set $y = 0$.[2]

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[1] When considering the possibility of education is as a signal, some have wondered why more able students would have a lower MC of schooling---as is required for signaling to work. A more complicated model has individuals acquiring both some level of education (a given degree from a particular school, for example) & a grade. If the more able are more likely to obtain a high grade, then signaling can work even if the cost of obtaining a level of schooling is the same for all types of individuals. For simplicity, I ignore grades & assume the MC of education is lower for the more able.

[2] If y affected productivity (which is, we hope, generally the case if y represents higher education), we could still have signaling, but the problem would be a bit more complicated to analyze. Imagine a world with perfect information, so employers know

Assumptions about individuals.

Let Smart individuals have productivity = 40 & Dumb individuals have productivity = 10. The total cost of obtaining the signal is $y/2$ for Smart individuals & y for Dumb individuals.

A separating equilibrium.

Again, start by ignoring pooling. Since y does not affect productivity, in a separating equilibrium, Smart individuals will set $y = y^* > 0$, & Dumb individuals set $y = 0$.

We must determine what levels of y^* will work, that is, levels which Smart individuals would choose, & that Dumb individuals would not choose.

Smart individuals must prefer or be indifferent to signaling/separating versus being viewed as dumb:

$$40 - y/2 \geq 10, \text{ or } \boldsymbol{y \leq 60}. \qquad (1)$$

Dumb workers must prefer to not mimic Smart workers (whatever y is), so:

$$40 - y < 10, \text{ or } \boldsymbol{y > 30}. \qquad (2)$$

Thus, signaling/separation will occur (again, ignoring pooling for now) if:

$$\boldsymbol{30 < y \leq 60}. \qquad (3)$$

Thus any level of y that exceeds 30 & does not exceed 60 will work in that, if such a level is believed by firms to mean the individual is Smart, then employers' beliefs will be confirmed (again, ignoring the possibility of pooling).

Competition by firms for workers.

Since any level of y consistent with (3) works for y^*, employers will compete for individuals by driving y^* as low as possible. For simplicity, say $y^* = 30$, even though it would actually have to be a tiny bit above 30 (assuming this is not a problem where y must be a whole #). Thus, we say y^* is driven as low as possible, to what is known as the *Riley outcome*, $y_{Riley} = 30$.

Pooling.

Now, for the moment, forget about the possibility of signaling. What would happen if all set $y = 0$? This is a pooling equilibrium. Suppose firms only know (through learning over time) the expected fraction of each type of individual. Further, suppose s is the fraction of Smart individuals in the population. Then, with pooling, firms will compete & drive the wage, W_{Pool}, to the level of expected productivity:

$$W_{Pool} = 40s + 10(1-s) = 10 + 30s = \mathbf{10(1+3}\boldsymbol{s}\mathbf{)}. \qquad (4)$$

Thus, if $s \rightarrow 0$ (all individuals are Dumb), $W_{Pool} = 10$, &, if $s \rightarrow 1$ (all individuals are Smart), $W_{Pool} = 40$.

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individuals' productivity & productivity is positively related to y. In this world, if Smart workers have a greater marginal benefit from education, they would obtain more education, $y = y_{Smart}$, than would Dumb workers, $y = y_{Dumb}$, with $y_{Smart} > y_{Dumb} > 0$. With firms not knowing individual productivity, to prevent Dumb individuals from mimicking Smart individuals, it might be necessary for the former to invest in even more education, call it y', with $y' > y_{Smart}$. Thus, a separating equilibrium would involve the more able investing more than they would if information about individual were costless, just as we will find in the case where we assume y does not affect productivity (so, with costless information [firms know individuals' productivity]), all would set $y = 0$.

What will the equilibrium be?

If employers offer to pay 40 for those who set $y \geq y^*$, what if no one chooses $y > 0$? Then employers will adjust their beliefs (because their initial beliefs will not be confirmed), & will compete for workers by offering to pay W_{Pool}.

Using the results from above, in a separating equilibrium, with $y = y_{Riley}$, the net payoff to a Smart individual is 40 - $y_{Riley}/2$ = 40 -30/2 = 25. Thus Smart individuals will only deviate from a pooling equilibrium by setting $y = y_{Riley}$ if their net payoff at least equals W_{Pool}:

$$25 \geq 10(1+3s),$$

$$2.5 \geq 1+3s,$$

$$1.5/3 = \mathbf{.5 \geq s.} \qquad (5)$$

In this case, if fewer than ½ of individuals are Smart, it pays the Smart individuals to deviate from a pooling equilibrium. Conversely, if there are enough Smart individuals in the population ($s > ½$), despite the lower pay Smart individuals receive when not distinguished from Dumb workers (W_{Pool} versus 40), it is not worth it for Smart individuals to expend $y_{Riley}/2$ = 15 to distinguish themselves & get paid more.

Examples.

❶ Suppose s = .25. Then W_{Pool} = 17.5 < 25: Smart individuals prefer separating/signaling to pooling.

❷ Suppose s = .75. Then W_{Pool} = 32.5 > 25: Smart individuals prefer pooling to separating/signaling.