E C O N O M I C S   B U L L E T I N

# Education as advertisement

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## *Abstract*

The paper perceives education as a type of money burning activity, much like advertisement, and examines its effect on social welfare. In a model where the employer's job assignment also functions as a signal a la Waldman (1984), there exists a separating equilibrium in which education credibly conveys information even when the single−crossing property fails to hold. Moreover, we also show that education as advertisement can actually be welfare−improving. This result indicates that education can be meaningful and even socially desirable even if its sole role is simply to waste resources.

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# 1 Introduction

Besides providing opportunities to accumulate human capital, many authors point out that another potential role of education is to convey hidden information. This point is well taken by the seminal work of Spence (1973).[1] In standard signaling models applied to the job market, it is typically assumed that a worker's productivity is his private information which is not directly observable to his employer. Even in this situation, there may exist a so-called separating equilibrium in which the worker can credibly convey his private information by sending a costly signal, such as education, to the employer. A striking implication of this model is that a worker may choose to invest in education even when it has no effect on his productivity itself.

The condition under which the separating equilibrium exists is known as the single-crossing property. The single-crossing property is critical since otherwise low-ability workers could always mimic the behavior of high-ability workers. Subsequent developments on this topic have revealed, however, that there are situations in which signaling matters even when the single-crossing property fails to hold: that is, money burning conveys credible information. Advertising activities by firms are the case in point. Kihlstrom and Riordian (1984) and Milgrom and Roberts (1986) were among the earliest which formalized the idea, originally advocated by Nelson (1970,1974), that an advertisement with no obvious informational content may carry some meanings. In those models, money burning matters because its expected returns are higher for more efficient firms: this draws clear contrast to the standard signaling model where it is the difference in the cost of signaling which makes separation possible. In Milgrom and Roberts (1986), for instance, only high-quality firms would be willing to advertise because only those firms can keep their customer base in the long run as true information is revealed over time.

In this paper we apply this idea to the labor market and explore the following questions: (i) are there circumstances under which education can play a similar role to advertisement? (ii) if so, then what is its effect on social welfare? To this end, the basic setup of the model follows Waldman (1984), Ricart i Costa (1988) and Bernhardt (1995) where: (i) the productivity of each worker is observable only to the employing firm; (ii) upon observing the productivity, the firm assigns the worker to either one of two jobs, the easy job and the difficult job; (iii) the job assignment is publicly observable. In this situation, a job assignment rule which maximizes the expected output may not be optimal because outside firms can use this information to gauge the worker's true productivity and may drive up the retention wage rate as a consequence: in other words, the firm's job assignment virtually functions as a signal.

We then extend this logic by incorporating signaling behavior into the model while we assume that the cost of signaling is independent of the ability type.[2] Even in this case, high-ability workers may successfully separate themselves from low-ability workers because low-ability workers are less likely to be assigned to the difficult job. This indicates that low-ability workers may not be able to attain the same payoff level by simply mimicking the behavior of high-ability workers. As a result, there arises a situation where a signal whose cost is totally independent of innate attributes conveys credible

[1] Also, see Riley (2001) for a survey on this topic.

[2] In a different context, Ishida (2003) incorporates signaling into Waldman's model to examine the role of signaling on the pace of promotion while the cost of signaling is assumed to be weakly decreasing in ability.

information: that is, any publicly observable way to waste money, such as burning money, can be a credible signal in this type of setup.

One critical aspect of the model is strategic interactions between the worker and the firm. In this model, both the worker and the firm send a signal to the market (outside firms) where a signal sent by the worker explicitly affects the firm's job assignment. Because of this, there arises a situation where separation due to money burning is not only possible but also socially efficient.[3] In the present setup, the incumbent firm has informational advantages over outside firms. This leads the firm to assign too few workers to the difficult job as it attempts to capture informational rents, as pointed out by Waldman (1984). This indicates that the source of inefficiency is the information asymmetry which exists between the incumbent firm and the market. Then, the worker may force the firm to adopt a more efficient job assignment rule by sending a publicly observable signal which alleviates the asymmetry. This result indicates that education can be meaningful and even socially desirable even if its sole role is simply to waste resources.

## 2 The Model

Consider a model with a risk-neutral worker and two risk-neutral employers, incumbent and prospective. For clarity, we refer to the incumbent employer as the firm and the prospective employer as the market. The worker is characterized by his ability type $a \in [0, 1]$, which is uniformly distributed on its support. The ability type is observable to the firm (and the worker) but not to the market.[4]

At the beginning, the worker has a chance to signal to the market. Let $s \in \{0, 1\}$ denote the signal ($s = 1$ when the worker chooses to signal), which is publicly observable. The signal can be, for instance, the amount of investment in education, but we assume here that it has no effect on the worker's productivity to highlight the conclusion of the model more emphatically. The cost of signaling is given by $c$. It is important to note that the cost is independent of the ability type: this implies that the single-crossing property does not hold in this model.

The output level of the worker depends on the job assignment as well as the ability type. There are two distinct types of job, called job zero ($j = 0$) and job one ($j = 1$). Job zero is the easier task which can be performed satisfactorily by any worker; job one is the more demanding task which is sensitive to the ability type. More specifically, given the job assignment, the worker can yield $y_j(a)$ units of output where

$$y_0(a) = y \in (0.5, 1) \text{ and } y_1(a) = a,$$

for all $a$.[5] Upon observing the ability type, the firm assigns the worker to either job. The firm takes

[3] The possibility that advertisement can be welfare-improving is pointed out by Bagwell and Ramey (1994a,b). The key element of their model is the complementarity between the retial firm and consumers: the retail store invests more, which lowers the marginal cost of selling, when it expects more consumers. It is important to note that the underlying mechanism which leads the economy to a more efficient outcome in our model is totally different. In the present model, advertisement, in the form of education, possibly improves social efficiency because it realizes more efficient job assignment patterns by narrowing the information gap between the incumbent firm and the market.

[4] An important point here is that this learning process is asymmetric in that only the current employer can learn the worker's productivity. See Katz and Ziderman (1990), Chang and Wang (1996) and Acemoglu and Pischke (1998) for applications of this idea.

[5] The assumption that $y \in (0.5, 1)$ is strictly to simplify the analysis and qualitatively inconsequential.

the wage rates as given when it decides the job assignment.

Finally, after the job assignment is made, the firm and the market simultaneously offer a wage to the worker. While the market cannot directly observe the ability type, it can observe the job assignment $j$ as well as the signal $s$: the market's offer is thus contingent on $j$ and $s$. The worker then chooses to work for whichever offers the higher wage.[6] We assume that the market is competitive so that it earns zero profit in equilibrium. If the worker accepts the market's offer, he partly loses his productivity due to the firm-specific nature of skills: he produces $\lambda y_j(a)$, $\lambda \in (0,1)$, when he is assigned to job $j$.

The timing of the model is summarized as follows.

1. Nature randomly draws the ability type $a \in [0,1]$.
2. The worker chooses whether to signal to the market $s \in \{0,1\}$.
3. Upon observing $a$ and $s$, the firm assigns the worker to either job.
4. The firm and the market simultaneously make a wage offer to the worker.

# 3 Analysis

## 3.1 Equilibrium with no money burning

The purpose of the paper is to show that there exists a separating equilibrium within the setup described above. Before we proceed, though, we first characterize a pooling equilibrium where the market has a belief that the signal conveys no information at all. Alternatively, we can think of this as a case where there is no publicly observable signaling device.

In the absence of any money burning activity, the only meaningful information that the market has is the job assignment made by the firm. This implies that the equilibrium wage rate is contingent solely on the job assignment. Let $w_j$ denote the equilibrium wage rate when the worker is assigned to job $j$.

The firm's problem is to determine the job assignment upon observing the ability type. If the firm assigns the worker to job one, the expected profit is $a - w_1$; if it assigns the worker to job zero, the expected profit is $y - w_0$. The firm thus promotes the worker if and only if

$$a - w_1 \geq y - w_0. \tag{1}$$

It is critical to examine how the wage rate $w_j$ is determined. To this end, we first conjecture that there exists some $x \in (0,1)$ such that the firm assigns the worker to job one if and only if $a \geq x$. Under the zero-profit condition, the equilibrium wage rate is equal to the worker's expected productivity at the market conditional on the job assignment and is therefore given by

$$w_j = \lambda \max\{E(a \mid j), y\}. \tag{2}$$

Given some $x$, the equilibrium wage rates are given by

$$w_0 = \lambda \max\{\frac{x}{2}, y\} = \lambda y \text{ and } w_1 = \lambda \max\{\frac{1+x}{2}, y\}.$$

[6] As a tie-breaking rule, we assume that the worker accepts the firm's offer when he is indifferent between the two.

We assume the existence of an interior solution throughout the analysis. Then, the following condition must be satisfied in equilibrium:

$$x - y = \lambda(\max\{\frac{1+x}{2}, y\} - y). \tag{3}$$

**Proposition 1** *When there is no signaling, the worker is promoted if*

$$a \geq x = \frac{\lambda + 2(1-\lambda)y}{2-\lambda}.$$

PROOF: Note first that if there exists an interior solution, it must be that $x > y$. This implies that (4) can be written as

$$x - y = \lambda(\frac{1+x}{2} - y). \tag{4}$$

Solving this yields the expression in the proposition.

Q.E.D.

## 3.2 Equilibrium with money burning

We now show that there exists a separating equilibrium within the setup described above. Suppose that the worker chooses to signal if and only if $a \geq z$. We say that there exists a separating equilibrium if there exists such $z \in (0, 1)$.

Since the market observes the signal and the job assignment, the equilibrium wage rate is now contingent on both of them. Let $w_{s,j}$ denote the wage rate given the signal $s$ and the job assignment $j$. Under the zero-profit condition, the equilibrium wage rate is given by

$$w_{s,j} = \lambda \max\{E(a \mid s, j), y\}. \tag{5}$$

The firm assigns the worker to either job based on the signal and the observed ability type. Suppose that the firm's job assignment rule takes the following cutoff form: the firm assigns the worker to job one if and only if $a \geq x_s(z)$, taking $z$ as given. We first establish a necessary condition for a separating equilibrium to exist.

**Lemma 1** *If there exists a separating equilibrium,* $x_1(z) = z$*.*

PROOF: Suppose first that $x_1(z) > z$. In this case, when $x_1(z) > a \geq z$, the worker chooses to signal but is assigned to job zero. If it is optimal, then it must also be optimal to signal when $a < z$ since the cost of signaling is identical. This indicates that separation is not possible. Now suppose, on the other hand, that $x_1(z) < z$. Similarly as above, if it is optimal to signal when $a \geq z$, then it must also be optimal to behave likewise when $z > a \geq x_1(z)$. This means that if there exists a separating equilibrium, it must be that $x_1(z) = z$.

Q.E.D.

This lemma reduces the number of cases we need to examine and thus substantially simplifies the analysis. We now proceed to actually construct a separating equilibrium for some $z \in (0,1)$. Given the signal, the firm assigns the worker to job one if and only if

$$a - y \geq w_{s,1} - w_{s,0}. \tag{6}$$

Given that $x_1(z) = z$, $w_{1,0}$ depends on the market's belief off the equilibrium path. Define $\mu \equiv E(a \mid s = 1, j = 0)$ as the belief off the equilibrium path. Given the job assignment rule, it is reasonable to assume that $\mu \in [0, z)$. The job assignment rule when the worker chooses to signal must then satisfy

$$x_1(z) - y = \lambda(\max\{\frac{1 + x_1(z)}{2}, y\} - \max\{\mu, y\}). \tag{7}$$

**Lemma 2** $x_1(z) = z = \dfrac{\lambda(1 - 2\max\{\mu, y\}) + 2y}{2 - \lambda}$.

PROOF: Note that $x_1(z) > y$ for (7) to hold, which in turn implies that $(1 + x_1(z))/2 > y$. Then, (7) can be written as

$$x_1(z) - y = \lambda(\frac{1 + x_1(z)}{2} - \max\{\mu, y\}). \tag{8}$$

Solving this yields the expression in the lemma.

Q.E.D.

Similarly, we can also obtain the job assignment rule when the worker chooses not to signal. Taking some $z$ as given, the job assignment rule must satisfy

$$x_0(z) - y = \lambda(\max\{\frac{z + x_0(z)}{2}, y\} - \max\{\frac{x_0(z)}{2}, y\}). \tag{9}$$

**Lemma 3** $x_0(z) = \dfrac{\lambda z + 2(1 - \lambda)y}{2 - \lambda}$.

PROOF: Note that $x_0(z) > y$ for (9) to hold. Combined with the fact that $z > y$ and $x_0(z) < 2y$, (9) can be written as

$$x_0(z) - y = \lambda(\frac{z + x_0(z)}{2} - y). \tag{10}$$

Solving this yields the expression in the lemma.

Q.E.D.

It follows from above that the equilibrium wage rates are obtained as

$$w_{0,0} = \lambda y,\ w_{0,1} = \lambda\frac{z + x_0(z)}{2},\ w_{1,0} = \lambda\max\{\mu, y\},\ \text{and}\ w_{1,1} = \lambda\frac{1 + z}{2}.$$

Given these, we are now ready to examine when a separating equilibrium can be sustained as an equilibrium outcome. For a separating equilibrium to exist, the worker must have the incentive to signal only when $a \geq z$. First, when $a \geq z$, the worker is assigned to job one even if he does not signal. This means that he chooses to signal if

$$w_{1,1} - c \geq w_{0,1}. \tag{11}$$

Second, when $a < z$, the worker is never promoted even if he chooses to signal. The worker chooses not to signal if

$$w_{1,0} - c < w_{0,0}, \tag{12}$$

$$w_{1,0} - c < w_{0,1}, \tag{13}$$

Note that (12) implies (13). There exists a separating equilibrium if there exists some $c$ that satisfies both (11) and (12), i.e, if

$$\frac{1+z}{2} - \frac{z + x_0(z)}{2} \geq \frac{c}{\lambda} > \max\{\mu, y\} - y. \tag{14}$$

It can be seen from (14) that separation is more likely when $\mu$ is sufficiently low.[7] To show that the existence of a separating equilibrium does not depend on the arbitrary nature of the belief off the equilibrium path, we consider the case where $\mu \in (y, z)$. Even in this case, a separating equilibrium exists under certain conditions if $c$ lies in some appropriate range.

**Proposition 2** *Suppose that $\mu \in (y, z)$. Then, there exists a separating equilibrium if $\lambda$ is sufficiently small. In this equilibrium, the worker is promoted if*

$$a \geq x_0(z) = \frac{\lambda z + 2(1-\lambda)y}{2-\lambda}.$$

PROOF: Given that $\mu \in (y, z)$, (14) can now be written as

$$\frac{1 - x_0(z)}{2} = \frac{(2-\lambda)(1-y) - \lambda(z-y)}{2(2-\lambda)} \geq \frac{c}{\lambda} > \mu - y. \tag{15}$$

There exists some $c$ that can satisfy this if

$$\frac{(2-\lambda)(1-y) - \lambda(z-y)}{2(2-\lambda)} > \mu - y, \tag{16}$$

which is further reduced to

$$(2-\lambda)(1 + y - 2\mu) > \lambda(z - y) = \frac{\lambda^2(1 + 2y - 2\mu)}{2-\lambda}. \tag{17}$$

It can be verified that this holds for any $\mu \in (y, z)$ if $\lambda$ is sufficiently small.

Q.E.D.

[7] If $\mu \leq y$, (12) is satisfied for any $c > 0$. This guarantees that a separating equilibrium exists as long as $c$ is sufficiently small.

### 3.3 Efficiency

In signaling models where signaling has no effect on the worker's raw productivity and only affects the distribution of wealth, signaling is in general welfare-reducing. In this model, however, there is a productivity gain from signaling because it forces the firm to adopt a more efficient job assignment rule by narrowing the informational gap between the firm and the market. Because of this, there may arise a situation where education as advertisement actually improves social welfare.

In the socially efficient outcome, the worker is promoted if and only if $a \geq y$. This cannot be achieved even with signaling as long as $\lambda > 0$. Still, the worker is more likely to be promoted in the separating equilibrium ($x > x_0(z)$), and this entails the efficiency gain from signaling. The productivity gain from signaling is computed as

$$\begin{aligned} x_0(z)y + \int_{x_0(z)}^1 a\, da - xy - \int_x^1 a\, da &= (x - x_0(z))\left(\frac{x + x_0(z)}{2} - y\right) \\ &= \frac{\lambda^2(1-z)(1+z-2y)}{2(2-\lambda)^2}. \qquad (18) \end{aligned}$$

We say that signaling improves social welfare if the productivity gain exceeds the cost of signaling $c(1-z)$, i.e., if

$$\frac{\lambda^2(1-z)(1+z-2y)}{2(2-\lambda)^2} > c(1-z). \qquad (19)$$

The lowerbound of $c$ is obtained from (14). With this and some manipulation, signaling can be welfare-improving if

$$\frac{\lambda(1+z-2y)}{2(2-\lambda)^2} \geq \max\{\mu, y\} - y. \qquad (20)$$

It can be seen from this that signaling is more likely to be welfare-improving when the market's belief off the equilibrium path $\mu$ is sufficiently low.

# 4 Conclusion

Two features of the model are in particular worth noting here. First, we show that a separating equilibrium exists even when the cost of signaling is totally independent of the worker's innate attributes. This result points out another important role of higher education: that is, the attainment of higher education can be used to advertise one's own hidden information. Second, we also show that this money burning activity can actually be welfare-improving under certain conditions. This result indicates that, even when education is simply a way to waste resources, it can still be meaningful and even socially desirable under certain conditions.

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