Does Signaling Solve the Lemons Problem?

by

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Abstract

Maybe. Lemons and signaling models generally deal with different welfare problems, the former with withdrawal of high quality sellers, and the latter with socially wasteful signals. Absent signaling, with asymmetric information, high productivity workers may not be employed where they are valued the most. If one's productivity is known in alternative employment, signaling that overcomes the lemons problem will only occur if it increases welfare.

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1. Introduction

Akerlof (1970) analyzed problems when price reflects the average quality of sellers because buyers know less than sellers about quality. If seller reservation prices are positively related to quality, high quality sellers may exit the market. This is the *lemons problem* in which asymmetric information results in reduced welfare (versus costless information).

Spence (1974) considered how high quality sellers could signal their quality to buyers. Löfgren *et al*. (2002) argue that Spence's work shows how the lemons problem can be overcome. However, Löfgren *et al*. acknowledge that, in the general case examined by Spence, the alternative to a signaling equilibrium is pooling where all are paid a wage equal to their expected productivity. There is no withdrawal of high quality sellers from the market. Welfare in the standard signaling model is reduced because of the cost of signaling, and the fact all signaling does is redistribute wealth.[1] Thus, lemons and signaling models are usually not concerned with the same welfare problems.

The intention herein is to consider a labor market with asymmetric information when there is a potential lemons problem. First, I consider when a lemons problem would occur. Second, I analyze whether the lemons problem will be overcome via signaling (albeit at some cost). Third, I examine whether signaling increases social welfare.

Consider recent research on lemons markets. Fuchs and Skrzypacz (2013) examine the impact on welfare in a lemons market when trade may be delayed. They suggest signaling via costly delay may increase welfare. Delay must be imposed by a regulator. Kim (2012) considers sellers' incentives to segment the market when buyers make a take-it-or-leave-it offer. His model assumes costless communication by sellers before trade occurs. Voorneveld and Weibull (2011)

[1] In an appendix, Spence (1974) considers a two-sector model in which there is a social return to signaling from correctly allocating individuals to jobs. However, most signaling models ignore sorting gains. Exceptions are Perri (2015) and the analysis herein.

allow buyers to receive a noisy signal of quality. They show there is a positive probability high quality goods will trade even with uninformative signals. They assume signals are costless and exogenous. Thus, none of this recent research considers how a lemons result can be overcome via costly signaling chosen by market participants.

2. A two sector asymmetric information model

In Akerlof (1970), there is one market so goods or services not sold are retained by sellers who value them less than buyers. Suppose there are two sectors in which individuals can work, S1 and S2, and the value of all workers is greater in S1 than in S2. A lemons problem then occurs if high quality workers are employed in S2 and not in S1. Since signaling is costly, even if signaling overcomes the lemons problem, welfare will never be as high as it would be with costless information.

There are many potential firms in either sector. The focus is on perfect Bayesian equilibrium (Gibbons, 1992), in which individuals may move first by signaling, and firms respond and compete for individuals in Bertrand fashion, yielding zero profit. Workers are either *highs* (H) or *lows* (L). In the usual lemons model, a prospective seller's value for a good is positively related to the amount a buyer who knew the good's quality would pay. Thus, I assume the alternative to primary sector employment, S1, is to receive compensation that is positively related to one's productivity in the primary sector. Productivity is assumed to be known in the alternative sector, S2, which could represent self-employment.

Productivity of an H in S1 = ax, $a > 1$, $x > 0$, and productivity of an L in S1 = x. In S2, productivity of an $H = kax$, and productivity of an $L = kx$, $0 < k < 1$. Let α equal the fraction of Hs in the population, with α known to all.

Absent signaling, S1 firms cannot observe an individual's productivity, but learn average productivity. If both types are employed in S1, firms there compete for workers and offer the pooling wage, $W_{pool,1}$, equal to expected productivity, with $W_{pool,1} = (\alpha a + 1 - \alpha)x$. If no *H*s are employed in S1, firms ultimately learn who they get on average. Then, in the usual lemons problem, the wage in S1 would equal *x*. Thus, *H*s will apply to S2 if α is relatively small so that $W_{pool,1} < kax$, or :

$$\alpha < \frac{ka-1}{a-1} \equiv \alpha^*. \tag{1}$$

Now $ka > 1$ in order for $\alpha < \alpha^*$. If $ka \leq 1$, $\alpha^* \leq 0$, and $kax \leq min\ W_{pool,1} = x$. Then *H*s would go to S1. If $\alpha < \alpha^*$, *H*s go to S2 and earn *kax*, and *L*s go to S1 and earn *x*.

If $\alpha < \alpha^*$, *L*s go to sector S1 where they are valued more than elsewhere, but, *H*s go to S2 where they are valued less than they are in S1. This is the classic lemons problem where the highest quality sellers are driven out of the market (S1) because the wage there would reflect expected and not actual productivity.

Let *H*s signal to reveal their productivity. The signal is denoted by *y*. The total cost of signaling is *y* for *L*s and *y*/*g* for *H*s, with $g > 1$. Assume *y* does not affect productivity.

In a signaling equilibrium, those who signal are viewed as *H*s and are offered *ax* in S1. Others are revealed as *L*s and are offered *x* in S1. For signaling to occur, *H*s must (weakly) prefer to be correctly viewed, and *L*s must not want to mimic them. These conditions are:

$$ax - y/g \geq x, \text{ and} \tag{2}$$

$$ax - y < x, \text{ so} \tag{3}$$

$(a\text{-}1)x < y \leq g(a\text{-}1)x.$ (4)

Although any y that satisfies *ineq*.(4) will induce a signaling equilibrium, assuming *H*s prefer signaling to going to S2, competition by firms for workers (Riley, 1979, and Cho and Kreps, 1987) in S1 will result in $y \approx (a\text{-}1)x \equiv y_{Riley}$. Then the net return to an *H* from signaling is:

$$ax - \frac{(a-1)x}{g} = \frac{x}{g}[a(g-1)+1], \quad (5)$$

and *ineq*.(5) is clearly positive.

If signaling occurs, there are always values of y for which *L*s will not mimic *H*s. However, Mailath *et al*. (1993) argue that the more able will deviate from a pooling equilibrium only when their payoff from signaling exceeds that from pooling, given $y = y_{Riley}$. Herein, *H*s would deviate from the equilibrium when they are employed in S2 only if the signaling payoff in *ineq*.(5) exceeds kax, or if:

$$a[g(1\text{-}k) - 1] + 1 > 0. \quad (6)$$

A sufficient condition for *H*s to prefer signaling to going to S2 is if $g(1\text{-}k) \geq 1$. If signaling occurs, the social return is that each *H* who moves to S1 from S2 adds output on net of $ax(1\text{-}k)$, which is also the wage gain to an *H*. Also, the social cost of signaling for an individual is $\frac{(a-1)x}{g}$. Therefore, signaling is socially worthwhile if $a(1\text{-}k) \geq \frac{(a-1)}{g}$, which simplifies to *ineq*.(6).

The gain in output exceeds the cost of signaling only if *ineq*.(6) holds.[2] *Thus, individuals will signal only when it increases welfare*.

Consider the effects of a, g, and k on the likelihood signaling occurs. Denote the left hand side of *ineq*.(6) by Z. For signaling to occur, $Z > 0$. Note, for *H*s to go to S2 absent signaling, $\frac{1}{a} < k < 1$.

Now $\lim_{k \to \frac{1}{a}} Z = (g - 1)(a - 1) > 0$, $\lim_{k \to 1} Z = 1 - a < 0$, and $\frac{\partial Z}{\partial k} < 0$. Signaling is less likely if the productivity of all in S2 is large enough ($dk > 0$). With $g > 1$, $\lim_{g \to 1} Z = 1 - ak < 0$, so, for a large enough marginal cost of signaling for *H*s (small enough g), signaling will not occur. An increase in a has an ambiguous effect on whether signaling occurs because it increases the wage for an *H* with signaling in S1, the wage for an *H* in S2, and y_{Riley}.

Consider the likelihood of a lemons problem occurring. The larger is α^*, the more likely there is a lemons problem. Using *ineq*.(1), $\frac{\partial \alpha*}{\partial k} > 0$ and $\frac{\partial \alpha*}{\partial a} > 0$. Since earnings (absent signaling) in the two sectors determine whether a lemons problem occurs, the marginal cost of signaling for the more able has no effect on the likelihood a lemons problem occurs. The higher are earnings in S2 ($dk > 0$), the more likely there is a lemons problem.

Why does an increase in a increase the chance of a lemon's problem, since such an increase raises productivity for *H*s in S1 more than in S2? The existence of a lemons problem depends on $W_{pool,1}$ and kax, that is, whether *H*s prefer S2 or S1 absent signaling. With $\frac{\partial W_{pool,1}}{\partial a} = \alpha x$, and $\frac{\partial (kax)}{\partial a} = kx$, if $\alpha < k$, S2 earnings rise faster than S1 earnings for *H*s as a increases. Since, $\alpha < \alpha^*$ for a lemons problem, if $\alpha^* < k$, then $\alpha < k$, and indeed $\alpha^* < k$.

[2] If both types have the same productivity in the secondary sector, S2, it can be shown that signaling always occurs and increases welfare.

In sum, a greater productivity for the more able where they are more productive (d$a > 0$) increases the likelihood of a lemons problem, and has an ambiguous effect on the likelihood of signaling occurring. A greater productivity for all where they are less productive (d$k > 0$), increases the likelihood of a lemons problem, and decreases the likelihood signaling will occur. A greater marginal cost of signaling for the more able (d$g < 0$), has no effect on the likelihood of a lemons problem, and decreases the likelihood of signaling occurring.

3. Summary

I find signaling *may* overcome the lemons problem, and inefficient signaling does not occur: the output gain from reallocating more able individuals to jobs where they are more productive at least equals the cost of signaling. My results add to the literature[3] that considers a possible social value of signaling. Even if the signal (say education) does not directly add to individual productivity, signaling may increase welfare by overcoming the lemons problem.

[3] See Spence (1974) and Perri (2015).

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