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Lemons & Loons

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ABSTRACT

In Akerlof (2012, 2013), Akerlof and Tong (2013), and Akerlof and Shiller (2015), it is argued that individuals often do not behave according to rational expectations. They show how buyers in a complete lemons market are worse off if they behave irrationally – like loons. I examine different situations with asymmetric information (including when workers may signal or be screened to reveal their ability) to determine the effects on welfare for loons and for society. Sometimes there are opposite effects for welfare, for society and loons. It is also possible for society to gain when loons, on average, gain from loony behavior.

Keywords: Lemons, Asymmetric information, Signaling

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1 Introduction

In a series of presentations[1] prior to publication of a book, *Phishing for Phools* (Akerlof and Shiller, 2015), and in a recent paper (Akerlof and Tong, 2013), George Akerlof has argued that individuals often do not behave according to rational expectations (RATEX), may ignore the possibility of adverse selection in a lemons market (Akerlof, 1970), and thus may be worse off because of

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[1]Examples of where Akerlof has presented his work on phishing for phools are Akerlof (2012), a fifty plus minute presentation to the University of Warwick, available as a video, and Akerlof (2012), a PowerPoint presentation at George Washington University. The book *Phishing for Phools* was published in September, 2015 after earlier versions of this paper had been written.

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their naïveté. By rational expectations, I mean that individuals accurately determine how much trade will occur, and thus what the price or wage will be.

According to Akerlof, a phool is one who is not stupid, but who makes a mistake. Phishing occurs as some try to influence others to do what is not in the best interest of the latter.

Akerlof argues "... if people are naïve, markets will take advantage of them" (Yap, 2012). Akerlof and Shiller (2015) argue that, in equilibrium, any opportunity for higher profit via phishing will have been exploited by phishers.

I say individuals behave as loons since one definition of a loon is "a crazy person,"[2] which captures the notion of one being irrational or prone to mistakes even if one is not manipulated by other market participants. I do not use Akerlof's term phool, since it implies manipulation by phishers. As argued below, such manipulation may not occur, and is not necessary for economic agents to make mistakes. Loon is a simple word which captures the notion that individuals may not be rational.

Akerlof's argument that phools can be manipulated into making mistakes implies the mistakes will always benefit those who phish the phools. Three points are noteworthy regarding the kinds of mistakes phools/loons will make.

First, in Akerlof's analysis of a lemons market, no phishing is required. All that is necessary is that mistakes are made by buyers. Second, if mistakes do not require phishing, then one would expect mistakes could go in either direction, for example, either underestimating or overestimating how much trade will occur in a lemons market. Becker (1962) argued we should view an irrational individual as random, and not as one who does the opposite of what would maximize his welfare. Third, there are cases of asymmetric information (labor market signaling and screening for example) where it is usually assumed competition by firms results in zero profit for them. Thus, phishing would not be advantageous for such firms.

For the reasons given in the preceding paragraph, I will consider mistakes that go in either direction. For example, buyers may either understate or overstate what the price would be in equilibrium. Akerlof (2012, 2013) and Akerlof and Tong (2013) focused on irrational behavior (mistakes) in lemons markets, that is, with asymmetric information and, possibly, adverse selection. I also analyze problems in such markets. There is no attempt to derive a general explanation for irrational or loony behavior.[3] Also, I do not consider

[2]Merriam-Webster On Line Dictionary, http://www.merriam-webster.com/dictionary/loon.

[3]Examples of articles that deal with agents who are not always rational are Akerlof and Dickens (1982), which deals with cognitive dissonance, and Akerlof and Yellen (1987), which considers markets in which a positive percentage of agents do not attempt to maximize their welfare. Akerlof and Tong (2013) explain how their analysis differs from previous research when agents may be naïve in that the previous literature does not consider adverse selection or the possibility of agents being "phished". I extend the work in Akerlof and Tong by considering cases of adverse selection in which individual irrationality can involve errors that

the possibility of learning in markets that can overcome the problem of loons. If such learning occurs, then irrational behavior might only be a short term problem. I simply wish to address the following questions. First, if loons exist, does their behavior always make them worse off? Second, can the behavior of loons actually increase total welfare? Third, can the welfare of loons increase when total welfare increases?

Generally, three things can happen with asymmetric information. First, there can be a lemons result where goods of relatively high quality are not offered for sale (adverse selection). Second, cost may be incurred to determine quality. In the labor market, this may take the form of signaling by prospective workers or screening by firms. The expenditure on signaling or screening may be a social waste because the revelation of quality may only redistribute wealth from the less able to the more able (Spence, 1974; Lazear, 1986). Third, reputation effects may enable sellers to overcome asymmetric information, and can induce the sale of high quality goods (Klein and Leffler, 1981; Rasmusen and Perri, 2001).

The focus in this paper is parallel to that in Mahoney and Weyl (2014). They consider the interaction of either adverse or advantageous selection and market power. One of their results is that increasing the extent of adverse selection increases total welfare in some cases. The focus herein is on how irrational behavior by individuals (loons) may interact with asymmetric information and affect both the welfare of loons and total welfare. Sometimes there are opposite effects for welfare for society and for loons. It is also possible for society to gain when loons, on average, are unaffected by or gain from loony behavior.

In order to focus on the possibilities with adverse selection discussed in the previous paragraph, the rest of the paper proceeds as follows. In the second section, I introduce a simple lemons model. In the third section, I look at Akerlof's complete lemons result (Akerlof, 2012, 2013, and Akerlof and Tong, 2013). The case with a partial lemons market is analyzed in the fourth section. In the fifth section, a somewhat different adverse selection problem, job market signaling by prospective workers, is considered. The problem of screening by firms of potential employees differs from that of individual signaling, and is considered in the sixth section. The seventh section contains a summary of the results.

2 Lemons Market Setup

Akerlof (2012, 2013) and Akerlof and Tong (2013) considers a lemons market problem when there is a uniform distribution of quality, x. Thus, I too assume

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can occur without phishing, and thus can go in either direction (understating or overstating equilibrium prices or wages).

x is distributed uniformally on $[x_{min}, x_{max}]$ with $x_{min} \geq 0$. Each seller of a good with quality x values the good by exactly x. Each buyer would pay vx for a good of known quality, so demand is perfectly elastic. Even with perfect information, a necessary condition to have a market with a gain from trade is for buyers to value goods more than sellers, or $v > 1$.

With asymmetric information and rational expectations (RATEX), buyers infer which goods will be sold. Not knowing x for any particular good, buyers offer a price equal to the expected value to them. Buyers assume the best goods will not be available for sale. Only goods below some quality level, x^*, will be offered for sale. Thus, buyers offer a price equal to $v\mathrm{E}(x|x_{min} \leq x \leq x^*) = (v/2)(x_{min} + x^*)$, given x is distributed uniformally. Since sellers value their cars by x, the price required by the seller of the highest valued car offered is simply x^*. For cars to be sold with quality of x^* or less:

$$\frac{v}{2}\left(x_{min} + x^*\right) \geq x^* \tag{1}$$

A sufficient condition to have no lemons market is $v \geq 2$. If $v = 1$, both buyers (if they knew x) and sellers value a good by the same amount. The average value to a buyer could only equal the maximum value to a seller if $x^* = x_{min}$. If $v \geq 2$, the average value to buyers at least equals the price demanded by the seller of the highest quality good offered $\forall x$. The entire range of goods would be offered for sale: $x^* = x_{max}$.

In general, with $x_{min} > 0$ and $1 < v < 2$, we can have $x_{min} < x^* < x_{max}$. I find x^* from the equality in Eq. (1):

$$x^* = \frac{vx_{min}}{2 - v}. \tag{2}$$

Using Eq. (2), with $x^* < x_{max}$, so there is a partial lemons problem (and not a case where all goods trade), and $E(x) = (x_{min} + x_{max})/2 =$ the population mean of x, we must have[4]:

$$v < \frac{2x_{max}}{x_{min} + x_{max}} = \frac{x_{max}}{E(x)}, \quad \text{or} \quad v\mathrm{E}(x) < x_{max}. \tag{3}$$

For there to be at least a partial lemons result with RATEX, the expected value of goods to buyers over the entire range of goods, $v\mathrm{E}(x)$, must be less than the maximum valued good to a seller, x_{max}. Otherwise, all units will be traded when that would be the case with perfect information.

[4]Voorneveld and Weibull (2011) allow buyers to receive a noisy signal of quality. The seller does not choose such a signal. They show there is a positive probability high quality goods will trade even with uninformative signals. In order to compare my results with those in Akerlof (2012, 2013) and Akerlof and Tong (2013), I ignore the possibility of an exogenous signal. In Section 5, I consider a signal chosen by sellers.

3 Akerlof's Example of a Complete Lemons Market

3.1 Setup and equilibrium with RATEX

In Akerlof (2012, 2013) and Akerlof and Tong (2013), it is assumed that (in my notation) $x_{min} = 0$, $x_{max} = 2$, and $v = 1.5$. Thus, in Eq. (1) does not hold, so no trade would occur with RATEX. The gain from trade, G, equals zero.[5]

3.2 Loons

In the complete lemons problem, one can only be irrational in one direction since we cannot have a negative amount of trade. Akerlof assumes buyers offer a price, P, equal to 1.5, and will buy any cars at $P \leq 1.5$. Thus, these loons naively believe (1) the entire range of quality will be offered for sale, (2) the market-clearing P is greater than it would be with RATEX, and (3) consumers will not be losers (on average). Demand is perfectly elastic at $P = 1.5$, so $P = 1.5$.

Sellers offer goods with $x \leq 1.5$. The average value of x traded, $\bar{x}$, equals .75. With $v = 1.5$, buyers value for $\bar{x}$ equals $1.5(.75) = 1.125$. Thus, buyers on average lose .375. Normalize the total number of goods to one. Then the number of goods traded equals .75. The total loss to buyers is $.75(.375) = .28125$. Some buyers gain from loony behavior. Anyone who obtains a unit of the good with $x > 1$ is better off since such a good is valued by more than 1.5, and $P = 1.5$.

Sellers gain $P - \bar{x} = 1.5 - .75 = .75$ on average. The total gain to sellers $= .75(.75) = .5625$.

Thus, G, the sum of consumer surplus (CS) and producer surplus (PS), equals $.5625 - .28125 = .28125$. Put differently, the gain from exchange, G, of .28125 comes from the fact goods with $\bar{x} = .75$, for which buyers value the goods more than sellers by $.5\bar{x}$ on average, are traded. With .75 the number traded, $G = (.5)(.75)(.75) = .28125$. Since buyers value goods more than sellers, irrational behavior by buyers which increases the volume of trade increases the gain from trade.

In this case, versus RATEX equilibrium, buyers are loons and lose on average, but sellers gain even more. This result fits Akerlof's view that those he calls phools can be phished (exploited) by those who are not phools (loons in this paper).

[5] Akerlof and Tong (2013) also consider the possibility of a consumer who spends his entire income on the good in question. I ignore such a problem for two reasons. First, nothing fundamental is changed by assuming an individual spends his entire budget on the good, except that an increase in supply can negatively impact buyers, something of interest but not for the questions of concern in this paper. Second, one generally would not expect all of one's budget to be devoted to one good, particularly one for which there is severe asymmetric information.

4 A Less than Complete Lemons Market

4.1 Setup and Equilibrium with RATEX

In the previous section, I considered Akerlof's example of irrational behavior (loons) in a world where the RATEX equilibrium is a complete lemons market – no trade. As shown in Section 2, there can also be lemons markets with some trade in RATEX equilibrium. Consider an example similar to that of Akerlof, but with some trade in RATEX equilibrium.

Suppose $x_{min} > 0$ and $v = 1.5$. Thus, the equality in Eq. (1) can hold. Let $x_{min} = 1$ and $x_{max} = 5$. From Eq. (2), $x^* = 3$. Also, $\bar{x} = 2$, and the average value to buyers is $1.5(2) = 3$, so $P = 3$. With perfectly elastic demand and RATEX, the average gain to buyers is zero – there is no CS.[6] The average gain to sellers $= P - \bar{x} = 1$, so, with .5 cars sold, the total gain to sellers is .5, and $G = CS + PS = .5$. G comes from the fact $\bar{x} = 2$, and each unit traded adds $.5\bar{x} = 1$ on average to the gain from exchange (since buyers value each unit by $.5x$ more than sellers), which, with .5 the number sold, yields $G = .5$.

4.2 Loons 1: Buyers overestimate price

Following Akerlof (2012, 2013) and Akerlof and Tong (2013), suppose buyers overstate the equilibrium number of goods that will trade with buyers at least earning zero CS. Suppose again we have a perfectly elastic demand for the good, but now this occurs at $P = 4$. Goods with $1 \leq x \leq 4$ are offered for sale, so $\bar{x} = 2.5$. Buyers on average value these goods by $v\bar{x} = 3.75$. Thus, buyers lose .25 on average. With the number sold = .75, $CS = -.75(.25) = -.1875$.

Sellers gain 1.5 on average, so they gain $.75(1.5) = 1.125$.Thus, $G = 1.125 - .1875 = .9375$. G comes from the fact .75 of cars are sold, with $\bar{x} = 2.5$, and a gain of $(v - 1)\bar{x} = .5\bar{x}$ on average per car, so $G = (.5)(2.5)(.75) = .9375$. As in Akerlof's complete lemons market, buyers overestimating P means they lose on average (versus RATEX), and sellers gain more than buyers lose, so society gains ($\mathrm{d}G > 0$).

4.3 Loons 2: Buyers underestimate price

Unlike the case when no trade would occur with RATEX, a partial lemons market would have trade. Loons could just as well underestimate the amount of trade that would occur. Now suppose buyers will buy any good if $P \leq 2$. We then have $x \leq 2$ offered for sale, and $P = 2$ (with perfectly elastic demand).

What happens when buyers underestimate the price relative to what would result in RATEX equilibrium is similar to what occurs with a binding price

[6] Those who buy goods with $x < 2$ have negative CS, and those who buy goods with $x > 2$ have positive CS. Total $CS = 0$.

ceiling. In general, when buyers have different values for x, demand would slope down. In that case, with a binding price ceiling,[7] buyers gain from the price ceiling because P falls, but lose because output, Q, falls. Hence, CS could rise or fall.

In the lemons model of Akerlof, and in the model in this section, there is perfectly elastic demand, so $CS = 0$ in RATEX equilibrium. Any P below the RATEX equilibrium P must result in some positive CS as long as $Q > 0$, that is, as long as any trade occurs. There is no CS to be lost as Q falls from its level with RATEX since there is no CS in RATEX equilibrium.

With loons, $\bar{x} = 1.5$, and the average car sold is valued by buyers by $1.5(1.5) = 2.25$. With $P = 2$, buyers on average gain .25. Total $CS = .25(.25) = .0625$ since .25 cars are sold. Sellers gain $2 - 1.5$ on average, so $PS = .25(.5) = .125$. Thus $G = .1875$. Put differently, .25 cars with $\bar{x} = 1.5$ trade, with a gain to society of $.5x$ for each car sold, so the average gain is $.5(1.5) = .75$, and the total gain $= .25(.75) = .1875$, which is less than G in the RATEX equilibrium. In this case, relative to RATEX equilibrium, CS rises (from 0 to .0625), PS falls (from .5 to .125), and $G = CS + PS$ falls (from .5 to .1875).

Akerlof concluded that irrational behavior by economic agents (loons) makes them worse off (on average), although, in his example, the gain from exchange actually increased. The example in this subsection shows how irrationality by economic agents can have opposite effects from those Akerlof found, with loons better off but society as a whole worse off. Still other possibilities may occur with asymmetric information, as will be shown below.[8]

5 Job Market Signaling

As in Akerlof's classic lemons model (1970), Spence (1974) analyzed problems of asymmetric information. However, in Spence's model, high quality sellers can, at some cost, signal their quality to prospective buyers. Löfgren *et al.* (2002) claimed that Spence showed how informational asymmetries can be eliminated via signaling. However, the signaling problem as usually modeled is different from the standard lemons model in that the welfare loss is not due to no trade. Rather, it is due to expenditure by high quality sellers to

[7] I ignore implicit price increases by sellers or time costs from queues that would implicitly raise price with a price ceiling.

[8] Akerlof and Tong (2013) also demonstrate how consumer naïveté can decrease total welfare when RATEX would result in no trade. This result occurs in the case of "bad goods" – those for which buyers (with perfect information) value the good less than a seller does. I do not consider such a case because, with bad goods, zero trade in equilibrium occurs even with perfect information. Asymmetric information does not change the equilibrium (unlike in the usual lemons market) unless it is combined with buyer naïveté.

differentiate themselves from low quality sellers, when expenditures simply redistribute wealth from the former to the latter.

Consider a labor market in which quality implies productivity. Assume two types of individuals, stars and lemons.[9] Stars have productivity $= \theta_S$, and lemons have productivity $= \theta_L$, with $\theta_S > \theta_L \geq 0$. The fraction of stars in the population is s. The usual approach in signaling models is to assume the alternative to signaling is a pooling equilibrium in which individuals are employed in the same jobs with signaling or pooling.[10] Relative to pooling, all signaling does is redistribute wealth from lemons to stars, so any expenditure on signaling lowers the gain from trade. In this section, I consider loons in the basic Spence model when signaling lowers the gain from trade.

In the standard signaling model, continuous units of some signal, y, may be obtained. As is often argued, suppose y represents units of education when y does not affect productivity. All education does is redistribute wealth, so any expenditure on education lowers G. The cost of education is $C_{Star} = y$ for stars and $C_{Lemon} = \beta y$ for lemons, with $\beta > 1$. In a signaling equilibrium, an individual assumes, if he obtains a sufficiently large amount of y, employers will believe he is a star, and he will be paid θ_S. Otherwise, he will be viewed as a lemon and paid θ_L. For signaling to occur, a star must want to be correctly identified, and a lemon must not want to mimic a star. Thus, we must have:

$$\begin{aligned} &\theta_S - y \geq \theta_L, \text{ or} \\ &y \leq \theta_S - \theta_L, \text{ and} \qquad (4) \\ &\theta_S - \beta y < \theta_L, \text{ or} \\ &y > \frac{\theta_S - \theta_L}{\beta} \qquad (5) \end{aligned}$$

Riley (1979) and Cho and Kreps (1987) demonstrate that the only signaling equilibrium that should survive experimentation by agents is the one with the lowest level of the signal that satisfies in Eqs. (4) and (5), call it y_{Riley}. Further, Mailath *et al.* (1993) show that more able individuals would not deviate from a pooling equilibrium in which both types set $y = 0$ unless more able individuals are better off signaling with $y = y_{Riley}$ than pooling. The latter argument will be used below. Thus:

$$y \approx \frac{\theta_S - \theta_L}{\beta} \qquad (6)$$

[9]Riley (2001) considers signaling with a continuum of quality, and shows how all but the lowest quality individual chooses excessive investment of education in a signaling equilibrium.

[10]Spence (1974) did consider an extension of his basic model in which there was a social gain from sorting individuals to different jobs. This problem is further considered in Perri (2015). Bickhchandani *et al.* (2013) also consider a case where there is a social gain to signaling from job allocation.

The payoff to a star from signaling is then:

$$\theta_S - y_{Riley} = \frac{(\beta - 1)\theta_S + \theta_L}{\beta} \tag{7}$$

with this payoff increasing in β because $\frac{\partial y_{Riley}}{\partial \beta} < 0$. Here education does not directly increase productivity, nor does it improve the sorting of individuals to jobs (Spence, 1974; Perri, 2015). All signaling does is redistribute wealth from lemons to stars (versus pooling; see below), while lowering wealth due to signaling cost.

Shiller (2013) argued that phishing occurs by large organizations. As argued above, phishing is not necessary. I simply assume individuals, and not firms, make mistakes. Individuals are in the market less frequently than are firms. Although individuals are assumed to know their own productivity, they may not know other important data – such as the composition of the labor force. Also, if firms moved first and offered a pooling wage, and firms made mistakes in judging the composition of the labor force, the analysis would essentially be the same. The point is that individuals are more likely to make mistakes than firms, even in the absence of phishing. Thus, consider the possibility of signaling when individuals may misjudge the fraction of types in the population.

If all set $y = 0$, pooling will occur with a wage and payoff of $s\theta_S + (1-s)\theta_L$. Using Eq. (7), a star will prefer signaling to pooling if:

$$s \leq \frac{\beta - 1}{\beta} \equiv s^*. \tag{8}$$

Lemons are essentially passive. If stars set $y = y_{Riley}$, lemons are revealed and they set $y = 0$. If stars set $y = 0$, lemons do the same and pooling occurs. In this problem, and in the screening problem in the next section, sellers are the informed agents, and they are the ones who may act as loons. This is consistent with Akerlof's argument (Akerlof, 2012, 2013, and Akerlof and Tong, 2013) that individuals, and not firms, are the ones likely to make mistakes. Also, the obvious way for mistakes to occur in this situation is for stars to misjudge what s is. We have then four possibilities for loony behavior by stars, whose decisions drive the market. Two of these have no impact on the market.

With $s =$ the actual fraction of stars in the population, suppose stars believe their fraction in the population is $\hat{s}$. If $max(\hat{s}, s) < s^*$, nothing changes: signaling occurs with either RATEX or loons. If $s^* < min(s, \hat{s})$, again nothing changes: pooling occurs with RATEX or loons.

The third possibility is if $\hat{s} < s^* < s$. Now stars will signal when they should pool. Stars lose, and so do lemons who are now paid θ_L versus the amount $s\theta_S + (1 - s)\theta_L$ they would receive with pooling. With signaling or pooling, there is no CS (to firms hiring workers) since individuals are paid either their actual or expected productivity. All of G goes to individuals as

PS.[11] G is lower than with pooling because of (with the number of individuals normalized to one) the amount $s[y_{Riley}]$ expended on educational signaling.

The fourth possibility is if $s < s^* < \hat{s}$. Now stars will not signal when they should do so. Stars lose, but lemons gain because they are now paid $s\theta_S + (1-s)\theta_L$ instead of θ_L — what they would get with signaling. Although stars are worse off because they are loons, G rises because PS increases by the amount $s[y_{Riley}]$ not expended on signaling. Lemons gain more than stars lose relative to the RATEX equilibrium. Thus, this problem differs from the previous lemons market cases considered herein because irrationality of some individuals in a group (workers in this example) can make the group better off on average even though the loons are worse off.

6 Simultaneous Screening and Pooling

6.1 Setup and equilibrium with RATEX

Lazear (1986) considered screening by firms of individual quality/productivity. This differs from the signaling model in the previous section in the following ways.

- There is a continuum of individual quality.
- Screening is an accurate test, that is, it direct reveals individual quality. With signaling, quality is revealed implicitly: those who do not obtain as much of the signal as others are viewed as low quality.
- Simultaneous screening and pooling occur (Spence, 2002).

The differences between the signaling model in Section 5 and the screening model considered in this section suggest it is useful to consider screening with loony behavior.

Let m = screening cost per individual. Some jobs do not screen. Salary firms pay a wage, w, equal to expected productivity, $E(z|\text{salary firms})$, with productivity denoted by z, and z distributed uniformally with a density of one on $[0, z_{max}]$. Piece rate firms screen individuals, which reveals productivity to all firms, and pay $z - m$.[12]

[11] Alternative earnings are set equal to zero in this section since they play no role in the analysis unless they are positively related to quality and stars would prefer alternative employment to pooling in this sector. I ignore such a possibility. As long as the wage in an alternative sector is less than the pooling wage, then the analysis is unchanged. If that were not true, the industry in question could not exist absent signaling (Bickhchandani *et al.*, 2013).

[12] I assume individuals pay for screening up front, so whether they stay at the piece rate firm where they are screened is immaterial. If worker ability were not publicly known after screening, salary firms would not know workers did not behave rationally. The analysis in

With RATEX, in equilibrium, the marginal individual has $z = z^*$, and is indifferent to being at either type of firm. Since those with the highest productivity will be the ones who find it beneficial to screen, net productivity at piece rate firms for the marginal individual equals expected productivity at salary firms for those with $z \leq z^*$, or $z^* - m = (z^*/2)$, so $z^* = 2m$. The wage, w, at salary firms with RATEX should equal the $E(z)$ at those firms, which equals m. The gain from exchange, G, is reduced by the amount spent on screening, with this amount equal to m times the number who screen, or $m(z_{max} - z^*)$.

Assume the market works this way. First, some individuals apply to piece rate firms and screen. Second, all other individuals apply to salary firms. Competition by firms for workers is rational. Thus, both piece rate and salary firms break even, so *CS* is zero. Loony behavior is only on the part of individuals – too many or too few applying to salary firms (versus with RATEX). Workers can only be screened initially. Otherwise, those who mistakenly go to salary firms because they overstate the wage there, would quit and apply to piece rate firms, and the RATEX equilibrium would result.[13]

6.2 Individuals understate the wage in salary firms

If individuals understate w, more will go to piece rate firms than with RATEX. Suppose the additional number who apply to piece rate firms is η, and they are the most productive of those who would, with RATEX, go to salary firms. Thus, those who apply to salary firms have $0 \leq z \leq 2m - \eta$. Now $E(z|\text{salary firms}) = m - (\eta/2) = w$.

The $2m - \eta$ individuals who go to salary firms with RATEX or loony behavior each earn $(\eta/2)$ less due to loony behavior, for reduced *PS* to them of $(2m - \eta)(\eta/2)$ .The η individuals who go to piece rate firms with loony behavior, and who would have gone to salary firms with RATEX, have $E(z) = (1/2)(2m - \eta + 2m) = 2m - (\eta/2)$. With screening cost of m, their average payoff is $m - (\eta/2)$, and they would have earned m with RATEX in salary firms. Because of loony behavior, in total, they lose $PS = (\eta^2/2)$.

Those who go to piece rate firms with either RATEX or loony behavior are unaffected – they receive $z - m$ in either case. Adding the total losses we

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the text would change only in that some of the gain or loss from loony behavior could be on the part of firms. With firms fully informed and acting rationally, they earn zero profit no matter how individuals behave in this model. The case with private information about screening is considered in the Appendix.

[13] If salary firms were the ones that could make mistakes, and they moved first and offered a wage based on their expectation of who would screen, the results would be similar in terms of total welfare. With individuals not making mistakes, they would apply to firms optimally given the wage offered by salary firms. The only difference would be, if individuals made mistakes and not firms, there is the question of whether loony individuals could be better off on average.

have $(2m-\eta)(\eta/2)+(\eta^2/2)=m\eta$– the additional screening cost due to loony behavior. Individuals lose on average, and firms are unaffected (they break even always), so society loses.

6.3 Individuals Overstate the Wage in Salary Firms

If individuals overstate w in salary firms, fewer will go to piece rate firms than with RATEX. Let η more individuals now apply to salary firms, and assume these individuals would be the least able of those who would apply to piece rate firms with RATEX. Now those who apply to salary firms have $0 \leq z \leq 2m+\eta$. Thus $\mathrm{E}(z|\text{salary firms}) = m+(\eta/2) = w$. Those who go to piece rate firms are unaffected.

All those in salary firms earn $(\eta/2)$ more than with RATEX. Thus, the $2m$ individuals who would be at salary firms with RATEX or loons all are better off, and gain PS of $m\eta$.

The η individuals who go to salary firms with loons, but not with RATEX, have $\mathrm{E}(z) = (1/2)(2m+2m+\eta) = 2m+(\eta/2)$. After screening cost, they would have had an average payoff of $m+(\eta/2)$ at piece rate firms. They are exactly as well off on average as with RATEX. The total gain in PS is $m\eta$ – the amount by which screening cost has been reduced.

The only individuals who lose are some of the loons who go to salary firms when, with RATEX, they would have gone to piece rate firms. They have above average productivity (for those in salary firms), $z > 2m+(\eta/2)$, and their payoff in piece rate firms would exceed the wage in salary firms. Those from that same group who have below average productivity are better off with loony behavior. With a uniform distribution, 1/2 of those who go salary firms when they would have gone to piece rate firms with RATEX are worse off in salary firms. They number $\eta/2$ .Unless η is large, we have an example where loony behavior increases total welfare (by reducing socially wasteful screening), we could have few individuals worse off due to loony behavior ($z_{max} - 2m - \eta$ have the same PS), and individuals are better off on average.

Note, I assumed that, when individuals understate the wage in salary firms, the η individuals who now go to piece rate firms (but who would have gone to salary firms with RATEX) are at the lower end of the productivity range in piece rate firms. Their mistake makes them worse off in piece rate firms than they would have been in salary firms.

When individuals overstate the wage in salary firms, the η additional individuals who now go to salary firms are assumed to be those who would have been at the lower end of the productivity range in piece rate firms. These individuals would have earned $m+(\eta/2)$ on average (net of screening cost) in piece rate firms. However, now the wage in salary firms equals $m+(\eta/2)$. The error in assessing w does not hurt (on average) the η who mistakenly go to salary firms. What is not individually rational does not hurt this group (on average) since firms rationally bid up the wage in salary firms, and since screening cost is reduced by the amount $m\eta$.

7 Summary

Akerlof (along with his co-authors Shiller and Tong) argues that the potential for mistakes by individuals is exploited by others, thus explaining phenomenon such as the recent financial market meltdown in the U.S. Further, he argues that firms may use reputation to exploit individuals' naïveté. The goal of this paper was not to challenge the idea that individuals make mistakes and can sometimes be exploited. Rather, if individuals may make mistakes in markets, it is of interest what the possible effects of those mistakes would be. Since Akerlof used an example of a lemons market, my objective was to consider lemons markets and other cases of asymmetric information to see the effects when agents are not rational – act as loons.

Whereas Akerlof found loons are worse off due to their behavior, although total welfare is higher, my analysis suggests a variety of possible results when individuals are loons. Loony behavior may have the opposite effect found by Akerlof, raising welfare for loons, but lowering total welfare. Additionally, loons may make society better off by reducing signaling or screening costs when signaling or screening lowers total welfare. In some cases, both society and loons (on average) are better off due to loony behavior.[14]

I only considered markets in which asymmetric information exists, and welfare may be reduced below the level attainable if information were less costly. I have done so for two reasons. First, such markets are used by Akerlof (2012, 2013) and Akerlof and Tong (2013) to demonstrate that mistakes may make individuals worse off. Second, Mahoney and Weyl (2014) combine adverse selection and market power, and find that increasing the former may increase welfare. Similarly, I considered irrational behavior in markets with asymmetric information or adverse selection to see how irrational behavior affects welfare.

In sum, irrational behavior can be bad for those who behave irrationally, but that is only one possibility. Those who are irrational may gain from such behavior, as may society. As a general principle, irrational behavior is not an explanation for markets performing worse than one would expect with rational agents.

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[14] Both loons and society are better off on average in the case with screening and piece rate firms when individuals overstate the wage in salary firms. Then all workers can make the same error, but only some (those with productivity that would be at the lower end of piece rate firms) change their behavior – applying to salary firms when individual rationality would have them apply to piece rate firms. With job market signaling, loony behavior by individuals (workers) can make them better off on average when signaling is efficiently avoided, although the more able individuals lose by not signaling.

A Appendix

A.1 Screening information is private

Now the information from screening is known only at the firm where one was screened. First piece rate firms screen, and then all others apply to salary firms. Suppose salary firms believe individuals will be rational, so these firms set the wage equal to m (see Section 6).Consider what happens if individuals understate or overstate the wage in salary firms.

If individuals understate what the wage will be in salary firms, too many will apply to piece rate firms. As before, it is assumed that the η additional (versus rational expectations [RATEX]) individuals who apply to piece rate firms are the most productive of those who would, with RATEX, go to salary firms.

With a wage of m in salary firms, the $2m - \eta$ individuals who apply to salary firms are as well off as they would be with RATEX.

The η individuals who go to piece rate firms and would have gone to salary firms with RATEX have productivity, z, $z \in [2m - \eta, 2m]$, so their average productivity is $2m - (\eta/2)$, and they earn $m - (\eta/2)$ on average, net of measurement cost, m. Since each would have earned m in salary firms, on average, they lose $(\eta/2)$, so their total loss versus RATEX is $(\eta^2/2)$.

Those who are in piece rate firms earn the same with or without RATEX.

Salary firms attract those with $z \in [0, 2m - \eta]$, so average productivity there is $m - (\eta/2)$. With a wage of m, these firms lose $(\eta/2)$ per worker on $2m - \eta$ workers.

The total loss versus RATEX is then $(\eta^2/2) + (2m - \eta)\eta/2 = m\eta$ – the additional screening cost incurred versus RATEX.

Versus the case when screening information is public, salary firms lose with worker understatement of the wage in those firms. With public screening information, workers at salary firms would lose.

However, firms with negative profit will not continue to exist. If salary firms learn who will apply to them, and, with competition for workers, set w so profit equals zero, the result in the text with public information regarding screening will occur.

If salary firms do not learn who will apply to them, in the long run, only piece rate firms will exist. Assuming alternative individual earnings (that is, outside piece rate and salary firms) are zero, piece rate firms would attract only those with $z \geq m$. Individuals with $z < m$ would be idle.

With RATEX, those with $z > 2m$ screen, so m additional individuals now screen. The social loss versus RATEX would equal $(m^2/2)$ (the average productivity of those who are idle times their number), plus the additional screening cost expended, m^2. Thus, the total loss versus RATEX is $3m^2/2$. If $(3/2)m > \eta$, the social loss would be larger with private information from screening than with public information.

If individuals overstate what the wage will be in salary firms, too few will apply to piece rate firms. As before, it is assumed that the η fewer (versus RATEX) individuals who apply to piece rate firms are the least productive of those who would, with RATEX, go to piece rate firms.

Again, the wage in salary firms is m. Those in salary firms have $z \in [0, 2m + \eta]$, so average productivity there is $m + (\eta/2)$, and each salary firm earns profit of $(\eta/2)$ per individual. With $2m + \eta$ individuals in salary firms, total profit there is $(2m + \eta)(\eta/2) = \eta(m + (\eta/2))$, which is a gain to salary firms versus RATEX.

The η individuals who go to salary firms, but would go to piece firms with RATEX, would have earned $m + (\eta/2)$ net of measurement cost at piece rate firms, so each loses $\eta/2$. Thus, the gain versus RATEX is $\eta(m + (\eta/2)) - (\eta^2/2) = \eta m-$ the savings from lower screening cost.

However, this equilibrium is not sustainable. Positive profit should induce salary firms to compete for workers, and thus bid up the wage until profit equals zero. Then the results would be the same as with public information.

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