Education Cost, Signaling, and Human Capital

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Abstract

Internet-based higher education may lower the time cost of education for less able individuals relative to that for the more able, increasing welfare when education adds to human capital. However, if education signals ability, *increasing* education cost for the less able *may* increase welfare by reducing over-investment in education by the more able. When education adds to human capital, *and* may be a signal of inherent ability, increasing education cost for the less able is most likely to increase welfare the larger the inherent productivity difference between the more and less able, and the larger the fraction of the more able in the population. At a high enough education cost for the less able, over-investment in education does not occur.

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1. Introduction

The increased use of online education could lead to significant changes in higher education (Acemgoglu, Laibson, and List, 2014). One effect of online courses may be to lower the time cost of education for less able individuals relative to more able individuals. Posner (2012) notes how online classes have advantages for students who cannot work as fast as others. The ability to watch lectures more slowly can reduce the total time costs for less able individuals because they spend less time trying to grasp material when they can watch a lecture at their own pace. Assuming education adds to human capital, lowering costs for the less able benefits them and has no effect on others.

When potential employers are uncertain about an individual's ability, education may be used as a signal of (pre-matriculation) ability (Spence, 1974, 2002). Suppose education is only a signal, that is, education does not add to one's human capital. If education does not affect productivity, the lower the level of education, the greater is social welfare. Spence (2002) discusses how a tax might be employed to reduce excessive education and increase welfare when education is not productive. Alternatively, since the level of the signal is inversely related to the educational cost difference between more and less productive individuals, raising this cost difference can increase welfare. Well before the advent of online education, Riley (1981) considered how lowering education cost for the less able could lower welfare:

> Consider "…the adoption of an innovation which increases the rate of educational advancement of the less able…The higher rate of educational advancement implies a reduction in the marginal time costs of education…and hence an increase in the education of…" the less able. The more able "…must *increase* their education….in order to be differentiated."[1]

[1] Riley, 1981, p.375.

McAfee (2013) suggests the best subjects for signaling are those that are less useful or practical since they may imply the biggest cost difference between more and less able individuals:

> "…interpreting long medieval poems could more readily signal the kind of flexible mind desired in management than studying accounting, not because the desirable type is good at it, or that it is useful, but because the less desirable type is so much worse at it."[2]

The idea of analyzing medieval poems suggested by McAfee (2013) as a good signal is actually supported by some evidence. Bukszpan (2012) reports on the value of seemingly useless degrees. One individual majored in epic Renaissance literature and works as a financial analyst. She claims her critical skills in analyzing literature are important in making smart investment choices. Of course, her education may have added to her analytical skills. However, some of what potential employers learned from her major is that she had analytical skills in order to master such a subject. This is the signaling role of education.

Herein, it is assumed education adds to productivity and signals inherent ability. A model is developed in Section 2 that enables us to consider the effect on welfare of changing education cost for the less able. Besides considering when raising or lowering education cost for the less able would increase welfare, there is another contribution of this paper. We find three differences between models when firms are uncertain of the ability of prospective employees and education is productive, versus the same case except when education is not productive. Only the first of these differences seems to have been previously considered. These differences are as follows.

First, the welfare-maximizing choice of education by those who are more able may be high enough that less able individuals find it too costly to mimic the more able. This possibility

[2] McAfee (2013), p.249.

was mentioned by Spence (2002). In this case, over-investment in education by more able individuals will not occur.

Second, at the other extreme, when the cost difference between the less and more able is relatively small, the more able may prefer a pooling equilibrium in which they receive a lower wage than they would if they were sorted from the less able. This result occurs because the over-investment by the more able required for sorting is prohibitively high. Although Spence (2002) recognized pooling might occur, he did not consider the following. With pooling, the more able choose the level of education they would under costless information regarding individual ability. *However, the less able then would over-invest in education.*

Third, unlike the case when education is not productive, *the less able may not prefer a pooling equilibrium to a signaling equilibrium* because, with the former, although the less able are paid more than with the latter, they obtain a higher level of education with pooling than with signaling. The possibility the less able might prefer to be sorted out from the more able rather than pool with them has implications for what equilibrium will occur (Section 3). The less able either over-investing in education or not desiring to pool with the more able are not features of standard signaling models where the productive effect of education is often assumed away.

In Section 2, the basic model is developed. When pooling would occur is analyzed in Section 3. In Section 4, numerical examples are considered to provide further insight on the value of raising or lowering education cost for the less able. A summary is in Section 5.

2. A model of productive education

Consider a world where there are two types of individuals, *A*s and *B*s. Education is denoted by y. The length of work life is set at one and discounting is ignored. Education cost is simply time cost (Riley, 1976, 1979b, and Weiss, 1983). An A gets y units of education by investing y of his lifetime. A B gets y units of education by investing for zy of his lifetime, $z > 1$. Employers observe only y.[3] Productivity depends on one's type and education. Productivity for an A is θy (received for $1-y$ of an A's work life), $\theta > 1$, Productivity for a B is y (received for $1-zy$ of a B's work life). Thus, a larger θ implies a larger inherent productivity difference between As and Bs. For simplicity, it is assumed education cost can be changed for Bs only; z can be increased or decreased by some policy.

With perfect information, an A would maximize $\theta y(1-y)$, and a B would maximize $y(1-zy)$, implying $y_A = ½$ and $y_B = \frac{1}{2z}$. Welfare would then be $\frac{\theta}{4}$ for an A and $\frac{1}{4z}$ for a B. Normalize the number of individuals to one, and let α equal the fraction of As in the population, with α known to all.

A B will not mimic an A to get paid θy for any y if $\theta y(1-zy) < \frac{1}{4z}$. Following Riley (1979a), the lowest level of y that will allow a signaling/separating equilibrium is the Riley outcome[4] for As, y_{Riley}. Bs would not mimic As for any $y > y_{Riley}$. For simplicity, assume an indifferent B would not mimic an A. Thus, y_{Riley} is obtained by setting $\theta y(1-zy) = \frac{1}{4z}$. We then have:

$$y = \frac{1 \pm \left(\frac{\theta-1}{\theta}\right)^{1/2}}{2z}. \quad (1)$$

[3] Riley (1979b) assumes educational quality is acquired more cheaply for the more able, but years of education are what is observable. Herein, it is assumed years of education completed, y, are observed, but total time devoted to obtaining education is not observed.
[4] The Riley outcome is when less able individuals set y equal to the level they would choose with perfect information, and more able individuals set $y = y_{Riley}$---the lowest level of the signal that induces a signaling equilibrium (Riley, 1979a). Using the *intuitive criterion* (Cho and Kreps, 1987), signaling only occurs at the Riley outcome.

The smaller root of $\frac{1 \pm \left(\frac{\theta-1}{\theta}\right)^{1/2}}{2z}$ is less than the perfect information level of *y* for a *B*. Thus, the lowest level of *y* that induces a *B* not to mimic an *A*, y_{Riley}, is:

$$y_{Riley} = \frac{1 + \left(\frac{\theta-1}{\theta}\right)^{1/2}}{2z}. \tag{2}$$

Note $\frac{\partial y_{Riley}}{\partial z} < 0$ and $\frac{\partial y_{Riley}}{\partial \theta} > 0$. Since a higher *z* makes it more costly for a *B* to mimic an *A*, the required education level for an *A* with signaling is reduced as *z* increases. Further, a larger θ makes it more worthwhile for a *B* to mimic an *A*, so a larger θ implies an increase in y_{Riley}. When $y_{Riley} > ½$, excessive investment in education by *A*s is necessary to induce *B*s not to mimic *A*s. This occurs if:

$$z < 1 + \left(\frac{\theta-1}{\theta}\right)^{1/2} \equiv z_{Riley}. \tag{3}$$

For $z \geq z_{Riley}$, both types of individuals obtain the levels of *y* they would with perfect information. Note, the maximum value of $\left(\frac{\theta-1}{\theta}\right)^{1/2}$ is when $\theta \to \infty$ and $\left(\frac{\theta-1}{\theta}\right)^{1/2} \to 1$. Thus, $z_{Riley} \leq 2$.

Let welfare for an *A* with $y = y_{Riley} > ½$ be noted by $W_A|_{y_{Riley}}$.

$$W_A|_{y_{Riley}} = \frac{1}{4z^2}\left\{2\theta[z-1]\left[1 + \left(\frac{\theta-1}{\theta}\right)^{1/2}\right] + 1\right\}. \tag{4}$$

An increase in z lowers y_{Riley} but, from inspection of *eq*.(4), does not unambiguously raise $W_A|_{y_{Riley}}$. At a large enough value for z, a lower y_{Riley} actually would lower W_A because of the direct effect of y_{Riley} on W_A. However, as shown below, this does not occur when $y_{Riley} > ½$. Intuitively, increasing z and moving y_{Riley} closer to $y = ½$ *should* increase welfare for an *A*. We have:

$$\frac{\partial W_A|_{y_{Riley}}}{\partial z} = \frac{1}{2z^3}\left\{\theta[2-z]\left[1+\left(\frac{\theta-1}{\theta}\right)^{1/2}\right]-1\right\}. \tag{5}$$

Since $z < 1 + \left(\frac{\theta-1}{\theta}\right)^{1/2}$ for $y_{Riley} > ½$, let $z = 1 + \left(\frac{\theta-1}{\theta}\right)^{1/2} - \varepsilon$, $\varepsilon > 0$. Then we have:

$$\frac{\partial W_A|_{y_{Riley}}}{\partial z} = \frac{\varepsilon\theta}{2z^3}\left[1+\left(\frac{\theta-1}{\theta}\right)^{1/2}\right] > 0. \tag{5'}$$

Thus, when excessive investment in education by the more able is required for signaling, an *A*'s welfare increases as education cost for *B*s increases.

Assuming $y_{Riley} > ½$, total welfare is $W = \alpha W_A|_{y_{Riley}} + \frac{1-\alpha}{4z}$, since welfare for a *B* who sets $y = \frac{1}{2z}$ is $\frac{1}{4z}$. We then have:

$$\frac{\partial W}{\partial z} = \frac{1}{4z^3}\left\langle 2\alpha\left\{\theta[2-z]\left[1+\left(\frac{\theta-1}{\theta}\right)^{1/2}\right]-1\right\}-(1-\alpha)z\right\rangle \equiv \frac{J}{4z^3}. \tag{6}$$

For an interior solution for z, $J = 0$. If $J = 0$, $\frac{\partial^2 W}{\partial z^2} < 0$, so we have a maximum of W with respect to z when $J = 0$. Totally differentiating the first order condition for z, with $J = 0$, we have:

$$\frac{1}{4z^3}\frac{\partial^2 W}{\partial z^2}\,\mathrm{dz} \;+\; \frac{1}{4z^3}\langle 2\left\{\theta[2-z]\left[1+\left(\frac{\theta-1}{\theta}\right)^{1/2}\right]-1\right\}+z\rangle \mathrm{d}\alpha$$

$$+\;\frac{2\alpha}{4z^3}[2-z]\left[1+\left(\frac{\theta-1}{\theta}\right)^{1/2}+\frac{1\left(\frac{\theta-1}{\theta}\right)^{-1/2}}{2\theta}\right]\mathrm{d}\theta = 0. \tag{7}$$

Using *eqs*.(5) and (5'), we know the {•} term in in *eq*.(7) is positive, so $\frac{dz}{d\theta}$ and $\frac{dz}{d\alpha}$ are both positive. Assuming the more able individuals overinvest in education in a signaling equilibrium, if these individuals are a larger fraction of the population ($\mathrm{d}\alpha > 0$), or if their skills are relatively more valuable ($\mathrm{d}\theta > 0$), total welfare is higher if the education cost of the less able is *increased*. An increase in either α or θ increases the output of *A*s. This makes lowering y_{Riley} by raising *z* more worthwhile since we move *A*s towards their welfare-maximizing level of *y*.

Denote the value of *z* that maximizes *W* by *z**, and note that *z** maximizes *W* only when *A*s set $y = y_{Riley} > ½$, and *B*s set $y = \frac{1}{2z}$.

3. Pooling

Pooling must be considered for two reasons. First, if *A*s prefer pooling to a signaling/separating equilibrium, we would see both *A*s and *B*s obtain the same level of education. Since, empirically, we observe many different levels of education chosen, we wish to see when *A*s would *not* prefer pooling. Second, as will be argued below, if *B*s would not prefer pooling to their outcome in a signaling equilibrium, then it will not be necessary for *A*s to set $y > ½$ in order to deter *B*s from mimicking them.

With pooling, an *A* would be paid $(\theta\alpha + 1\text{-}\alpha)y$ for 1-y of his life. An *A* would choose y with pooling to maximize $(\theta\alpha + 1\text{-}\alpha)y(1\text{-}y)$, yielding $y = ½$. Thus, pooling involves both types setting $y = ½$, the perfect information level of y for an *A*.

When education is not productive, with perfect information, all would set $y = 0$. Thus, with pooling, *A*s would set $y = 0$. In that case, *B*s prefer pooling to a signaling equilibrium. In both equilibria, *B*s set $y = 0$, but, with pooling, *B*s are paid the expected productivity of both types, which exceeds what they are paid in a signaling equilibrium when $y = 0$.

When education is productive, and $y = ½$ with pooling, pooling is not unambiguously preferred by *B*s. They get paid more than they would in a separating equilibrium, $(\theta\alpha + 1\text{-}\alpha)y$ versus y, but they must also obtain a higher level of education , ½ versus $\frac{1}{2z}$. The payoff to a *B* from pooling with $y = ½$ is $\frac{(\alpha\theta+1-\alpha)}{2}(1-\frac{z}{2}) = \frac{(\alpha\theta+1-\alpha)}{4}(2-z)$, and the payoff to a *B* in a separating equilibrium is $\frac{1}{4z}$. Thus, *B*'s prefer pooling to a separating equilibrium if:

$$\alpha > \left(\frac{1}{\theta-1}\right)\left(\frac{1}{z(2-z)}-1\right). \qquad (8)$$

An increase in z raises a *B*'s education cost regardless of whether pooling or signaling occurs. For large or small values of z, *B*s prefer a signaling equilibrium to pooling. We find *B*s prefer pooling to a signaling equilibrium if $z_1 < z < z_B$. In all cases we consider, $z_1 < 1$, so z_1 is irrelevant for our analysis. *Therefore, we say Bs prefer pooling to a signaling equilibrium if* $z < z_B$, *or Bs prefer pooling to a signaling equilibrium unless z is too large.*

When *A*s prefer signaling to pooling, it must be the case that pooling would occur absent signaling, since an *A*'s decision whether to signal is based on pooling being the alternative to signaling. Suppose $z > z_B$. *B*s prefer the signaling equilibrium in which they are paid *y* and set $y = \frac{1}{2z}$ to the pooling equilibrium with $y = ½$ and a wage of $(\theta\alpha + 1\text{-}\alpha)y$. Following the logic of *undefeated equilibrium* (Mailath *et al*., 1993), *B*s will not deviate from $y = \frac{1}{2z}$ and a wage = *y* because they realize the outcome at $y = ½$ is for the pooling wage and *not* a wage of θy in the skilled sector. [5]

Undefeated equilibrium essentially allows commitment to wage offers by firms to be endogenous (Koufopoulos, 2011, Perri, 2014). Thus, if all choose $y = ½$, firms realize these individuals are not all *A*s, and the pooling wage replaces a wage equal to the productivity of *A*s. The equilibrium in this case should be the one with perfect information: *A*s set $y = ½$ and get paid θy, so *A*s get their best possible outcome. Again, *Bs* would not deviate from the equilibrium in which they are paid *y* and set $y = \frac{1}{2z}$ because they know the wage offer of θy would not result if all set $y = ½$.

For *A*s, comparing $W_A|_{y_{Riley}}$ (*eq*.(4)) to an *A*'s payoff with pooling, $\frac{\alpha\theta+1-\alpha}{4}$, *A*s prefer a signaling equilibrium with $y = y_{Riley} > ½$ if:

$$\alpha < \langle\frac{1}{\theta-1}\rangle\langle\frac{1}{z^2}\left\{2\theta[z-1]\left[1+\left(\frac{\theta-1}{\theta}\right)^{1/2}\right]+1\right\}-1\rangle. \quad (9)$$

[5] Mailath *et al.* (1993) use the idea of *undefeated equilibrium* to find when a pooling equilibrium would be broken by a signaling equilibrium, when the latter is preferred to the former by the more able. The *intuitive criterion* (Cho and Kreps, 1987) rules out all pooling equilibria in such situations. Herein, we use undefeated equilibrium to show that a pooling equilibrium would not survive when the less able prefer signaling to pooling.

We find *A*s prefer signaling to a pooling equilibrium if $z_A < z < z_2$. In all cases we consider, $z_2 > 2$, so z_2 is irrelevant for our analysis. *Thus, we say As prefer signaling to a pooling equilibrium if* $z > z_A$.

In all of the cases we consider $z_A < z_B$. Thus, there is a range of z, $z_A < z < z_B$, in which a separating equilibrium could occur because *A*s prefer separating to pooling, and *B*s prefer to pool at $y = ½$, and be paid $(\theta\alpha + 1\text{-}\alpha)y$ rather than be paid y in a signaling equilibrium in which they set $y = \frac{1}{2z}$.

4. Analysis.

We now summarize what was derived above and what will be found in the numerical examples in this section.

1) If $z < z_A$ (found in *ineq*.(9)), *A*s prefer pooling to signaling. Both *A*s and *B*s would set $y = ½$, so *B*s overinvest in education in a pooling equilibrium.

2) If $z > z_A$, *A*s prefer signaling to pooling .

3) If $z < z_B$ (z_B found in *ineq*.(8)), *B*s would prefer pooling to setting their perfect information level of y.

4) *A*s prefer signaling to pooling and signaling occurs with *A*s setting $y = y_{Riley} > ½$ if $z_A < z < z_B$.

5) With z_{Riley} from *ineq*.(3), if $z > min(z_B, z_{Riley})$, the perfect information levels of y are obtained: *A*s set $y = ½$, and *B*s set $y = \frac{1}{2z}$.

In the examples we consider, $z_A < z_B < z_{Riley}$. Thus, at least for the values for θ and α considered herein, z_{Riley} is not relevant because the perfect information levels of y for both types result when $z > z_B$. Table One shows critical values for z for given values of θ and α. Table Two shows total wealth, W, for α of either .2 or .4, and θ of 1.5, 2, and 3.

For brevity, we do not consider all the values of α and θ in Table One. Also, as seen in Table One, high values of α are more likely to result in a pooling equilibrium in which both types of individuals obtain the same amount of education. Since empirically different levels of education are actually obtained by individuals, we use relatively low values of α. Using α of either .2 or .4, if $z \geq 1.2$, pooling does not occur with the values of θ we use.

If pooling did occur, raising education cost for the less able, d$z > 0$, necessarily lowers welfare, assuming z is not increased so much that pooling no longer occurs. With pooling, *B*s set $y = ½$, that is, they overinvest in education relative to a world of perfect information. All that happens with pooling as z increases is *B*'s welfare falls; *B*s continue to set $y = ½$. However, unless we have relatively large values for θ and α, z_A is relatively low (Table One), so it is unlikely pooling occurs.

On average, lifetime earnings with a bachelor's degree are 74% higher than with a high school degree, 47% higher than with some college, and 31% higher than with an associate's degree (Carnevale *et al*., 2011). From Table Three, when z is 1.2, and θ is either 1.5 or 2, we are not too far from the empirical difference between the lifetime earnings of a high school and college graduate. The educational difference for these two cases (58% and 71%) understates the high school versus college difference if we view y as measuring education after one could leave school, and that is age 16---typically after one's sophomore year. In that case, a high school graduate has $y = 2$, and a college grad has $y = 6$.

If we compare bachelor's and associate's degrees, and y again measures education after the sophomore year of high school, then y for an associate's degree is 4, and y for a bachelor's degree is 6, or $\frac{y_A}{y_B}$ = 1.5. This is identical to the ratio of y_A to y_B for θ equal to either 1.5 or 2, and *z* equal to 1.5, and is similar to the ratio for θ equal to 1.5 and *z* equal to 1.2. However, the lifetime earnings differential in our theoretical model is far above that found empirically for bachelor's degree recipients versus those who earn associate's degrees. From Table Three, when θ = 1.5 and *z* = 1.2, which yields the lowest ratio of lifetime earnings for *A*s relative to *B*s, the ratio of earnings (1.576), is about double what is found empirically (1.3---a 30% advantage) for those with a bachelor's degree relative to those with an associate's degree.

With the six combinations of θ and α in Table Two, suppose *z* = 1.5, and can be either increased or decreased by 20%. Thus, *z* becomes either 1.2 or 1.8. Lowering *z* to 1.2 lowers welfare in four cases, raises welfare in one case, and, in one case, welfare is unchanged as *z* is decreased. Raising *z* to 1.8 lowers welfare in five cases, and raises welfare in one case. Thus, at least starting with *z* = 1.5, it appears that most changes in *z* will decrease welfare.

Alternatively, suppose *z* = 1.2, and can be increased by 50%. Raising *z* to 1.8 lowers welfare in three cases, and raises welfare in the other three cases, the latter occurring when θ = 3 and α = .2, θ = 2 and α = .4, and θ = 3 and α = .4. Increasing *z* is more likely to raise welfare the larger are α and θ. Any gain in welfare from raising *z* is due to *A*s over-investing less in education. Therefore, an increase in *z* is more likely to increase welfare the more *A*s there are relative to *B*s. Also, increasing *z* is more likely to raise welfare the larger is y_{Riley}, and a larger θ implies a larger y_{Riley}. Thus, a larger θ is more likely to result in an increase in welfare as *z* increases.

To see what can happen to welfare, *W*, if *z* were raised in small increments, consider the case when θ = 2 and α = .4. Now z_A = 1.103, z^* = 1.4, and z_B = 1.535. If, *z* is 1.2, pooling does not occur. We have y_A = .711, so, relative to a perfect information world, *A*s overinvest in education by about 42%. *B*s choose $y = \frac{1}{2z}$. Raising z from 1.2 to 1.4 lowers y_{Riley} to .61, so *A*s gain welfare, and this gain exceeds the loss to *B* from their education cost increasing (since welfare, given signaling, increases in this case until $z = 1.4$). *W* increases by about 6%. Given signaling (which occurs until $z > z_B = 1.535$), with $z > z^* = 1.4$, further increases in z lower welfare, and *W* falls by about .3% as z increases from 1.4 to 1.5. Increasing z from 1.5 to 1.6 results in $y_{Riley} < ½$, so, at this point, both types choose the same level of y they would with perfect information. The loss in welfare to *B*s dominates slightly the gain in welfare to *A*s (given 40% of individuals are *A*s), and *W* falls by about 1%. Further increases in z unambiguously lower *W* since *A*s are unaffected (continue to set $y = ½$), and *B*s are worse off as their education cost increases.

With $\theta = 2$ and $\alpha = .4$, if z increases from 1.2 to 1.8, *W* increases by about 1%. Clearly, what z is initially, and how much z changes determine what happens to welfare. As noted above, increasing z is more likely to raise welfare the larger are α and θ.

5. Summary

Internet-based higher education may lower the time cost of education for less able individuals relative to that for the more able, increasing welfare when education adds to human capital. [6] When education is a signal of inherent ability, possible over-investment in education by the more able may occur (Spence, 1974, 2002). When over-investment occurs, it is because it is necessary to prevent the less able from mimicking the educational choices of those who are

[6] There are many issues concerning online education. One is the importance of direct personal contact (lacking online) in education (Becker, 2012). A second issue is how much the internet will replace traditional university courses. Weissmann (2012) argues campuses involve more than teaching, and mentions the signaling value of education. It is possible online courses provide worse signals because some of what is required in other classes, such as attendance and group projects that require personal contact, is missing. Roth (2012) suggests that elite universities will survive the online class revolution, at least in part because of the signaling that occurs at such schools. Since there is a continuum of universities in terms of quality, Roth's argument implies schools that are not elite, but that are not at the lowest end of the continuum, may also survive the spread of online education.

more able. Less over-investment occurs the larger the difference in education cost between less able and more able individuals. More abstract education may result in an increase in the educational cost difference between less and more able individuals.

When education adds to human capital, *and* may be a signal of inherent ability, increasing education cost for the less able is most likely to increase welfare the larger the inherent productivity difference between the more and less able, and the larger the fraction of the more able in the population. However, at a high enough education cost for the less able, over-investment in education does not occur.

Given the possibility for significant growth in online education, the signaling role of traditional and online education, and the possible value of abstract education in sorting individuals are topics that deserve attention.

Table One. Critical values for *z*.					
θ	α	z_A	z^*	z_B	z_{Riley}
1.5	.2	1.017	.855	1.302	1.577
1.5	.4	1.035	1.198	1.408	1.577
1.5	.6	1.055	1.382	1.48	1.577
1.5	.8	1.077	1.498	1.535	1.577
2	.2	1.046	1.076	1.408	1.707
2	.4	1.103	1.4	1.535	1.707
2	.6	1.18	1.555	1.612	1.707
2	.8	1.297	1.647	1.667	1.707
3	.2	1.05	1.329	1.535	1.816
3	.4	1.113	1.597	1.667	1.816
3	.6	1.198	1.712	1.739	1.816
3	.8	1.331	1.776	1.784	1.816
4	.2	1.052	1.472	1.612	1.866
4	.4	1.117	1.622	1.739	1.866
4	.6	1.206	1.786	1.802	1.866
4	.8	1.345	1.835	1.84	1.866

Note: 1) for $z > z_A$, *A*s prefer separating at $y_{Riley} > ½$ to pooling; 2) for $z > z_B$, *B*s prefer separating at $y = \frac{1}{2z}$ to pooling; 3) for $z < z_{Riley}$, $y_{Riley} > ½$ = the perfect information *y* for *A*s; and 4) z^* maximizes welfare assuming $y_{Riley} > ½$.

Table Two. Examples of welfare with different values of θ, α, and z.					
θ	α	z	y_A	y_B	W
1.5	.2	1.2	.657	.417	.234
1.5	.2	1.4	.5	.357	.254
1.5	.2	1.5	.5	.333	.242
1.5	.2	1.6	.5	.313	.231
1.5	.2	1.8	.5	.278	.214
2	.2	1.2	.711	.417	.249
2	.2	1.4	.61	.357	.238
2	.2	1.5	.5	.333	.267
2	.2	1.6	.5	.313	.256
2	.2	1.8	.5	.278	.239
3	.2	1.2	.757	.417	.277
3	.2	1.4	.649	.357	.28
3	.2	1.5	.605	.333	.277
3	.2	1.6	.5	.313	.306
3	.2	1.8	.5	.278	.289
1.5	.4	1.2	.657	.417	.26
1.5	.4	1.4	.563	.357	.255
1.5	4	1.5	.5	.333	.25
1.5	.4	1.6	.5	.313	.244
1.5	.4	1.8	.5	.278	.233
2	.4	1.2	.711	.417	.279
2	.4	1.4	.61	.357	.297
2	.4	1.5	.569	.333	.296
2	.4	1.6	.5	.313	.293
2	.4	1.8	.5	.278	.283
3	.4	1.2	.757	.417	.346
3	.4	1.4	.649	.357	.381
3	.4	1.5	.605	.333	.387
3	.4	1.6	.568	.313	.388
3	.4	1.8	.5	.278	.383

Table Three. Relative education and welfare (lifetime earnings) for *A*s and *B*s.			
θ	z	y_A/y_B	W_A/W_B
1.5	1.2	1.576	1.623
1.5	1.5	1.5	2.25
2	1.2	1.705	1.973
2	1.5	1.5	3
3	1.2	1.815	2.654
3	1.5	1.709	4.414

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