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THE ROLE OF INTEGRITY IN ECONOMIC INTERACTION

by

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Two hundred years ago Adam Smith examined the workings of an economy in which all individuals are selfish, and discovered the important concept of the invisible hand. Since Edgeworth (see Sen 1977), standard economic theory has followed Smith's lead and concentrated on a world where individual behavior is motivated by narrow self-interest. As Sen points out, however, this is not an assumption based on empirical observation, and, in fact, in a variety of circumstances its employment will yield quite misleading results.

In this paper I explore the idea that, rather than solely being motivated by narrow self interest, much behavior is motivated by an underlying consideration of what is right and wrong. That is, many people behave with what is commonly referred to as integrity. This paper proceeds by investigating the significance of integrity in a variety of economic environments. In particular, I analyze models wherein a proportion of the population has integrity, while the remainder of the population follows standard assumptions and thus lacks integrity. My goal is twofold. First, I would like to characterize equilibria under this type of heterogeneity. Second, I hope to identify situations in which agents who possess integrity have a disproportionately large effect on equilibrium, and situations in which agents who lack integrity have a disproportionately large effect.[1]

The outline for the paper is as follows. Section I investigates a claim originally made by Akerlof concerning honesty and dishonesty.

> ...Consider a market in which goods are sold honestly or dishonestly; quality may be represented, or it may be misrepresented. The purchaser's problem, of course, is to identify quality. The presence of people in the market who are willing to offer inferior goods tends to drive the market out of existence — as in the case of our automobile "lemons." It is this possibility that represents the major costs of dishonesty — for dishonest dealings tend to drive honest dealings out of the market....
> (Akerlof 1970, p. 495)

To rephrase this slightly, Akerlof is claiming that in a one period product quality setting, where quality is not publicly observable, the agents who lack integrity tend to be disproportionately important. To investigate this claim I construct a simple model wherein, prior to the purchase decision, producers announce the quality of their product. It is further assumed that a proportion p of the firms is honest and will thus accurately reveal quality, while a proportion $(1-p)$ is dishonest and is thus willing to misrepresent quality. The results of the analysis are basically supportive of Akerlof's claim. That is, as long as the proportion of honest firms is relatively small, the market completely breaks down and the equilibrium is exactly as if all the firms were dishonest. However, it is also true that if the proportion of honest firms were to be above some critical value, then some high quality units might be forthcoming. Overall, therefore, the analysis does support the notion that the agents who lack integrity tend to be disproportionately important.

Section II considers a model of theft. In this model there is a set of property owners who can invest in protection against theft, and a set of potential thieves. A proportion p of these potential thieves have integrity and each is thus unwilling to steal, while a proportion $(1-p)$ lack integrity and will thus steal if property owners take inadequate protection. Even more strongly than in the previously described model, the results here indicate that the agents who lack integrity are the ones who are disproportionately important. That is, as long as there is just one potential thief who lacks integrity, the unique equilibrium is exactly as if <u>all</u> the potential thieves lacked integrity.

Before describing Section III, it is worthwhile to contrast the intuition behind the theft model and the intuition behind the product quality model. In the product quality model, if honest agents try to provide high quality, then dishonest agents will try to pass themselves off as honest agents. This lowers the valuation consumers place on "announced" high quality, and thus makes it less likely that honest agents will find the provision of high quality worthwhile. The intuition behind the theft model is quite different. What goes on there is a selection process. If there is just one agent who lacks integrity, that agent will only rob from the property owner who has invested the least in protection. This means that the property owners are forced into a game, where the goal is not to be this owner. The result is that all owners are forced to invest heavily in protection -- just as if there were many potential thieves who lacked integrity. To summarize then, in the first two sections I identify two circumstances in which agents who lack integrity tend to be disproportionately important. First, those who lack integrity will tend to be disproportionately important in a one period product quality setting, where quality is not publicly observable. Second, a somewhat more general principle is that those who lack integrity will tend to dominate in a world where such individuals impose their negative behavior on the agents who have done the least to protect themselves from it.

As opposed to the first two sections, Section III presents a model in which integrity, rather than the lack of it, tends to be the dominating factor. This model formalizes a claim made by Milgrom and Roberts (1982b). Their claim was that by adding a little bit of uncertainty (a la Kreps and Wilson 1982, and their own work), it is possible to overcome the last period problem associated with markets where reputation for quality is an issue. To formalize this claim I construct a model which contains a monopolist who is of one of two types. With probability p the monopolist has integrity, which in this case means he is unwilling to provide "shoddy" merchandise. With probability $(1-p)$ the monopolist lacks integrity, and is therefore willing to provide shoddy merchandise. The results of the analysis are quite supportive of the Milgrom and Roberts conjecture. That is, by having even just a small probability that the monopolist has integrity, it is possible that the last period problem will be almost completely avoided. Or in other words, in a world where it is possible to establish a reputation for integrity, the agents with integrity will be the ones who tend to be disproportionately important. At the end of Section III I discuss the relationship between the models of Sections I and III, both of which are concerned with the provision of quality.

One might ask what conclusions can be drawn from the above results as regards the common practice of assuming that all agents in the economy lack integrity. My feeling is that since agents in the real world are obviously heterogeneous in terms of this characteristic, the practice of assuming that all agents lack integrity is relatively more defensible when agents who lack integrity have a disproportionately large effect on equilibrium. Thus, the above suggests that there are relatively strong justifications for making the standard assumption either in a one period product quality setting, or when agents who lack integrity tend to impose their negative behavior on the agents who have done the least to protect themselves from it. However, in a world where it is possible to establish a reputation for integrity, the standard practice would seem to be less defensible.

I. Product Quality and Honesty: A One Period Model

In this section I investigate Akerlof's claim that in a one period product quality setting, where quality is not publicly observable, dishonest firms tend to be disproportionately important.[2] Let there be N risk neutral firms with the following technology. A firm can either produce units of quality $\bar{q}$ at constant cost per unit $\bar{c}$, or produce units of quality $\underline{q}$ at constant cost per unit $\underline{c}$, where $\bar{q} > \underline{q}$ and $\bar{c} > \underline{c}$. It is further assumed that the quality of the units produced by a particular firm is private information to that firm.

For the demand side let there be M identical risk neutral consumers each of whom consumes either zero units or one unit of the good produced by this industry. Further, each consumer i has the profit function

(1) $$\Pi_i = vq_i - e_i,$$

where v is the valuation consumers place on quality, q_i represents the quality of the unit purchased by consumer i, and e_i denotes consumer i's expenditure on this purchase (note: if consumer i does not purchase a unit, then $q_i = 0$). Two restrictions are imposed on the parameters. First, $v(\bar{q}-\underline{q}) > \bar{c}-\underline{c}$. This restriction guarantees that in a full information world only high quality units will be produced. Second, $v\underline{q} > \underline{c}$. This restriction is not necessary for the qualitative results, but rather makes the statement of the propositions much simpler.

The timing of events inside the model is as follows. First, each firm announces the price at which it will sell units, makes an announcement concerning quality, and decides on the actual quality it will provide. Second, each consumer observes these price/quality announcements and decides whether or not to purchase a unit, and if the decision is to purchase which firm to purchase from. Two simplifying assumptions are made concerning this sequence of events. If a consumer is indifferent between purchasing and not purchasing, it is assumed that he purchases. Additionally, if a consumer is indifferent concerning which of a set of firms to purchase from, then he chooses randomly over this set.

A further set of assumptions concerns the quality announcement referred to above. First, a proportion p of the firms is honest, and thus will never have a discrepancy between announced quality and actual quality. Second, a proportion $(1-p)$ of the firms is dishonest, and thus will determine the announcement simply by considering what maximizes profits. Finally, it is assumed that whether or not a firm is honest is not public information, but consumers do know the value p.

To solve the model it is assumed that each firm believes its own price/quality announcement has no effect on consumers' expectations of quality given an announcement. This is consistent with how Cooper and Ross (1984) solved a similar model, and is in general a more reasonable assumption the larger is N.

It is now possible to proceed to the analysis. It is clear that if all firms were honest, then the specification is the equivalent of a full information world, and thus the following is true.

Proposition 1: If $p=1$, then only $\bar{q}$ units are sold, and they are sold at a price $\bar{c}$.

Proposition 1 simply states that if all firms were honest, then the model yields a first best result. The other polar case follows.

Proposition 2: If $p=0$, then only $\underline{q}$ units are sold, and they are sold at a price $\underline{c}$.

Proof: Given the setup of the model, the actual choice of quality cannot have an effect on the number of customers a firm receives. Thus, there is never an incentive for a dishonest firm to provide high quality. Consumers in turn realize this and ignore all quality announcements. Finally, competition over price drives price down to $\underline{c}$.

Proposition 2 states that if all firms were dishonest, then the market completely breaks down. That is, even though consumers are willing to pay the extra cost of producing high quality, no high quality units are forthcoming.

I have now analyzed the two polar cases of pure honesty and pure dishonesty. The next two propositions consider restrictions on the parameter space which are between these two polar cases.

Let $p^* = (\bar{c}-\underline{c})/v(\bar{q}-\underline{q})$. This value turns out to be crucial in terms of the results.

Proposition 3: If $0 < p < p^*$, then only $\underline{q}$ units are sold, and they are sold at a price $\underline{c}$.

Proof: As before, dishonest firms will necessarily have an incentive to produce low quality. Now suppose consumers only believe that low quality units will be produced, and thus ignore quality announcements. This belief will be self-fulfilling because the honest firms will also decide to produce low quality. Therefore, having only low quality units produced is an equilibrium, and in this equilibrium competition over price will drive price down to $\underline{c}$.

In the Appendix I prove this equilibrium is unique.

Proposition 3 supports Akerlof's claim that in this setting dishonest agents tend to be disproportionately important. That is, as long as the proportion of honest firms is relatively small, the market completely breaks down and the equilibrium is exactly as if all the firms were dishonest.

Proposition 4: If $p^* < p < 1$, then there are two types of equilibria. There are a multiplicity of equilibria in which

i) each firm announces $(P',\bar{q})$, where P' is some price in the interval $[\bar{c},\underline{c}+v(q'-\underline{q})]$, and $q' = p\bar{q} + (1-p)\underline{q}$;

ii) honest firms produce $\bar{q}$ units;

iii) dishonest firms produce $\underline{q}$ units.

There is also an equilibrium where only low quality units are produced, and they are sold at a price $\underline{c}$.

Proof: That having only low quality units produced is an equilibrium follows from the same logic as in the proof of Proposition 3. To demonstrate that the other situation described in the proposition is also consistent with equilibrium, pick an arbitrary price in the interval $[\bar{c},\underline{c}+v(q'-\underline{q})]$ and call this price P'. For the announcement $(P',\bar{q})$, let consumers believe that with probability p a purchase is a high quality unit. For all other announcements, let consumers believe that with probability zero a purchase is a high quality unit. Because $p > p^*$, a firm will not be able to make any announcement consistent with positive profits, such that consumers won't prefer the announcement $(P',\bar{q})$. Thus, it is rational for all firms to announce $(P',\bar{q})$. Further, this makes the quality expectations of consumers consistent with equilibrium.

In the Appendix I prove no other equilibrium exists.

Proposition 4 shows that Akerlof's claim does not hold universally. That is, if the proportion of honest agents were to exceed some critical value, then the market would no longer necessarily completely break down and some high quality units might be forthcoming.

The intuition behind Propositions 3 and 4 is as follows. If honest agents try to provide high quality, then dishonest agents will try to pass themselves off as honest agents. This, in turn, lowers the valuation consumers place on announced high quality. If $p < p^*$ the valuation is lowered to a point where the extra valuation of announced high quality does not cover the extra costs of actually producing high quality, with the result being that the market completely breaks down and no high quality units are forthcoming (Proposition 3). If $p > p^*$ the resulting valuation is such that the extra valuation of announced high quality will cover the extra costs of producing high quality, and in this case the model is capable of supporting the provision of high quality units (Proposition 4).

Two final points will be considered in ending this section. The first concerns the multiple equilibria aspect of Proposition 4. The problem of multiple equilibria frequently occurs in the type of game considered here. The typical response is then to argue about the plausibility of the various equilibria. Rather than go through a long discussion concerning which of the equilibria is most plausible, I will simply point out that for very high values of p the equilibrium where the market has completely broken down does not seem plausible. That is, as the proportion of dishonest firms in the market approaches zero, it seems unlikely that their existence will prevent honest firms from providing high quality.

As a final point I will consider the determinants of the critical value for p. Remember $p^* = (\bar{c}-\underline{c})/v(\bar{q}-\underline{q})$. This indicates when the market is likely to break down, and when it is likely to support the provision of high quality units. First, the higher is the cost differential between high and low quality production, the more likely is the market to break down. Second, the larger is each consumer's added valuation for high quality, the less likely is the market to break down.

II. A Model of Theft

In this section I investigate a model of theft. Let there be N identical risk neutral property owners, each of whom owns an object valued an amount V by everyone in the economy. Let there also be a skill involved in stealing, and let this skill be possessed by M risk neutral individuals, $M > N$. These individuals will be referred to as potential thieves, and it is assumed that each potential thief attempts either zero robberies or one robbery.[3] If a potential thief attempts a robbery and is successful, he is then in possession of the property which he values an amount V. There is also a possibility, however, that he will be caught, in which case he is penalized an amount X.

The next step is to consider what property owners can do to prevent theft. It is assumed that each property owner can make expenditures on protection against theft, the value of the expenditure by property owner i being denoted e_i.[4] Further, $w(z)$ is defined as the probability of success of a potential thief who attempts a robbery from a property owner who has invested in protection an amount z, where of course $w' < 0$.

Of the potential thieves, not all are actual threats to steal. That is, pM of the potential thieves, although possessed of the skill needed to commit a burglary, have integrity and will thus steal under no circumstance. On the other hand, $(1-p)M$ of the potential thieves lack integrity, and thus will steal if it is in their narrow self-interest to do so. That is, a potential thief who lacks integrity will attempt a robbery if there is an opportunity available to him such that

$$wV - (1-w)X > 0, \tag{2}$$

otherwise he refrains from stealing.

Let $w^* = X/(V+X)$ and e^* be such that $w(e^*) = w^*$. To make the model interesting it is assumed that $w(0) < w^*$ and $e^* < w^*V$. These two restrictions guarantee the following. First, if a property owner takes no protection against theft, then a potential thief will find it in his narrow self-interest to steal from him. Second, the level of protection needed to deter theft is less than the expected loss associated with having someone attempt a robbery.

The timing of events inside this model is simple. First, the property owners simultaneously decide on their expenditures on protection. Second, each potential thief observes these investments in protection, and decides whether or not to attempt a robbery. Third, if the decision is to attempt a robbery, then the potential thief must also decide which property owner to rob from. Two simplifying assumptions are made at this point. First, if a potential thief is indifferent concerning which owner to attempt a robbery from, then he chooses randomly over this set. Second, if two or more thieves attempt to rob the same property owner, it is as if one attempted a robbery while each of the others did not. Further, the choice of which of the thieves is credited with having attempted the robbery is purely random.

The analysis follows. It is clear that if all potential thieves have integrity, then there is no need for property owners to invest in protection. This yields Proposition 5.

Proposition 5: If $p = 1$, then there are no attempted thefts and $e_i = 0$ for all i.

The next step is to investigate the other polar case.

Proposition 6: If $p = 0$, then there are no attempted thefts and $e_i = e^*$ for all i.

Proof: Suppose one property owner invests less than e^* in protection, and call this expenditure $\hat{e}$. Independent of the expenditures on protection of the other property owners, there are enough potential thieves such that at least one will attempt to rob this property owner. The expected profits of this property owner is therefore $(1-w(\hat{e}))V - \hat{e}$. This property owner could have instead made an expenditure e^*, and guaranteed that no potential thief would try to steal from him. This is due to (2), and the fact that $w^*V - (1-w^*)X = 0$. The property owner's expected profit for this alternative is $V - e^*$. Because $e^* < w^*V$ and $w' < 0$, it is necessarily the case that $V - e^* > (1-w(\hat{e}))V - \hat{e}$. Thus, there is an alternative which yields higher expected profits than the supposed behavior, and therefore it cannot be that any property owner invests less than e^* in protection. Finally, it is clear from the setup of the model that there is no incentive for a property owner to invest more than e^* in protection.

Proposition 6 tells us that in this model the only difference between the two polar cases is the expenditures on protection. That is, whether $p = 0$ or $p = 1$ there are no actual thefts. This, however, is accomplished with no expenditures on protection when $p = 1$, while when $p = 0$ each property owner expends e^*. The intuition behind Proposition 6 is simple. When $p = 0$ there is at least one potential thief who lacks integrity for each property owner. Further, given the restriction $e^* < w^*V$, a property owner will prefer to deter theft rather than with certainty have someone attempt a robbery.

The next step is to consider intermediate values for p. This is done in Proposition 7.

<u>Proposition 7</u>: If $p < 1$, then there are no attempted thefts and $e_i = e^*$ for all i.

Proof: Suppose all property owners invest e^* in protection. Given (2), no thefts will occur. To show that the situation described in Proposition 7 is an equilibrium, therefore, all that needs to be demonstrated is that no property owner will want to deviate from this situation. If all property owners expend e^*, then each property owner receives $V - e^*$. Given that theft is deterred at e^*, the only realistic deviation is that some property owner invests an amount $\hat{e}$, $\hat{e} < e^*$. As long as there is at least one potential thief who lacks integrity, and given that all other property owners are expending e^*, someone will attempt to rob this property owner. Thus, the expected profits of this alternative strategy is $(1-w(\hat{e}))V - \hat{e}$. Further, as in the proof of Proposition 6, because $e^* < w^*V$ and $w' < 0$ it is necessarily the case that $V - e^* > (1-w(\hat{e}))V - \hat{e}$. Thus, the situation described in Proposition 7 is an equilibrium.

In the Appendix I demonstrate that this equilibrium is unique.

Proposition 7 tells us that, even more strongly than in the previous model, in this model it is the agents without integrity who are disproportionately important. That is, as long as there is at least one potential thief who lacks integrity, the equilibrium is as if all the potential thieves lacked integrity. The intuition for this result is as follows. Suppose there is just one potential thief who lacks integrity. If he decides to attempt a robbery, he will rob from the property owner who has invested the least in protection. This forces the property owners into a game, where the goal is to not be this low investment owner. The result is that all the owners invest heavily in protection -- exactly as if there were many potential thieves who lacked integrity.

One question which arises concerns the strength of the results. Some readers might question the model because the results are in some sense "too strong." Even if the number of property owners were to be driven towards infinity, there will be large investments in protection as long as there is just one potential thief who lacks integrity. The reason the results are so strong is that if this thief attempts a robbery, then with probability one he robs from the property owner who has invested the least in protection.

Suppose there wasn't this type of perfect correlation between who is robbed and who invests the least in protection, as would be the case, for example, if there was imperfect information concerning the expenditures on protection of each of the property owners. Then the presence of only one agent who lacks integrity would not have such a dominating effect on the equilibrium. My conjecture, however, is that as long as there is some correlation between who is robbed and who invests little in protection, there will remain a tendency for the agents who lack integrity to be disproportionately important.

A final point concerns the general applicability of the results. As indicated earlier, in this model the potential thieves who lack integrity tend to dominate because they impose their negative behavior on the agents who have done the least to protect themselves from it. This principle, however, should be applicable more broadly than simply an environment where theft is an issue. For example, consider a world where a proportion of workers lack integrity and are thus willing to shirk, while the remaining workers have integrity and will thus shirk under no circumstance. Further, let firms have the ability to monitor their workers. Just as the potential thieves who lacked integrity were disproportionately important in the theft model, so should the workers who lack integrity be disproportionately important in this setting. The logic is as follows. Workers who are willing to shirk will migrate to employers who do the least monitoring. This forces the employers into a game where the goal is not to be one of these firms. The final result being that the level of monitoring in the economy is higher than would be suggested by the proportion of workers in the population willing to shirk.

III. Reputation and the "Craftsman" Mentality

As opposed to the two previous sections, in this section I consider an environment where integrity, rather than the lack of it, tends to be the dominating factor. In particular, I consider a finite period product quality model and show that by adding a small probability that the seller has integrity, it is possible to overcome the last period problem associated with markets where reputation for quality is an issue.[5]

Let there be a risk neutral monopolist who faces a T period horizon. In each period it is assumed the monopolist can either produce units of quality $\bar{q}$ at constant cost per unit $\bar{c}$, or produce units of quality $\underline{q}$ at constant cost per unit $\underline{c}$, where $\bar{q} > \underline{q}$ and $\bar{c} > \underline{c}$. Further, in each period t the quality of the units produced by the monopolist is not publicly observable by the consumers. However, in each period t consumers do know the quality of output produced by the monopolist in every period k, where $k < t$.

The monopolist discounts future profits by a factor β, where β is a draw from a random variable which has a cumulative distribution function $F(.)$. The realization of β is not observed by consumers. Further, $F(.)$ is assumed to satisfy the following restrictions: $F(\underline{\beta}) = 0$, $F(\bar{\beta}) = 1$ and $F'(z) > 0$ for $z \in (\underline{\beta},\bar{\beta})$. That is, β falls somewhere between the extreme values $\underline{\beta}$ and $\bar{\beta}$, and the density function for β is strictly positive in this interval. Note, the assumption that β is not known with certainty is not crucial to the qualitative nature of the results. Rather, it allows us to solve for an equilibrium consisting of pure strategies, as opposed to one consisting of mixed strategies.

The demand side of the model will be similar to the demand side of Section I. That is, in each period t there are M identical risk neutral consumers each of whom consumes either zero units or one unit of the good produced by the monopolist.[6] Further, each consumer i has the profit function

$$\Pi_i = vq_i - e_i, \tag{3}$$

where q_i represents the quality of the unit purchased by consumer i and e_i denotes consumer i's expenditure on this purchase (note: if consumer i does not purchase a unit, then $q_i = 0$). I also make restrictions on the parameters similar to the restrictions imposed in Section I. First, $v\underline{q} > \underline{c}$. This restriction is exactly the same as a restriction imposed in Section I. As previously, this restriction is not necessary for the qualitative results, but rather makes the statement of the propositions much simpler. Second, $\underline{\beta}v(\bar{q}-\underline{q}) > \bar{c}-\underline{c}$. This condition states that if a consumer's added valuation for high quality is discounted for one period, it necessarily exceeds the extra cost of producing high quality. Without this assumption the model becomes much more complex. Note, as the distribution for β collapses around $\beta = 1$, i.e., no discounting, the assumption $\underline{\beta}v(\bar{q}-\underline{q}) > \bar{c}-\underline{c}$ converges toward the Section I assumption $v(\bar{q}-\underline{q}) > \bar{c}-\underline{c}$.

Finally, it is assumed that with probability p the monopolist has integrity and with probability $(1-p)$ the monopolist lacks integrity, where this probability is independent of the realization of β. Also, whether or not the monopolist has integrity is not public information, but consumers do know the value p. One thing to note at this point is that what is meant here by integrity is somewhat different than in Section I. When the monopolist has integrity in this section, then it is said that he has a "craftsman" mentality. That is, he gets a psychic return from producing high quality units such that, when this return is taken into account, his actual cost is lower when he produces high quality rather than low quality units. Or in other words, if the monopolist lacks integrity then he is willing to produce "shoddy" merchandise, while if he has integrity then his output will always be high quality. At the end of this section I discuss both how the results would change if integrity were simply equated with honesty, and the connected issue of how Section I and Section III are related.[7]

The timing of events inside this model is simple. The monopolist announces a period 1 price and decides on a period 1 quality, where this quality choice is not publicly revealed. Period 1 consumers then decide on their purchase decisions. The monopolist then announces a period 2 price and decides on a period 2 quality. Further, knowing the monopolist's period 1 quality choice, period 2 consumers proceed to make their period 2 purchase decisions. Finally, this process repeats through period T. One simplifying assumption is made concerning this sequence of events. That is, as in Section I, if a consumer is indifferent between purchasing and not purchasing, it is assumed that he purchases.

The analysis follows. If with probability one the monopolist has integrity, then it is clear that he will provide high quality in every period. This yields Proposition 8.

Proposition 8: If $p = 1$, then in each period the monopolist produces high quality and sells at the price $v\bar{q}$.

Proposition 8 states that if the monopolist has integrity with probability one, then the model yields a first best result.[8] The other polar case follows.

Proposition 9: If $p = 0$, then in each period the monopolist produces low quality and sells at the price $v\underline{q}$.

Proof: Consider first period T. The monopolist can derive no return from providing high quality in this period, and thus he will necessarily provide low quality. Now consider period k, where it is known that the monopolist will necessarily provide low quality in every subsequent period. Given this, there can be no return from providing high quality in period k, and thus the monopolist must also provide low quality in period k. Finally, the above two ideas yield that the monopolist must provide low quality in every period, and in turn his price in each period must equal $v\underline{q}$.

Proposition 9 states that if with probability one the monopolist lacks integrity, then the market completely breaks down. That is, even though consumers are willing to pay the extra cost of high quality production, no high quality units are forthcoming. The logic for the result is contained in the proof. In the last period the monopolist will necessarily choose to produce low quality, and because consumers realize this there is no incentive for the monopolist to provide high quality in period T-1. Subsequently, this causes the equilibrium to unravel such that the monopolist produces low quality in every period.

Propositions 8 and 9 consider the model under the two polar assumptions that the monopolist has integrity with probability one, and the monopolist lacks integrity with probability one. The next step is to consider the model under the assumption that p is strictly between zero and one. To analyze this case I treat the problem as an extensive form game with imperfect information (see Harsanyi 1967-1968), where "Nature" moves first and selects both the monopolist's discount rate, and whether the monopolist does or does not have integrity. As is typical in such games, even under the assumption of perfection (see Selten 1975) there is a problem of multiple equilibria. In this particular game, however, there is a simple restriction which eliminates this problem by ruling out equilibria which seem to be implausible. In solving for an equilibrium one must specify, for each period t, consumers' expectations of quality, given both a past history of events and the monopolist's period t price. All the equilibria but one display the property that consumers' expectations depend in a discontinuous fashion on the period t price. Since consumer inferences of this type seem to be rather implausible, I will restrict the analysis to the equilibrium whoch does not depend on this type of inference.[9]

Before proceeding to the proposition, it is necessary to present some definitions. Let $G(z) = 1 - F(z)$. Also, let the sequence $\beta_1', \ldots, \beta_T'$ satisfy the following equation,

$$(4) \qquad G(\beta_t') = \frac{p}{1-p}\left[\beta_t' \left(\frac{v(\bar{q}-\underline{q})}{\bar{c}-\underline{c}}\right) - 1\right] + G(\beta_{t+1}')\, \beta_t' \left(\frac{v(\bar{q}-\underline{q})}{\bar{c}-\underline{c}}\right),$$

where $\beta_T' = \bar{\beta}$. It is easy to demonstrate that the sequence $\beta_1', \ldots, \beta_T'$ is unique. Finally, let there also be a sequence $\beta_1^*, \ldots, \beta_T^*$ such that $\beta_t^* = \max\{\underline{\beta}, \beta_t'\}$ for $t = 1, \ldots, T$, and a sequence $P_1^*, \ldots, P_T^*$ such that the following equation holds.

$$(5) \qquad P_t^* = \frac{pv\bar{q} + (1-p)v[\bar{q}G(\beta_t^*) + \underline{q}[G(\beta_{t-1}^*) - G(\beta_t^*)]]}{p + (1-p)\, G(\beta_{t-1}^*)}$$

The proposition follows.

<u>Proposition 10:</u> If $0 < p < 1$ and in each period t consumers' expectations of quality do not depend discontinuously on the period t price, then the following describes the unique perfect Nash equilibrium.

i) If the monopolist has integrity, then his output is always high quality.

ii) If in period t the monopolist provides low quality, then in every period k, $k > t$, the firm supplies low quality at the price $v\underline{q}$.

iii) If the monopolist lacks integrity and $\beta >(<) \beta_t^*$, then the monopolist provides high (low) quality in every period k, $k <(>) t$.

iv) If the monopolist has provided high quality in every period k, $k < t$, then the price in period t equals P_t^*.

Proof: i) and ii) are easy to prove. If the monopolist has integrity, then his costs are lower if he produces high quality output. Thus, he will never have an incentive to produce low quality output. This proves i). In turn, i) yields that if the monopolist produces low quality in period t, then with probability one he lacks integrity. Given this, the equilibrium for periods $t + 1,\ldots,T$ must follow Proposition 9. This proves ii).

Now consider period T, and suppose the equilibrium up to period T is as described by i) through iv). Also, suppose that either the monopolist has integrity or $\beta > \beta_{T-1}^*$. Let consumers' expectations of average quality in period T be independent of price and equal $(p\bar{q}+(1-p)G(\beta_{T-1}^*)\underline{q})/(p+(1-p)G(\beta_{T-1}^*))$. Under this circumstance the monopolist will necessarily charge P_T^*. Additionally, from i) we know the monopolist will provide high quality if he has integrity, while it is clear that he will provide low quality if he doesn't. This yields that the correct expected value for quality is also $(p\bar{q}+(1-p)G(\beta_{T-1}^*)\underline{q})/(p+(1-p)G(\beta_{T-1}^*))$. Thus, consumers' expectations of quality are consistent with actual quality, and therefore if the equilibrium is described by i) through iv) for periods $1,\ldots,T-1$, then it is also described by i) through iv) for period T.

Now consider period t, $t < T$, and suppose the equilibrium is described by i) through iv) for periods $1,\ldots,t-1,t+1,\ldots,T$. Also, suppose the monopolist either has integrity or $\beta > \beta^*_{t-1}$. Let consumers' expectations of average quality in period t be independent of the period t price and equal $(p\bar{q}+(1-p)[\bar{q}G(\beta^*_t)+\underline{q}(G(\beta^*_{t-1})-G(\beta^*_t))])/(p+(1-p)G(\beta^*_{t-1}))$. Under this circumstance the monopolist will necessarily charge P^*_t. From i) we know the monopolist will provide high quality if he has integrity. If he doesn't have integrity then he will provide high (low) quality if $\beta >(<) \hat{\beta}$, where

$$\hat{\beta}[P^*_{t+1}-v\underline{q}] = \bar{c}-\underline{c}. \tag{6}$$

That is, he will provide high (low) quality if the return from providing high quality another period is greater (less) than the cost. Rearranging (6) yields $\hat{\beta} = \beta^*_t$. This in turn yields that the correct expected value for quality is also $(p\bar{q}+(1-p)[\bar{q}G(\beta^*_t)+\underline{q}(G(\beta^*_{t-1})-G(\beta^*_t))])/(p+(1-p)G(\beta^*_{t-1}))$. Thus, consumers' expectations of quality are consistent with actual quality, and therefore if the equilibrium is described by i) through iv) for periods $1,\ldots,t-1,t+1,\ldots,T$, then it is also described by i) through iv) for period t.

Taking these results together yields that i) through iv) constitute an equilibrium. In the Appendix I demonstrate this equilibrium is unique.

Proposition 10 demonstrates that in this world integrity, rather than the lack of it, tends to be the dominating factor. That is, by having just a small probability that the monopolist has integrity, the last period problem is overcome and the equilibrium tends to more closely resemble what occurs when the monopolist has integrity with probability one, than what occurs when he lacks integrity with probability one. To see this let us consider what Proposition 10 states concerning a case where one would intuitively feel that high quality should be provided in most periods, yet when $p = 0$ low quality is always the norm. Specifically, consider what happens when T approaches infinity. Let t^* be the last period in which the monopolist provides high quality with probability one, and note that the monopolist's price equals $v\bar{q}$ for all periods prior to and including t^*. As T approaches infinity, the proposition tells us that t^*/T approaches one. That is, even for small values of p, the proportion of periods in which it is just as if the monopolist had integrity with probability one approaches unity.

The intuition for this result is as follows. When $p = 0$ the equilibrium unravels because there is zero probability that the monopolist will provide high quality in period T, and this results in no incentive for the monopolist to provide high quality in period $T-1$. For any $p > 0$, the above logic does not hold. Now there is a positive probability that the monopolist will provide high quality in period T, and this results in a positive probability that in period $T-1$ even a monopolist who lacks integrity will provide high quality. Further, if T is very large, this will eventually work its way back through the equilibrium such that, independent of whether the monopolist has integrity, for most periods the monopolist will provide high quality with probability one.

The next step is to do some simple comparative statics. Specifically, again consider the ratio t^*/T.[10] Proposition 10 yields that the following three things tend to increase t^* (proofs are left to the reader): (i) an increase in p; (ii) an increase in the ratio $v(\bar{q}-\underline{q})/(\bar{c}-\underline{c})$; and (iii) a rightward shift of the β distribution — i.e., a shift from the distribution $F(.)$ to $\hat{F}(.)$, where $\hat{F}(z+\delta) = F(z)$, $\delta > 0$. In other words, if there is either an increase in the probability that the monopolist has integrity, an increase in the proportional amount by which the added valuation of high quality exceeds the extra cost of high quality, or a shift towards lower discounting, the change in the equilibrium will be such that the equilibrium more closely resembles what occurs when the monopolist has integrity with probability one.[11]

The above concludes the analysis of Section III. A final point which needs to be addressed concerns the relationship between Sections I and III. Section I equates integrity with honesty and demonstrates that, in a one period product quality setting, the presence of agents who lack integrity will lower the return from the provision of high quality, and thus may cause agents with integrity to simply provide low quality. Section III equates integrity with having a craftsman mentality and demonstrates that, in a multi-period product quality setting, a positive probability that the seller has integrity eliminates the last period problem, and thus makes it likely that even if the seller lacks integrity he will provide high quality for most periods. The clear question is what happens in Section III if, as in Section I, integrity is simply equated with honesty. To answer this consider period T. Similar to Section I, the presence of a probability that the seller is dishonest lowers the return from the provision of high quality. If it is lowered enough, even an honest seller may decide to produce low quality. This means the last period problem would not necessarily be avoided, and the equilibrium could be just as if the seller was dishonest with probability one. Or in other words, if in Section III integrity was simply equated with honesty, it will no longer be the case that integrity is so clearly the dominant factor.

IV. Conclusion

In this paper I explored the idea that, rather than being motivated solely by narrow self-interest, much individual behavior is motivated by an innate desire of individuals to behave with integrity. In particular, I analyzed a variety of economic environments under the assumption that a proportion of the population has integrity, while the remainder of the population follows standard assumptions and thus lacks integrity. My goal was to identify situations in which agents who possess integrity have a disproportionately large effect on equilibrium, and situations in which agents who lack integrity have a disproportionately large effect. The analysis yielded three major results. First, in a one period product quality setting, where quality is not publicly observable, the agents who lack integrity tend to be disproportionately important. Second, a somewhat more general principle is that those who lack integrity tend to dominate in a world where such individuals impose their negative behavior on the agents who have done the least to protect themselves from it. Third, in a world where it is possible to establish a reputation for integrity, integrity, rather than the lack of it, tends to be the dominating factor.

Appendix

Proof of Uniqueness for Proposition 3: Any other equilibrium must contain one or more prices associated with an announcement of high quality, such that there is positive sales and a probability strictly greater than zero that a purchase will be a high quality unit. Suppose this is the case, and call these prices $P_1,\ldots,P_K$. There are two sub-cases to consider. Suppose first each dishonest firm makes one of the announcements referred to above. Let q_k^e be the expected quality, from a consumer's standpoint, of a purchase at a firm making the announcement $(P_k,\bar{q})$, $k \leq K$. The fact that all dishonest firms are making one of these announcements yields that for some k, $q_k^e <$ $p\bar{q} + (1-p)\underline{q}$. Denote this k as k_1. The restriction $p < p^*$ yields $v(q_{k_1}^e - \underline{q}) < \bar{c} - \underline{c}$. In turn, this yields that one honest firm could announce $(P_{k_1} - v(q_{k_1}^e - \underline{q}) - \varepsilon, \underline{q})$, and have all consumers purchase from it. Given $v(q_{k_1}^e - \underline{q}) < \bar{c} - \underline{c}$, this would obviously yield higher profits than the posited equilibrium strategy. Thus, this situation cannot be part of an equilibrium.

Now suppose at least one dishonest firm does not make one of the announcements referred to initially. Call this firm's announcement $(\hat{P},\hat{q})$. For this announcement expected quality equals $\underline{q}$. This situation can only occur if consumers are indifferent between the announcements $(\hat{P},\hat{q})$ and $(P_1,\bar{q})$, which can only occur if $\hat{P} < P_1$. However, because consumers choose randomly among firms over which they are indifferent, this dishonest firm must feel that its expected sales is independent of whether it announces $(\hat{P},\hat{q})$ or $(P_1,\bar{q})$. This, in turn, yields that this firm will only announce $(\hat{P},\hat{q})$ if $\hat{P} > P_1$. This is a contradiction, and therefore this situation can also not be part of an equilibrium.

Proof that no other equilibrium exists for Proposition 4: Any other equilibrium must contain one or more prices associated with an announcement of high quality, such that there is positive sales and a probability strictly greater than zero that a purchase will be a high quality unit. Suppose this is the case, and call these prices $P_1,\ldots,P_K$. Some sub-cases can be ruled out by the logic used in the proof of uniqueness for Proposition 3. The first such sub-case is where at least one dishonest firm does not make one of these announcements. The second such sub-case is where each dishonest firm makes one of these announcements, but $P_k > \underline{c} + v(q'-\underline{q})$ for $k = 1,\ldots,K$. The proof now follows if I can rule out the following sub-case, i.e., that there are at least two such announcements. This situation can only occur if consumers are indifferent between the announcements $(P_1,\bar{q})$ and $(P_2,\bar{q})$. However, because consumers choose randomly among firms over which they are indifferent, each firm must feel that its expected sales is independent of whether it announces $(P_1,\bar{q})$ or $(P_2,\bar{q})$. For a firm to announce $(P_1,\bar{q})$, therefore, it must be the case that $P_1 > P_2$, while for a firm to announce $(P_2,\bar{q})$ it must be the case that $P_2 > P_1$. This contradicts the idea that these are distinct announcements, and thus this situation can also not be part of an equilibrium.

Proof of Uniqueness for Proposition 7: As argued previously, because e^* deters theft there cannot be an equilibrium where a property owner invests more than e^* in protection. The only other possibility, therefore, must be consistent with the property owner who invests the least in protection investing less than e^*. Suppose this is the case, and call this investment $\hat{e}$. There are two sub-cases to consider. Suppose only one property owner has an expenditure equal to $\hat{e}$. Because all other property owners have expenditures greater than $\hat{e}$ and because there is at least one potential thief who lacks integrity, someone will certainly attempt to rob this property owner. Thus, his expected profits equal $(1-w(\hat{e}))V - \hat{e}$. He has an alternative strategy, however, of investing e^* in protection and deterring theft. This yields expected profits of $V - e^*$. As previously, because $e^* < w^*V$ and $w' < 0$, it is necessarily the case that $V - e^* > (1-w(\hat{e}))V - \hat{e}$. That is, there is an alternative strategy which yields higher expected profits, and thus the posited situation cannot be part of an equilibrium.

The other sub-case is where two or more property owners invest $\hat{e}$. Denote this number as n, and denote the number of potential thieves who lack integrity as m. If $m > n$, then someone will certainly attempt to rob each of these property owners and the proof follows as above. If $m < n$, then each of these property owners faces a probability of an attempted robbery equal to $\frac{m}{n}$. Thus, the expected profits of each of these property owners is $(1 - \frac{m}{n} w(\hat{e}))V - \hat{e}$. An alternative strategy for one of these property owners is to invest $\hat{e} + \varepsilon$. Because $n < m$ and $n - 1$ property owners are still investing $\hat{e}$, all attempted thefts will now be from one of the remaining property owners investing $\hat{e}$. Thus, the property owner investing $\hat{e} + \varepsilon$ will deter theft. This alternative strategy therefore yields expected profits of $V - \hat{e} - \varepsilon$, which given ε infinitely small must exceed $(1 - \frac{m}{n} w(\hat{e}))V - \hat{e}$. In other words, there is an alternative strategy which yields higher expected profits, and thus the posited situation cannot be part of an equilibrium.

Proof of Uniqueness for Proposition 10: The proof in the text demonstrates that i) and ii) must be properties of any equilibrium. Thus, I need only demonstrate that iii) and iv) must also be properties of any equilibrium.

Suppose the monopolist lacks integrity, and suppose he provides high quality in period T-1 with probability zero. Call t^* the first period in which, if the monopolist lacks integrity, the probability of high quality output equals zero. If high quality has been provided in all previous periods, the price for period t^*+1 output would be $v\bar{q}$. Consider a realization of β such that, when the monopolist lacks integrity, he provides high quality in period t^*-1. Because $\underline{\beta}v(\bar{q}-\underline{q}) > \bar{c}-\underline{c}$, under this realization of β the monopolist will necesssarily have an incentive to provide high quality in period t^*. This is a contradiction, and thus it can't be that if the monopolist lacks integrity, then he provides high quality in period T-1 with probability zero.

Given the above, it is easy to demonstrate that there must be a value $\hat{\beta}$ with the following properties. First, if $\beta >(<) \hat{\beta}$, the monopolist provides high (low) quality in period T-1. Second, if $\beta = \hat{\beta}$, the monopolist is indifferent concerning the quality he provides in period T-1. Now consider period T, and let q^e be the equilibrium quality expectation of consumers if high quality has been provided in all previous periods. Let P_T be the price announced by the monopolist in period T under this circumstance. Because of the continuity restriction, it must be the case that $vq^e = P_T$. Additionally, an equilibrium must satisfy both $q^e = [p\bar{q}+(1-p)G(\hat{\beta})\underline{q}]/[p+(1-p)G(\hat{\beta})]$, and $\hat{\beta}(P_T-v\underline{q}) = \bar{c}-\underline{c}$. Manipulating these equations yields $\hat{\beta} = \beta^*_{T-1}$ and $P_T = P^*_T$. Finally, repeating this argument for periods T-1,T-2,...,1 yields that the equilibrium in Proposition 10 is unique.

Footnotes

[1]Other than Sen, recent works which have moved in the direction of broadening what is acceptable behavioral motivation include Hirschman (1970, 1984), Winston (1982), and Akerlof (1983). None of these works, however, specifically consider the role played by heterogeneity.

[2]Recent papers which analyze models similar to the one in this section include Chan and Leland (1982), Wolinsky (1983), and especially Cooper and Ross (1984). The basic difference between these previous papers and the model of Section I is that they concentrate on the role played by consumer information, where it is either incomplete or costly, while I consider the role played by honesty.

[3]If potential thieves could attempt many robberies, then it is obvious that the potential thieves who lack integrity would be disproportionately important. I, therefore, assume that each potential thief can only attempt one robbery, and show that even in this case the potential thieves who lack integrity are disproportionately important.

[4]Tullock (1967) has previously considered the idea that property owners can invest in protection against theft. However, his analysis does not specifically consider how these investments depend on the number of individuals willing to steal.

[5]Recent papers which have considered reputation in a multi-period product quality setting include Dybvig and Spatt (1980), Klein and Leffler (1981), Shapiro (1982, 1983), and Rogerson (1983). None of these papers, however, specifically consider how the last period problem might be overcome in a finite period setting.

[6]The results of the model are independent of whether there is a single set of consumers who live for T periods, or T distinct sets of consumers each of whom lives for one period.

[7]Winston (1982) has recently considered some of the implications of this type of psychic return in the production process.

[8]Of course, even with perfect information, a monopoly is not in general associated with a first best result. In Proposition 8 there is a first best result for two reasons. First, consumers are perfectly identical. Second, each consumer purchases either zero units or one unit of the monopolist's output.

[9]This restriction is similar to a restriction suggested in Milgrom and Roberts (1982a) -- see their footnote 10.

[10]It is being assumed here that the initial situation is such that $t^* < T-1$.

[11]I have done some further analysis of this issue which suggests that, in the determination of t^*, the value for $v(\bar{q}-\underline{q})/(\bar{c}-\underline{c})$ is much more important than the value for p. To see this consider the equilibrium as the distribution for β collapses around $\beta = 1$. I will consider the following two special cases: $p = .01$ while $v(\bar{q}-\underline{q})/(\bar{c}-\underline{c}) = 2$, and $p = 1/3$ while $v(\bar{q}-\underline{q})/(\bar{c}-\underline{c}) = 1.02$. In both cases, if the monopolist lacks integrity, then the probability that he will provide high quality in period $T-1$ is approximately .01. However, in the first case $t^* = T-6$, while in the second $t^* = T-56$. That is, the change in t^* suggested by the movement of $v(\bar{q}-\underline{q})/(\bar{c}-\underline{c})$ swamps the change suggested by the movement of p.

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