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Market Prices and Illegal Practices

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This paper focuses on contractual relationships between two parties in which the contracted price can be interpreted by one of the parties and by an outside observer (like a court) as a signal that the other party engages in illegal activities in carrying out the contract. We use the Benckiser case as an illustration of such a situation. We construct a simple game to explain the court's decision to sentence Benckiser to pay for the damage created by the contracted party for the fact that the price it had paid was so low that it should have been interpreted as a signal of illegal activities. More generally, the paper discusses price-setting behavior when illegal practices may occur.

I. Introduction

In contractual relationships legal offenses can be committed by one of the parties involved. In some of those cases the offending party is convicted for the offenses but is not in a position to pay for the damages. Is there then a possibility of holding the other party liable for those damages in case the contract is correctly specified and the other party is unaware of the offense?

A legal case in which this question was relevant is the so-called Benckiser case discussed by the Dutch Supreme Court [for a reference in Dutch, see Nederlandse Jurisprudentie (1990), no. 712]. Benckiser, a German company, produces citric acid. The production process produces toxic gypsum as a by-product. After having received some other offers (among which was an offer of 100 to 150 Deutschmark per ton from a firm in the former German Democratic Republic), Benckiser contracted in 1985 a Dutch building materials supplier, called Bos, for the purpose of making this toxic gypsum useable as raw material in the construction industry. Bos received a price of 53 Dutch guilders (or 46 Deutschmark) per ton. Instead of processing the gypsum in its factory, Bos dumped the gypsum illegally in different places in The Netherlands. Bos was convicted in a criminal lawsuit but was offered no possibility of redress for the clean-up costs of the pollution. Two factors were decisive in the illegal dumping of Bos: its financial position and the division of power in the organization. The combination of these factors made it possible for the owner (director) of Bos to send the receipts from the contract to an unknown destination and let the firm go bankrupt. Benckiser could not have known about the financial position or internal division of power of Bos, except

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perhaps at prohibitively high cost. In a second legal proceeding, initiated by the Dutch government for the recovery of the clean-up cost, the question arose of whether Benckiser could be held responsible for the environmental damages caused by Bos. Consecutive Dutch courts answered in the affirmative. They argued that, considering the very low price Benckiser paid for the processing of its gypsum, it should have known that Bos would not process the gypsum in a legal way. Accepting Bos' offer, Benckiser wittingly took the chance that Bos would dump illegally, for which it could be held responsible. Accordingly, Benckiser was sentenced to remove the gypsum at its own expense out of The Netherlands.

One question we address in this paper is whether the court's decision can be rationalized in a simple game in which the economic objectives of the parties involved are taken into consideration. Although the model is built around the Benckiser case, we believe that it applies more generally to cases in which price offers are to be interpreted as signals of illegal activity. Examples may include resale after theft, misappropriation, selling gray-market movie video tapes, and so on. The observation that price can be a signal of illegal activities may seem rather straightforward in all of these cases. However, as a court may draw conclusions about the illegality of some practices based on observed low prices (and as firms know this), the question is why firms engaged in illegal activities prefer to make a low price offer, especially because higher prices lead to larger profits.

More generally, the paper examines the way market prices for legal and illegal practices interact. In particular, we will show that when illegal or black market prices are lower than the prices for comparable commodities produced in a legal way, they usually are substantially lower. Moreover, the analysis shows that price variation in black markets tends to be much larger than price variation in legal markets. Finally, we scrutinize a common argument that raising the penalties or the chance of being caught have favorable social consequences. Our model shows that this is not always the case.

The model has two firms offering a price to process Benckiser's waste. Benckiser does not know whether the firms will dump legally or illegally. It knows, however, the cost of legal processing, the probability q with which illegal dumping is discovered, and the firm that did it is sentenced, the probability q' with which it is traced and sentenced itself when illegal dumping has taken place and the punishments when discovery occurs. We show that for certain parameter configurations there exists a separating equilibrium in which illegal firms charge prices that are consistently below the prices charged by firms that process legally. As this will turn out to be the only equilibrium in which prices below the marginal cost of legal processing are charged, we argue that a low price indeed signals illegal dumping. Accordingly, we can rationalize the court's decision. The role of Bertrand-type competition in the model is to provide the illegally operating firm with incentives to charge low prices.

For other parameter values a unique pooling equilibrium exists in which both legal and illegal firms charge prices equal to the marginal cost of the legally operating firms. Interestingly, when $q = q'$ only a pooling equilibrium exists as the condition for a separating equilibrium *cannot* be fulfilled. The reason is that an illegally operating firm has to charge substantially lower prices to compensate for the risk the other firm runs by accepting a low price. When this risk is high (q' close to q), the required compensation is so large that it is not profitable to charge low prices. Thus, the notion that prices may signal illegal activity is not as straightforward as it seems at first sight.

The model that we use has some features of signaling models that are known in the economics literature. In particular, there is a large literature on the issue of whether price is a signal of product quality [see, e.g., Gabszewicz and Thisse (1979); Stiglitz

(1987, 1989); Tirole (1993)]. One of the key insights of this literature is that if there is sufficient consumer heterogeneity, firms that produce items of different quality can charge different prices in equilibrium. In this sense price signals quality. Consumers buy the good at the price/quality ratio they prefer, and producers do not want to charge different prices. The main feature that makes our model different from the existing literature is that there is only one ''consumer'' in our model, namely, Benckiser, so that there cannot be any consumer heterogeneity.

The paper is organized as follows. Section II presents a game theoretic model that can be used to discuss situations, such as the Benckiser case, in which price offers can be regarded as signals of illegal activities. The model is analyzed in Section III. Section IV concludes with some general observations.

II. A Model

In this section we describe a simple model that provides a game theoretic rationale for both the court's evaluation of the case and for Benckiser's decision to accept the low offer. The simplest model one can think of has, apart from Bos, one other firm that makes a price offer to Benckiser to process its toxic gypsum (think of the offer from the firm in the former German Democratic Republic). The cost per unit (say 1000 tons) of illegal dumping is given by c_0, and the cost difference between legal and illegal processing is equal to c_1. Hence, legal processing costs $c_0 + c_1$. For notational simplicity, we assume that only one unit of chemical waste is being sold. The chance illegal dumping is discovered, and the firm that did it is traced and sentenced is given by q. The penalty in case of discovery is denoted by g, which mainly consists of the cost of cleaning up the polluted area.

The firms can be of two types, depending on the level of their initial wealth w: type L, the ''low-quality'' type that has a low level of initial wealth w_L; and type H, the ''high-quality'' type that has a high level of initial wealth w_H. The only interesting case is when $qw_L < c_1 < q^*\min[g, w_H]$. In the rest of the paper we assume this to be the case. In other cases both types of firms choose the same action so that one cannot distinguish between different firms. Moreover, Benckiser does not know the types of firms it is dealing with, and the firms do not know each other's type.

We think of the above as a simplified model of the situation described in the Introduction to this article. In the industry under consideration there are some firms who dump illegally, whereas others process the gypsum legally. There can be different reasons why a firm chooses to dump legally or illegally. One reason could be that firms have different estimates about the probability of discovery of illegal dumping; a second reason could be that one firm is better able to hide the illegality of its dumping activities than another firm. Here, we have chosen to follow the information provided by the Benckiser case and focus on the structural characteristics of the firm. As briefly explained in the Introduction, the financial position (which is modeled here as the initial wealth w) and the internal division of power determined that Bos was able to evade the redress of the removal of the toxic gypsum. Both factors can only be determined by outsiders (like Benckiser) at a prohibitively high cost. This is why Benckiser does not know the type of firm.

In the model, the two firms who bid for Benckiser's waste are also unaware of the financial position of their competitor. We think this is the most natural assumption to make, because it implies that a competitor and Benckiser have the same information regarding the financial position of other firms.[1]

Benckiser knows the cost $c_0 + c_1$ of legal processing. It also knows that it cannot be sued if it pays a high price (larger than or equal to $c_0 + c_1$), because at such a price Benckiser cannot infer what type of firm it deals with. However, at a price lower than $c_0 + c_1$ Benckiser might have to pay for the cleaning costs if illegal dumping has taken place and the firm whose offer is accepted cannot pay for these costs. Let $q' > 0$ be the probability that Benckiser is traced and sentenced when illegal dumping has taken place and the transaction price was smaller than $c_0 + c_1$.[2] It follows that $q' \leq q$.

The sequence of events of the game is then as follows:

1. Nature determines the types of the two firms; there is a probability α (respectively, $1 - \alpha$) that a firm is of a high (respectively, low) type. The probability that one firm is of a certain type is independent of the probability that the other firm is of a certain type. Accordingly, there are three possible states of nature: Both firms are of a high type; both firms are of a low type; or one firm is of a low type and the other of a high type.
2. The two firms simultaneously and independently of each other set prices at which they are willing to process the toxic gypsum.
3. Benckiser decides which offer to accept. It observes the prices that are offered, but does not know the type of the two firms.
4. The firm whose offer is accepted decides whether or not to process the gypsum in a legal way.
5. If the gypsum is dumped illegally, nature determines whether or not the firm that dumped illegally is sentenced (with probability q) and whether Benckiser is sentenced (with probability q' if the accepted price offer is strictly smaller than $c_0 + c_1$).

The payoffs are not difficult to specify. Both firms receive a payoff of $p_i - c_0 - c_1$ if their offer is accepted and they process the gypsum in a legal way, and their payoff is 0 if their offer is not accepted. If their offer is accepted and they dump illegally, then the payoff is $p_i - c_0 - qg$ if $w > g$ and $p_i - c_0 - qw$ if $w < g$. The idea behind this specification is that a firm is always liable for the total amount g, but that enforcement is restricted by a firm's wealth.[3] The payoff to Benckiser is equal to $-p_i - q'(g - w)$ if an offer $p_i < c_0 + c_1$ is accepted and the firm dumps illegally and cannot pay the cleaning costs, i.e., Benckiser is liable for the damages that cannot be paid by the firm. Otherwise, it is $-p_i$. The structure of the game and the payoffs are common knowledge.

[1] If a firm were to know the financial position of its competitor, the results would change in the following way. When both firms have the same financial position they will engage in Bertrand competition, and equilibrium prices will be equal to marginal cost (including expected clean-up costs when they apply). When financial positions differ, a separating equilibrium exists, with the firm with low initial wealth charging a price that is just low enough for Benckiser to accept the offer, which makes it liable for the clean-up cost. The mixed-strategy separating equilibrium that we obtain in our model will not hold.

[2] Assuming that the probability that Benckiser is sentenced is independent of $c_0 + c_1$ does not change the results in a qualitative way.

[3] Alternatively, one could argue, as one of the referees pointed out, that a court may be able to appropriate the profits from the transaction so that a firm's wealth is equal to its initial wealth plus $p_i - c_0$, the profit it has made on the transaction. However, substituting $w + p_i - c_0$ for w will only complicate the analysis without affecting the qualitative results in any way. For this reason, and because in the Benckiser case Bos was able to send the receipts from the contract to an unknown destination, we have chosen the formulation given in the text.

III. Analysis

Recall that the purpose of the model is to provide some insight into the way black market prices and prices in illegal markets interact. In particular, we would like to analyze the following points: (1) Could Benckiser have known that it was dealing with a low-type firm and that the toxic gypsum would be dumped illegally on the basis of the low price that was offered? (2) Why would low-type firms not charge the same price as high-type firms? (3) When black market prices are lower than legal market prices, why are they considerably lower? (4) Why does price variation in black markets tend to be much larger than price variation in legal markets.

The answer to the first question is in two steps. First, we show that for certain parameter configurations a separating equilibrium exists in which the low-type firm charges ''low'' prices and the high-type firm sets a ''high'' price. Second, we show that a pooling equilibrium in which both types of firms charge ''low'' prices does not exist. From the description of the model in the previous section it follows that the minimum price of legal dumping is equal to $c_0 + c_1$. So, we will interpret a ''low'' price as a price strictly lower than $c_0 + c_1$ and a ''high'' price as a price larger than or equal to $c_0 + c_1$. The two steps taken together imply that ''low'' prices should be interpreted as a signal of a low-type firm and, hence, as a signal of illegal dumping. The answers to the other three questions will be given at the end of this section.

In the analysis below we will use the notion of a perfect Bayes-Nash equilibrium and, in addition, we will employ the refinement of the intuitive criterion [see Cho and Kreps (1987); and, for example, Gibbons (1992)]. Before analyzing the equilibrium price offers, three general observations can be made. First, as Benckiser does not risk being sentenced if it accepts a price offer that is larger than or equal $c_0 + c_1$, the two firms engage in Bertrand competition for prices larger than $c_0 + c_1$. Hence, in any equilibrium both firms will never charge a price strictly larger than $c_0 + c_1$. Second, a low-type firm will dump the gypsum in an illegal way regardless of the price it offers, whereas the high-type firm will always process legally. This is a straightforward consequence of the assumption that $qw_L < c_1 < q^*\min[g,w_H]$. Third, if one firm sets a price equal to $c_0 + c_1$ and the other sets a price below $c_0 + c_1$, then Benckiser will accept the lower price if, and only if, it is smaller than $c_0 + c_1 - q'(g - w_L)$. This is because it knows that a high-type firm cannot profitably choose a price below $c_0 + c_1$, and, hence, it infers that the low price is set by a firm that will dump illegally.[4] Benckiser's expected payoff of accepting the low price is equal to $-p(L) - q'(g - w_L)$, whereas the payoff of accepting the higher price is equal to $-(c_0 + c_1)$. The first expression is larger than the second for prices below $c_0 + c_1 - q'(g - w_L)$.

Now we will state and prove the two main propositions of this paper. First, we show that for certain parameter values a separating equilibrium exists in which the low-type firms set prices much lower than high-quality firms. It turns out that the low types choose a mixed strategy. Next, we show that for the other set of parameter values a pooling equilibrium exists in which both types of firms set a price equal to the marginal cost of the high-quality firm.

PROPOSITION 1: *Suppose* $\frac{1}{2}(c_1 - qw_L) - q'(g - w_L) > 0$. *The following strategies form the unique perfect Bayes-Nash equilibrium satisfying the intuitive criterion:*

1. *The strategy* $p(H)$ *for a high-type firm is:*

[4]This is implied by the intuitive criterion.

$$p(H) = c_0 + c_1.$$

2. *The strategy* $p(L)$ *for a low-type firm is a mixed strategy distribution (see Figure 1):*

$$P(p(L) = p) = \frac{\alpha(c_1 - qw_L - q'(g - w_L))}{(1-\alpha)(p - c_0 - qw_L)^2} \quad \text{for}$$

$$p \in [c_0 + qw_L + \alpha(c_1 - qw_L - q'(g - w_L)),\ c_0 + c_1 - q'(g - w_L)];$$

$$P(p(L) = p) = 0 \text{ for other values of } p.$$

3. *The strategy for Benckiser is:*

accept p_i *when* (p_i, p_{-i}) *is offered and* (a) $p_i < p_{-i}$ *and* $p_i \leq c_0 + c_1 - q'(g - w_L)$, (b) $p_i = c_0 + c_1$ *and* $c_0 + c_1 - q'(g - w_L) < p_{-i} < c_0 + c_1$ *or* (c) $c_0 + c_1 \leq p_i < p_{-i}$. *Benckiser accepts one of the offers with a probability equal to* $\frac{1}{2}$ *if* $p_i = p_{-i}$.

Figure 1 illustrates the mixed strategy density function of the low-type firm.

PROOF: *We first check whether the proposed strategy combination is an equilibrium. It is clear that the high-type firm cannot benefit from deviating. This is also true for Benckiser: If it gets an offer from a low-type firm, its payoff is equal to* $-p(L) - q'(g - w_L)$, *whereas an offer of a high-type firm results in a payoff of* $-c_0 - c_1$. *The first expression is not smaller than the second if* $p(L) \leq c_0 + c_1 - q'(g - w_L)$. *For all strategies in the support of the mixed-strategy distribution of the low-type firm this condition is satisfied. This explains part* (a) *of Benckiser's strategy. Part* (b) *of its strategy follows from the intuitive criterion. Finally, part* (c) *applies if nature draws two high-type firms. In this case, Benckiser is indifferent between their offers and randomizes with probability* $\frac{1}{2}$.

Let us then concentrate on the optimality of the strategy of the low-type firm. According to the proposed equilibrium the low-type firm sets a price $p(L)$ *smaller than or equal to* $c_0 + c_1 - q'(g - w_L)$. *The expected payoff of any pure strategy in the support of the mixed-strategy distribution is given by*

$$\pi(p_i(L), p_{-i}) = (1-\alpha)[1 - F(p_i(L))](p_i(L) - c_0 - qw_L) + \alpha(p_i(L) - c_0 - qw_L), \quad (1)$$

where p_{-i} *is the price the other firm offers and* $\pi(p_i(L), p_{-i})$ *is the expected profit firm* i *receives if it is of a low type, if it sets a price* $p_i(L)$, *and if the competitor chooses* p_{-i}. *Finally,* $F(p_i(L))$ *is the chance that the competitor's price is smaller than* $p_i(L)$. *Equation (1) consists of two parts. The first part gives the profit that the firm receives if the other firm is also of a low type, but charges a higher price, whereas the second part is the profit the firm makes if the competitor is of a high type.*

In equilibrium, the low-type firm should be indifferent between all the pure strategies over which the firm randomizes. Straightforward calculations show that

$$F(p_i(L)) = \frac{1}{1-\alpha} - \frac{\alpha(c_1 - qw_L - q'(g - w_L))}{(1-\alpha)(p_i(L) - c_0 - qw_L)}.$$

Substituting this expression into equation (1) reveals that choosing a pure strategy in the support of the-mixed strategy distribution yields an expected payoff of $\alpha(c_1 - qw_L - q'(g - w_L))$, *which is indeed independent of* $p_i(L)$. *Note that the condition* $\frac{1}{2}(c_1 - qw_L) - q'(g - w_L) > 0$ *mentioned in the proposition implies that the expected profit is positive.*

Now, we consider different kinds of deviations. First, choosing a price below the support of the mixed-strategy distribution yields a payoff of $p_i - c_0 - qw_L$, *which is smaller than the equilibrium payoffs for all* $p_i < c_0 + qw_L + \alpha(c_1 - qw_L - q'(g - w_L))$. *This explains the lower bound of*

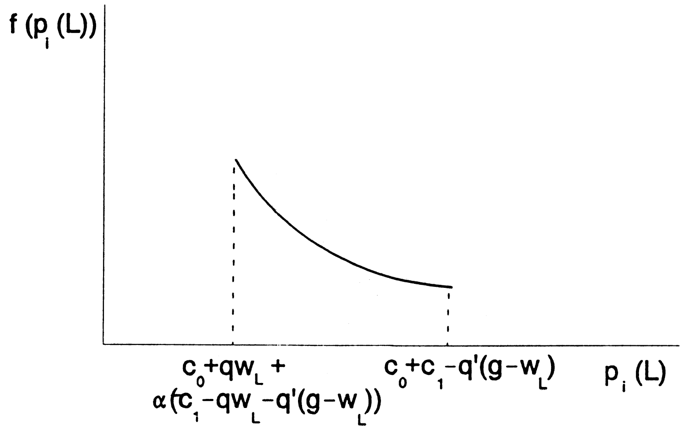

FIG. 1. Mixed strategy density of the low-type firm.

the support. Second, deviating to a price p_i *such that* $c_0 + c_1 - q'(g - w_L) < p_i < c_0 + c_1$ *is not beneficial, because Benckiser will reject such an offer. This is also true for deviations to prices strictly larger than* $c_0 + c_1$. *Finally, choosing a price exactly equal to* $c_0 + c_1$ *yields an expected payoff of* $\alpha(c_1 - qw_L)/2$. *This deviation is not optimal if* $\frac{1}{2}(c_1 - qw_L) - q'(g - w_L) > 0$, *which is the condition on the parameter values that is mentioned in the proposition. Hence, the strategy combination forms an equilibrium.*

Finally, we show that this is the unique perfect Bayes–Nash equilibrium satisfying the intuitive criterion. The argument is in several steps. First, it is easy to see that for the parameter values under consideration there does not exist a pooling equilibrium. Second, a separating equilibrium in pure strategies does not exist. In a separating equilibrium, it must be the case that $p(L) \leqslant c_0 + c_1 - q'(g - w_L)$. *At prices equal to or just below* $c_0 + c_1 - q'(g - w_L)$, *the low-type firms engage in a kind of Bertrand competition; not knowing whether the competitor is also of a low type, they want to slightly undercut the price the competitor will charge if it is of a low type. However, if prices tend to* $c_0 + qw_L$, *each low-type firm is better off pretending to be of a high type and to charge* $c_0 + c_1$. *Third, for similar reasons an equilibrium in mixed strategies with a discrete distribution does not exist. Fourth, from equation (1) it follows that an equilibrium with mixed strategies with a continuous support must satisfy the following differential equation*

$$(1 - \alpha)[1 - F(p_i(L)] + \alpha = (1 - \alpha)(p_i(L) - c_0 - qw_L)f(p_i(L)),$$

where $f(p_i(L))$ *is the density function of the mixed-strategy distribution. The strategy for the low type given in the proposition is the only strategy that satisfies this differential equation.*[5]

The next step is to show that a pooling equilibrium exists for all other parameter values. In this equilibrium both types of firm set a price equal to the marginal cost of the high-quality firm.

[5]Strictly speaking, there is a possibility that there are mass points at the supremum and infemum of the distribution. However, one can show that if there would be a mass point at the supremum in one firm's strategy, the other firm would be better off setting a price just below the supremum. At the other extreme, if there is a mass point at the infemum of one firm's distribution, this infemum must be larger than $c_0 + qw_L + \alpha(c_1 - qw_L - q'(g - w_L))$ and the other firm can set a price just below this infemum. Hence, in equilibrium there cannot be mass points at the end points of the distribution.

PROPOSITION 2: *Suppose that* $\frac{1}{2}(c_1 - qw_L) - q'(g - w_L < 0$. *The following strategies form the unique perfect Bayes–Nash equilibrium satisfying the intuitive criterion:*

1. *The strategy for* both *types of firms is:*

$$p(L) = p(H) = c_0 + c_1;$$

2. *The strategy for Benckiser is:*

Accept p_i *when* (p_i, p_{-i}) *is offered and* (a) $p_i < p_{-i}$ *and* $p_i \leqslant c_0 + c_1 - q'(g - w_L)$, (b) $p_i = c_0 + c_1$ *and* $c_0 + c_1 - q'(g - w_L) < p_{-i} < c_0 + c_1$, *or* (c) $c_0 + c_1 \leqslant p_i < p_{-i}$. *It accepts one of the offers with a probability equal to* $\frac{1}{2}$ *if* $p_i = p_{-i}$.

PROOF: *First, we check that the strategies form an equilibrium. It is clear that the high-type firm and Benckiser cannot do better by deviating from the proposed price offer. The equilibrium payoff of the low-type firm is* $\frac{1}{2}(c_1 - qw_L)$. *If the low-type firm deviates from the equilibrium strategy and sets a price* $p(L)$ *such that* $c_0 + c_1 - q'(g - w_L) < p(L) < c_0 + c_1$, *Benckiser will infer that it is a price from a low-quality firm and will reject it. If it deviates from the equilibrium strategy by setting* $p(L) \leqslant c_0 + c_1 - q'(g - w_L$, *its maximal deviation payoff is equal to* $c_1 - qw_L - q'(g - w_L)$. *This is not larger than the equilibrium payoff if* $\frac{1}{2}(c_1 - qw_L) - q'(g - w_L) \leqslant 0$. *But this is implied by the condition on the parameters specified in the proposition.*

The fact that there are no other perfect Bayes–Nash equilibria satisfying Cho and Kreps' intuitive criterion follows from two observations: (1) Benckiser's strategy is the only strategy that a rational firm will choose that is consistent with this criterion; and (2) given this strategy, the firms engage in a form of Bertrand competition.

Combining the arguments of Propositions 1 and 2 yields the result that the only way in which the low price offer by Bos could be rationalized by Benckiser and the court is that Bos would dump the toxic gypsum illegally.

Consequently, Benckiser wittingly took the chance of being held liable for the damages. It probably thought that the probability of discovery was so small that the expected payoff of accepting Bos' price for processing the toxic gypsum was larger than the (expected) payoff of accepting a much higher price. In this way, the model explains the court's evaluation and Benckiser's decision to accept the price that Bos offered.

The three other questions that we set out to explain can be answered relatively easily by means of the above analysis. The reason why illegally operating firms do not charge the same price as other firms in the separating equilibrium is that this decreases the probability that Benckiser will accept their price offer. Under the condition that $\frac{1}{2}(c_1 - qw_L) - q'(g - w_L) > 0$ the decrease in the probability of making profits outweighs the increased profits the firm could make when it gets to process the gypsum. This answers question (2) at the beginning of this section.

The reason why illegally operating firms charge prices considerably below the prices charged by the other firms in the separating equilibrium [question (3)] is that illegally operating firms should compensate Benckiser for the risk (measured by q') it takes in accepting prices below the marginal cost of legal processing. A similar argument explains that the condition for the separating equilibrium to prevail is violated when q' becomes large, say $q' = q$.[6] The reason is that in a separating equilibrium the illegally operating firm gives part of the foregone cost to Benckiser to guarantee that the latter

[6]The reader can easily verify that the two inequalities $\frac{1}{2}(c_1 - qw_L) - q'(g - w_L) > 0$ and $c_1 < q$*min$[g, qw_H]$, which is the condition guaranteeing that some firms process legally, are inconsistent with each other when $q = q'$.

accepts the low price. The minimal compensation Benckiser requires is given by the expected cost of accepting the low price offer, which is equal to $q'(g - w_L)$. When $q = q'$, the illegally operating firm has to give all the foregone cost as a compensation in terms of a lower price to Benckiser. The maximal revealing price it can ask so that Benckiser accepts is equal to $c_0 + c_1 - q(g - w_L)$. The illegally operating firm has a cost of $c_0 + qw_L$. Thus, a revealing price leads to negative profits in this case.

Finally, the large variation in black market (or illegal) prices is formally represented in the outcome of the model by the existence of a mixed strategy for the price decisions of the illegally operating firms. As in most black markets there is very little information concerning potential black market competitors, there is a (small) chance that participants in the black market have some monopoly power. According to our model this is the main reason for price dispersion in black markets.

Another aspect of the model is that it allows us to analyze the effects of government policies aimed at reducing the societal cost of illegal activities. In this respect an interesting phenomenon occurs in the context of our model. Usually, economists argue that illegal activities diminish, hence that the associated societal cost decreases, when the probability with which illegal activities are discovered increases and/or the size of the punishment increases. In our model, the policy measures that the government can take have two effects: They affect the decision of how to process the chemical waste, and they also affect the pricing decisions of the firms. Looking at the condition that determines whether the equilibrium will be pooling or separating, it is apparent that policy measures that make illegal activities more costly (an increase in q, q', and g) make it more likely that the equilibrium will be pooling and not separating. From a societal point of view, however, one may argue that a separating equilibrium is to be preferred to a pooling equilibrium as society does not have any legal remedy to have a firm such as Benckiser pay for the environmental damage it has caused in the latter type of equilibrium. Thus, in contrast to conventional wisdom, in our model societal costs may actually increase if the probability of discovery and/or the size of the punishment increases. Of course, if the probability of being caught increases to such an extent that the condition $qw_L < c_1$ is violated, all firms will process the waste in a legal way.

IV. Conclusion

In this paper we have rationalized the court's decision in the Benckiser case to sentence Benckiser for the clean-up costs. The court stated that the price Benckiser had paid to its contracted party was so low that it should have been interpreted as a signal of illegal dumping. The court's evaluation corresponds to a separating equilibrium in our game. We showed that firms that will dump illegally, because of their structural characteristics, charge prices that are significantly lower than the prices charged by firms that will process the gypsum in a legal way. As this is the only equilibrium in which prices below the marginal cost of legal processing are charged, these low prices are signals of illegal dumping. The court's decision is in line with the common-sense notion that low prices are indicative of illegality. But the fact that a court draws certain conclusions from observing low prices makes it less straightforward that a firm prefers to signal the illegality of its activities. Consequently, the game shows that, depending on the parameter values, there are two possible equilibrium outcomes: a pooling equilibrium in which illegal activities are carried out under the veil of legality; and a separating equilibrium in which firms that act in an illegal way can be distinguished from firms acting legally. These equilibria have important consequences for social costs, because in a pooling equilibrium firms that carry out illegal activities are more difficult to catch. At the same time, there is no legal remedy for the damages against the parties to the contract, because they could not have inferred from the prices offered that illegal practices would follow. This is why government policies aimed at reducing the societal costs of illegal activities by increasing penalties and/or the chance of being caught can produce a counterproductive effect, as it makes a pooling equilibrium more likely.

One element of the structure of the separating equilibrium we have found above is worth emphasizing. It is that firms that dump illegally randomize over prices that are substantially lower than prices charged by firms that process the gypsum in a legal way. Generalizing this result to other cases suggests an explanation for the fact that we typically observe substantial price dispersion among illegal activities: Due to the lack of good information, price competition in the black market does not work in the same way as price competition in other markets.

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