Cartels and Antitrust: The Role of Fines in Deterring Violations at the Margin*

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I. Introduction

The potential benefits of effective antitrust action include both increased economic efficiency through the expansion of output and improved equity through the redistribution of income from monopolies to consumers. A large and growing literature is devoted to empirically testing and documenting the economic consequences of antitrust casebringing activity.[1] A second, empirical literature is focused on the role which economic variables play in the determination of casebringing activity by the United States Department of Justice.[2]

What separates these two bodies of literature are the behavioral linkages between anti-

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1. Several recent works in this literature are noteworthy. Asch and Seneca [2] find that firms known to be engaged in collusion, surprisingly, were less profitable than those not known to be so engaged. Feinberg [6] suggested that Asch and Seneca's finding was actually the observation of the deterrent effect of antitrust action. Choi and Philippatos [4] report pricing restraint after prosecution but the deterrent effect decreases with the number of times the corporation has been indicted. Block, Nold, and Sidak [3] show that successful antitrust prosecution reduced markups in the bread industry although Feinberg [8] could not find this effect in aluminum ingot, gypsum, plumbing fixtures, concrete pipe, or book matches. Garbade, Silber, and White [10] report a negative effect on firms' stock prices upon announcement of the filing of suits. In a theoretical rather than an empirical vein, Lee [11;12] and Feinberg [7] examine antitrust enforcement in a game-theoretic setting in which the antitrust agency and a cartel interact. The solution is the optimal level of enforcement.

2. In principle, the agency can employ the well-known estimates of welfare loss, which date from the work of Harberger, in weighing the benefits and associated costs of bringing cases against particular firms. These estimates form at least the implicit basis for determining an optimal allocation of agency resources. From this premise, Long, Schramm, and Tollison [14] test for economic determinants of antitrust action. They conclude that excess profit and welfare loss play a minor role and one secondary to industry sales which possesses strong explanatory power throughout their study. Siegfried [16] employing less aggregated data finds considerable instability on the signs of the coefficients and much less explanatory power than did Long, Schramm, and Tollison. The conclusion which Siegfried [15, 573] draws is that "economic variables have little influence on the Antitrust Division." Siegfried, as well as Asch [1], suggests that the DOJ may employ more complex criteria than has been commonly thought. More recently, Nellor and Laband [15] again suggest that welfare loss is not an important determinant of agency casebringing activity.

trust strategy and economic benefits. This is the topic of a recent paper by Smith and Vaughan [17] which develops a Becker-Stigler crime model to examine an ongoing cartel's decision to fix prices and restrict output at the margin. In this model, the cartel takes the antitrust agency's casebringing activity into account and reacts by choosing the level of restraint of trade which maximizes expected profits. Strategy in their model becomes a choice variable of the agency. The agency is assumed to alternately focus upon the economic variables suggested by the empirical work of Long, Schramm, and Tollison [14], namely, profit (equity), total revenue (size), and welfare loss (economic efficiency) in the determination of whether or not to bring a suit.

From their model of antitrust crime, Smith and Vaughan conclude that if profit is the determinant of antitrust litigation, cartel output is unchanged, welfare loss is increased, and equity remains unserved. If total revenue is employed as the determinant, output is reduced below the simple monopoly level, welfare loss is again increased, and profit is reduced. Economic efficiency and equity are simultaneously served if a strategy based on welfare loss is adopted. In terms of marginal deterrence, antitrust, thus, possesses the potential for damage as well as benefit depending upon the litigation strategy in place.

This paper examines a second potentially powerful deterrent to antitrust crime, one which has been traditionally recognized, namely, the damage provisions of Section IV of the Clayton Act. In contrast to previous analyses of fines (see [5] for an overview), we focus on marginal deterrence rather than total deterrence.

We find that the current fine system based on treble damages does not deter illegal restraint of trade at the margin. In general, progressive fines are preferable but not always. The economic effects of fines importantly depend upon the particular litigation strategy which the antitrust agency employs in bringing cases and the basis upon which the Court awards damages.

Litigation strategy plays the critical role in marginal deterrence of antitrust crime whether damages are determined on the basis of cartel profit or monopolistic overcharge. If marginal costs are constant, the particular litigation strategy in place solely determines whether antitrust is inefficient, ineffective or efficient in promoting economic welfare. Further, the damage to economic welfare caused by an inefficient litigation strategy can never be completely reversed even by the most beneficial of fines. Similarly, the economic benefit of an efficient litigation strategy can never be entirely offset even by the most damaging of fines.

An additional obstacle to effective deterrence arises when damages are awarded on the basis of monopolistic overcharge. In this case, all types of fines, progressive, proportional and regressive, can induce the cartel to further restrict output. In this regime, a fine's effect on the cartel depends upon the structure of marginal cost. This places the effect of fines outside the policy prerogative of the antitrust agency and the Courts—a fact which leads us to reject monopolistic overcharge as a basis for damages and to search for alternatives. As one possible candidate, we suggest that fine progressivity be determined on the basis of welfare loss with fines levied on monopoly profit. This regime possesses the important property of always promoting economic efficiency regardless of the litigation strategy in place or the structure of marginal cost.

The plan of the paper is as follows. Section II examines the interaction of fine structure and litigation strategy under profit based damages while section III examines this interaction when damages are based on monopolistic overcharge. Section IV considers the implications

of allowing fines to vary with the welfare loss caused by the existence of the cartel. Section V offers concluding remarks.

II. Marginal Deterrence and Fine Progressivity

Assume that an ongoing cartel maximizes expected profit (π_e) taking into account the economic determinants of the agency's casebringing activity and the fine structure which it will face if convicted. Although horizontal price fixing is illegal per se, the antitrust agency is able to exercise considerable judgment on which cases to prosecute. The economic rationale under which the agency exercises this judgment is referred to in the remainder of this paper as litigation strategy. The economic determinant which the agency employs in deciding whether or not to file suit is denoted by θ, and, following the empirical studies [1; 14; 16] of casebringing activity, is alternately defined as profit (π), total revenue (R) and Marshallian welfare loss (WL).

The objective function of the cartel is given by:

$$\pi_e = p(q)q - c(q) - s(\theta)\tau D \tag{1}$$

where $p(q)$ is the inverse market-demand function, $c(q)$ is the cartel's total production cost and, D denotes damages from cartel activity. The term s is the subjective probability, from the perspective of the cartel, that a successful suit will be brought, and τ is the anticipated fine as expressed as a fraction or multiple of profit. It is reasonable to assume that the probability s will increase with θ, that is, $[\partial s/\partial\theta > 0]$.[3]

Section IV of the Clayton Act provides for recovery of treble damages for any person who suffers injury to business or property as a result of an antitrust violation. Although these penalties are assessed in private cases, it is accurate to say that public prosecution will result in treble damages, for public prosecution acts as a trigger for private antitrust litigation. We follow Block, Nold, and Sidak [3] and Smith and Vaughan, in defining the variable τ as the combined civil and criminal penalty for price fixing as expressed as a proportion of cartel damages.[4]

Treble damages most certainly have a significant impact on antitrust crime by totally deterring some potential violators from engaging in any restraint of trade. This has been widely recognized in a literature (see for example [5]) to which we have nothing to add. The question addressed here is marginal deterrence in which an ongoing cartel is induced by the threat of prosecution to alter the level of criminal activity in which it engages. That is, we consider the effect of fines on the level of illegal activity of firms that are not law abiding.

Antitrust case histories reveal that damages in price fixing cases have been determined by either of two methods. The first equates damages to the profits accruing to the conspirators and the second considers the difference between the cartel price and the price that would have prevailed under competitive conditions. We first analyze profit-based damages. Overcharge-based damages are considered in the following section.

3. Readers are referred to Smith and Vaughan's paper for a more detailed discussion. Also see Thistle [18] which extends the Smith-Vaughan model to consider durable goods cartels.

4. This is not an insignificant simplification, but it does provide a convenient starting point. Injunctions are not considered. Criminal sanctions for price-fixing of up to 3 years of imprisonment, a fine of $100,000 per individual and a fine of $1 million per corporation are to be captured by τ as well as treble damages.

In engaging in criminal activity, the cartel must choose the optimal degree of restriction of trade taking into account possible fines resulting from antitrust action. Defining damages as cartel profit ($D = \pi$) and allowing the fine multiple to vary as a function of cartel profit, the first-order-condition governing the cartel's choice of the level of restraint of trade is:

$$\partial\pi_e/\partial q = (1 - s\tau)(mr - mc) - (\partial s/\partial\theta)(\partial\theta/\partial q)[\tau\pi] - (\partial\tau/\partial\pi)(\partial\pi/\partial q)s\pi = 0 \qquad (2)$$

where mr and mc are, respectively, marginal revenue and marginal cost of production.[5] Equation (2) can be rewritten as:

$$(1 - s\tau)mr = (1 - s\tau)mc + (\partial s/\partial\theta)(\partial\theta/\partial q)[\tau\pi] + (\partial\tau/\partial\pi)(\partial\pi/\partial q)s\pi \qquad (3)$$

where the left-hand-side is expected marginal revenue (mr_e) and, the right-hand-side is expected marginal cost (mc_e). The second term on the right-hand-side of (3) is, in Smith and Vaughan's terms, the marginal litigation effect because it captures the impact of litigation strategy on expected marginal cost.

The third term on the right-hand-side of (3) can be thought of as marginal progressivity because it captures the effect of fine progressivity on expected marginal cost.[6] Progressive fine systems are defined by an increasing fine multiple, proportional systems by a constant multiple and regressive systems by a decreasing multiple. Formally, a fine system is defined as progressive, proportional or regressive as $\partial\tau/\partial\pi \gtreqless 0$.

The first observation to be made from equation (3) is that, under current antitrust statutes, treble damages have no effect on deterring antitrust crime at the margin.[7] At present, treble damages are applied to all levels of criminal restraint of trade regardless of degree of severity, that is, the current fine system is proportional. As a result, $\partial\tau/\partial D = 0$ and the marginal progressivity term disappears from equation (3). Proportional fines simply do not deter illegal restraint of trade at the margin. This suggests that antitrust may be foregoing a potentially advantageous tool in the task of mitigating the effects of price fixing. The establishment of a progressive fine structure offers an attractive policy alternative but is not enough in itself as pointed out in the following theorem.

Assuming satisfaction of second-order-conditions, a unique equilibrium[8] and monopoly profit as the basis for damages, the following theorem holds:

5. The second-order-condition for maximization of expected profit is given by:

$$\begin{aligned}\partial^2\pi_e/\partial q^2 = &-2(\partial s/\partial\theta)(\partial\theta/\partial q)\tau(\partial\pi/\partial q) + (1 - s(\theta)\tau)(\partial^2\pi/\partial q^2)\\ &- [(\partial^2 s/\partial\theta^2)(\partial\theta/\partial q)^2 + (\partial s/\partial\theta)(\partial^2\theta/\partial q^2)][\tau\pi]\\ &- (\partial^2\tau/\partial\pi^2)(\partial\pi/\partial q)^2\, s\pi - (\partial\tau/\partial\pi)(\partial^2\pi/\partial q^2)s\pi\\ &- (\partial\tau/\partial\pi)(\partial\pi/\partial q)(\partial s/\partial\theta)(\partial\theta/\partial q)\pi - (\partial\tau/\partial\pi)(\partial\pi/\partial q)^2\, s < 0.\end{aligned}$$

6. At the simple monopoly level of output (q_{sm}), expected marginal revenue equals expected marginal cost, i.e., $(1 - s\tau)mr = (1 - s\tau)mc$. The immediate implication of this observation in conjunction with (3) is that the effect which antitrust has on cartel output (i.e., marginal deterrence) depends only upon the sign and magnitudes of Smith and Vaughan's marginal litigation effect and fine progressivity. The cartel engages in that level of restraint of trade for which the sum of these two terms equals zero.

7. Smith and Vaughan [17] demonstrate that parametrically increasing the magnitude of τ will strengthen the marginal impacts of litigation strategy, so in this sense fines can be said to create marginal incentives for cartels to alter output. However, the issue presently addressed is whether fines give rise to incentives at the margin which are independent and apart from litigation.

8. The assumption of a unique equilibrium and satisfaction of second-order-conditions can be relaxed. Multiple profit equilibria then become distinct possibilities. As Formby, Layson, and Smith [9] recently point out, multiple equilibria are possible and at times likely even when not considering expected profit.

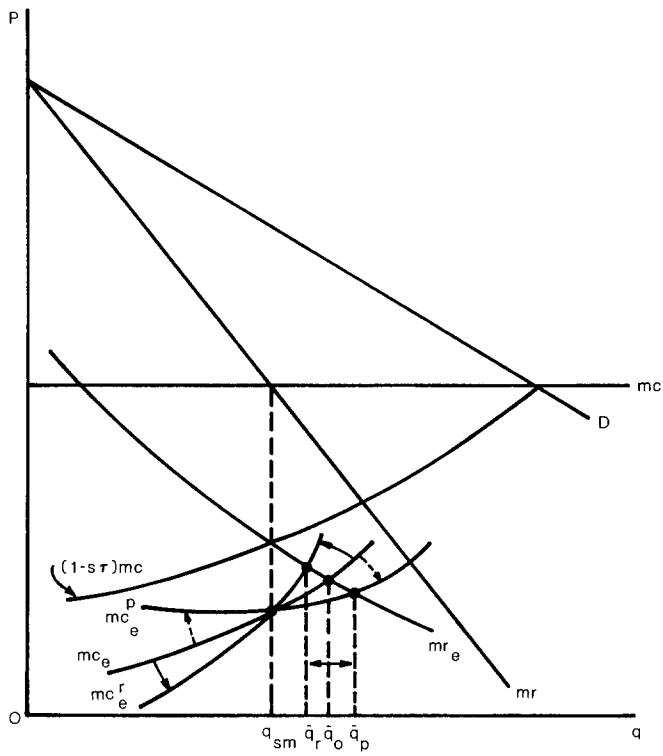

Figure 1. Effects of Fine Progressivity Under Efficient Litigation Strategy.

THEOREM 1. *Whether the antitrust system is effective, ineffective, or deleterious in marginally deterring antitrust violations is solely determined by litigation strategy and not by the system of fines. Formally, sgn* $(\bar{q} - q_{sm}) = -\text{sgn}\,(\partial\theta/\partial q)$ *for all* $\partial\tau/\partial\pi$ *where* q_{sm} *is simple monopoly output,* $\bar{q}$ *denotes equilibrium output of the cartel and the sign of* $\partial\theta/\partial q$ *is evaluated at* $q = q_{sm}$.

The theorem, which is formally proven in the Appendix, states that litigation strategy alone determines whether antitrust policy is beneficial or injurious to economic efficiency at the margin. Fine structure can vary from highly regressive to highly progressive but it is litigation strategy which dictates whether the cartel imposes greater welfare losses on consumers than would a simple monopoly. Once an economically inefficient litigation strategy is established, the fact of damage can be mitigated but not reversed, even by the most beneficial of fine systems. Conversely, once an effective detection and conviction system is in place, the most adverse fine system cannot completely offset its benefits. Changes in fine progressivity have no effect and antitrust is condemned to a state of impotence if $\partial\theta/\partial q = 0$. This property suggests that the structure of detection is of primary importance and that any fine system is of secondary importance when damages are defined as monopoly profit. This important property can be described as a hierarchical ordering of qualitative effects.

This is not to suggest that fine progressivity is impotent. To the contrary, if $\partial\theta/\partial q < 0$, a progressive fine can induce a larger expansion in cartel output than does litigation strategy. In general, a progressive fine always promotes economic efficiency while a regressive fine always promotes inefficiency if, we emphasize, the litigation strategy is efficient to begin

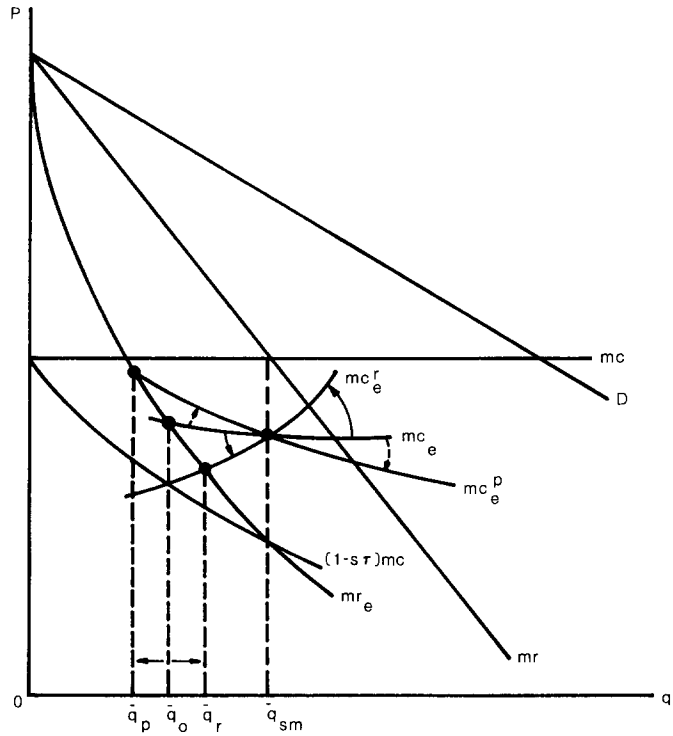

Figure 2. Effects of Fine Progressivity Under Inefficient Litigation Strategy.

with. Importantly, however, these effects are reversed in the presence of a different litigation strategy, as pointed out in the following corollary (see the Appendix for the formal proof).

COROLLARY 1. $\partial\bar{q}/\partial(\partial\tau/\partial\pi) \gtreqless 0$ *as* $\partial\theta/\partial q \gtreqless 0$.

The corollary establishes that a progressive fine increases, decreases or leaves cartel output unchanged depending upon whether litigation strategy is efficient, ($\partial\theta/\partial q < 0$), inefficient ($\partial\theta/\partial q > 0$), or neutral ($\partial\theta/\partial q = 0$). Compounding errors are possible if the judiciary, for example, pursues a policy governing fines which would be correct under one litigation strategy but another system is in fact extant. If an inefficient strategy exists, then regressive fines minimize damage to economic efficiency whereas if an efficient strategy exists, progressive fines are preferable.[9] The point remains, however, that one must not establish an inefficient litigation strategy in the first place.

These results can be seen in Figures 1, 2 and 3 which correspond to litigation strategies based on welfare loss, total revenue and profit respectively. In each figure, the expected marginal cost curves for proportional, progressive and regressive fines are labeled mc_e, mc_e^p and mc_e^r respectively and the resulting equilibrium outputs correspondingly labeled $\bar{q}_o$, $\bar{q}_p$ and $\bar{q}_r$.

The figures are drawn using the equilibrium output under proportional fines as a reference point and then rotating the expected marginal cost curve to demonstrate the effects of

9. See Elzinga and Breit [5, 137] for a related discussion on marginal deterrence, detection and progressivity of fines. Elzinga and Breit prefer a proportional fine. From our analysis, a progressive fine is to be recommended.

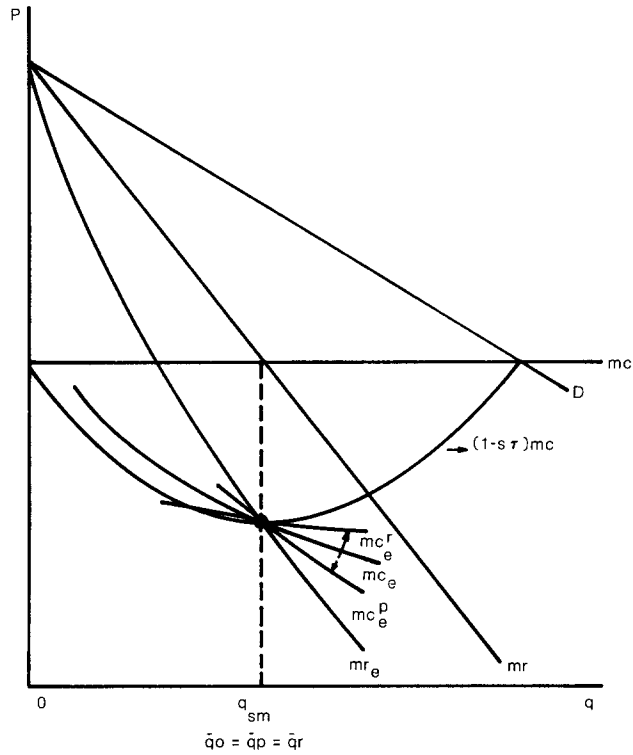

Figure 3. Effects of Fine Progressivity Under Neutral Litigation Strategy.

regressivity (shown by solid arrows) and progressivity (shown by dashed arrows). Fines, levied against profit, rotate the expected marginal cost curve around the locus $q = q_{sm}$. Regressive fines rotate the expected marginal cost curve in a counterclockwise direction while progressive fines rotate expected marginal cost in a clockwise direction.[10]

In order to visualize Theorem 1 and Corollary 1, consider Figure 1 in which casebringing activity is based upon consideration of Marshallian welfare losses. A progressive fine increases output from $\bar{q}_o$ to $\bar{q}_p$ while a regressive fine decreases output to $\bar{q}_r$. Furthermore, continuously increasing regressivity will rotate the expected marginal cost curve until it approaches its limiting position of the vertical line defined by $q = q_{sm}$. As a result, the intersection of expected marginal cost and expected marginal revenue must always occur to the right of monopoly output, q_{sm}.

This contrasts with the situation in Figure 2 in which casebringing activity is based on consideration of size (total revenue). In this regime, the imposition of a progressive fine decreases output while a regressive fine increases output—exactly opposite results from those obtained in the case of an efficient litigation strategy. Continuously increasing regressivity rotates expected marginal cost but only up to the limiting position, $q = q_{sm}$. All

10. This is the case because, under regressive fines, marginal progressivity is negative for outputs less than q_{sm}, zero at q_{sm}, and positive for outputs greater than q_{sm} as is easily established by noting that

$$(\partial\pi/\partial q) \gtreqless 0 \text{ as } q \gtreqless q_{sm} \text{ and } \partial\tau/\partial\pi < 0.$$

The progressive case follows immediately from noting $\partial\tau/\partial\pi > 0$.

possible intersections of expected marginal revenue and marginal cost occur at outputs less than simple monopoly output.

The case in which profit serves as the economic determinant of casebringing activity is shown in Figure 3. Fine progressivity and changes in progressivity have no effect on output. The expected marginal cost function merely rotates around the same intersection with expected marginal revenue leaving cartel output unchanged at the simple monopoly level.

In summary, fines play a more complicated role than might, at first, be expected if damages are levied on the basis of profit. We find the secondary role of fines somewhat surprising and investigate, in the next section, whether this finding holds when monopolistic overcharge is used as the basis for damages in price fixing cases.

III. Monopolistic Overcharge

The fundamental tradition in antitrust is to award damages on the basis of monopolistic overcharge. Courts have not always followed this tradition and have, in some instances, confused monopolistic overcharge with monopoly profit by tending to employ the terms interchangeably. However, monopolistic overcharge possesses a separate economic identity and warrants independent consideration. Monopolistic overcharge is defined as the difference between the cartel's price and the price which would have prevailed under competitive conditions. Damages in this case are given by:

$$D = [p(q) - p_c]q \tag{4}$$

where p_c is the competitive price and where the competitive price must equal marginal cost at the competitive output denoted by $\overline{mc}$, i.e., $p_c = \overline{mc}$.

Under a regime based upon monopolistic overcharge, the first-order-condition for the maximization of expected profit becomes:

$$\partial\pi_e/\partial q = (mr - mc) - (\partial s/\partial\theta)(\partial\theta/\partial q)\tau[p(q) - \overline{mc}]q - (\partial\tau/\partial D)(\partial D/\partial q)s[p(q) - \overline{mc}]q - s\tau[mr - \overline{mc}] = 0. \tag{5}$$

Interpretation is facilitated by rewriting (5) as:

$$(1 - s\tau)mr = (1 - s\tau)mc + (\partial s/\partial\theta)(\partial\theta/\partial q)\tau[p(q) - \overline{mc}]q + s[mr - mc][(\partial\tau/\partial D)D] + s(mc - \overline{mc})[(\partial\tau/\partial D)D + \tau]. \tag{6}$$

Several comparisons of profit and overcharge based damages can be drawn by contrasting (3) with (6). First, the qualitative economic effects of the litigation strategy are the same under either definition of damages because the signs of the second expression in (3) and (6) are the same.[11] Second, the only terms which can possibly give rise to a qualitative difference between the two damage regimes are the last two on the right-hand-side of (6) and the last term on the right-hand-side of (3). The term, $s[mr - mc][(\partial\tau/\partial D)D]$, from (6) is symmetric to and has the same economic effect as the term, $s(mr - mc)[(\partial\tau/\partial\pi)\pi]$, from (3)—both result in a rotation of the expected marginal cost curve around the vertical locus

11. The quantitative effect of litigation strategy may and will most likely be different because the magnitudes of damages are likely to differ under the two definitions.

defined by simple monopoly output. Neither term contributes independence to changes in fine progressivity apart from litigation strategy.

The qualitative and independent economic effect of fine progressivity, must, therefore, rest solely upon the last term of (6), $s(mc - \overline{mc})[(\partial\tau/\partial D)D + \tau]$. In this term, the expression $[(\partial\tau/\partial D)D + \tau]$ is the rate of change in the total fine (τD) with respect to a change in the level of damages (D). This term will always be positive because increased damages will most certainly lead to greater total fines regardless of whether the fine system is regressive, progressive or proportional. To assume otherwise would imply that greater restraint of trade is to be rewarded with a lower total fine—an obvious inducement to greater criminal activity which the agency seeks to avoid.

We are left with the conclusion that the independent effect of fine progressivity depends upon the sign of the term $(mc - \overline{mc})$ which is positive, zero or negative as current marginal cost is greater, less or equal to marginal cost at the competitive output. This conclusion is not innocuous for it states that the answer to the question of whether fine progressivity possesses an independent effect on cartel output apart from litigation strategy rests solely upon cost structure and not upon the value of the policy variable, fine progressivity ($\partial\tau/\partial D$). Cost structure, of course, lies outside the policy prerogative of the antitrust agency and, because we are dealing with ongoing, undetected cartels, cannot be known with certainty.

Consider the three possible cases in which the cartel's level of marginal cost (mc) is equal to, greater than or less than marginal cost at the competitive level of output. In the empirically important case of constant marginal cost, $[mc - \overline{mc}] = 0$ for all levels of output.[12] In this case, fine progressivity does not play an independent role, apart from litigation strategy, in deterring restraint of trade at the margin. This is easily seen because, under conditions of constant marginal cost, monopolistic overcharge exactly equals operating profit. As a result, in the most likely empirical case, the analysis and conclusions of the previous section apply in their entirety to overcharge damages as well.

An incentive for the cartel to increase output beyond the monopoly level is created when $[mc - \overline{mc}] < 0$ regardless of whether the fine multiple is progressive, regressive, or proportional. Conversely, a perverse incentive for the cartel to decrease output will always arise when $[mc - \overline{mc}] > 0$. Without definite knowledge of the marginal cost structure of the cartel, perverse incentives resulting from fine progressivity cannot be ruled out. This provides one reason to reject damages based upon monopolistic overcharge. A second reason, which applies equally well to damages based upon monopoly profit, is the failure to deter restraint of trade at the margin in the most likely empirical case of constant marginal cost. Either reason is sufficient for rejection when it is recognized that a better alternative exists.

IV. A Suggested Alternative

One alternative to profit and monopolistic based damages is suggested in the following corollary.

COROLLARY 2. *If the fine multiple is allowed to vary as a function of welfare loss (WL), although the fine is still to be based upon ability to pay, namely, monopoly profit,*

12. Most empirical studies of industrial cost structure reveal that marginal cost is constant over a large range of outputs. See Scherer [13, 81–118] for a review of the literature on cost structure.

then the fine system is placed on an equal basis with litigation strategy in effecting changes in output and welfare loss.

The corollary can be understood (formal proof is in the Appendix) by noting that fine progressivity no longer rotates the expected marginal cost curve around $q = q_{sm}$, but rather shifts the curve in a manner similar to the litigation effect. As a result, if the courts are willing to permit testimony by economic experts to determine the fine multiple on the basis of econometric estimates of welfare loss, then, litigation strategy would no longer serve as a precondition to the effects of fine system nor would its effects be dependent upon cost structure.[13] The importance of this finding lies in the fact that independence of policy tools prevents compounding errors and permits fines to reverse the effects of a perverse litigation strategy.

As a final observation, if the courts are reluctant to consider welfare losses as the basis for fine progressivity, the same quantitative economic results can be achieved by an efficient litigation system and progressive fines based entirely on profit. This is the case because, as shown in Figure 1, although the effect of fines is to rotate the expected marginal cost curve, the shift in the cost curve due to litigation strategy permits progressive fines to quite effectively change output and welfare loss. It is imperative, however, that litigation strategy be efficient if this regime is to provide economic benefit rather than damage.

V. Conclusion

The deterrence of restraint of trade, either in total or at the margin, depends upon both the probability of litigation and the fines accompanying successful litigation. In antitrust literature, treble damages are widely regarded as an important force in the deterrence of antitrust crime. In this paper, we employ a Becker-Stigler crime model to investigate the role which fines and damages play in marginally deterring antitrust violations.

We find that proportional fines, of which treble damages are an example, fail to marginally deter illegal restraint of trade. This suggests that antitrust may be foregoing a useful tool in the task of mitigating the damage to economic efficiency caused by price fixing. We consider progressive fines on profit as an alternative and find that they are at times preferable to proportional fines but not always. In general, fines which promote economic efficiency in the presence of one litigation system will prove harmful in the presence of a second litigation system. For example, a progressive fine on cartel profit promotes economic efficiency in the presence of a litigation strategy based on welfare loss but has exactly the opposite effect in the presence of a litigation strategy based on size.

We also find that fines, in general, play a secondary role to litigation strategy in marginal deterrence when damages are defined as they currently are in antitrust law. In the empirically important case of constant marginal cost, the system of detection and litigation solely determines whether antitrust is ineffective, efficient or inefficient regardless of whether

13. We assume throughout the paper that monopoly profit is positive. Tom Lindley has pointed out an interesting possibility to us. If the cartel is formed and has zero monopoly profit, then, a welfare based fine is a necessity for the fine would be zero if based on profit (truly, a watchdog without teeth). It should also be obvious that if damages were defined in terms of welfare loss and the fine were a function of and levied on welfare loss, then, independence would again emerge. This alternative is not likely to be viable in practice. The courts have not been willing to consider damages incurred to individuals who have not purchased the product. The argument is persuasive because of the obvious invitation to nuisance suits which such damages would invite.

damages are defined by the courts as either cartel profit or monopolistic overcharge. Further, the damage to economic welfare caused by an inefficient litigation strategy can be mitigated but not completely reversed by fines. Conversely, the most adverse fine system cannot completely offset the economic benefit of an efficient litigation strategy.

We also demonstrate that, when damages are defined as monopolistic overcharge, all fines whether progressive, proportional or regressive can cause cartels to further restrict output. The effects of the fine system, in this case, are dependent upon the structure of marginal cost and thus outside the policy control of the courts and Congress. These considerations lead us to reject fines and fine progressivity based upon the monopolistic overcharge and to consider alternatives to the current fine system—alternatives with effects not conditional upon either cost structure or litigation strategy.

As one alternative, we suggest that fine progressivity be determined on the basis of welfare loss with fines levied on monopoly profit. This regime has the important advantage of establishing independence of the fine structure both from litigation strategy and from cost structure. Finally, we note that if a litigation strategy based on welfare loss is in place, then, a fine structure, progressive in nature and in which progressivity varies with the level of and fines are levied upon monopoly profit, constitutes as a second, viable but less desirable alternative because independence of the fine system is sacrificed.

Appendix

THEOREM 1. $\operatorname{sgn}(\bar{q} - q_{sm}) = -\operatorname{sgn}(\partial\theta/\partial q)$ *for all* $\partial\tau/\partial\pi$ *evaluated at* $q = q_{sm}$.

Proof. Marginal progressivity, defined by $mp \equiv (\partial\tau/\partial\pi)(\partial\pi/\partial q)s\,[p(q)q - c(q)]$, is monotonic in $\partial\tau/\partial\pi$ for any given q. Further,

(i) $\lim_{\partial\tau/\partial\pi\to+\infty} mp = +\infty$; $\lim_{\partial\tau/\partial\pi\to-\infty} mp = -\infty$ for $q < q_{sm}$

(ii) $\lim_{\partial\tau/\partial\pi\to+\infty} mp = 0$; $\lim_{\partial\tau/\partial\pi\to-\infty} mp = 0$ for $q = q_{sm}$

(iii) $\lim_{\partial\tau/\partial\pi\to+\infty} mp = -\infty$; $\lim_{\partial\tau/\partial\pi\to-\infty} mp = +\infty$ for $q > q_{sm}$.

Consider increases in fine progressivity. Increasing $\partial\tau/\partial\pi$ monotonically increases expected marginal cost for every output less than simple monopoly output, monotonically decreases expected marginal cost for every output greater than simple monopoly output, and leaves expected marginal cost unchanged at simple monopoly output. The marginal cost function rotates in a clockwise direction but, by (i), (ii), and (iii) the limit of the rotation is the locus $q = q_{sm}$. Consider a reference equilibrium output, denoted as q^R established for $\partial\tau/\partial\pi = 0$, that is, under proportional fines (the Smith-Vaughan case). As proven by Smith and Vaughan, if $\partial s/\partial\theta > 0$, then $q^R < q_{sm}$. Given any expected monotonic marginal revenue function[14] and $\partial\tau/\partial\pi = 0$, all possible expected marginal cost functions generated by changing $\partial\tau/\partial\pi$ must intersect mr_e at outputs less than q_{sm}. Further,

$$\lim_{\substack{\partial\tau/\partial\pi\to+\infty \\ \partial s/\partial\theta>0}} \bar{q} = q_{sm}.$$

Therefore, $\bar{q} < q_{sm}$ for all $\partial\tau/\partial\pi$ given as $\partial s/\partial\theta > 0$. Similar argument establishes

$$\lim_{\substack{\partial\tau/\partial\pi\to-\infty \\ \partial s/\partial\theta>0}} \bar{q} = q_{sm}$$

14. For a discussion of upward sloping marginal revenue schedules see [9].

and $\bar{q} > q_{sm}$ for all $\partial\tau/\partial\pi$ given $\partial s/\partial\theta < 0$. Finally, the fact that $\bar{q} = q_{sm}$ for all $\partial\tau/\partial\pi$ if $\partial s/\partial\theta = 0$ follows immediately by noting that $q^R = q_{sm}$ *and that* $mc_e = mr_e$ at q_{sm} for all $\partial\tau/\partial\pi$.

COROLLARY 1. $\partial\bar{q}/\partial(\partial\tau/\partial\pi) \gtreqless 0$ *as* $\partial\theta/\partial q \gtreqless 0$.

Proof. Again consider fine progressivity, $\partial\tau/\partial\pi$, as an independent policy parameter. A change in progressivity can be visualized as a rotation of the function $\tau = \tau(\pi)$ around the point $(\bar{\tau},\bar{\pi})$ *altering the slope but not the level of the function. Totally diferentiating* (2), *invoking the implicit function theorem and considering equilibrium output*, $\bar{q}$, as a function of fine progressivity, $\partial\tau/\partial\pi$, we have $\partial\bar{q}/\partial(\partial\tau/\partial\pi) = (mr-mc)s\tau/\partial^2\pi_e/\partial q^2 \gtreqless 0$ as $q \gtreqless q_{sm}$ or $\partial s/\partial\theta \gtreqless 0$ as is established by Theorem 1 and by noting that $\partial^2\pi_e/\partial q^2 < 0$ from second-order-conditions.

COROLLARY 2. *If the fine multiple is allowed to vary as a function of welfare loss* (*WL*), *the fine system becomes independent of litigation strategy and cost structure.*

Proof. Under the assumptions that $\tau = \tau(WL)$ and that an efficient litigation strategy based on welfare loss is in place, the first-order-condition becomes:

$$\partial\pi_e/\partial q = (1 - s\tau)(mr - mc) - (\partial s/\partial WL)(\partial WL/\partial q)\tau\pi - (\partial\tau/\partial WL)(\partial WL/\partial q)s\pi = 0. \quad (7)$$

The fine progressivity term in (7), $(\partial\tau/\partial WL)(\partial WL/\partial q)s\pi$, is symmetric to the litigation term, $(\partial s/\partial WL)(\partial WL/\partial q)\tau\pi$. The economic consequences must correspondingly be the same.

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