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COST-RAISING STRATEGIES

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I. Introduction

Economists and courts have long been concerned with conduct that creates or enhances market power by disadvantaging rivals.[1] For example, there is a considerable body of economics and legal literature concerning predatory pricing, that is, setting low prices in the short run in order to induce a rival to exit and then recouping the lost revenues by raising prices after exit. In recent years the logic of traditional predatory pricing theories has been criticized, most significantly because of the difficulty of making such a strategy credible.[2]

Economists have responded to this controversy in two ways. First, an extensive literature is developing the conditions under which predatory pricing is credible. For example, Fudenberg and Tirole (1985) show that, because of incomplete information, victims of predatory pricing might be unable to borrow funds to finance their short run losses, even if the capital market is well functioning.[3] A variety of other articles have

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1 For a review and a synthesis based on the concept of cost-raising strategies, see Krattenmaker and Salop (1986).

2 For example, see Kreps and Wilson (1982), Milgrom and Roberts (1982), and Easterbrook (1981).

3 See also Benoit (1984).

explored the predator's incentives to follow what might appear to be irrational pricing strategies in order to gain a reputation as a hard competitor.[4] In this same vein, Saloner (1985) shows that Standard Oil's alleged practice of pricing low to induce the rivals to sell out for a favorable price can be a rational strategy in some cases.

We take a second approach. We conjecture that below-cost pricing is seldom the sole tactic employed by a would-be predator. Instead, a variety of other strategies designed to raise rivals' costs are likely to be used to supplement any attempt to use low prices to cause rivals to contract or exit. For example, Standard Oil allegedly raised the price it charged to transport rivals' oil on its pipelines at the same time that it lowered the price of refined products. Similar allegations of a price squeeze were made in Alcoa.[5] More recently, AT&T was alleged to exclude long distance rivals from equal access to the local telephone network, in addition to setting low prices.[6] Predatory pricing may also be used in combination with other policies against new entrants whose products are in test markets, to disrupt the entrants' tests.[7]

Cost-raising tactics are not always limited to a supplementary role. In some cases, cost-raising strategies can be used to disadvantage rivals or drive them out of the market without the need to set low prices. For example, while AT&T was not found liable for predatory pricing, it did not

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[4] See Kreps and Wilson (1982) and Milgrom and Roberts (1982).

[5] 148 F.2d 416 (1945).

[6] 708 F.2d 1081 (1983).

[7] See Salop and Shapiro (1980), Scharfstein (1984) and Fudenberg and Tirole (1985).

escape liability for denying rivals equal access. In another classic antitrust case, the Lorain Journal newspaper conditioned sales of advertising space on advertisers' promises not to purchase additional advertising from a competing radio station.[8] Other possible cost-raising strategies include a variety of exclusive dealing arrangements, inducing input suppliers to discriminate against rivals, lobbying legislatures or regulatory agencies to create regulations that disadvantage rivals, commencing R&D and advertising wars, and adopting incompatible technologies. Because these strategies are predatory, but do not involve classic predatory pricing, they are sometimes referred to as "non-price predation".[9]

In this paper, we show that strategies designed to raise rivals' costs have a number of advantages over predatory pricing. First, cost-raising strategies do not have an inherent problem of credibility. Such strategies may be profitable whether or not the rivals exit, since higher cost rivals have an incentive to cut back output and raise prices immediately, which may make it possible for the predator to reap gains even in the short run.[10] Second, the predator does not generally need a "deep pocket" or the benefit of imperfect capital market to finance its strategy.[11] Finally, unlike predatory pricing, the possession of

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[8] 342 U.S. 143 (1951).

[9] Since these strategies sometimes involve prices (e.g., raising the price of an input), perhaps a better term is "cost-predation".

[10] See Salop and Scheffman (1983).

[11] Indeed, in many cases, even ignoring the resulting price increases, the predator's direct costs of a cost-raising strategy may be far lower than the costs inflicted on the rivals. For example, a regulation may be very inexpensive for the predator to satisfy even as

classical market power (i.e., downward sloping demand curve) in the relevant output market is not essential for the success of cost-raising strategies, since even perfect competitors can benefit if rivals have higher costs.[12]

This paper is organized as follows. In Sections II and III, we set out the general model for analyzing cost-raising strategies. These sections generalize and extend the results reported in Salop and Scheffman (1983). The specific model analyzed in Section III assumes the predator can fully control a parameter that affects its costs and those of its rivals, for example where the parameter is a regulatory instrument.[13] In Section IV, we define and analyze strategies based on "overbuying" inputs, such as the conduct alleged in Alcoa. Finally, Section V develops a theory of raising rivals' costs through vertical integration, and shows that vertical integration can be anticompetitive, even for technologies in which an input is used in fixed proportions.

II. The General Model

We begin with a general model of competition between the predator and a competitive (price-taking) fringe, where the predator may be either a price taker or a dominant firm.[14] Let $D(p)$ be market demand, and let the predator's and fringe's cost functions be given, respectively, by the functions $C(x,\alpha)$ and $G(y,\alpha)$, where outputs are given by x and y, and where

competitors' compliance costs skyrocket.

[12] Inframarginal rents increase with price, and higher cost rivals may shift up the industry supply curve, thereby increasing price.

[13] See Salop, Scheffman, and Schwartz (1984).

[14] See Salinger (1985) for the case of an oligopolistic fringe.

a cost-raising parameter, α, influences the costs of all firms, perhaps symmetrically.[15] For example, α could be interpreted as a regulatory parameter, the price of an input, expenditures on advertising or research and development.[16] We adopt the convention that increases in α raise the average and marginal costs of the fringe and the average costs of the predator, i.e., the partial derivatives C_α, G_α, and $G_{y\alpha}$ all are non-negative.[17] We assume that the predator has the power to control the level of α, subject to a general market constraint formalized by the equation $F(\alpha,p,x,y) \geq 0$. In subsequent sections, we consider particular forms for this constraint corresponding to specific institutional settings.

The fringe supply curve is denoted $S(p,\alpha)$, which can be derived from the fringe cost function in the usual manner:[18]

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[15] The fringe cost function and resulting supply curve may be treated as long run functions encompassing potential entry by additional price-taking firms. Lack of entry barriers is signalled by constant marginal costs and a perfectly elastic supply curve. Thus, in principle, dynamic elements can be taken into account in the analysis. We treat p and α as scalars, although the results are generalized easily to vector-valued variables.

[16] We will not treat the case where market demand also depends on α (for example, when α represents advertising expenditures), but many of our results are easily generalizable to that case.

[17] if increases in α reduce the predator's costs (i.e., if $C_\alpha < 0$), then increases in α would have an independent "efficiency" benefit to the "predator" beyond any exclusionary benefits.

[18] Assuming $y > 0$, fringe supply satisfies the usual first-order condition relating price to marginal cost, $p = G_y(y,\alpha)$. The properties of the supply curve are as follows: $S_p = 1/G_{yy} \geq 0$ and $S_\alpha = -G_{y\alpha}/G_{yy} \leq 0$. If $G_{yy} > 0$, the fringe supply curve is upward sloping. If $G_{yy} = 0$, then $S_y = \infty$, and the predator has no classical market power in the downstream market, but instead faces a perfectly elastic residual demand curve. Of course, even in that case the predator may benefit from shifts in his residual demand curve.

$$S(p,\alpha) = \underset{y}{\operatorname{argmax}}\, [py - G(y,\alpha)]. \tag{1}$$

Thus, the predator faces the general profit-maximizing problem:

$$\begin{aligned} \max_{\{p,x,\alpha\}} \quad & [px - C(x,\alpha)],^{19} \text{ subject to} \\ & x + y = D(p), \\ & y = S(p,\alpha), \\ & F(\alpha,p,x,y) \geq 0. \end{aligned} \tag{2}$$

Without placing more structure on the market constraint function $F(\alpha,p,x,y)$, the first order conditions for equations (2) do not yield interesting interpretations.

III. Direct Control Over α

In this section, we assume that the market constraint has a very simple form: the predator has direct and complete control over α, subject only to the constraint $\alpha \geq \bar{\alpha}$. The *ex ante* value of α, $\bar{\alpha}$, may correspond to the predator choosing α solely on the basis of cost-minimization (i.e., $C_\alpha = 0$), an exogenous status quo, or an alternative proposed by a rival. Thus, we assume that the predator has a type of market power in an "input market", in the sense that α corresponds to a variable in a relevant input

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[19] If the predator does not have classical market power in the output market, price is not a choice variable. Instead, output x is determined by the relationship $p = C_x(x,\alpha)$. See Salop, Scheffman and Schwartz (1984) for a detailed analysis of this case.

market, such as price.[20] We assume here that the predator's choice of output level has no direct effect on the value of α.[21]

Several institutional settings are suggested by this formal structure. In the Pennington case studied by Williamson (1968), it was alleged that a large coal producer induced the labor union to drive up the wage rate. Under this interpretation, $\alpha > \bar{\alpha}$ would correspond to a wage increase.[22] In another interpretation, α and $\bar{\alpha}$ can be treated as alternative regulations that could be adopted by an agency the predator is trying to "capture."[23] One also could view α as a level of advertising or research and development expenditures chosen by the predator to which the fringe reacts by raising its own advertising or research levels.[24]

Formally, rewriting the maximization problem in (2), we have

$$\max_{\{p,\alpha\}} \; [p(D(p) - S(p,\alpha)) - C(D(p,\alpha) - S((p,\alpha),\alpha)], \tag{2'}$$

subject to $\alpha \geq \bar{\alpha}$.

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[20] In this formulation, regulations can be analyzed as inputs that are forced on the firms, rather than being purchased.

[21] This would not always be the case, for example, if α was the price of an input purchased by both the predator and the fringe in a competitive market. A model of this type is taken up in the following sections.

[22] In this formulation it is assumed that the union rations labor to clear the market at the higher wage.

[23] Elsewhere, we have presented a model in which we examine the determinants of who controls the regulatory process (Salop, Scheffman and Schwartz (1984)). In that case, the "market power" may simply involve partial control over the regulatory process. For a summary of the literature on the use of regulation as a cost-raising strategy, see McCormick (1984).

[24] The fringe's profit-maximizing reaction function is implicit in the cost derivative G_α. However, under this interpretation, any effects of advertising or R&D on market demand are ignored.

The first order conditions for an interior maximum $(x, y > 0,\ \alpha > \bar{\alpha})$ are given as follows:

$$(p - C_x)/p = 1/\epsilon^R \tag{3a}$$

$$(p - C_x) = -C_\alpha/S_\alpha, \tag{3b}$$

where ϵ^R is the elasticity of residual demand faced by the predator.[25]

Equation (3a) is the usual Lerner markup equation for a dominant firm. At an interior equilibrium $(\alpha > \bar{\alpha})$, combining (3a) and (3b) yields

$$S_\alpha/(D_p - S_p) = C_\alpha/x.^{26} \tag{4}$$

The interpretation of (4) is straightforward. The left-hand side of (4) equals $\partial p/\partial\alpha|_x$, where this derivative represents the change in price arising from the reduction in fringe output resulting from the increase in α, holding the output of the predator fixed. In other words, the left-hand side of (4) is the derivative representing the vertical shift in the residual demand curve facing the dominant firm. The right-hand side of (4) is the derivative of average cost (AC^D) of the predator with respect to α, holding its output fixed. Therefore, an interior solution must satisfy the condition $\partial p/\partial\alpha = \partial AC^D/\partial\alpha$, where these derivatives are evaluated at the profit-maximizing point (x^*, α^*).

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[25] $\epsilon^R = -(\partial(D - S)/\partial p)(p/(D - S)) = \epsilon/\sigma + (1-\sigma)\varsigma^F/\sigma$, where ϵ is the price-elasticity of market demand, ς^F is the price-elasticity of fringe supply, and σ is the market share of the predator.

[26] It can easily be shown that the condition corresponding to (4), if the fringe has constant returns-to-scale technology, is: $[1 - (p - C_x)\epsilon/p]/(C_\alpha/D) = 1/AC^{F\prime}(\alpha)$, with ϵ the price elasticity of market demand and $AC^{F\prime}(\alpha)$ is the derivative of the fringe's average cost with respect to α. The first order conditions for y require $p - C_x \geq 0$ and $(p - C_x)y = 0$.

We now state the following <u>sufficient</u> condition for a cost-raising strategy to be profitable, i.e., for $\alpha^* > \bar{\alpha}$.

<u>Proposition 1</u>

Let $\bar{x}$ be the profit maximizing output for the predator when $\alpha = \bar{\alpha}$ (i.e., $\bar{x}$ is the solution of (3a) for $\alpha = \bar{\alpha}$). $\alpha > \bar{\alpha}$ is profitable if

$$\partial p/\partial \alpha > \partial AC^D/\partial \alpha, \tag{5}$$

where the derivatives are evaluated at $(\bar{x},\bar{\alpha})$.

This sufficient condition requires that the vertical shift in the predator's residual demand curve must exceed the vertical shift in its average cost curve, evaluated at the non-strategic equilibrium ($\alpha = \bar{\alpha}$). This result follows directly from the fact that the predator's profits at $\bar{x}$ equal $(p - AC^D)\bar{x}$, where AC^D is the predator's average costs.[27]

The sufficient condition (5) is more likely to hold: (i) the larger is the vertical shift in the fringe supply curve resulting from an increase in α (S_α large); (ii) the smaller is the impact of an increase in α on the predator's average costs (C_α/x small); and (iii) the less elastic are the market demand curve and the fringe supply curve ($-(D_p - S_p)p/x$ small).

A. <u>Effect on Price</u>

Consider now the effect of increasing α on price. Denoting the predator's profit by π^D, $dp/d\alpha$ can be determined by totally differentiating the predator's first order condition for price, $\pi^D_p=0$.

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[27] The interpretation of (5) is provided in Salop and Scheffman (1983).

Since the second order conditions require $\pi^D_{pp} < 0$, sign $dp/d\alpha$ = sign $\pi^D_{p\alpha}$, or

$$\text{sign } dp/d\alpha = \text{sign } [-S_\alpha - C_{x\alpha}(D_p - S_p) - (p - C_x)S_{p\alpha}]. \tag{6}$$

The first term on the right hand side of equation (6) is positive. The sign of the second term is ambiguous because of the ambiguity of the sign of $C_{x\alpha}$, i.e., the effect of an increase in α on the predator's <u>marginal</u> cost is ambiguous.[28] The sign of the third term depends on the sign of $(D_{p\alpha} - S_{p\alpha})$, the effect of an increase in α on the <u>slope</u> of the residual demand curve, which is also ambiguous. Thus, it is possible for $dp/d\alpha$ to be negative.[29]

This is a straightforward result, analogous to the well-known ambiguity of the effect of an increase in demand on a monopolist's profit-maximizing price. However, this result alerts us to the fact that if the predator has downstream market power, both the shift in the fringe supply curve and its slope are critical in determining the effect of an increase in α on price. In summary, we have the following proposition.

<u>Proposition 2</u>

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[28] We have only assumed that C_α is negative.

[29] An example in which $dp/d\alpha < 0$ is as follows. Suppose market demand is $Q = (1 - p)$, and that initially fringe supply is inelastic at one unit. Suppose further that the predator's cost are zero and that an increase in α changes fringe supply to the function: $y = p^2/100$, $p \leq 10$; $y = 1$, for $p > 10$. It is easy to see $S_\alpha \leq 0$. The initial equilibrium price is $p^* = 5$, while the equilibrium price after the increase in α is $p^* = 4.7$, so that the price falls with an increase in α. The key to this example is that although $S_\alpha \leq 0$, the fringe supply curve becomes much more elastic with an increase in α, making the predator's residual demand curve more elastic.

Profitable cost-raising strategies may result in a <u>decrease</u> in price if the predator has market power in the output market. A sufficient condition for price to increase is $C_{x\alpha} \geq 0$ and $S_{p\alpha} \leq 0$.[30] If the predator does not have downstream market power, profitability of cost-predation requires that price increase.

B. <u>Effect on Fringe Output and Profits</u>

We now examine the effect of an increase in α on fringe output. From the fringe supply function, we have

$$dy/d\alpha = S_p dp/d\alpha + S_\alpha \tag{7}$$

Because, by assumption, $S_\alpha < 0$, then if $dp/d\alpha < 0$, it follows that fringe output necessarily falls ($dy/d\alpha < 0$). However, in some cases it may be profitable for the predator to increase price sufficiently to permit the fringe output even to expand ($dy/d\alpha > 0$), although in such a case the predator must restrict its own output enough so that total output falls in order to effect an increase in price.[31] As with the ambiguous price effect, the result depends on the effect of an increase in α on the elasticity of the predator's residual demand curve. Summarizing, we have the following result.

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[30] This should clear since the critical issue is how C_x and ϵ^D change with α (see (3)a)), and $-S_{\alpha p} \geq 0$ is a sufficient condition for $\partial\epsilon^D/\partial\alpha \leq 0$.

[31] An example in which $dy/d\alpha > 0$ is as follows: Suppose market demand is $Q = (11 - p)$ and the predator's costs are zero. Suppose further that for $\alpha = 0$, fringe supply curve is perfectly elastic at a price of one, but for $\alpha > 0$ the fringe supply curve becomes $y = (p - 1)/\alpha$ for $0 < \alpha < 1$, $y = (p - 1)$ for $\alpha \geq 1$. Then, for $\alpha = 0$, the equilibrium price $p^* = 1$ and output of the fringe is zero. However, if the predator can set α, it will set $\alpha^* = 1$, leading to a new price of $p^* = 5/2$ with fringe output rising to $3/2$. Of course the key to this example is that the increase in α makes the fringe supply curve much less elastic.

Proposition 3

An increase in α has an ambiguous effect on fringe output. However, if price falls ($dp/d\alpha < 0$), then fringe output also must fall ($dy/d\alpha < 0$).

Because an increase in α has an ambiguous effect on price and fringe output, it is probably not surprising that the effect of an increase in α on fringe "profits" (inframarginal rents) is also ambiguous.[32] Suppose that fringe supply is upward sloping and that further entry is blocked so that the fringe earns inframarginal rents. Fringe profits are given by $\pi^F = py - G(y,\alpha)$. Differentiating π^F and recalling that $p = G_y$, we have

$$d\pi^F/d\alpha = y(G_{yy}dy/d\alpha + G_{y\alpha} - G_{y\alpha}/y) \tag{8}$$

In the standard case in which fringe output falls ($dy/d\alpha < 0$), fringe profits necessarily fall, unless fringe marginal costs rise sufficiently relative to fringe average costs.[33] Summarizing, we have the following proposition.

Proposition 4

Sufficient conditions for fringe profits to fall are: either (i) $dp/d\alpha < 0$, or (ii) $dy/d\alpha < 0$ and $(G_{y\alpha} - G_\alpha/y) < 0$. A sufficient condition for fringe profits to rise is $dy/d\alpha > 0$ (which itself requires $dp/d\alpha > 0$), and $(G_{y\alpha} - G_\alpha/y) > 0$.

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[32] Thus, characterizing the conduct as necessarily "predatory" in this case would be in error. The conduct could sometimes be characterized as "collusive". Indeed, in the example discussed in footnote 27, fringe profits actually increase with α.

[33] It is easy to see that if fringe marginal costs increase much more than fringe average costs, the fringe's inframarginal rents (the area behind the fringe supply curve) may increase.

These two conditions are of particular interest because they depend only on price or on the output of the fringe and its technology.

C. Effect on Welfare

In this section, we analyze the welfare effects of these strategies. Let the conventional welfare indicator (the sum of consumer plus producer surplus) be denoted by W. Then, we have

$$dW/d\alpha = [D(p) - S(p,\alpha)]dp/d\alpha - (p - C_x)S_\alpha(p,\alpha) - C_\alpha - G_\alpha + \Omega'(\alpha),^{34} \quad (9)$$

where $\Omega(\alpha)$ is a measure of welfare in other markets affected by α.

Without placing more structure on the problem, the properties of $\Omega(\alpha)$ are undefined. If α is a regulatory parameter affecting only the downstream market, the effects of increased regulation ($\alpha > \bar{\alpha}$) on welfare outside the downstream market are likely to be unimportant, unless there are substantial resources used up (rather than simply transferred) to influence the regulatory authority. If α is the price of an input, then some of the increases in costs arising from an increase in α represent only a transfer to the input owners.[35] Until later sections, where we have sufficient structure to determine the properties of Ω, we will concentrate on partial equilibrium welfare effects. We will denote partial equilibrium welfare by $\hat{W}$, where $\hat{W} = W - \Omega$.

From equation (9) it should be clear that the sign of $d\hat{W}/d\alpha$ is

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[34] $W(\bar{p},\bar{\alpha}) = \int_{\bar{p}}^{\infty} D(p)dp + \bar{p}\bar{x} - C(\bar{x},\bar{\alpha}) + \bar{p}S(\bar{p},\bar{\alpha}) - G(S(\bar{p},\bar{\alpha}),\bar{\alpha}) + \Omega(\alpha)$. We normalize by setting $\Omega(\bar{\alpha})=0$.

[35] For example, in the case considered by Williamson (1968), the cost-raising strategy took the form of an increase in the union wage, which resulted in a transfer to union members. However, rent-seeking conduct may transform such transfers into welfare losses.

ambiguous.[36] For example, if $dp/d\alpha < 0$, it would not be surprising that $d\hat{W}/d\alpha > 0$. Furthermore, even if $dp/d\alpha \geq 0$, welfare could rise because the strategy may reduce the output of a higher cost rival, increasing producer surplus more than any decrease in consumer surplus.[37] This result only can occur if the predator has market power that results in $p > MC$. If price equals marginal cost, then the diversion of output to the predator must raise total costs.

Of course, a sufficient increase in price will cause enough reduction in consumer surplus to result in $d\hat{W}/d\alpha < 0$. Substituting (3b) into (9), we have:

$$d\hat{W}/d\alpha < 0 \text{ if } dp/d\alpha > S_\alpha/(D_p - S_p) - (C_\alpha + G_\alpha)/(D - S). \qquad (11)$$

The term $(S_\alpha/(D_p - S_p))$ is the price rise due to an increase in α, assuming the predator holds its output fixed. Therefore, equation (11) holds if the predator does not increase its output when α is increased. Summarizing, we have the following result:

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[36] This follows because if the predator has market power in the output market, fringe and predator marginal costs will not be equalized, leading to a typical second best welfare calculus.

[37] Suppose demand is $Q = (a - bp)$ and the predator's costs are zero. Suppose further that for $\alpha = 0$, fringe supply is $y = [(a - 4b) + bp]$ and for $\alpha=1$, fringe supply is $y = (a - 6b) + 2bp$. It can easily be shown that the equilibrium price is $p = 1$ for $\alpha = 0$ or $\alpha = 1$, so that consumer surplus is the same in each equilibrium. However, producer surplus is larger in the case of $\alpha = 1$ because a greater proportion of the output is produced by the lower cost predator (which has zero costs). What is driving this example is that the marginal costs of the fringe and the predator are not equalized because of market power exercised in the output market by the predator.

Proposition 5

In general, increasing α has an ambiguous effect on partial equilibrium welfare, even if price rises, when the predator has classical market power. However, if the predator does not increase its output, welfare necessarily is reduced. If price rises, consumer welfare is reduced by an increase in α. If the predator is a price taker and price does not fall, total equilibrium welfare must fall.

D. α an input price

We now place additional structure on the previous model by specifying the way in which α affects costs. We assume in this section that α is the price of an input A that is used by both the predator and the fringe. Denoting $\bar{\alpha}$ as the competitive price of A, we assume that the predator can raise the input price above the competitive level without increasing its purchases of A.[38] Although the first order conditions for the predator are still given by (3), when α is an input price additional results can be derived because of the properties of C_α and S_α.

By the usual duality properties of cost functions, we have $C_\alpha = A^D$ and $G_\alpha = A^F$, where A^D and A^F are the (cost minimizing) demands for A by the predator and fringe, respectively. Assuming that fringe supply is given by (1), the fringe's (cost minimizing) demand for A satisfies $\partial A^F/\partial y = G_{y\alpha}$. Therefore, from (4) and (5), a sufficient condition for $\alpha > \bar{\alpha}$ to be profitable is

$$(-\partial A^F)/\partial y/G_{yy}(D_p - S_p) > A^D/x, \text{ evaluated at } (\bar{x},\bar{\alpha}). \tag{12}$$

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[38] Our specification of this model is similar to that of Williamson (1968). Thus, we are assuming that some actor in the input market, e.g., an union, rations the sales of the input at a higher price. Williamson makes some restrictive assumptions (fixed coefficients, constant-returns-to-scale technology for the predator and the fringe), which, we will see, greatly limit the range of possible equilibrium outcomes.

As with (5), the left hand side of (12) is $\partial p/\partial\alpha|_x$, and the right-hand side of (12) is the derivative of average cost of the predator with respect to α for output of the predator kept fixed. Notice that a necessary condition for a cost-raising strategy to be profitable is that A not be an inferior factor for the fringe ($\partial A^f/\partial y \geq 0$), since otherwise an increase in α would increase fringe output.

Sufficient condition (12) can be rewritten to facilitate its interpretation. Let $\rho = (\partial A^f/\partial y)(y/A^f)$, the elasticity of fringe demand for input A with respect to fringe output. Then from (12), at $(\bar{x},\bar{\alpha})$ we have

$$-S_p/(D_p - S_p) > (A^D/x)/\rho(A^f/y). \tag{13}$$

Since the left hand side of (13) is less that one, (13) requires that $(A^D/x) < \rho(A^f/y)$. Hence, the greater is the fringe's use of input A per unit of output <u>relative to</u> the predator's use of that input per unit of output, the more likely that cost-predation will be profitable.[39] The results contained in (12) and (13) are summarized in the following proposition.

<u>Proposition 6</u>

If α is the price of input A, for the predator to raise α profitably, A must not be an inferior factor for the fringe. The profitability of a cost-raising strategy is more likely:

(i) the more elastic is the fringe input-expansion path for A;
(ii) the less elastic is the fringe supply curve:
(iii) the less elastic is the market demand curve; and
(iv) the greater is fringe use of input A per unit of output relative to the predator's.

[39] Since $\rho > 1$ is possible, this input use asymmetry is not necessary for the profitability of cost-predation.

1. Welfare effects

In assessing the welfare effects of an increase in the input price, we must recognize that some of the cost increase borne by the predator and the fringe is a transfer to input suppliers. In terms of the notation used above,

$$\Omega'(\bar{\alpha}) = d[\alpha(A^D + A^F)]/d\alpha, \tag{14}$$

i.e., the change in payments to owners of the input, which can be positive. Since $C_\alpha = A^D$ and $G_\alpha = A^F$, the welfare effect summarized in equation (9) can be written:

$$dW/d\alpha = [D(p) - S(p,\alpha)]dp/d\alpha - (p - C_x)S_\alpha(p,\alpha) - A^D - A^F + \Omega'(\alpha), \tag{9a}$$

Since $dW/d\alpha = d\hat{W}/d\alpha + \Omega'(\bar{\alpha})$ and $\bar{\alpha}(d(A^D + A^F)/d\alpha) < 0$, it is easily seen from (11) that Proposition 5 now holds for <u>total</u> welfare W.

IV. Overbuying Strategies

In this section we assume that α is the price of an input A that is supplied by a competitive industry according to the supply curve $A(\alpha)$. Now, in order to raise the input price, the predator must purchase additional quantities of the input.[40] As a result, its marginal factor cost of increasing α exceeds C_α (where, as before, $C(x,\alpha)$ is the minimized cost of buying inputs to produce x at input price α).

The equilibrium condition in the input market corresponding to the market constraint $F(\alpha,p,x,y) \geq 0$ in (1) now is given by

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[40] This overpurchasing may be carried out by excessive open market purchases of inputs or by excessive purchases of productive capacity to produce inputs, i.e., by excessive vertical integration. We will discuss vertical integration explicitly in the next section.

$$A(\alpha) - A^F(\alpha,p) - A^D = 0, \tag{15}$$

where $A^F(\alpha,p)$ is the fringe demand function for input A and A^D is the quantity of A purchased by the predator. We make the standard assumptions that $A' > 0$, $A^F_\alpha < 0$, $A^F_p > 0$. From (15), we can derive the function $A^D(\alpha,p)$ that gives the level of purchases of A required for the predator in order to raise the price of A to α, given p (i.e., the residual supply function for A).

Let $z = (z^1,\ldots,z^m)$ denote the quantities of other inputs, $r = (r^1,\ldots,r^m)$ denote their prices, and let $f(z^D,A^D)$ denote the predator's production function. The predator's cost function, $\tilde{C}(x,\alpha,r,p)$, can be defined as follows:

$$\tilde{C}(x,\alpha,r,p) = \min_{\{z_i^D\}} [\Sigma r_i z^D + \alpha A^D(\alpha,p)], \text{ subject to} \qquad f(z^D,A^D) = x. \tag{16}$$

By the "Envelope Theorem", we have

$$\tilde{C}_\alpha = A^D + (\alpha - \chi f_A)A^D_\alpha,\text{[41] and} \tag{17a}$$

$$\tilde{C}_p = (\alpha - \chi f_A)A^D_p,\text{[42]} \tag{17b}$$

where $\chi = \tilde{C}_x$, is the predator's marginal cost.

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[41] Notice that if the predator was a perfect competitor in the A-market, then $\tilde{C}_\alpha = A^D$ (the usual duality relationship). If the predator was a simple monopsonist in the A-market, the first order conditions for α would require $\tilde{C}_\alpha = 0$.

[42] $\tilde{C}_p$ is the change in the dominant firm costs arising from a change in p, resulting from the fact that a change in p changes the fringe demand for A and therefore the net supply of A available to the dominant firm.

The first order conditions for profit-maximization for the predator can be derived as in (4), yielding

$$(p - \tilde{C}_x)/p = (1 - \tilde{C}_p/x)/\epsilon^D, \text{ and} \tag{18a}$$

$$(p - \tilde{C}_x) = -\tilde{C}_\alpha/S_\alpha. \tag{18b}$$

Following equation (5), these equations can be combined to yield

$$S_\alpha/(D_p - S_p) = (\tilde{C}_\alpha/x)/(1 - \tilde{C}_p/x). \tag{19}$$

As before, the left hand side of (19) is the vertical shift in the residual demand curve facing the predator and the right hand side is the vertical shift in its average costs.[43]

In the model of the preceding section, it was straightforward to determine whether a cost-raising strategy was being pursued - a necessary and sufficient condition was $\alpha > \bar{\alpha}$. In the present model, however, all purchases of A automatically increase α, so that as long as the predator actually uses its purchases of A to produce output, we do not have a simple benchmark.

There are two potential benchmarks we may consider. One useful benchmark is classical (dominant firm) monopoly/monopsony conduct. By this we mean the level of input purchases that would arise if the predator behaved as a dominant firm facing a residual demand curve $R(p,\alpha)$ and a residual supply curve $A^D(\alpha,p)$, but ignored the strategic effects of α

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[43] $\partial AC^D/\partial\alpha = [\tilde{C}_p(\partial p/\partial\alpha)]/x.$

on its rivals' input costs and the resulting effects on price.[44] A second benchmark is the cost-minimizing (efficient) level of input purchases.

We take up the simple monopoly/monopsony (MM) benchmark first. In that model, the MM's optimal choice of A would imply $\tilde{C}_\alpha = 0$, i.e.,

$$A^D + (\alpha - \chi f_A)A^D_\alpha = 0. \tag{20}$$

In this case, the MM's marginal revenue product for A equals the marginal factor cost (MFC) of A.[45] In contrast, if a strategically-minded MM also realizes and acts on the knowledge that α affects R and that p affects A^D, the first order conditions for α (17b) require

$$(\alpha - \chi f_A)A^D_\alpha + A^D > 0 \tag{21}$$

Thus, for strategic behavior, the marginal revenue product of A for the predator is below its marginal factor cost.[46] The intuition is straightforward. The predator, recognizing the effect of an increase in α on fringe supply finds it in its interest to purchase relatively more A than if it were a simple monopsonist. It is in this sense that the

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[44] Formally, this assumes that the dominant firm ignores the effect of α on the predator's residual demand function and the effect of p on A^D.

[45] The marginal revenue product of A is χf_A and the marginal factor cost of A is $\alpha + A^D/A^D_\alpha$.

[46] For a diagrammatic explanation of this result see Salop and Scheffman (1984).

predator "over-purchases" the input.[47] The results of this section are summarized in the following proposition.

Proposition 8

> A necessary and sufficient condition for increasing α to be profitable is $MFC_A^D - \chi f_A > 0$, i.e., the marginal factor cost of A exceeds the predator's marginal revenue product of A.

In principle, MFC_A^D and χf_A could be quantified, in which case an empirical test for overbuying could be carried out.

Using the simple monopoly-monopsony model as a benchmark has two shortcomings for policy purposes. First, the condition given in Proposition 8 may be difficult to measure in practice. Second, although buying more inputs than would a non-strategic MM indicates an intent to raise rivals' cost to gain power over price, the strategy may not reduce economic efficiency. This is because a monopsonist under-purchases the input, relative to the efficient level, so that purchasing more than a monopsonist may improve welfare.

These two considerations suggest a second possible benchmark - the input purchase level that would be chosen if the predator was a perfect competitor in both input and output markets. If the predator so overpurchases the input that the value of the input price α exceeds the

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[47] It is not possible to state a general result summarizing the relationship between the strategic and non-strategic equilibria. However, simple examples bear out the intuition about the effects of strategic overbuying. For example, let market demand be a - bp. Suppose both the fringe and the predator use one unit of A to produce one unit of output, and that $A^F(\alpha,p) = (p - \alpha)$. Suppose further that A is supplied according to the supply function $A(\alpha) = k\alpha$. Finally, assume that the predator's only cost of production is the cost of A. Then it can be shown that the cost-predation equilibrium has a lower p and higher α than the equilibrium in which the predator acts as a simple monopolist-monopsonist.

value of the input's marginal product (pf_A), then it must be true that the purchaser both intended to raise rivals' costs and also bought so much extra input that economic welfare must have declined, even ignoring the additional inefficiencies induced by the increase in competitors' costs. This benchmark clearly is far more permissive than the classical monopoly/monopsony purchase level. However, it can be profitable to raise rivals' costs sufficiently to exceed this benchmark.[48]

This more permissive benchmark is analogous to Areeda and Turner's (1975) marginal cost pricing rule for judging allegations of predatory pricing. Although a price below the short run profit-maximizing level may indicate an intent to drive rivals from the market and may reduce economic welfare even if the entrant is less efficient,[49] Areeda and Turner chose the more permissive static, non-strategic pricing standard. Their arguments in favor of the Areeda-Turner rule can be applied to our competitive benchmark.

Moreover, it is interesting to note that our competitive benchmark also involves a comparison of marginal cost and price. If a perfectly

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[48] Suppose that the fringe requires one unit of A to produce one unit of output. Then, assuming that the fringe has increasing costs in other inputs, a plausible fringe supply function is $S(p,\alpha)$, and fringe demand for A is $A^F(\alpha,p) = (p - \alpha) \geq 0$. Suppose that A is supplied inelastically at A^*, but that the predator does not use A in production. Thus, an equilibrium with $\alpha > 0$, $A^D > 0$ proves the result. Assume that the predator has constant average cost of production of c. Finally, assume that industry demand is linear, $D(p) = a - bp$. It is easily shown that the equilibrium in this model is $p^* = (a + bc - A^*)/2b$, $\alpha^* = [a - (b + 1)A^*]/2b$, $A^D = (A^* - c)/2$, if $[a - (b + 1)A^*] > 0$. If this condition holds $\alpha^* > 0$, then $A^{D*} > 0$, even though the marginal productivity of A for the predator is zero. Thus, the predator purchases A at a price above its marginal revenue product and above the value of the marginal product of A (which in this case are both zero).

[49] See Hay (1981).

competitive firm purchases inputs beyond the efficient level to a point where the price of the input exceeds its marginal value product, that firm will be in a position where its marginal cost (of increasing its output with that input) exceeds the price it receives for its output. This is easy to show. For a perfect competitor with no monopsony power, the marginal cost of increasing output by expanding use of a particular input equals the price of that input α divided by its marginal product f_A. Formally, if the predator was a perfect competitor, we would have MC $= \alpha/f_A$. It follows that the competitor's marginal cost exceeds the price of output p if the input price α exceeds the marginal value product $p^f A$ (i.e., if $\alpha > pf_A$, then $MC = \alpha/f_A > p$). Thus, if the predator violates our competitive benchmark, his marginal cost <u>measured by treating him as a competitor</u> would exceed price.

V. <u>Vertical Integration</u>

Consider now the case in which the predator is partially vertically integrated, that is, it self-manufactures a portion of its overall input requirements. The model of Section IV is easily extended to incorporate this possibility. We will now show that the firm may (over-) purchase inputs on the outside "merchant" market even when it is more efficient to produce the input internally, in order to increase the costs of competitors. This can occur even if the production technology exhibits fixed proportions.

Interpreting $A^D(\alpha,p)$ as <u>net</u> purchases of input A by the predator (where $A^D(\alpha,p) < 0$ means that predator is a net seller of A), let A^{*D} be the quantity of input A <u>produced</u> by the predator and let $c(A^{*D})$ be its cost of production. Then the predator's cost function is given by

$$\tilde{C}(x,\alpha,p) = \min_{\{z_i^D, A^{*D}\}} [\Sigma r_i z_i^D + \alpha A^D(\alpha,p) + c(A^{*D})], \tag{22}$$

$$\text{subject to } f(z^D, A^{*D} + A^D(\alpha,p)) = x.$$

It is easily seen that the minimization of (22) with respect to A^{*D} requires

$$c'(A^{*D}) - \chi f_A = 0. \tag{23}$$

This condition implies that the predator always produces input A efficiently, i.e., at the level at which its marginal cost of production is equal to its marginal revenue product.

The other equilibrium conditions are the same as (17). Therefore, since as shown above, $(\alpha - \chi f_A) > 0$ may be characteristic of an equilibrium, it follows from (23) that $(\alpha - c'(A^{*D})) > 0$ may also obtain.[50] In short, it may be profitable for the predator to purchase the input on the market at a price exceeding its own marginal cost of producing the input internally. This is because purchases of the input raise the costs of the fringe and the reduction in fringe supply may more than compensate for the predator's increased input cost.

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[50] An example in which $(\alpha - c'(A^{*D})) > 0$ can be easily constructed along the lines of the example of footnote 45. Assume now that the predator must also use one unit of A to produce one unit of output and that it can produce A at a constant average cost of c. Assuming the demand curve and technology of the fringe is the same as in the preceding footnote the equilibrium in this model is also $p^* = (a + bc - A^*)/2b$, $\alpha^* = [a - (b + 1)A^*]/2b$, $A^D = (A - c)/2$, $x^* = [a + bc - A^*]/2$, and $A^{*D} = [a + (2 - b)c - A]/2$, where A^{*D} is the amount of A produced by the predator (assuming $(a + (2 - b)c - A) > 0$). Since α^* doesn't depend on c, it is clearly possible to have $(\alpha^* - c) > 0$.

Asymmetry in the extent of vertical integration enhances the likelihood that this strategy will be profitable. This can be illustrated with the following simple example. Suppose the predator and the fringe each have a fixed proportion technology that requires one unit of the input to produce one unit of output. Assume that only the predator is vertically integrated into input production and it produces a fraction β of its input needs internally. In this case, an increase in α by an amount $\Delta\alpha$ increases the predator's average costs by $(1-\beta)\Delta\alpha$. This increase is smaller than the increase in fringe marginal cost of $\Delta\alpha$. Because market prices depend on fringe marginal costs, the asymmetry in vertical integration may be the basis of a profitable exclusionary strategy.

Of course, there is also an indirect effect on the predator's average cost equal to $\Delta\alpha A(\alpha)\epsilon_A$ arising from the increased purchases required to increase α by $\Delta\alpha$, where ϵ_A is the price elasticity of supply of A. Nonetheless, the asymmetry between the vertically integrated predator and the unintegrated fringe is more likely to make cost-predation profitable, even if there is no input substitutability.[51] This is summarized in the following result.

<u>Proposition 9</u>

> Vertical integration can be anticompetitive, even with a technology that permits no input substitution.

Proposition 9 shows that a fixed coefficient technology is <u>not</u> a sufficient condition for the absence of anticompetitive impact of a vertical merger. (c.f. Bork (1978)).

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[51] The example in the preceding footnote provides proof of this proposition.

VI. Summary and Conclusions

In this paper, we have developed a general model in which a predator can use cost-raising strategies to increase its profits by disadvantaging its rivals. Our results suggest that cost-raising strategies can be an important anticompetitive instrument even if the "predator" is a price-taker in the output market. Moreover, sometimes the anticompetitive effects are more collusive than predatory, in that the fringe's profits sometimes increase. Such strategies can include preemption in upstream input markets and vertical integration, abuse of the regulatory process, advertising and product differentiation.

There is more work needed in this area. First, the models in this paper do not incorporate the possibility of fringe counterstrategies against the predator's conduct. Although we have shown elsewhere (Salop, Scheffman and Schwartz (1984)) that the scope of such counterstrategies are limited, they can provide a constraint on potential cost-raising strategies in some cases. Second, we have focused on the case of a competitive fringe. Although some work has been carried out for oligopoly markets (see, e.g., Salinger (1985)), additional structure could be added to that model and counterstrategies could be studied productively. Third, more detailed analysis of efficiency could allow the welfare results to be made more precise. Finally, models of optimal antitrust policy in a regime of limited market information for the enforcement authorities could be constructed using the structure set out here.

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