IDENTIFYING PARTICIPANTS
IN A PRICE-FIXING CONSPIRACY:
OUTPUT & MARKET SHARE TESTS REEXAMINED

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Abstract

If there is a cartel agreement among a subset of firms in an industry, it should be predicted that all firms in that industry will increase prices. Nevertheless, industry prices alone should not indicate that a particular firm is guilty of that conspiracy. According to the output test and its market share variant if the output or the market share of the firm that claims to be innocent in the collusive activity rises in response to the price increase, that firm's claim should be accepted as true. Using a collusive variant of the dominant firm model, this paper shows that these are not robust tests to reveal innocence or guilt, and characterizes cases where they may pardon a guilty firm (Type I error) or indict an innocent firm (Type II error). This paper also shows that a market share test can not be used to prove a dominant firm's intent for predatory pricing

JEL Classification: G18, L41, K42

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I. INTRODUCTION

Widely accepted economic theory predicts that, all firms in an industry will increase their prices following a cartel agreement, even though that agreement may involve only a subset of firms in that industry. During antitrust litigation circumstantial evidence of collusion may easily persuade a jury that all firms in a highly concentrated oligopolistic industry are guilty of price fixing in violation of Sherman Act Section 1.[1] Therefore, even though data on industry prices can be interpreted to indicate collusion, such data are inconclusive on the question of a particular firm's involvement in such a cartel agreement. An output test --and its market share variant-- has been suggested to predict a fundamentally different observable behavior that would distinguish participants from nonparticipants in a collusive activity. Simply, the output test proposed by Blair and Romano [1990] states that participants in a cartel agreement will decrease their outputs according to the agreed upon quotas, while the nonparticipants will do the opposite and increase their output. Consequently, Blair and Romano argue that if the output or market share of a firm that claim to be innocent rises in response to the price increase, that firm's claim should be accepted as true.[2]. Since historical data on output trends of a firm are readily available, participants can be separated from nonparticipants very easily.

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[1] Such circumstantial evidence may be an increase in price without any obvious increase in cost or demand; presence of excess capacity; lack of any other mode of competitive conduct such as credit, delivery terms, advertising; selling on a delivered price basis, etc. Sherman Act Section 1 holds that "[e]very contract, combination in the form of trust or otherwise, or conspiracy in restraint of trade or commerce among the several States, or with Foreign nations, is declared to be illegal." 15 U.S.C. ∫ 1 (1988). While this is rather general language, it usually refers to conspiracies to fix prices or share markets. See United States v. Socony-Vacuum Oil Co., 310 U.S. 150 (1940), where the Supreme Court, on appeal, sustained the verdict of guilty. Since then, the per se rule toward price fixing in the 1940 decision has been the controlling case. The per se rule says that price fixing is illegal regardless of the circumstances and that there is no allowable defense.

[2] Blair and Romano [1990, 41] draw their analysis upon experience of litigation support in an actual case, "Economic analysis of the facts and circumstances in *E.W. French & Sons, Inc. v. General Portland, Inc.* (Civil Action No. 78-1928-TJH (tx) (C.D. Cal. Oct. 2, 1985)) provides a real illustration of the output test's usefulness. French sold ready-mix concrete, which is made from sand, water, and cement. General Portland produced and sold cement to French and French's rivals. Among other things, French alleged that General Portland and five rivals had conspired, to fix cement prices at artificially high levels in Southern California. A version of the output test was presented to the court and proved persuasive for the defendant General Portland." Blair and Romano [1990, 39] conclude that "...the output test is fairly obvious due to the behavioral differences of participants and nonparticipants. Every cartel participant will decrease its output while the opposite is true for a non-participant."

This paper shows that the output and the market share tests are not robust, and they do not establish sufficient behavioral differences driving a wedge between participants and nonparticipants in a cartel agreement. Using a collusive variant of the dominant firm model we characterize those conditions where the output and market share tests may indict an innocent firm and find innocent a conspirator firm. We demonstrate that market price and output patterns in an industry can be observationally equivalent, whether or not a particular firm in that industry is a participant in the conspiracy. We also show that the same tests may be used to wrongly prosecute a dominant firm for predatory pricing under section 2 of the Sherman Act.

II. AN EXAMPLE

Consider the following three firm oligopoly.

Industry inverse demand function (**D)** : $P = 100 - Q_T$

Firm A's marginal cost function: $MC_D = 20$

Firm B & C's aggregate supply function (S_f): $P = 40 + Q_f$

(see Figure 1)

Suppose that in the past the industry has been dominated by a monopoly firm (firm A). Recently, there has been entry by two minor competitive fringe firms (firms B and C) that competed as price takers. As a result of their entry and contribution to total output prices dropped. Customers welcomed these developments. Suppose that prior to the suspected cartel activity, firm A, the dominant firm, acted as a price leader, and the competitive fringe firms competed on the price it announced. This would result in prices equal to the horizontal sum of the marginal cost curves of firms B and C.[3] In figure 1, we can see that S_f, which is the horizontal sum of the competitive fringe firms' marginal cost curves, intersects the residual demand at a price of $45 and an output of 5 units. Firm A equates its marginal cost to the

[3] Here, to keep the calculations simple, and without loss of generality, we took only two identical competitive fringe firms as price followers. In a more general framework, it would be plausible to have several competitive fringe firms each setting its MC to the price announced by the dominant firm. The aggregated supply function of the fringe firms would be the horizontal sum of their marginal cost curves (S_f in figure 1). The classical cartel problem of individual firm's cheating above their agreed upon quotas would be amplified as the number of fringe firms increase.

marginal revenue corresponding to residual demand, announces the profit maximizing price of $45 and produces 50 units of output. This brings the industry supply to a total of 55 units, firm A's market share to 91percent, and the markets clear.

TABLE 1 ABOUT HERE

Now suppose that almost simultaneously prices in the industry increased for no apparent reason justifying a price increase. A group of unhappy customers who noted that the price rise had been uniform across all three firms filed a lawsuit alleging that the three firms had violated section 1 of the Sherman Act by engaging in a price fixing conspiracy. Although the firms have been somewhat guarded about the causes of the price increase, all three categorically deny the charges and claim innocence of any wrongdoing.

If we assume that firm A is telling the truth about its innocence, then the other producers must have embarked on a price fixing conspiracy while firm A continued to pursue an independent profit maximizing pricing policy. When the cartel agreement between firms B and C was established, the two cartel members agreed on the production quotas so as to maximize their joint profits, taking into account that firm A would continue to produce that level of output at which its marginal cost equals the marginal revenue corresponding to the residual demand after whatever output the cartel selected. However,

although it looks peculiar that a dominant firm with a 91percent market share in a three firm oligopoly would be a price leader and at the same time behave passively with respect to the collusive acts of two minor firms, this is a natural consequence of the Stackelberg type price leadership behavior. Besides, this passive behavior in which firm A accepts the output leadership of the other two firms is very profitable. Firm A as a passive nonparticipant enjoys the benefits of output quotas the cartel members commit themselves, while continuing to act as a price leader to maximize its profits independently. Clearly this means that firm A has to produce that residual level of output at which the markets will clear at the new announced price.

In this variant of the dominant firm model, we first find firm A's residual demand curve , which equals the market quantity demanded minus the conspirators' output had they been acting competitively at all prices. For firm A, which claims noninvolvement in any price fixing conspiracy, this is a safe assumption, becuse it is the worst case scenario that yields firm A a security level of profits. Secondly, we find the residual demand's corresponding marginal revenue curve in order to find the profit maximizing price firm A would announce. These curves are d and MR respectively. Firm A maximizes its profits by producing that level of output where the residual marginal revenue, MR, equals its marginal cost, which is depicted as MC_D . Suppose that firm A adopts a new price of $50 which the conspirators also adopt. The cartel's commitment to their quotas increases profits of all firms, participants' and the nonparticipants's alike. It is important to notice that the fringe firms' price will be bid up to the newly announced price of $50 regardless of the quantity setting conspiracy between them. If either firm B or C (or both) did not increase its price, all customers would place orders with it at the old price. But none of the fringe firms would want to sell additional output at the old price, because doing so would reduce its profits (see Figure 1). Competitive bidding among firm B's and firm C's customers who now face an alternative price of $50, will bid up their price until it is in line with firm A's price of $50. It should be noted that prior to the formation of a cartel agreement between firms B and C, firm A produced 50 units while each of the colluders produced 2.5 units. Consequently, industry output (55 units) equals the sum of fringe firms' output (5 units) and that of firm A's output (50 units). If the fringe firms behaved

competitively as they would claim to have behaved, their output would have risen from 5 units to 10 units following the new price announced by firm A because their aggregated marginal cost (S_f) equals the price of $50 at an output of 10 units. On the other hand, if they would have behaved competitively, firm A's output would have fallen to 40 units and its profits would have declined. But then firm A would revert back to the initial price of $45.[4]

All three firms benefit from a price increase whether or not there is a partial conspiracy between firms B and C, or a conspiracy encompassing all three firms. The economic results are counterintuitive. First, each of the conspirators produces exactly the same output as before the collusion started. Therefore, an output test to prove their conspiracy would fail. Secondly, their collective market share increased from 9 percent (5/55) to 10 percent (5/50) which reduces the overall concentration in the industry, which is a good defensive weapon by the attorneys of firms B and C. Hence, the market share test to identify them as conspirators would also fail.[5] What is even more counterintuitive is that if the cartel breaks down -- as it often does --, and firms exceed their total quotas of 5 units such that the $50 price can not be maintained, then firm A can increase its output and market share by following a short-run profit maximization strategy and force them into producing a 5 unit total output.

This last point is also in contrast to the general assertion in the literature (see, for example, Bhagwati [1970], Gaskins [1971], Baron [1973]). Previous literature on the dominant firm with a competitive fringe has contended that the dominant firm will either maximize its present value by charging the short

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[4]Obviously, the ultimate constraint on market power by a dominant firm is the ease with which competing fringe firms can expand their output and grow, and new competitors can enter. In practice, however, competitors' ability to survive and grow, and their size relative to the incumbent dominant firm hinges upon the dominant firm's response. If the dominant firm is hostile and predatory, in the example above, a limit price of $40 would keep all fringe firms out and would probably call for antitrust action.

[5]Blair and Romano [1990, 50-51] propose using the market share test instead of the output test, particularly when there is a shift in demand during the period of suspected collusion. A decrease in demand would generate greater incentives for collusion since profits will be suppressed. On the other hand, an increase in demand, ordinarily, would cause the price to rise without any price fixing conspiracy. But if there is collusion, the price increase will be greater, and also, identifying a pre-conspiracy benchmark price will be more difficult. Blair and Romano [1990, 51] observe that, "Beginning with the preconspiracy market shares of the industry members, one can examine changes in market shares."

run profit maximizing price (setting price at the limit price and precluding any competition), or by following a mixed strategy balancing current profits and future market share it will optimally manage its market share. The basic premise is that in the absence of collusion, the expansion (or rate of entry) of the competitive fringe firms is a function of current product price. Accordingly, it has been claimed that, by following a short-run profit maximization strategy, the dominant firm would allow its market share to decline over time. It follows that a dominant firm with a high current price and high profit levels is sacrificing some future profits through erosion of its market share (see Worchester [1957]; Pashigian [1968]; Scherer [1990] 225, 357; Krouse [1990] 110). Our static example shows that the decline in the market share of the dominant firm which is facing expansion by a competitive fringe is not a general result: firm A's market share will increase to 91 percent, which is its old market share prior to formation of the cartel between the firms B and C. Under different circumstances -- independent of the collusion scenario above -- this rather short-run and myopic profit maximization behavior may be mistaken for predatory pricing and/or entry blockage; consequently firm A may be sued in violation of section 2 of the Sherman Act[6]

Third, firm A --the nonparticipant dominant firm-- produced less output after the formation of the cartel than before: 45 units versus 50 units. When the cartel members set their production quotas at 2.5 units each, setting a higher price and cutting down production became profitable for firm A. An output test would obviously place firm A into the ring of conspirators even though it is a nonparticipant in the cartel

[6] Sherman Act Section 2 prohibits monopolization, attempts to monopolize, and combinations and conspiracies to monopolize "any part of the trade or commerce among several states, or with foreign nations." If excessive expansion by the fringe firms, say through entry of new firms, causes the dominant firm's profits fall to the point that it is better off trying to supply the entire market by just undercutting the least-cost fringe supply, the market will be monopolized. In this limiting case, since the real intention cannot be inferred, the short-sighted profit maximizing response by the dominant firm can be mistaken for a deliberate predatory pricing and, therefore, subject to prosecution in violation of Section 2. A classic example, discussed by the Supreme Court [Matsushita Electric Industrial Co. v. Zenith Radio Corp. (475 U.S. 574 (1986)] is a firm that reduces its prices, not because it has lowered its costs, but rather to induce the exit of rivals so that it may later recoup the costs of its price cutting through monopoly profits. Naturally, in order to be able to recoup its costs of predation, the firm must be able to keep potential competitors from entering the market during its recoupment period. A majority of five supreme court justices announced their view that such a practice should be expected to occur infrequently.

agreement. Only a decrease in total production (5 units) by firm A would have accommodated a higher price of $50, otherwise the market would not have cleared. Accompanied by the decrease in output, firm A's market share also decreases by the same amount the other firms' share increase. If firm A was part of the conspiracy a drop in market share coupled with a decrease in its output would easily identify it using the output and the market share tests, but incorrectly pardon firms B and C. But if, as we have modeled, firm A is not part of the conspiracy and is simply reacting to the output response of its competitors in search of the profit maximizing price, the output and the market share tests incorrectly indict firm A, but fail to indict firms B and C which are the actual conspirators.

Finally, if all three firms reached an understanding through wholly tacit means, again, these tests fail to capture all culprits.[7] In a tacit agreement firm A would unilaterally restrict its output and announce a higher price (say $50) and expect that the other two firms would behave similarly. If firms B and C collectively increase their outputs to 10 units in response to this high price, firm A would be voluntarily sacrificing short run profits in search of a tacit cooperation and coordination. Failing to induce that cooperation firm A would then return to the initial low price of $45. But, what if firms B and C increase their output to 6 units or 7 units rather than their capacity of 10 units at $50 price? All three firms are still better off than before and all three have the incentives to engage in an overt or tacit agreement to increase prices.[8] A tacit coordination to restrict output is as much a restraint over trade as overt agreements and should be deemed a violation of antitrust laws [see Posner, 1969; Turner, 1962]. Yet, the output test and the market share test would single out firm A as the only violator of antitrust laws concluding that the other two firms are innocent.

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[7] Under the current law it is insufficient to show that the industry price is consistent with collusive behavior. Viscusi, Vernon & Harrington[1992, p.134] state that, "Current law is such that to prove that firms are guilty of price fixing, one needs a "smoking gun," for example a memo from a CEO to his competitor stating what the collusive price is to be. It is insufficient to show that the price decisions of firms are consistent with firms acting collusively. Though firms that collude without overtly communicating result in the same welfare losses as does a cartel that does overtly communicate, only the latter can be prosecuted under Section 1 of the Sherman Act".

[8] If firm A announces a new price of $50 and firms B and C increase their collective output not exceeding 8.33 units, then all firms would be strictly --although disproportionately -- better off. Obviously, firm A does have the incentive to initiate such a tacit unilateral agreement.

The economic intuition behind this result is that firm A , as a dominant firm and Stackelberg price leader incorporates into its price decision the output response of the competitive fringe at each and every price level, and picks that price which maximizes its profits. However, the collusive behavior of the fringe firms and their exogenously determined output quotas enables the dominant firm to announce higher prices without the fear of a higher output response and to the mutual benefit of all firms in the industry. Obviously, a post cartel price of $50 is an artifact of our example and the result of our premise that firm A is innocent of the conspiracy. If firm A is a participant in the collusion, or if it is informed and assured about the fringe firms' committment to a collective quota of 5 units, its profit maximization problem calls for a price of $57.5 and a corresponding output of 37.5 units. While this higher price yields higher profits to all firms, it also provides higher incentives for the breakup of the cartel and puts firm A in a less defensible position for its noninvolvement in the conspiracy.[9]

(see the appendix for proofs and generalization of our results)

III. CONCLUSION

Contrary to the common belief in antitrust litigation an output test and its market share variant do not lend themselves to easy identification of participants and nonparticipants in collusive agreements. Cartel agreement among a subset of firms in an oligopolistic industry results in a higher industry price and a lower total output. A general presumption is that if all firms in the industry are active participants of the cartel, then their individual outputs should also fall. Therefore, a firm whose output -- and market share -- increases along with increasing price should be deemed innocent. While this may be intuitive and correct for a majority of the cases, it is, nevertheless, not a general result and inconclusive in identifying a

[9] Basenko and Spulber [1989, 409] argue that announcement of antitrust policy has two effects, " The quantitative effect is that existing cartels may choose to lower markups to reduce the risk of prosecution. The qualitative effect is that firms may choose not to collude at all and thus set prices competitively". It is reasonable to assume that firm A, under the 'quantitative effect', would increase its price with caution. Moreover, a higher price, and the resulting higher profits beg the question of how the cartel quotas are determined. Given the complexity of the economic analysis of such bargaining problems, this is not the place to address them.

participant of a conspiracy in violation of Sherman Act. Section 1. We showed that cartel agreements among all firms in a highly concentrated oligopolistic industry where a subset of the firms increase or maintain their output -- and increase their market shares -- while others do the opposite to the mutual benefit of all firms, are possible. In those cases the aforementioned tests fail: they find innocent a subset of the firms involved in the conspiracy and indict a subset of others not involved.

Interestingly, one corollary of our results is that a dominant firm, in passively responding to an expanding competitive fringe by decreasing price may increase its output and market share -- and increase total concentration in the industry --, thereby inviting a law suit for violation of Sherman Act Section 2. Despite the fact that this outcome of lower prices is desirable from a policy perspective, welfare judgments are sensitive to the source of the market power, and one may be concerned about the price setting role of the dominant firm and the consequent market concentration. Obviously, the ultimate constraint on market power by a dominant firm is the ease with which competing firms can grow and new competitors can enter. In practice, however, a competitors ability to enter, survive and grow, and their size relative to the incumbent dominant firm depends upon the dominant firm's response. Two type of response by the dominant firm should be expected: one that is accommodating and adjusting to increasing competition, and the other hostile and predatory. Our results point out to cases in which not only the output but also the market share of the dominant firm increase regardless of the underlying intent in that response. The second type of predatory response calls for a Section 2 antitrust case. However, from an antitrust prosecutor's perspective the two type of responses are observationally equivalent: both result in a lower market price with a dominant firm that is increasing its output and market share, and a competitive fringe of firms with a declining market share. Consequently, output and market share data alone also fail to justify either an antitrust action or lack of an antitrust action against a dominant firm.

Unfortunately, this gray area generated by the output test and its market share variant creates added incentives for collusion, whether tacit or overt, and for predatory pricing since many of the culprits would escape under these tests.

APPENDIX

In this appendix we analyze the algebra of the dominant firm's profit maximization problem and generalize to the three cases of the change in output and market shares when the supply of the fringe firms exogenously change.

Consider the following simple model. The overall inverse demand function of the industry is given by $P = A\text{-}BQ_T$, and the dominant firm's own effective or residual demand function is given by $P = a\text{-}bQ_D$. The supply curve, S_f, of the competitive fringe, which is the horizontal summation of the fringe marginal cost curves, is given by the function $P = d + Q_f$. Without loss of generality, we assume that marginal cost of the dominant firm is constant for the relevant range of output: MC_D = . (see Figure 1)

To maximize profits, the dominant firm equates marginal revenue with marginal cost and obtains its profit maximizing output.

$$Q_D = \frac{a\text{-}\gamma}{2b} \quad . \tag{1}$$

Substituting (1) into residual demand function, we arrive at the market price:

$$P = \frac{a+\gamma}{2} \tag{2}$$

The fringe supplies where $MC = P$, implying that

$$Q_f = \frac{1}{\delta}\left(\frac{a+\gamma}{2} - d\right) \tag{3}$$

Total industry output is given by (1)+(3):

$$Q_T = Q_D + Q_f = \frac{1}{2}\left\{\frac{1}{\delta}(a+\gamma\text{-}2d) + \frac{1}{b}(a\text{-}\gamma)\right\} \tag{4}$$

Market share of the dominant firm is given by,

$$\alpha = \frac{Q_D}{Q_T} = \frac{(a-\gamma)\delta}{b(a+\gamma-2d)+\delta(a-\gamma)} \quad (5)$$

Note that γ (marginal cost of the dominant firm), d, and δ (vertical intercept and slope of the fringe supply function) are exogenous to the model and together they determine the magnitude of a, b, P, and α.

Next, through algebraic manipulation, we obtain the vertical intercept and the slope of dominant firm's residual demand function. They are given by the following equations respectively:

$$a = A\text{-}B\left(\frac{A\text{-}d}{B+\delta}\right) \quad (6)$$

$$b = B\left(\frac{\delta}{B+\delta}\right). \quad (7)$$

Next we work out the comparative statics of the effect of a change in the competitive fringe's supply function on the market shares. The supply curve S_f of the competitive fringe is the horizontal sum of the individual marginal cost curves. We assume rising marginal costs ($\delta>0$) for the fringe firms to guarantee that the fringe remains relatively small. For simplicity, we will let only the slope (δ) of the supply curve to change to depict the changes in output decisions of the fringe firms.[10] Consequently, entry and/or short-run expansion by the rival fringe firms would cause δ to decrease.

Partially differentiating equation (5) w.r.t. δ we get:

$$\frac{\partial}{\partial} = \frac{[\ a'+(a-\ )]b(a+\ -2d)+\ (a-\ )]-\ (a-\ )[b'(a+\ -2d)+d'(\ +b)+(a-\ )]}{D^2}$$

where D denotes the denominator of equation (5).

It is easy to show that $a' = \frac{\partial a}{\partial \delta} = \frac{\frac{B(A-d)}{(B+\ )^2}}{}$ and $b' = \frac{\partial b}{\partial \delta} = \frac{B^2}{(B+\ )^2}$.

Substituting a', b' and equation (7), and further simplifying we obtain:

[10] Suppose all fringe firms have MC given by $P = d + \delta^* q_i$. Then fringe supply curve is given by $P = d + \frac{\delta^*}{N} Q_f$, where N is the number of fringe firms. Hence, it is immediate that δ declines in N.

$$\frac{\partial\alpha}{\partial\delta} = \left(\frac{\delta B}{D^2(B+\delta)^2}\right)[2b(\gamma-d)(A-d) + \delta(a-\gamma)(a+\gamma-2d)] \quad (8)$$

It is evident that the coefficient $(\delta B/D^2(B+\delta)^2)$ is always positive. Since we are looking for the sign of $(\partial\alpha / \partial\delta)$ rather than the magnitude of it, we ignore the coefficient. Manipulating the term in brackets by dividing it by 2 we get:

$$b(\gamma-d)(A-d) + \delta(a-\gamma)\left(\frac{a+\gamma}{2} - d\right).$$

But, *(a+)/2 = P*. Hence, the sign of $(\partial\alpha / \partial\delta)$ is determined by

$$b(\gamma-d)(A-d) + \delta(a-\gamma)(P- d).$$

Since by construction *(A - d)* is always greater than *(P - d)*, we can write:

$$[b(\gamma-d) + \delta(a-\gamma)](P- d) < \frac{\partial\alpha}{\partial\delta} < [b(\gamma-d) + \delta(a-\gamma)](A- d) \quad (9)$$

Equation (9) holds because the the terms in brackets in both sides of the inequality are equal. Since both *(A - d)* and *(P - d)* are non-negative, the sign of $\frac{\partial\alpha}{\partial\delta}$ is determined by the sign of

$$b(\gamma-d) + \delta(a-\gamma). \quad (10)$$

From the price elasticity of competitive fringe supply curve, ($_s$), we have

$$\delta = \frac{1}{s}\frac{P}{Q_f} \quad (11)$$

Similarly, price elasticity of dominant firm's residual demand curve can be manipulated to yield:

$$b= -\frac{1}{D}\frac{P}{Q_D} . \quad (12)$$

Substituting (11) and (12) into (10) we obtain:

$$-\frac{1}{D}\frac{P}{Q_D}(\gamma - d) + \frac{1}{s}\frac{P}{Q_f}(a - \gamma) . \quad (13)$$

The sign of (13) ultimately determines the direction of change in relative market shares. Absolute value of *(- d)* is the measure of cost advantage of the dominant firm at zero output level, and no restriction is placed on its sign. On the other hand, (a-γ) is non-negative by construction. Hence, from (13) we have,

$$-\frac{1}{D}\frac{P}{Q_D}(\gamma - d) + \frac{1}{s}\frac{P}{Q_f}(a - \gamma) \geq 0$$

Which can be easily manipulated to obtain,

$$-\frac{D}{s} \geq \frac{Q_f}{Q_D}\frac{(d-\gamma)}{(a-\gamma)} \qquad (14)$$

Note that there are two conflicting effects at work as the competitive fringe output contracts (in the sense of a leftward rotation of the supply curve of the fringe): (i) the fringe output tends to decrease at any given price, and (ii) the residual demand curve for the dominant firm shifts to the right, leading to higher price and higher fringe output. Which effect dominates depends on the elasticity of fringe supply and elasticity of the residual demand. From (14) we obtain the following cases:

Case I : $(\gamma > d) \Rightarrow \frac{\partial\alpha}{\partial\delta} > 0$

which implies expansion of output by the competitive fringe firms decreases the dominant firm's market share and contraction of their output increases the dominant firm's market share.[11]

Case II : $(\gamma \leq d)$

(i) $\frac{\partial\alpha}{\partial\delta} = 0$ if and only if $-\frac{D}{s} = \frac{(d-\gamma)}{(a-\gamma)}\frac{Q_f}{Q_D}$

which implies expansion by the fringe firms brings about a proportionate output response by the dominant firm. Thus, the market shares do not change.

(ii) $\frac{\partial\alpha}{\partial\delta} > 0$ if and only if $-\frac{D}{s} < \frac{(d-\gamma)}{(a-\gamma)}\frac{Q_f}{Q_D}$

which implies the market share of the dominant firm declines as competitive fringe expands (same as case I).

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[11] $\frac{\partial\alpha}{\partial\delta} > 0$ means that as slope of the competitive fringe supply curve ,(δ), increases the market share of the dominant firm (α) increases. Conversely, when δ decreases α decreases. To our knowledge this is the generally recognized result (see Worchester [1957], Bhagwati [1983], Scherer [1980,1990]).

(iii) $\frac{\partial \alpha}{\partial \delta} < 0$ if and only if $-\frac{D}{s} > \frac{(d-\gamma)}{(a-\gamma)} \frac{Q_f}{Q_D}$.

This is the counter-intuitive case where the dominant firm reacts to expansion of the competitive fringe firms by more than a proportionate increase in its output. The dominant firm's output and market share increases in this case. The limiting case under this scenario implies the possibility that the dominant firm can keep out all rival firms at the limit price d. Conversely, if the fringe firms form a cartel and agree on keeping their output levels constant in the face of a price increase, it is in the best interest of the dominant firm to increase price, decrease its output and market share which would make it a suspect of participating in the conspiracy under the proposed output and market share tests.

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