Preliminary

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Aftermarket Exclusion

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Abstract:

A model of aftermarket exclusion is presented that includes an independent service organization. The model employs a modified version of sequential exclusion, a strategy first suggested by Rasmusen, et. al. (1991), and allows for strategic contracting between the independent service organization and upstream firms. The presence of the independent firm makes exclusion more costly in markets where buyers' preferences vary and systems are differentiated, but *not* in markets where buyers and systems are homogeneous. Furthermore, the fact that exclusion is more costly when markets exhibit differentiation suggests that the presence of service organizations may mitigate the welfare losses associated with exclusion in these circumstances, namely, the reduction in output *and* loss of product variety. When this presence is insufficient to promote entry, antitrust enforcement may provide buyers some protection, as observed in a current antitrust case, *United States v. General Electric Co.*

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1. Introduction

The emerging aftermarket literature focuses on, *inter alia*, the incentives of durable good manufacturers to exploit their installed base customers and the implications for welfare (see, Borenstein, et. al. (1995,1996), McCabe (1997), Shapiro (1995)). Unwilling to commit to "low" prices in their proprietary aftermarkets, manufacturers compete for sales by setting equipment prices too low. This distortion in relative prices may contribute to significant allocative inefficiency. In some cases this inefficiency may arise from illegal aftermarket practices (*United States v. General Electric Co.*, 1997-1 Trade Reg. Rep. (CCH) ¶ 71,765 (denying motion to dismiss)). In *United States v. General Electric Co.* (henceforth, *US v. GE*) it is alleged that GE's licensing policy regarding advanced diagnostic software for medical equipment has resulted in less competition in GE's and other vendor's aftermarkets. GE licensees -- large hospitals with in-house service capabilities -- are prohibited from servicing *any* vendor's medical equipment that is operated outside of their own facilities.[1]

The broad scope of the restriction suggests that GE's motivation for its licensing policy may extend beyond the aftermarket exploitation hypothesis. Indeed, in *US v. GE* the government asserts that the license restriction has reduced competition in the sale of medical *equipment*. The government's complaint describes how equipment sales are dependent on timely service support and that, because of minimum efficient scale effects, vendors lacking a sufficient local installed base suffer a competitive disadvantage. The GE licensees are considered high-quality, low-cost service providers. Since they are prevented from servicing these other vendors' equipment, the effect of the restriction may

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[1] Furthermore, the government asserts that GE's licenses are "unrelated to any of GE's legitimate interests in licensing its software..." In other words, GE's licenses are naked restraints.

be to limit, if not block, entry, especially in sparsely populated regions.[2]

The notion that incumbent firms can deter entry through the use of exclusionary contracts with customers has received considerable attention in the antitrust literature over the past decade. Two types of arguments have been made. Aghion and Bolton (1987) consider exclusionary contracts between an incumbent and buyer(s) that include finite stipulated damages. Entry occurs only if the entrant's costs are sufficiently low to compensate buyers for damages. *Partial* exclusion is profitable because it extracts rents from the entrant when entry does occur (contracts that fully exclude offer no benefit). Innes and Sexton (1994) extend this framework to show that coordinated buyer/entrant contracting can reverse this result: exclusion occurs only when entry is inefficient. The alternative exclusion argument, first described by Rasmusen, Ramseyer and Wiley (1991) and later refined by Segal and Whinston (1996), involves less complex contracting and no cost uncertainty (henceforth, RRW and SW, respectively). *Full* exclusion occurs when a critical number of buyers sign exclusive agreements. Furthermore, exclusion is more likely when contract offers are made sequentially rather than simultaneously. Although both strategies allow the incumbent to, in RRW's words, "...take advantage of its unity and the customer's disunity," the former approach permits the incumbent to exploit each customer's knowledge of their place in the queue and the number of accepted offers.[3]

Though these arguments are fairly general, their two-dimensional vertical structure -- sellers and buyers -- is inadequate for analyzing exclusion that is facilitated by

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[2] In such regions -- *US v. GE* was filed in the U.S. District Court, District of Montana -- local *independent* service organizations, those unaffiliated with any vendor or medical facility, are typically small one or two-person operations providing service for old, less complex equipment in the most remote locations. Hence, they are not viable service alternatives for potential entrants.

[3] In most systems markets (equipment plus service), sequential play is a more realistic assumption. Buyers are in the market at different times, and sign contracts of varying lengths

aftermarket practices. If durable goods manufacturers' aftermarkets are not fully proprietary, then any useful model of exclusion must account for the strategic role played by alternative service organizations (whether independent or integrated downstream).[4] The facts of *US v. GE* suggest that a model of *aftermarket* exclusion may involve agreements with buyers, service organizations or both.

In this paper I propose a model of aftermarket exclusion that includes these alternative service organizations. The model borrows the concept of sequential exclusion from RRW and SW and extends it by allowing for strategic contracting between the service organization and the incumbent or entrant. My preliminary results indicate that the presence of the service organization makes exclusion more costly in markets where buyers' preferences vary and systems are differentiated, but *not* in markets where buyers and systems are homogeneous. This is notable, for several reasons. First, the existing exclusion literature has heretofore focused its attention on homogeneous markets. Second, most systems markets, including medical equipment, exhibit significant differentiation. Third, the fact that exclusion is more costly in differentiated markets suggests that the presence of service organizations can mitigate the welfare losses associated with exclusion, namely, the reduction in output and loss of product variety. When the presence of an alternative service organization is insufficient to promote entry by another equipment vendor, antitrust enforcement may provide buyers some protection, e.g. in *US v. GE.*

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[4] An OEM's aftermarket is proprietary when it has monopoly control over critical replacement parts, software, etc. that are necessary for servicing its equipment. In the case of medical equipment, GE faces competition for most aftermarket inputs, with the exception of advanced diagnostic software. Although GE sells its equipment bundled with basic diagnostic software, this software is less efficient, i.e. repairs take considerably more time.

The paper is organized as follows. After describing the model and reviewing the concept of sequential exclusion, I analyze the problem of aftermarket exclusion in two cases: (1) homogeneous buyers and systems and (2) diverse buyers and differentiated systems. I conclude with a discussion of the results and directions for future research.

2. The Model

The exclusion game considered here involves four types of players: (1) the incumbent firm, *I*, who sells both equipment and related aftermarket services , (2) an entrant firm, *E*, with similar capabilities, (3) *N* buyers for these "systems" (equipment plus service), and (4) an efficient (in-house) service organization, *SO*. The game consists of three periods. In period 1, *I* may offer each buyer an exclusionary systems contract. This contract commits the buyer to purchasing systems only from the incumbent. *I*'s offers are made sequentially, the buyer's acceptance is permanent, and it is observed by all other players in the game. In period 2, *E* decides whether to enter or not. If it chooses to enter, it has the option to outsource service to *SO*. If *E* elects to outsource, it offers a (non-exclusive) contract to *SO*. The incumbent may make a counter-offer to *SO* that induces *SO* to reject *E*'s offer. In period 3, active firms set prices, p_j, for systems. If the incumbent decides to offer exclusionary contracts in period 1, it is assumed that *I* is able to discriminate between those buyers who accepted the offer and those that did not (the "free" buyers), with prices p_S and p_F, respectively. If *E* enters, it competes with *I* for sales to free buyers, setting a price p_E. (Competition is Bertrand)

Each buyer has demand for systems, $Q_{ij}(p_j)$, $Q_{ij}'(p_j) < 0$, where *i* denotes the buyer type and *j* (= *I*, *E*) indicates whether the system is purchased from the incumbent or entrant.[5]

[5] Implicit in the notion of a single system price is the ability of vendors to sign long-term service contracts at the same time equipment purchases are made. Given this assumption, vendors have an incentive to negotiate terms that minimize costs, i.e. terms that encourage buyers to use

Buyer *i* chooses the system *j* which provides it with the greatest net surplus,

$$\max_j \{\int_{p_j}^{\infty} Q_{ij}(p)dp\}.$$

In case of period 3 ties, I assume that the vendors split the free buyers.

The average cost of each system is $C(n_j)$, where n_j is an integer corresponding to the number of buyers serviced by firm j ($= I, E$). $C(\bullet)$ is common across firms and exhibits limited scale effects. That is, $C(n_k) > C(n_k+1)$ for $n_k < Z$, and $C(n_k) = C$ for all $n_j \geq Z$. To rule out natural monopoly, $2Z < N$ (this last assumption is most relevant when the homogeneous case is examined). It is assumed that the scale effects are due to the service component and that marginal equipment production costs are constant.[6]

RRW and, later SW, provide sufficient conditions for exclusion in a traditional vertical context. Since these results are the starting point for the analysis in this paper it is helpful to review them at this point. For exclusion to succeed enough buyers, N^*, must sign exclusionary contracts to deter entry. To learn whether this is feasible for a specific set of parameters, N^* must be first calculated, and second, the profitability of the exclusion strategy must be determined.

For example, suppose that $Q_{ij}(p_j) = Q(p_j)\ \forall\ i,j$ (identical buyers and systems) and that the

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the optimal amount of service. Thus, regardless of the *system* price, a fixed amount of service is purchased. Note that this assumption eliminates the usual source of aftermarket inefficiency, namely, exploitation.

[6] This cost structure is similar to RRW's. SW criticize this formulation because *E*'s entry decision is indeterminate. However, this problem can be eliminated by assuming that *I* and *E* always incur some (small) fixed per/system cost of selling when they are active in period 3. Thus, *E* only enters if it expects to make sales and can recover the fixed costs. In the case of medical equipment this is a very realistic assumption.

SO is unavailable to *E* in period 3. Let *S* equal the number of buyers who sign the exclusionary agreements.

LEMMA 1 : Entry is deterred if $S \geq N^*$, where N^* is defined as the lowest integer such that

$$N^* > N - 2Z \qquad (1)$$

PROOF:

Following RRW, equation (2) can be rewritten as

$$Z > \frac{1}{2}(N - N^*) \qquad (2)$$

The right-hand side of (3) is the market share of *E* if $p_F = p_E = C$. Because that market share is less than *Z*, *E*'s average cost exceeds *C*. This is unprofitable since *I* will match *E*'s price when $p_E = C$. If $p_E > C$, *E* cannot make any sales since *I* can undercut that price; *E*'s profits are negative (see footnote 7). If $p_E < C$, *E*'s profits are also negative.

To motivate the principal result of the exclusion literature, consider the following argument (made by RRW and modified by SW). Number the *N* sequential stages of period 1 in reverse order by $T = 1, \ldots, N$, where stage *T* is the one at which *T* buyers remain to be offered contracts. The incumbent's decision whether to exclude at stage *T* depends on the comparison of the continuation benefits and costs at this stage. Both values depend on *S*, the number of buyers who have already signed exclusionary contracts.

The incumbent's cost of exclusion at stage *T* depends on buyers' willingness to accept exclusionary contracts, which is in turn determined by their expectation of the chance of exclusion if they reject. Suppose each remaining buyer is critical for exclusion, i.e.

$S + T = N^*$. Then each remaining buyer will not accept the incumbent's offer unless they receive a payment, X^*, equal to the amount of consumer surplus lost if exclusion is successful, CS(C) - CS(p^m), or

$$\int_C^\infty Q(p)dp - \int_{p^m}^\infty Q(p)dp$$

where p^m (= arg $\max_p$(p-C)Q(p)) is I's optimal period 3 price to buyers that have signed contracts, as well as to those who haven't if E is inactive. Hence, the continuation cost of exclusion is $(N^* - S)X^*$. The continuation benefit of exclusion is $(N - S)\Pi$, where $\Pi = (p^m - C)Q(p^m) < X^*$. The Incumbent will choose to exclude if and only if these benefits exceed the costs: $(N - S)\Pi \geq (N^* - S)X^*$. This expression can be rewritten as

$$S \geq \frac{N^*X^* - N\Pi}{X^* - \Pi} \qquad (3)$$

In some cases, exclusion can occur at zero continuation cost. Suppose there is one more buyer left than is necessary for exclusion, i.e. $S + T = N^* + 1$ and $S < N^*$. If condition (3) is satisfied, the next remaining buyer realizes that its rejection of a contract does not prevent the incumbent from proceeding with exclusion. Hence, this buyer is willing to sign a contract for free. Since this reasoning applies to all subsequent buyers, the continuation cost of exclusion is zero.

However, if condition (3) is violated, rejection by the next buyer prevents exclusion. This buyer will sign a contract for no less than X^*. More generally, the incumbent needs to sign up sufficient buyers for X^* so that condition (3) is satisfied. Depending on the cost of this strategy, the incumbent may or may not choose to exclude.

SW find that the continuation cost of exclusion depends on two numbers: (1) the number of "captured" buyers, S, and (2) the number of buyers left in excess of those necessary for exclusion, $k = T + S - N^*$. They define S_k to be the minimum number of captured buyers required for costless exclusion at a stage where there are k more buyers left than is necessary for exclusion. They demonstrate that the sequence S_k can be described as:

$$S_0 = N^*$$
$$S_{k+1} = \frac{S_k X^* - N\Pi}{X^* - \Pi} \quad \textit{for } k \geq 0$$

When $k = 0$, each remaining buyer is necessary for exclusion, and so for the continuation cost to equal zero it must be that $S \geq N^* = S_0$. Earlier we observed that when $k = 1$ a zero continuation cost can be achieved if condition (3) is satisfied. This is equivalent to $S \geq S_1$.

Using the S_k, SW then prove the following proposition:

PROPOSITION 1: *When the incumbent makes offers to buyers sequentially, exclusion occurs in a subgame perfect equilibrium if and only if* $S_{N-N^*+1} \leq 0$. *If exclusion occurs, the cost of exclusion is* $\max\{x^* S_{N-N^*}, 0\}$. *Otherwise, no buyer signs an exclusionary contract.*

This proposition provides a simple method to determine whether exclusion is profitable in the standard vertical context. Extending its usefulness to the more complex case of aftermarket exclusion is relatively straightforward. However, it is first necessary to explore the implications of this distinct strategic environment. I consider two general cases: (A) identical buyers and identical systems and (B) diverse buyers and differentiated systems.

A. Identical Buyers and Systems

In this first case, I assume that $Q_{ij}(p_j) = Q(p_j)\ \forall\ i,j$ and that the *SO is* available to E in period 3. Furthermore, assume that Π, X^*, and N^* take on values that together satisfy the critical exclusion condition in proposition 1, $S_{N-N^*+1} \leq 0$. Does the availability of SO influence this result? Anticipating successful exclusion in period 3, E can offer *SO* a contract to provide service at cost C in exchange for a lump sum payment, L_E. If $N - S > 0$, then entry is feasible.[7] However, since post-entry profits for E are zero, E cannot afford $L_E > 0$. Because exclusion generates positive profits for I, the incumbent can make a counter-offer, L_I ($= \epsilon > 0$), to *SO* in period 2 that ensures exclusion in the final period. In other words, so long as buyers and systems are identical the availability of an alternative service organization SO does not alter the exclusion equilibrium.

B. Diverse Buyers and Differentiated Systems

Suppose that buyers consist of two types, B_I and B_E, and that the vendors' systems are differentiated across some important dimension(s). Given a common price p for systems, buyers of type B_I place a higher valuation on systems sold by I, i.e. $Q_{II}(p) > Q_{IE}(p)\ \forall$ p. Similarly, buyers of type B_E prefer E's systems, i.e. $Q_{EE}(p) > Q_{EI}(p)\ \forall$ p. There are N_E buyers of type B_E, and $N - N_E$ buyers of type I. I assume that $N - N_E > Z$.[8] *SO* is available to E.

Absent strategic behavior by I, this market structure implies that entry is always profitable for E, even for $N_E < Z$. With *SO*'s assistance, E can always set a price, $p_E \geq C$, so that $CS_{EE}(p_E) \geq CS_{EI}(C)$, i.e. buyers of type B_E select E's system. Since it is costly for I to have all buyers of type B_E sign exclusionary contracts (remember, $X^* = [CS_{EI}(C)$ -

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[7] If $N - S = 1$ assume that the sole remaining free buyer chooses the entrant.

[8] This assumption, together with the demand structure, implies that E cannot win any type B_I buyers.

$CS_{EI}(p_F^m)] > \Pi = (p_S^m - C)Q_{EI}(p_S^m))$ exclusion may only succeed if *E* does not contract with *SO*.[9]

To determine whether exclusion is profitable for *I*, two issues need to be considered: (1) the impact of successful exclusion on *I*'s profits from sales to buyers of type B_I, and (2) the relative costs of exclusionary contracts with buyers of type B_E and strategic contracting between *I* and *SO*. To begin, consider Proposition 1 again. It can be restated as follows:

Exclusion occurs if and only if $N \cdot \Pi - \max\{x^* S_{N-N^*}, 0\} \geq 0$.

The first term on the left-hand-side of the inequality, $N \cdot \Pi$, corresponds to the benefits of exclusion. In the present case, there are two potential sources for these benefits, $N_E \cdot \Pi$ and $(N-N_E) \cdot \Delta\pi$, where the latter expression refers to the increase in I's profits from sales to buyers of type B_I.[10]

The second term on the LHS, $\max\{x^* S_{N-N^*}, 0\}$, represents the costs associated with the N^* exclusionary contracts in the SW framework. However, since it may be too costly to block entry via such contracts, we also need to consider the relative costs of strategic contracting between *I* and *SO*. Clearly, *I* wishes to minimize the sum total of these costs.

The SW framework can be modified to accommodate this objective. Proposition 1 implies that, for appropriate values of *N*, N^*, X^*, and Π, the cost of exclusion is less than $X^* \cdot N^*$, and in some cases, equal to zero. In the present context, however, N^* must be

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[9] If E is expected to be active in period 3, buyers of type B_E have no incentive to sign exclusionary contracts for less than X^*.

[10] $\Delta\pi = (p^m - C)Q_{II}(p^m) - (p-C)Q_{II}(p)$, where $p^m = \arg\max_p (p-C)Q_{II}(p)$, and p s.t. $CS_{II}(p) \geq CS_{IE}(C(N_E))$.

redefined. In SW, N^* is the minimum number of "captured" buyers necessary to achieve exclusion; its magnitude depends on the extent of scale effects. With system differentiation, these scale effects are still relevant but the potential availability of *SO* adds another constraint. Specifically, N^* is *the number of captured buyers that deters entry when SO is available; furthermore, N^* should be chosen to minimize the total cost of exclusion.* More formally,

LEMMA 2:

Entry is deterred if $S \geq N^*$, where N^* satisfies the following two constraints:

(1) $CS_{EI}(C) \geq CS_{EE}(C(N_E - N^*))$

(2) $(N-N_E) \cdot \Delta\pi + N_E \cdot \Pi \geq L_E$

where $\Pi = (p_S - C) \cdot Q_{EI}(p_S)$, and p_S is the monopoly price charged to buyers of type B_E that have signed exclusionary contracts, as well as the $N_E - N^*$ remaining free buyers ($p_F = p_S$); $L_E = (N_E - N^*) \cdot (p_E - C) \cdot Q_{EE}(p_E)$ where $p_E \leq p_E^m$ is the price charged by *E* if it wins the bidding for *SO*, satisfying the inequality, $CS_{EE}(p_E) \geq CS_{EI}(C)$.

PROOF:

E will not enter independently (without *SO*) if the number of captured buyers is large enough to raise its costs above some threshold. Constraint (1) satisfies this requirement. Given N^*, *E* cannot outbid *I* for *SO*, and thus cannot hope to enter by outsourcing service to *SO*. Constraint (2) requires that I's gains from successful exclusion exceed *E*'s profits from making sales to $N_E - N^*$ buyers. Thus E is outbid by *I*.

In other words, if $S \geq N^*$ at the end of period 1 then E will be unable to outbid I for SO's services in period 2, and E will not enter. We can now establish the following result:

COROLLARY 1:

For diverse buyers and differentiated systems, aftermarket exclusion occurs if and only if $N_E \bullet \Pi + (N-N_E) \bullet \Delta\pi - max\{x^* S_{N_E - N^*}, 0\} - L_I \geq 0$.

PROOF:

Since N^* performs the same role as in Proposition 1, SW's result for the cost of signing exclusionary contracts, $max\{x^* S_{N_E - N^*}, 0\}$, holds as well.

An Example

Suppose $N_E = 100$. Let demand for buyers of type B_E equal $Q_{EI}(p) = 90 - p$ and $Q_{EE}(p) = 100 - p$. Common system costs are $C(1) = 50 = C(n) + 2(n - 1)$ for $n < 100 - Z = 15$, and $C(n) = C = 20$ for all $n \geq 15$. To simplify the analysis, assume that $\Delta\pi = 0$. Then, $CS_{EI}(C) = 2450$, $CS_{EI}(p^m) = 612.5$, and so $X^* = CS_{EI}(C) - CS_{EI}(p^m) = 1837.5$. $\Pi = (p^m - C)Q_{EI}(p^m) = 1225$. To calculate the RHS of constraint (2) in Lemma 2, $CS_{EE}(p_E) \geq CS_{EI}(C)$ must hold, implying that $p_E = 30$, and thus $L_I = (N_E - N^*) \bullet 700$. Constraint (1) is satisfied for $N^* \in [90, 99]$. Constraint (2) is satisfied for any value of N^* in this range. Therefore, if $S \geq N^*$, then entry is deterred. We still need to identify the value of N^* that minimizes the costs of exclusion and verify that exclusion is profitable. The cost of exclusionary contracts, $max\{x^* S_{N-N^*}, 0\}$, equals zero for values of N^* as large as 96. For $N^* = 97$, $S_3 = 19$. Since $L_I\,(N^* = 96) < x^* S_3 + L_I\,(N^* = 97)$, $N^* = 96$ minimizes exclusion costs ($2800). It is easy to check that the condition in Corollary 1 is satisfied for this value of N^*. Hence, aftermarket exclusion is successful.

3. Discussion

This paper demonstrates that the presence of an alternative service organization makes exclusion more costly in markets where buyers' preferences vary and systems are differentiated, but *not* in markets where buyers and systems are homogeneous. This is notable, for several reasons. First, the existing exclusion literature has heretofore focused its attention on homogeneous markets. Second, most systems markets, including medical equipment, exhibit significant differentiation. Third, the fact that exclusion is more costly in differentiated markets suggests that the presence of service organizations can mitigate the welfare losses associated with exclusion, namely, the reduction in output and loss of product variety. When the presence of an alternative service organization is insufficient to promote entry by another equipment vendor, antitrust enforcement may provide buyers some protection, e.g. in *US v. GE*.

Future versions of this and other papers will examine alternative market structures, including cases where multiple service organizations are available to entrant(s), or where buyer demand exhibits different types of asymmetry.

Bibliography

Aghion, Philippe and Patrick Bolton (1987). "Contracts as a Barrier to Entry," American Economic Review, June, Vol. 77, pp. 388–401.

Borenstein, Severin, Jeffrey K. Mackie-Mason, and Janet S. Netz (1995). "Antitrust Policy In Aftermarkets." Antitrust Law Journal. Vol. 63, Issue 2, pp. 455–82.

Borenstein, Severin, Jeffrey K. Mackie-Mason, and Janet S. Netz (1996). "Exercising Market Power in Proprietary Aftermarkets," unpublished manuscript.

Innes, R. and R. J. Sexton (1994). "Strategic Buyers and Exclusionary Contracts," American Economic Review, June, Vol. 84, pp. 566–84.

McCabe, Mark J. (1997). "Analyzing Welfare in Related Markets: Durable Goods and Aftermarkets," EAG Discussion Paper 97-4, US Department of Justice.

Rasmusen, Eric B., J. Mark Ramseyer, and John S. Wiley, Jr. (1991). "Naked Exclusion," American Economic Review, December, Vol. 81, pp. 1137–45.

Segal, Ilya R. and Michael D. Whinston (1996). "Naked Exclusion and Buyer Coordination," Harvard Institute of Economic Research Discussion Paper Number 1780, September.

Shapiro, Carl (1995). "Aftermarkets and Consumer Welfare: Making Sense of Kodak." Antitrust Law Journal. Vol. 63, Issue 2, pp. 483–511.