Quantity 'Forcing' and Exclusion: Bundled Discounts and Nonlinear Pricing

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I INTRODUCTION

Allegations of anti-competitive exclusion through 'quantity forcing' have featured prominently in a line of recent cases, including *Ortho*, *Virgin-BA, Concord Boat*, and *LePage's*.[1] These cases share some important features.

- Unlike explicit exclusive dealing, the alleged exclusion occurs not by barring purchases from rivals, but by inducing (or 'forcing') customers to increase their purchases from the defendant — seemingly a pro-competitive action.
- Unlike ordinary predatory pricing, the inducement is not via a simple cut in the per-unit price of that product, but essentially through a payment that is conditional on reaching a certain quantity threshold. With 'market share discounts' the threshold is expressed not as an absolute quantity but as a percentage of the buyer's total purchases of that product.
- At times, the inducement is offered in that market alone (e.g., *Concord Boat*), through pricing schemes such as all-or-none offers, all-units-discounts — if a certain threshold is met, the buyer gets a price cut also on all previous units — or comparable schemes, that we label collectively 'nonlinear pricing.'
- In other cases, the inducement is via discounts on other products sold by the alleged excluder over which it possesses significant market power. (*SmithKline*, *Ortho*, *Virgin*, and *LePage's*; the latter featured also outright payments by 3M to some stores for exclusivity). The 'discounts' are off the prices of those other products if purchased alone. Because such multi-market discounts are conditional on reaching the target on the first product, they are sometimes called 'bundled' or 'tied' discounts.
- In *LePage's* the inducements were not offered market wide, but selectively to key accounts.

These practices raise important issues for economic analysis and antitrust policy:

- Can consumers be harmed by output-expanding initiatives that, unlike predatory pricing, need not be temporary?
- If so, how might one identify anti-competitive uses of these practices? For example, do standard price-cost tests for predatory pricing suffer from additional drawbacks when non-linear pricing is used? Does the so called

[1] Ortho Diagnostic Sys., Inc. v. Abbott Labs., Inc., 920 F. Supp. 455 (S.D.N.Y. 1996); Virgin Atlantic Airways Ltd. v. British Airways PLC, 69 F. Supp. 2d 571 (S.D.N.Y.) 1999), aff'd, 257 F.3d 256 (2d. Cir. 2001); Concord Boat Corp. v. Brunswick Corp., 207 F.3d 1039 (8th Cir. 2000); LePage's Inc. v. 3M,324 F.3rd 141 (3rd Cir. 2003), *cert. denied*, 124 S. Ct. 2932 (2004). An earlier case raising similar issues is SmithKline Corp. v. Eli Lilly & Co., 575 F.2d 1056 (3rd Cir. 1978) (*SmithKline*).

Ortho test properly identify predatory tying?[2]

- Can tying be used, as some have claimed, to exclude competitors without incurring any profit sacrifice — 'costless exclusion'? If so, the competitive threat from tying is much greater than for other practices judged under the rule-of-reason. Moreover, a profit sacrifice test for general exclusionary or predatory conduct[3] would then be vacuous in the case of exclusionary tying.

We find it important to distinguish between two potential roles of the practices in question: *rent extraction* and *monopolization*. The former refers to collecting more fully for any market power that the firm has legitimately acquired; the latter entails acquiring, maintaining or extending market power in ways that harm the firm's trading partners.[4] At the normative level, one could take the position that only monopolization should be prohibited — if the market power was legitimately acquired, unfettered rent extraction should be allowed. Moreover, a rent extraction motive may be present also where structural conditions make monopolization implausible We shall avoid the term 'exclusion' in such situations.

The analysis is organized as follows. We begin with tying. Section II presents a simple model of unrelated products, 1 and 2, where firm *A* is a monopolist over product 1 but faces competition from firm *B* in product 2. We review how tying can permit fuller rent extraction when the monopolist is only able to use 'linear pricing' — constant per-unit prices for each product.[5] Essentially, tying serves as an imperfect substitute for richer pricing instruments such as two-part tariffs or other nonlinear pricing. We identify the impact of tying on consumer surplus and total surplus when the monopolist can commit to offer product 1 only tied with 2 (pure tying) or can offer a tie but must also continue to offer product 1 unbundled at its simple monopoly price (mixed tying

Section III builds on the analysis to examine the *Ortho* test and related tests. We show that these tests can convict-the-innocent by finding a violation where tying benefits the firm without harming consumers. This problem arises because the test ignores any output expansion in the tying market engendered by the discount, an expansion that benefits the firm and overall efficiency. Moreover, a firm can pass the test when engaging in tying that (compared to no tying) harms both consumers and total surplus,

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[2] The test was proposed by the plaintiff's economic expert, Janusz Ordover, but has come to be known more generally as the *Ortho test*.

[3] The profit sacrifice test or some variant thereof is advocated by Bork (1978], Ordover and Willig [1981], Melamed [forthcoming] and Werden [forthcoming]. Schwartz [1989] points out some limitations, while Salop [forthcoming] rejects the approach, in favor of a consumer harm standard.

[4] For a recent reminder of this distinction see Heyer [2005]. We shall use the term 'monopoly' not literally but as shorthand for substantial market power, and similarly for 'monopolization.'

[5] See Burstein [1960] and Mathewson and Winter [1997] who extend his analysis.

and when the single-product competitors in product 2 have lower cost than the tying firm. (This scenario might be termed acquit-the-guilty, except that in our setting tying is motivated by rent extraction, not exclusion).

Section IV questions the premise that the monopolist can implement tying but is limited to charging per-unit pricing. Suppose a seller can require that a buyer purchase a second good only from that seller (a "tie-out"). That same seller should also be able to collect a fixed fee, by requiring the buyer — as a condition for obtaining the monopoly good at its specified per unit price — to purchase *even a small quantity* of the tied product at a suitably inflated price. Moreover, with identical buyers and full information, charging a fixed fee through such a 'minimal tie-in' is superior to a tie-out if the purpose is rent extraction. Mathewson and Winter [1997] show that a rent extraction role for tying can resurface if the monopolist lacks full information on consumers' demands and demands for the two products are affiliated (loosely, are positive correlated in all cases). We review their argument and note some limitations. Overall, we conclude that outside of metering contexts (with complementary products), there are significant open questions about the optimality of using tie-outs purely for rent extraction, instead of other contracting instruments likely to be available. Monopolization of the tied market, on the other hand, offers a clear motive for inducing buyers to purchase a large share of their requirements of the target product from the would be excluder — 'quantity forcing' — if the target product exhibits significant economies of scale. Quantity forcing, if it diverts enough demand, can deny scale economies to competitors and threaten their vigor or even viability. One way to implement quantity forcing in the target market is by offering a tied discount on a second product. However, since providing the incentives through tied discounts is generally more costly than providing them through nonlinear pricing of the target product alone this explanation leaves unanswered the question why an excluder would choose to exclude in this manner.

Section V considers the single-product case. We review briefly the theory of "naked exclusion" — why monopolization through explicit exclusive dealing contracts can be profitable given scale economies and lack of buyer coordination.[6] In most of the antitrust cases mentioned, the contested practices did not include explicit exclusive dealing.[7] However, drawing on Bernheim and Whinston [1998], we show that the basic divide-and-conquer logic can allow profitable exclusion (though less frequently) also through quantity forcing contracts. While reliance on quantity forcing makes the firm's output higher than under naked exclusion, consumer welfare and overall welfare can still be lower than in the non-exclusionary benchmark.

Section VI reviews some recent non-exclusionary explanations for quantity

[6] Rasmusen, Ramseyer and Wiley. See also Segal and Whinston [2000] and Innes and Sexton [1994]

[7] In *Lepage's* one of the allegations involved payments for exclusivity.

forcing contracts, including price discrimination when buyers have private information about their demands, and inducement of effort by dealers. Section VII presents concluding remarks. We see no clean test to distinguish benign from exclusionary motives for quantity forcing practices. However, our analysis suggests that the profit sacrifice approach has some bite, at least conceptually — exclusion will often require a departure from the outcome that maximizes rent extraction from existing market power. A workable policy approach is likely to combine this principle with structural screens, such as the degree of scale economies in the target market and whether competitors' viability is seriously at risk.

II TYING FOR RENT EXTRACTION UNDER ONLY LINEAR PRICING

For simplicity and in keeping with the main articles discussed below, we focus on tied products that are unrelated in both cost and demand. The argument that tying can induce costless exclusion has been made recently even for such unrelated products. (With complementarities, it is well known that tying can arise for efficiency reasons, for price discrimination, or for exclusion.) In our view, this argument confounds exclusion with the use of tying for fuller rent extraction by a monopolist who can only employ linear pricing. The rent extraction argument, due to Burstein [1960], and Mathewson and Winter [1997] who extend his analysis, as well as some shortcomings of the *Ortho* test (see Section III), can be illustrated in the following simple environment.

Suppose firm A is a secure monopolist over product 1. In product 2, it faces an actual or potential rival, firm B (or a competitive fringe) capable of offering an identical product 2. Thus, suppliers of product 2 offer perfect substitutes (homogeneous goods). Demand for each product depends only on its own price. Firm A has constant marginal and average costs for both products, (c^1, c^2).[8] For now, assume that firm B also has marginal cost c^2 and no fixed cost. These conditions imply that firm B is equally efficient as A, and they rule out tying to monopolize market 2 since firm B can operate efficiently at any small scale.[9] We will later relax both conditions. A typical buyer's demands for products 1 and 2 are denoted $q^1 = D^1(p^1)$, $q^2 = D^2(p^2)$ and shown in Figure 1, for simplicity as linear.

We note briefly some alternative interpretations of these demand curves for purposes of welfare analysis. The buyer may be one of several identical final consumers (heterogeneous buyers are discussed later). In that case, the *height* of the demand curve

[8] We will generally use superscripts to denote the product / market.

[9] Monopolization of market 2 through tying is implausible also if there are modest scale economies but a large share of all customers who desire product 2 are not interested in product 1 — that is, there is a large enough stand-alone demand for product 2 to support numerous single-product competitors.

for each product represents the buyer's *marginal* willingness to pay (in dollars per unit) for that product; the *area* under the demand curve from the quantity 0 to any quantity q represents the consumer's *total* willingness to pay (in dollars) for that entire quantity q when the alternative is to get none of this product.[10] This area minus the actual payment to the supplier — the triangular area under the demand curve but above a given price — is *consumer surplus*, the buyer's net gain from purchasing the particular quantity at the given price. More reflective of the antitrust tying cases, the buyer instead may be an intermediary, say a retailer. Following much of the literature, suppose that in such cases the retailer is a local monopolist in selling to final consumers. If the retailer can only charge per-unit prices, then the height of its demand curve for each product equals its marginal revenue from the sale of that product, net of any other costs; the area under its demand curve up to any quantity q reflects the *retailer's* maximum willingness to pay for that quantity, but this amount now understates the full social value of that quantity by leaving out consumer surplus of end users.[11] For brevity, we shall use "consumer surplus" to denote the buyer's surplus also in this case, and "total surplus" or "welfare" to denote the *joint surplus of the sellers and the immediate buyer*. Let W denote total welfare, consumer surplus plus profit.

II.A Monopoly Linear Pricing Leaves Consumer Surplus and Inefficiency

In Figure 1, the simple monopoly price-quantity point is m^1 in market 1 and m^2 in market 2. These are the price-quantity pairs firm A would choose if it were an unconstrained monopolist in both markets / products. If firm A faces perfect competition in 2 *and* cannot tie its products, it stays at m^1 but prices 2 at marginal cost, leading to the socially efficient point in market 2, denoted e^2. Observe that in market 1, the monopoly price leaves consumer surplus equal to the triangle S_m^1, and a "deadweight loss" equal to the triangle m^1e^1n — the loss in welfare from choosing the monopoly quantity instead of expanding to the efficient point e^1, where demand intersects marginal cost.

Note also that if firm A could charge a fixed fee as well as a per-unit price (or use other forms of nonlinear pricing), then it would capture both triangles as increased profit: it would cut price down to marginal cost c^1, thereby expanding consumption and eliminating the deadweight loss, and charge a fixed fee equal to the consumer surplus realized at point e^1.[12] However, given the assumed restriction to only per-unit prices,

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[10] The above interpretation holds under the assumption (which we will maintain throughout) that the consumer's utility function is quasi-linear with respect to money. Independent demands for 1 and 2 emerge if, the utility function is also additively separable in products 1 and 2. See Mathewson and Winter [1997].

[11] If the retailer instead is *a perfectly price discriminating* monopolist, then its demand fully reflects the product's value to final consumers and the welfare analysis proceeds as if the supplier sold directly to them.

[12] Outside our simplified full-information setting, a monopolist may prefer to set the per-unit price above marginal cost and extract part of its rent through a margin on sales rather than solely through the fixed fee.

there is a rent extraction role for tying. We illustrate this for two alternative cases: firm A may offer a tied package, but must also offer product 1 at the simple monopoly price, a practice Nalebuff [2004a] calls *mixed tying*;[13] or it may engage in *pure tying*.

II.B Mixed Tying — Monopoly Product Must Remain Available Unbundled at the Simple Monopoly Price

Under mixed tying, the consumer's *unbundled* option is point m^1 in market 1, yielding consumer surplus S_m^1, and point e^2 in market 2, that yields an additional S_e^2 (the triangle $\bar{p}^2 e^2 c^2$), for a total of $S_U = S_m^1 + S_e^2$. To be accepted, any tied offer must leave consumer surplus of at least S_U. Thus, firm A's gain from adding a tied offer cannot come from harming the buyer.

Nevertheless, mixed tying can benefit firm A — by reducing the deadweight loss on product 1. This is done by cutting its price somewhat below the monopoly level while raising the price of 2 somewhat above marginal cost, and requiring buyers to buy 2 at this higher price as a condition for obtaining the lower price on 1. The deadweight loss will be reduced because starting at the efficient point e^2 in market 2, a small rise in price and fall in quantity reduces welfare W only negligibly (since the consumer's marginal value approximately equals marginal cost), but the quantity expansion in 1 increases W significantly (since marginal value starting at the monopoly quantity is well above marginal cost). Since total welfare can be increased, there exists a pair of prices firm A can charge that leave the same *consumer surplus* S_U as the unbundled option but yields higher profit.[14] Firm A's profit maximizing mixed-tying prices, (p_{xt}^1, p_{xt}^2), lie below the simple monopoly levels and above marginal costs: $(c^1, c^2) < (p_{xt}^1, p_{xt}^2) < (p_m^1, p_m^2)$.

Geometrically, to maintain S_U, the mixed tying prices (p_{xt}^1, p_{xt}^2) are set so that the consumer's gain from the price cut on product 1 (trapezoid $p_m^1 m^1 x^1 p_{xt}^1$ in Figure 1) equals the loss from the price rise on product 2 (trapezoid $p_{xt}^2 x^2 e^2 c^2$). We return to this property of the mixed-tying prices when discussing the *Ortho* test. Observe that this pricing pattern still leaves both quantities below their efficient levels and, hence, is still inferior to charging a fixed fee in market 1 and setting both prices at marginal costs.[15]

See Tirole [1988,chapter 4]. However, claims of costless exclusion through tying have been made even for this simple setting.

[13] Greenlee, Reitman and Sibley [2004] also analyze mixed tying.

[14] The explanation for the existence of such welfare increasing prices is sometimes couched differently: that a small price cut from the monopoly level in market 1 has a negligible (zero to the first order) effect on profit while a small increase starting from marginal-cost pricing in market 2 will significantly raise profit. However, this argument does not establish that consumer surplus has not fallen, which is needed for the tie to be accepted.

[15] This is why, in the absence of fixed fees, the monopolist would gain by tying to the monopoly good 1

II.C Pure Tying — Monopoly Product Is Only Offered Tied

Now consider a case stressed in some recent articles.[16] Firm A is not constrained — by regulation or otherwise — to continue offering product 1 at the monopoly price; it may offer product 1 only tied with 2, or also unbundled but at a price of its choosing. By raising the unbundled price of 1 to a prohibitive level ($\bar{p}^1$ or higher), firm A can de facto adopt pure tying, and reduce the consumer surplus under the unbundled option from $S_U = S_m^1 + S_e^2$ to S_e^2, the level available by buying only product 2 competitively. Thus, pure tying removes the consumer surplus S_m^1 that was available from buying product 1 unbundled at its monopoly price. Making the unbundled option less attractive lets firm 1 set the pure-tying prices (p_t^1, p_t^2) above the mixed-tying levels (p_{xt}^1, p_{xt}^2) discussed above.

II.C.1 Effect on Consumers and Overall Welfare

The pure tying prices are determined by the following alternative conditions:

(i) *Unconstrained Monopoly:* If the simple monopoly prices (p_m^1, p_m^2) yield consumer surplus of at least S_e^2, what the consumer would get by rejecting the tie and buying only product 2 competitively, then firm A will set its tied prices at the simple monopoly levels in both markets: $(p_t^1, p_t^2) = (p_m^1, p_m^2)$.

(ii) *Constrained Monopoly*: If consumer surplus at (p_m^1, p_m^2) is less than S_e^2, then to yield consumer surplus of S_e^2 firm will A set its pure tying prices below the monopoly levels, but still higher than under mixed tying: $(p_{xt}^1, p_{xt}^2) < (p_t^1, p_t^2) < (p_m^1, p_m^2)$.

Case (i) arises, for example, if market 2 is small relative to 1, while (ii) arises if market 2 is relatively large.

The possible welfare effects of pure tying are as follows:

Consumer Surplus under pure tying is lower than under no tying or mixed tying. This result follows immediately because pure tying raises the prices of both goods relative to mixed tying which, in turn, yields the same consumer surplus as no tying ($S_U = S_m^1 + S_e^2$).

Welfare under pure tying is lower than under mixed tying. This, too, follows because pure tying raises prices above the mixed tying levels, which already exceed marginal costs. Thus, consumption of both goods is reduced further below the efficient levels.

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numerous competitive products if possible, and setting lower markups on each of the tied goods so as to reduce the overall consumption distortion. See Burstein [1960]. Interestingly, 3M "tied" many different office products to purchases of its generic tape.

[16] Mathewson and Winter [1997], Greenlee, Reitman and Sibley [2004], Farrell [2005], Nalebuff [2005].

Welfare under pure tying can be lower or higher than under no tying.

- Welfare is higher under pure tying if the prices are close to marginal costs, as will occur if market 2 is large relative to 1. Tying then lets firm *A* exploit its monopoly power relatively efficiently: it accepts a large price reduction in the monopoly market in exchange for a positive but small margin in the larger market 2. Figure 1 illustrates such a case.
- Welfare is lower under pure tying if market 2 is relatively small. The pure tying prices then will be near, or equal to, the monopoly levels, so tying reduces price only slightly if at all in market 1, but raises price in market 2 substantially above its no tying level of marginal cost.

These results will prove useful when discussing the properties of the *Ortho* test.

II.C.2 Greenlee, Reitman and Sibley Test

Greenlee, Reitman and Sibley (GRS) [2004] propose a simple test to judge how tying affects consumer surplus: if the unbundled price of the monopoly good rises (perhaps to a prohibitive level) after the introduction of tying, then consumer surplus must fall. As explained above, the firm will set its tied prices to leave consumer surplus equal to (or trivially higher than) the maximal level attainable by buying, instead, at the new unbundled prices. Since the unbundled option has been degraded — the unbundled price of the monopoly product has risen by hypothesis while the price of the competitive product is unchanged (at marginal cost) — consumer surplus at the tied prices also will be lower.Conversely, if the unbundled price of the monopoly product falls or remains unchanged, then the introduction of tying cannot harm consumers.[17]

II.C.3 Costless Exclusion?

Case (i) above, Unconstrained Monopoly, seemingly illustrates costless exclusion through tying.[18] By offering the monopoly product 1 only in a tie, firm *A* is able to set the monopoly price also for product 2, while denying sales to single-product competitors there. However, the proper characterization of such an outcome in our view is fuller rent extraction rather than exclusion. By assumption, market 2 here is not susceptible to monopolization. Furthermore, the motive for tying here would vanish if full rent extraction were achievable in market 1: pure tying, even if it permits the monopoly

[17] Note that, strictly speaking, this case is inconsistent with GRS's formal analysis where a monopolist would always raise its unbundled price after introducing a tied offer.

[18] For example, Nalebuff [2005, pp. 326-7, 343]. Note that his markets *A* and *B* correspond to our 1 and 2 (we adopt the alternative notation to conform with Bernheim and Whinston [1998], whose work we discuss later). On p. 327, he writes: "With tying, the firm … can achieve the exclusion at no cost ... by threatening to raise the à la carte price of *A* while maintaining the optimal price if the customer accepts the tied sale." He is describing pure tying.

prices in both markets, is only an inferior substitute to charging a fixed fee in market 1. Tying is inferior because it distorts consumption levels away from the first best, whereas a profit-maximizing two-part tariff for product 1 would avoid inefficiency by setting the per unit price at marginal cost, and collect the maximal profit through the fixed fee.

III *ORTHO* AND RELATED TESTS FOR PREDATORY TYING

The above analysis sheds light on some drawbacks of the *Ortho* test for identifying exclusionary tied discounts. We analyze two versions of the test. One version compares *prices* in the two markets, and finds a violation if the tied price of product 2 minus the price cut on the tying product 1 is less than the average variable cost of product 2. The other version, analyzed in the Appendix, allows for different quantities in the two markets by comparing *revenues* rather than per-unit prices; it finds a violation if the revenue from product 2 minus the foregone revenue on product 1 due to the tie is less than the total variable cost of supplying the particular quantity of product 2.

III.A The *Ortho* Test Can Find a Violation When Tying Is Beneficial, By Ignoring Increased Sales of the Monopoly Product

We now show that both versions of the test can err by finding a violation in cases where monopolization is ruled out by assumption *and* tying is used for rent extraction that increases overall welfare relative to no tying, i.e., the test can convict the innocent. The details differ between the price and revenue versions of the test, but the fundamental problem is that when assessing the 'sacrifice' on product 1 embodied in tying it with 2, the test ignores any increased sales of product 1. Under the assumed conditions (only linear pricing), it is possible for this expansion (i) to be profitable for firm *A* only if allowed to tie and (ii) to increase overall welfare despite the price rise on the tied good.

We analyze here the price version of the *Ortho* test. A violation is presumed, subject to rebuttal, in the test market 2 if

[sum of all tied prices – sum of unbundled prices except 2] < (unit cost of 2) (1)

The term in square brackets is the *implicit price* of good 2 when purchased through the tied offer. Predation is presumed if this implicit price is below some measure of unit cost (at various times, average variable cost, marginal cost have been suggested as measures). In our two good setting, if firm *A* offers good 1 at an unbundled price p_u^1 and at tied prices $(\hat{p}_{xt}^1, \hat{p}_{xt}^2)$ along with good 2, the test reads

$$[p_{xt}^1 + p_{xt}^2 - p_u^1] < c^2 . \quad (2)$$

We highlight a problem with the test by expressing it equivalently as

$$[(p^1_{xt} + p^1_{xt}) - (c^1 + c^2)] \; < \; (p^1_u - c^1) \tag{3}$$

If the unbundled price of good 1 were set at average cost, then $(p^1_u - c^1) = 0$, and the test would boil down to whether the sum of tied prices is below the sum of average costs. However, if the unbundled price contains a markup, $(p^1_u - c^1) > 0$, then the test can find predation even if the unbundled price stays at the simple monopoly level ($p^1_u = p^1_m$), the case we defined as *mixed tying*. And recall that, compared to no tying, mixed tying leaves consumer surplus unchanged and must increase overall welfare.[19]

To see that the test can be failed if the firm engages in mixed tying, consider (3) using the *equilibrium* mixed tying prices and set $p^1_u = p^1_m$. The test now reads,

$$[(p^1_{xt} + p^1_{xt}) - (c^1 + c^1)] \; < \; (p^1_m - c^1), \tag{4}$$

The right side is the simple monopoly margin on good 1, which is independent of the relative sizes of the two markets. However, as the size of market 2 increases relative to 1, the left side becomes arbitrarily small, because to induce acceptance of the tie in the large market, the good 1 monopolist must accept a low margin on both products. The test would therefore find a violation.[20] Perversely, failing the test is more likely in cases where the efficiency gains from tying are greater — when tying permits a large price reduction in the price of the monopoly good for only a small increase in the other price. Such an outcome can arise, for example, if demands in the two markets are otherwise identical (same elasticity at common prices) but the tied market 2 is large relative to the monopoly market 1, as in the example presented in the Appendix.

No Output Expansion for the Monopoly Product. The core problem is that the test *ignores the possible output expansion for the monopoly good induced by the tied discount*, and therefore overstates the profit sacrifice from the discount. However, if quantity demanded of the monopoly good does not increase as its price is reduced, then the discount on good 1 granted with the tie will not increase overall welfare, while the increase in the price of good 2 (relative to the no tying, competitive level) will reduce welfare. In such a case, tying cannot be profitable purely for rent extraction purposes,

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[19] As noted earlier, in our simple setting firm *A* would prefer — absent regulation or other constraining factors — to raise the unbundled price of good 1 to a prohibitive level so as to make the unbundled option less attractive to the consumer and thus raise the prices it can charge for the tied offer. Stepping beyond the model, there are reasons why the simple monopoly price for good 1 might continue to be available on an unbundled basis, at least for some customers, and therefore could be used in the test. One possibility is that firm *A* is unable to commit to supplying good 1 only tied with 2; anticipating that its tied offer may be rejected, it then posts what would be its optimal unbundled price for good 1, namely, the simple monopoly price. This scenario, if applicable to all consumers, rules out the pure tying case.

[20] A formal example is presented in the Appendix.

and an exclusionary motive becomes more plausible. Thus, an important question is the sensitivity (elasticity) of demand for the tying good to reductions in its price.[21]

III.B The *Ortho* Test Does Not Protect Equally Efficient Competitors

One virtue sometimes claimed for the *Ortho* test is that it finds a violation whenever the tie excludes "equally efficient competitors" in the tied market.[22] It is debatable whether antitrust generally, or predatory pricing rules specifically, should only prevent exclusion of equally efficient competitors.[23] Whatever the merits of such a goal, however, it is not achieved by the *Ortho* test nor by the Nalebuff test discussed shortly. Exclusion of single-product sellers of good 2 from access to customers who also demand the monopoly good 1 occurs whenever those customers accept the tie, regardless of how the competitors' cost for good 2 compares with the alleged excluder's cost.[24]

For example, consider the *Ortho* test. The Appendix develops the following example: firm A has the same unit cost c in the two markets, demands are linear, and demand for good 2 is s times as large as demand for good 1. Firm A's profit maximizing mixed-tying prices are then equal, and the common level $p_{mt}(s)$ is set to leave the same consumer surplus as under the alternative of buying good 1 unbundled at the monopoly price p_m^1 and good 2 competitively from rivals at cost. Let c' denote rivals' unit cost.

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[21] This point was recognized by the District Court judge in the *Ortho* case. "Ordover's testimony assumes that the effect of the package pricing was simply to reduce the revenues generated by sales of HTLV and HIV-12 by an amount equal to the difference in the bundled and unbundled prices of those assays. … [But] Abbott's CCBC [package] pricing reasonably may be expected to have increased its unit sales of all of the assays and thereby to have generated added profits offsetting, at least in part, the revenue loss attributable to the price cuts. Ordover's deposition testimony does not confront this matter with any specificity." Westlaw, p. 16

[22] "Below-cost pricing, unlike pricing at or above that level, carries with it the threat that the party so engaged will drive equally efficient competitors out of business, thus setting the stage for recoupment at the expense of consumers." *Ortho* (Page 13 of Westlaw; ¶ 9 of Opinion?).

[23] The *Ortho* opinion states: " ... only price cutting that threatens equally or more efficient firms is condemned under Section 2." (Page 15 of Westlaw; ¶ 11 of Opinion?) Judge Posner (2001, pp. 194-195) has advocated applying the equally efficient competitor standard to all Section 2 conduct. In our view, there are sound arguments against confining antitrust to protecting only competitors deemed "equally efficient." Often, competitors are differentiated in some dimension and their product variety has value for overall welfare and consumers. The relevant choice is then not between the survival of one firm or the other, but between having a single firm or both. However, given the serious uncertainty costs and the risks of chilling pro-competitive price cutting under a vague rule of reason approach, a case can be made for adopting a pricing safe harbor based on information known to the firm. Some measure of cost is a natural candidate and, given the need to pick some level, the equally efficient competitor benchmark might serve as a defensible pragmatic compromise.

[24] Whether denial of access to customers who demand both products should be meaningfully characterized as exclusion is a separate question. In our model thus far, monopolization of good 2 cannot be the purpose of the tie, since the market structure there was assumed inherently competitive (constant costs, no entry barriers); moreover, one could modify the model to allow for consumers who demand good 2 but not 1, in which case market 2 would retain independent competitors even with the tie.

The *Ortho* test is passed if: $2[p_{xt} - c] > (p_m^1 - c)$. If rivals are equally efficient $(c' = c)$ and market 2 is *small* relative to 1 (*s* is small), the test will be passed, since p_{xt} will be below but close to p_m^1. Finally, if rivals' cost is less than firm *A*'s $(c' < c)$, then to induce acceptance of the tie firm 1 must cut p_{xt}. But if the efficiency gap is not too large or if market 2 is sufficiently small, then firm *A* still passes the test — while depriving more efficient suppliers of good 2 the sales to customers who also demand good 1.

Moreover, a firm can pass *Ortho* while engaging in *pure tying* even where this reduces total surplus. (Recall from Section II.C that in this model consumer surplus is always lower with pure tying than no tying, but total surplus can be lower or higher). To show this, modify the above linear demand assumptions as follows: demand for good 1 has a lower vertical intercept but larger horizontal intercept than for good 2. Let firm *A* implement pure tying by setting the unbundled price of good 1 at the choke price, $\bar{p}^1$, the demand curve's vertical intercept. Suppose the *Ortho* test measures the price sacrifice on good 1 as the difference between its unbundled price and its tied price. Finally, suppose that pure tying allows firm *A* to sustain the monopoly prices in both markets, p_m^1 and p_m^2. This is possible even when good 2 rivals have lower cost than firm *A* $(c' < c)$, provided the *horizontal* demand intercept is sufficiently larger for good 1 than for 2 (the consumer surplus from good 1 at the monopoly price will then exceed the consumer's loss from buying good 2 at its monopoly price instead of competitively at c'). The test is passed if $(p_m^2 - c) > (\bar{p}^1 - p_m^1)$. Given any demand curve for good 1, this condition is met if the *vertical* intercept for good 2 is sufficiently higher. Thus, a firm can pass *Ortho* while charging unconstrained monopoly prices and diverting sales from more efficient rivals.[25]

In sum, the *Ortho* test is subject to the following drawbacks:

- When the firm adopts mixed tying, total surplus rises relative to no tying, while consumer surplus remains unchanged. Yet the test can be failed. ("Convict the innocent").
- When the firm adopts pure tying consumer surplus is always lower than under no tying. Yet the test can be passed even when competitors in the tied market have lower cost and total surplus falls relative to no tying. ("Acquit the guilty," with the caveat that tying so far has been assumed to be motivated by rent extraction, not monopolization).

[25] With linear demands and marginal cost *c* in both markets, the monopoly price in each market is the average of *c* and the vertical demand intercept (i.e. choke price) in that market. Fix the intercept in market 1, and increase that in 2 enough to pass the test. Given these vertical intercepts, firm *A* under pure tying can charge the unconstrained monopoly prices if the *horizontal* intercept is sufficiently larger in market 1.

III.C Nalebuff Test

Nalebuff [2005, pp. 328 and 336] states that "exclusionary bundling" arises when a firm with market power in product *A* (our 1) facing competition in *B* (our 2) charges an incremental price for an *A*-*B* bundle over the price of *A* alone that is less than the firm's long-run average variable costs of *B*. This is the same condition as (1) above.

He offers the absence of exclusionary bundling as a safe harbor: passing the test implies no violation. If the test is failed, two additional elements must apply to find a violation (see his p. 342). First, a significant fraction of the *B* market is subject to foreclosure. Second, the tying firm "could have reasonably understood that its tie or bundle discount would have the effect of foreclosing rivals." Nalebuff goes on to discuss how his test would apply in *SmithKline*, *Ortho*, and *LePage's*.

This variation on the *Ortho* test suffers from the same convict-the-innocent flaws identified above. While the test is couched as solely a safe harbor, the added elements needed for a violation seem weak. First, if significant foreclosure means the diversion of a large market share from rivals to the excluding firm, such an outcome is entirely consistent with a pure rent extraction role for tying, unrelated to monopolization of the tied good. Second, there also is no efficiency defense along the lines of "no consumer harm." As shown in our mixed tying example — and as stressed by Nalebuff [2004a] — mixed tying (at least in the short run) cannot harm consumers and increases overall welfare. Yet a firm engaging in mixed tying could be found to violate his test, for the same reasons shown earlier for why the *Ortho* test can be failed.

It is also worth stepping back and asking, what is the underlying principle for using the firm's average cost of the tied product when testing for exclusionary bundling? Nalebuff's rationale is that any safe harbor must employ information readily available to that firm, such as its own cost. While the rationale has merit, the same criterion is met by using *any multiple x* of the firm's average cost as long as the law is clear about the level of *x*. The case for using the firm's actual average cost ($x = 1$) must therefore rest on other arguments.[26] One candidate rationale is that pricing which fails the test would preclude equally efficient single-product competitors from selling to customers who also demand the monopoly good. However, we have shown that "exclusion" of such competitors can occur also with pricing that passes the test. Thus, the test has little to do with protecting equally efficient single-product competitors, whatever the merits of such a goal.

[26] Nalebuff (p. 334) writes: "The goal of the exclusionary bundling test is to see if the monopolist itself could afford to sell *B* on an à la carte basis when competing against its own bundle." But it is not evident why this should be a relevant standard.

IV WHY TYING? A CLOSER LOOK

IV.A Rent Extraction Role for Tying When Fixed Fees Are Feasible?

Our analysis thus far has assumed that the tying firm can only charge per-unit prices, it is unable to charge also a fixed fee or to use other forms of nonlinear pricing. While there may exist circumstances where the only feasible contract in the monopoly market is a per-unit price, Mathewson and Winter [1997] (MW) point out that such conditions are inconsistent with the premise that tying is feasible. If tying can be imposed, then a fixed fee can be charged in the tied market simply through a price-quantity contract: by making good 1 available only if the customer also buys *any* specified quantity of good 2 at a suitably inflated price, the monopolist can essentially levy a fixed fee for the right to purchase good 1. A fixed fee can be charged by specifying even a minor quantity; we shall call such a contract a "*minimal tie-in*" to distinguish it from a *tie-out*, whereby the customer is required to buy *all* (or a very high share of) its good 2 purchases from this firm. A minimal tie-in contract seems no harder to enforce than a tie-out.

Furthermore, with identical buyers and complete information, a fixed fee implemented through a minimal tie-in avoids the inefficiencies created by a tie-out, and therefore allows the firm to extract the maximal rent for its good 1 monopoly. A minimal tie-in leaves consumers' quantity choices in the other market undistorted at the margin, while a tie-out distorts their choices, which reduces the total rent that can be extracted. Thus, MW conclude that tying — in the sense of a tie-out — would not be chosen for rent extraction purposes in the case of identical buyers. Whenever such a contract is feasible, it is dominated by a simple price-quantity contract in the tied market.

The same conclusion holds with heterogeneous buyers if the seller is informed about their individual demands and can offer them customized contracts with differing fixed fees (or other customized nonlinear contracts). Indeed, in some of the antitrust cases noted earlier, customized nonlinear contracts were offered to different buyers (*SmithKline, LePage's*). Full tying or approximations thereof, whereby discounts were conditioned on the buyer sourcing from that firm a very high share of its total purchases, were added — according to plaintiffs — only in response to entry (e.g., *SmithKline*) or to an increase in the competitive threat posed by a growing rival (e.g., *LePage's*).

MW argue that a rent extraction role for tying can resurface even if the firm can offer a uniform two-part tariff to all customers, provided there is asymmetric information about demands. Specifically, suppose only the buyer knows his level of demand for good 1 (the buyer's 'private information'), but the monopolist knows that demands for goods 1 and 2 are affiliated (loosely, a customer with relatively high demand for one good is also more likely to have relatively high demand for the other). Tying the competitive product and pricing it above marginal cost then can extract additional rent (and at least some

customer types are better off with tying). Note the importance of the assumption that the two demands are statistically linked (affiliated). If they are statistically independent, MW show (for a particular example) that tying for this purpose is ineffective.

Affiliated demands across otherwise unrelated products therefore expands the universe where tying may be used for rent extraction beyond the traditional case of direct metering, where a fixed good is consumed together with variable quantities of a complementary good (such as a camera and film). Observe, however, that when tying is used to exploit affiliation in demands, such a motive is more accurately portrayed as rent extraction than exclusion. MW's framework, like ours, precludes monopolization of market 2 by assumption. The purpose for tying is to more fully extract the rent available due to the monopoly over good 1 and this motive is present independent of whether conditions in market 2 are conducive to foreclosure.

Observe also that the affiliated demands explanation for tying fits less well in environments where *share contracts* are used, as was true in some of the pertinent antitrust cases. In order to verify that the buyer is purchasing from firm *A* the specified share of its total purchases of the tied product, firm *A* must observe also the buyer's purchases from other firms. But in such a case, firm *A* may be able to use total purchases of the tied product as a signal about the buyer's demand for the monopoly good and adjust the fixed fee accordingly — it may not have to specify that a high share in the tied market be bought from it, or require a complete tie out. In short, outside of metering contexts, if the goal is purely rent extraction from the monopoly good, then achieving it does not require — and may conflict with — forcing a buyer to obtain a large percentage of its total requirements of the competitive good from that same firm.

IV.B Tying for Monopolization

By contrast, requiring customers to buy a large share of their requirements for the competitive good from the good 1 monopolist — quantity forcing — is consistent with a monopolization motive in market 2 if rivals there face economies of scale instead of constant unit costs as assumed thus far. If explicit exclusive dealing requirements are not feasible, denying scale economies to rivals may have to be done indirectly, by requiring consumers to purchase a large share of their requirements from the would be excluder.

While monopolization through quantity forcing must be taken seriously in the presence of large scale economies, it is worth stepping back and asking whether quantity forcing in the target market is aided by tying another product and, if so, how. The economic literature suggests reasons why a firm's presence in one market (our 1) can increase its gain from monopolizing another market (market 2) or its ability to do so.[27]

[27] For a comprehensive survey, see Church [2005].

These reasons often hinge on the firm being a threatened monopolist in one market and seeking to impede entry there by monopolizing an adjacent product that is strongly complementary, and therefore needed by competitors (or their customers) to contest the monopoly.[28] In such cases, tying can be analyzed as an attempt to drive out rivals in the complementary product through a *refusal to deal* in the monopoly good, rather than through quantity forcing in the target market.

Many of the articles on exclusion through tied discounts, however, as well as some of the cited cases, do not involve do not involve strongly complementary goods. [29] We therefore abstract from these scenarios by assuming that the products are unrelated in both costs and demands. For independent goods, we ask: why might the firm prefer to implement quantity forcing in the target market *by granting discounts off other tied products* rather than providing inducements solely in the target market?

Whinston [1990] proposes one explanation: by making its monopoly product available only bundled with the competitive one, the firm is essentially committing itself to charge a lower price in the second market, a commitment which is profitable if and only if it induces the rival to exit or refrain from entering.[30]

Another possible explanation is that providing the discounts in other markets may make the inducement offered for expanding purchases in the target market less transparent to antitrust enforcers — especially if the discount is spread over multiple markets. This, in turn, may help escape condemnation of a discount as "predatory."

Aside from these two scenarios, however, it is not evident that tying provides a cheaper way to implement quantity forcing than through direct incentives in the target market. The next section considers quantity forcing in a single product setting.

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[28] Recent contributions include Church and Gandal [2000], Choi and Stefanides [2001], Rey and Tirole [2003], Carlton and Waldman[2002]. Nalebuff [2004] presents a model where tying deters entry when demands for the two products are independent but see Brennan [2005] for a critique.

[29] *Ortho* likely represents a case where strong complements were tied and, indeed, among the plaintiff's claims was an assertion that Abbot anticompetitively attempted to maintain its monopoly position in some of the blood tests. However, the bulk of the Opinion focused on foreclosure in the non-monopolized market.

[30] In Whinston's example, tying cannot be for rent extraction, since in his monopoly market consumers have identical unit demand, and linear pricing then suffices to extract all consumer surplus. Tying indirectly commits the good 1 monopolist to charge a lower price for good 2 because when sales of 1 are made only in a bundle with 2, losing a sale of 2 means also losing the monopoly margin on 1. To prevent this, the firm sets the implicit price of good 2 (in the bundle) lower than the explicit price it would charge for 2 if selling the goods separately. As Whinston points out, this argument requires that the firm be able to commit to sell the products only as a bundle. Given such commitment ability, tying may enable "costless exclusion" because the tie may not harm the firm's profit when it is the sole seller of both goods, in the special case where all consumers demand both goods. However, tying would still fail the "no economic sense" test for exclusionary conduct advanced by Melamed [2005], Werden [2005] and others, because tying would reduce the firm's profit if the rival were not excluded.

V QUANTITY FORCING AND EXCLUSION VIA NONLINEAR PRICING OF A SINGLE PRODUCT

The basic idea for how quantity forcing can be used to exclude rivals in the presence of scale economies can be traced back to the limit output model of Bain and Sylos-Labini, as exposited by Modigliani [1958]. There, an incumbent monopolist deters entry by committing to an output level that depresses the residual demand left for entrants just below their average cost curve. That analysis, however, did not explicitly analyze the contracting process, in particular, why far-sighted buyers would willingly participate in a scheme that deters competition.

Subsequent authors showed that exclusion could succeed despite the harm to at least some buyers, due to lack of coordination among them. We first review this logic when a firm can offer contracts that require customers not to buy from other suppliers. We then show that the divide-and-conquer logic can make exclusion profitable also when, instead of requiring exclusivity, a firm offers nonlinear contracts that induce high purchases from it — quantity forcing.

V.A Scale Economies and Divide-and-Conquer via Exclusive Dealing Contracts

Rasmusen, Ramseyer, and Wiley [1991] (RRW) showed how a firm could profitably foreclose competitors by offering to some buyers a lump sum payment in exchange for a commitment to buy only from it — "naked exclusion".[31] In their model, there is an initial monopolist, firm M, but in the second period a second firm E can enter with an identical product. Each firm's marginal cost is constant at a level c for outputs beyond some minimum level Q^*, but infinite at lower outputs.[32] Thus, Q^* is the *minimum viable scale* (MVS). Market demand at price c exceeds $2Q^*$, so the market can support two competing firms with equal shares (and, because of the discontinuous nature of scale economies, both firms would still operate at minimum unit cost). If entry occurs, the market is split evenly and homogeneous-products Bertrand competition drives both prices to c. If firm M remains a monopolist, it can only charge linear pricing, and sets the simple monopoly price m, depressing consumption and yielding the familiar monopoly deadweight loss.

Suppose firm M can offer any buyer a lump sum payment for committing to buy only from it in the second period. Let X^* denote a buyer's loss of consumer surplus due to a price increase from the competitive level c to the monopoly level m (geometrically,

[31] Segal and Whinston [2000] refined the analysis, and showed that the ability to offer discriminatory contracts across buyers is necessary for profitable exclusion. See also Innes and Sexton [1994].

[32] Thus, the average and marginal cost is L-shaped; this is an extreme representation of scale economies, but the results do not hinge on this simplifying assumption.

X^* is a trapezoid). If a single buyer's demand at price c, denoted $d(c)$, exceeds MVS, $d(c) \geq Q^*$, then exclusion is unprofitable. Any individual buyer can then support entry, so exclusion would require signing up all buyers and paying each X^*; but since monopoly pricing reduces overall welfare, the per-buyer monopoly profit π falls short of X^*. However, if two or more buyers are needed to support entry, then divide-and-conquer could make exclusion profitable. If scale economies are sufficiently large, the excluder can afford to lose money on each buyer to whom it pays X^* because it will extract the monopoly profit π from all buyers, including those who are not compensated.

The role of scale economies can be seen as follows. Let N denote the number of independent, identical buyers. The minimal number of buyers firm M must sign up to foreclose entry, N^*, is determined by the condition $(N - N^*)d(c)/2 = Q^*$, total demand by "free" buyers, $(N - N^*)d(c)$, of which 1/2 would go to the entrant, equals MVS. Therefore, $N^* = N - 2Q^*/d(c)$. Firm M can sign up N^* buyers to exclusivity if it pays them a total of N^*X^*. Its second-period profit from monopoly pricing to *all* buyers is $N\pi$. Thus, exclusion is profitable if $N^*X^* \leq N\pi$, or $N^*/N \leq \pi/X^*$, the fraction of all buyers that must be signed is less than the ratio of monopoly profit per buyer to a buyer's loss in consumer surplus from monopoly pricing. Substituting for N^* in $N^*/N \leq \pi/X^*$ yields, after some algebra, that exclusion is profitable provided MVS as a fraction of market demand at the competitive price exceeds a given threshold:

$$\frac{Q^*}{Nd(c)} \geq \frac{1}{2}\left[1 - \frac{\pi}{X^*}\right].$$

For example, if each buyer's demand $d(p)$ is linear, then $\pi/X^* = 2/3$, so exclusion is profitable provided MVS relative to the competitive quantity exceeds 1/6.[33]

Segal and Whinston and Innes and Sexton stress that profitable exclusion hinges on the *ability* to make *discriminatory offers* across buyers. Even when all buyers accept exclusivity, this outcome is driven by buyers' recognition that if they rejected exclusivity, the firm could and would find it profitable to pay others. The role of discriminatory offers in enabling divide-and-concur recurs in the analysis of Bernheim and Whinston [1998] (BW) discussed below.

Finally, in RRW's analysis the excluding firm enjoys a first mover advantage in contracting: it can approach all buyers before the potential entrant arrives on the scene. Spector [2004] allows the entrant to compete for contracts. He finds that if the firms are sufficiently asymmetric, exclusion can still be profitable and the outcome is ex post

[33] The above condition was derived assuming that the excluder must pay X^* to each of N^* buyers. RRW show that there exists equilibria where firm M excludes entry while paying virtually nothing, because each buyer believes he is not pivotal to the entrant's success and therefore accepts exclusivity with M for the slightest payment. Segal and Whinston argue (for the case where contracts are offered to buyers simultaneously rather than sequentially) that these costless exclusion equilibria fail to satisfy a commonly applied criterion (coalition-proofness) that is satisfied by the costly (but profitable) equilibrium.

monopoly pricing. However, the rents from monopolization are captured not solely by the excluder but also by a subset of the buyers who are signed to exclusivity, a finding reminiscent of BW's analysis as well as that of O'Brien and Shaffer [1997] (OS).

V.B Exclusion via Quantity Forcing

RRW's analysis is relevant because it highlights the role of divide-and-conquer. But it must be adapted in important ways to address the antitrust cases discussed in the Introduction. There, the contested practices did not involve explicit exclusive dealing, i.e., prohibitions on buying also from rivals. Rather, demand for rivals' products was depressed *indirectly* through contracts that provided strong incentives for some buyers to expand purchases from the alleged excluder — quantity forcing. Furthermore, as noted above, RRW's framework grants the excluder a strong first mover advantage, at odds with cases discussed earlier where the rival producers were already present and could offer their own quantity forcing contracts. Finally, note that the use of quantity forcing contracts implies that firms in such cases are not, in practice, limited to only linear pricing, as assumed by RRW. To analyze exclusion through quantity forcing, therefore, requires a framework where rival firms compete by offering nonlinear pricing contracts.

V.B.1 Nonlinear Pricing to a Single Buyer

OS [1997] and BW [1998] analyze the following situation. Firms A and B compete with differentiated products: their products are imperfect substitutes. Suppose for now that they sell to a single buyer. The buyer may be a local monopolist dealer; it demands both products, reflecting the diverse preferences of its final customers. For simplicity, assume that both firms have constant (but possibly different) marginal costs. Both firms (indexed below by $j = A, B$) are able to offer general nonlinear contracts.

Let $T_j(q_j)$ the total payment to firm j as a function of the quantity purchased from it, q_j, and q_j^t denote a specified *target* quantity. Let p_j denote the per-unit price charged by firm j and F_j denote a fixed-fee payment to firm j. We can focus on two types of contracts:

$$\textit{Two-part tariff}: \qquad T_j(q_j) = F_j + p_j q_j$$

$$\textit{Quantity forcing}: \qquad T_j(q_j) = F_j^t \text{ if } q_j = q_j^t \text{ and } \infty \text{ for any } q_j \neq q_j^t.$$

A two-part tariff gives the buyer the flexibility to select any quantity while paying a constant per-unit price and a fixed fee.[34] The particular forcing contract above allows a

[34] With constant marginal costs, two-part tariffs that set $p_j = c_j$ will suffice to achieve the efficient quantities. If marginal costs are not constant, the natural extension is a contract $F_j + C_j(q_j)$ where $C_j(q_j)$ is

target quantity q_j^t for a fixed payment F_j^t and any other quantity is refused (requires an infinite payment). Less extreme contracts can also implement quantity forcing. For example, if the buyer chooses any quantity below q_j^t the per-unit price is p; but if it meets or exceeds q_j^t, the price drops to $p - d$ on *all purchases* – the so-called "all-units-discounts". This amounts to cutting the marginal price to $p - d$ once the target is reached (as with ordinary sliding-scale pricing) *and*, in addition, refunding the buyer a lump sum equal to $q_j^t d$ for reaching the target.

When such contracts are available, the standard monopoly deadweight loss arising under linear pricing will be eliminated — a seller and a buyer will choose the quantity that maximizes their joint surplus and use a fixed fee (or other nonlinear pricing) to divide this surplus. Thus, potential efficiency losses from exclusion in this setting arise not from monopolistic per-unit pricing (as in RRW) but from diminished product variety. Denote by q_A^s the quantity of product A that would maximize the joint surplus of the buyer and firm A when its product is the single one available: q_A^s is the quantity where firm A's marginal cost intersects the buyer's demand curve for A derived conditional on buying none of B. Let (q_A^b, q_B^b) denote the quantities of the two products that would maximize the joints surplus of the buyer and *both firms* (equivalently, of the buyer and an integrated firm that had available both products) if efficiency requires carrying *both* products. If, instead, scale economies (e.g. due to fixed costs) make it jointly efficient to carry only one product, let it be product A, and the efficient quantity q_A^s defined earlier.[35] Observe that since the products are substitutes, $q_A^s > q_A^b$. Two part tariffs suffice to implement the efficient solution in either case: if both firms offer per-unit prices equal to marginal costs and fixed fees needed to cover at least their fixed costs, the buyer would choose (q_A^b, q_B^b) or $(q_A^s, 0)$, depending on which option yields higher joint surplus.

Foreclosure is said to occur when the jointly efficient outcome involves sale of both products, (q_A^b, q_B^b), but firm A instead induces exclusion of product B. In the case of a *single buyer*, OS show by example, that foreclosure through quantity forcing is possible sometimes — if the incremental contribution of product B to the joint surplus of firm B and the buyer is not positive, given that the buyer is purchasing q_A^s.[36] Foreclosure in this

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the firm's total variable cost of supplying the associated output. Bernheim and Whinston call these "sellout contracts".

[35] The identity of the "stronger" product will depend on both demand and cost differences. There is, of course, no loss of generality in assuming that product A the stronger one — this is just a matter of labeling.

[36] Observe that, if exclusive dealing (ED) is feasible, foreclosure can always occur: firm A could stipulate ED, and offer the bilaterally efficient output for it and the buyer conditional on product B being out, coupled with a suitable fixed fee (the highest such fee leaves the buyer just indifferent to dropping product A and purchasing the optimal quantity from firm B at its cost). However, for reasons discussed next, foreclosure will not be profitable in this single buyer setting.

case is still inefficient overall, taking into account the loss to the excluded rival, because the incremental value of product *B* to the buyer is artificially depressed by firm *A* 'forcing' an excessive quantity of its product, q_A^s instead of q_A^b. This foreclosure outcome can be implemented, for example, using the forcing contract described earlier, by specifying the target quantity as q_A^s.

OS and BW do not analyze *market share* contracts. However, such contracts also can potentially achieve foreclosure. Let product *A*'s market share in the non-foreclosure equilibrium be $s = q_A^b / (q_A^b + q_B^b)$. Suppose firm *A* offers the buyer an inducement to buy at least a higher share than *s* from firm *A*. To meet this higher share target, the buyer must either raise its purchases from *A*, which indirectly reduces its demand for *B*, or directly reduce its purchases from *B*. Both effects reduce the sales of product *B*, possibly rendering it non viable.

Even though foreclosure can be feasible, both OS and BW show that foreclosure will *not be profitable* to firm *A* in the single-buyer setting. Whenever it is jointly efficient for the buyer and the two firms to have both firms supply, firm *A*'s profit is reduced if it induces exclusion of firm *B*. The intuition is that when nonlinear contracts are available, firm *A* can extract profit not solely through a per-unit price on its own sales, but also through a fixed fee whose level can capture some of the surplus that the buyer earns from the other product. Thus, if it is better for the three parties collectively to have both products supplied, then firm *A* can realize higher profit by accepting such an outcome and setting a higher fixed fee.[37]

V.B.2 Nonlinear Pricing to Multiple Buyers: Profitable But Costly Exclusion, and Predation at the Margin

Intuition suggests that (inefficient) exclusion can become profitable once we move from a single buyer environment to multiple (non-competing) buyers, due to the divide-and-conquer logic. BW confirm this intuition. We review their analysis in more detail in the Appendix, and summarize it here.

BW develop a two-buyer example where both firms simultaneously offer non-linear contracts to each buyer in sequence. That is, when contracting with the first buyer, it is not possible to specify also the terms to the second, for example, because that second market has not yet developed (BW's "non-coincident markets"). Suppose that (i) firm *B* must incur a fixed cost if it wishes to produce, and makes this decision following the outcome of negotiations with the first buyer, (ii) this fixed cost is high enough that firm *B* can cover it only if it sells to both buyers (i.e. there are important scale economies), and (iii) Firm A has already incurred this fixed cost. BW show that even when it is socially

[37] If, instead, firms are limited to linear prices, then the firm with the product differentiation advantage may find exclusive dealing profitable, because it derives profit only on a per unit sales basis and ED increases those sales. See Mathewson and Winter [1987].

efficient to have both firms sell to both buyers, foreclosure of firm *B* can be profitable to firm *A* and can arise in equilibrium.

The key is that foreclosure allows firm *A* to extract as monopoly profit the second buyer's entire value for firm *A*'s product, whereas competition between *A* and *B* would leave surplus to the second buyer. If the first buyer's loss from reduced variety is small relative to the gain from extracting full monopoly rents for product *A* from the second buyer, then foreclosure can arise. The first buyer is aware that its high purchases from firm *A* will induce exclusion of firm *B* and deprive the first buyer of valuable variety, but firm *A* is able to 'bribe' the buyer to partake in foreclosing *B* by drawing on the anticipated monopoly profits from the second buyer. The analysis yields several interesting conclusions.

Foreclosure Does Not Harm the Pivotal Buyer. In the models analyzed by BW and OS the first buyer always gains from exclusive dealing because this forces firms to engage in tougher all-or-nothing competition for its business.[38] The harmed parties are the excluded firm and the second buyer — who cannot participate in the initial contracting with the first buyer. This echoes a common finding in the economics literature: profitable contracting among a subset of agents can inflict harm on parties absent from the contracting table. The antitrust lesson is that inefficient exclusion may not be detected by asking if the participating buyers have been 'coerced' — the harm is likely to fall on others.

Profit Sacrifice on the First Buyer. Compared to the profits firm *A* would earn if it accepted firm *B* (by refraining from quantity forcing and instead employing a two-part tariff), under foreclosure firm *A* earns lower profit on the first buyer, whom it must compensate through a lower fee for distorting the quantity choices by reducing variety. Since foreclosure is profitable on balance, an antitrust test that asked it firm *A* was sacrificing profit overall by excluding would obviously acquit. However, if the test was applied to the first buyer alone, it would reveal that exclusion entailed a profit sacrifice.

Predation at the Margin. Depending on cost and demand parameters, firm *A* may be able to exclude *B* by 'forcing' the first buyer to purchase from it their bilaterally efficient quantity conditional on firm *B* being out, q_A^s. If firm *B*'s fixed cost is lower, however, foreclosure may require inducing the first buyer to expand its purchases of *A* even beyond q_A^s, so as to further depress that buyer's residual demand for the substitute product *B*. In such a case, there is predation at the margin: the quantity exceeds the level that would result if firm *A* set price equal to marginal cost and let the buyer select the quantity. The implicit price for the marginal units is thus below marginal cost. Observe that a test that compared average revenue with average cost would acquit; a test that

[38] Because of the "all-or-nothing" form of competition, Firm A can profit from exclusion only if it has *some* advantage over B, in this case, by having already sunk its fixed cost.

compared *incremental* revenue with incremental cost would find predation, provided it adopted the correct quantity increment. As a practical matter, of course, this is a daunting task.

VI NON-EXCLUSIONARY MOTIVES FOR QUANTITY FORCING

VI.A Heterogeneous Consumers and Indirect Price Discrimination

With identical customers, simple two-part tariffs suffice for rent extraction, so quantity-forcing contracts discussed above may raise eyebrows. However, two-part tariffs are no longer sufficient for maximal rent extraction when a monopolist faces heterogeneous buyers and cannot directly price discriminate, e.g., because he cannot identify the particular demand curve of any given buyer (the buyer's 'type'), though he knows the distribution of demands.[39] In such cases, the monopolist's profit-maximizing indirect ('2nd-degree') price discrimination entails offering the same *menu* of non-linear contracts to all potential buyers, with the menu designed to induce self selection — different buyer types (indexed by $i = 1, \ldots n$) select different contracts. Kolay, Shaffer and Ordover [2004] remind us that optimal indirect discrimination cannot be implemented with menus of two-part tariffs. However, it can be implemented through contracts such as menus of all-units-discounts. Note that all-unit-discount contracts all have the 'suspicious' property that *total* payments fall over *some* range as purchases rise past the threshold. The message of Kolay et al. is that such contracts need not be motivated by exclusion.

However, if the sole purpose were monopoly price discrimination, this could also be achieved by offering a menu of contracts $\{q_i, T_i\}$ where q_i is the quantity intended for (and, in equilibrium, chosen by) a particular type i, and T_i is the total payment for that total quantity.[40] This optimal menu has the natural property that total payment demanded always rises with quantity (T_i increases with q_i.)[41] These more natural contracts would seem simpler to implement. By contrast, if the purpose is exclusion, then the monopolist wants to stress to buyers the importance of not falling below certain purchase thresholds, and discontinuities may be intended to serve as such a reminder.

Market Share Discounts. With competing firms instead of a monopolist, specifying the minimal purchases needed to qualify for a discount not as absolute quantities but as *percentages* of the buyer's total purchases — share contracts — raises a

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[39] Direct discrimination may also be infeasible for legal reasons, e.g., in some contexts, any offer made to one customer must be made available to all.

[40] For example, wireless phone companies offer "buckets" with differing number of minutes for different fixed monthly fees.

[41] See Tirole [1988], pp 145-148.

perception that the purpose may be to deny business to competitors rather than increase it for the firm. An alternative explanation put forth for share discounts is that buyers differ *exogenously* in their sizes — e.g., small versus large retail stores — and hence in their ability to attain specified volume levels; basing the discounts on the *share* of each buyer's total purchases made from that manufacturer may provide incentives for all buyers to increase their purchases.[42]

One rationale for the above behavior may be a blend of 3rd-degree price discrimination (there are exogenous differences between certain observable buyer classes such as large versus small stores, to motivate reliance on share-of-purchases rather than absolute volumes) and 2nd degree price discrimination (within a given group there is buyer heterogeneity that is unobserved by the seller — such as high or low preference for its product). At an informal level, optimal screening *within* the class of small buyers and optimal screening within the class of large buyers takes the same *relative* form: some types choose, in equilibrium, smaller quantities than other types within the same class. A menu of contracts that is intended to serve as a screening contract for *all* sizes of buyers might then conceivably take the form of a market share contract since such contracts would have this same qualitative feature.

However, two issues arise. First, it appears that only highly particular environments would yield that the *optimal* (size-specific) menu of contracts implies precisely the same market share thresholds for both smaller and larger buyers. Conditions under which share discounts indeed implement the profit-maximizing form of price discrimination given the information constraints faced by the seller remain to be explored. Second, and more importantly, a contract that makes outcomes contingent on market share gives the privately informed buyer *an extra way to impede price discrimination* by distorting the information available to the seller. A buyer could, in some circumstances, meet a market share threshold partly by reducing its purchases from other sellers, as an alternative to expanding its purchases from the first seller.

Both issues highlight that if the goal is solely price discrimination, market share discounts are *prima facie* suboptimal mechanisms. One could imagine reasons why such contracts nevertheless would be chosen for price discrimination — perhaps it is simply too costly to tailor each contract for each individual buyer, or perhaps because of equity or legal concerns,[43] a seller is unwilling to present significantly different menus to different customers. However, in such cases, the defendant should be prepared to offer some evidence along these lines.

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[42] This argument is noted in *Concord* and attributed to Brunswick's economic expert, Dr. Frederrick Warren-Boulton.

[43] For example, the Robinson-Patman Act may prohibit a seller from offering different buyers different menus of contracts.

VI.B Market Share Discounts to Induce Dealer Effort

Mills [2004] offers an efficiency explanation for share discounts, suggesting they may be a means to induce retailers to engage in otherwise unenforceable merchandising activity. He develops a model where retailers who are heterogeneous in size and skill, can take an action that increases demand for the product of a monopolist supplier. The retailer's consumers purchase either the monopolist's product or an inferior (in the vertical differentiation sense) rival product. If the monopolist were able to monitor the retailer's activities, then she would simply pay the retailer explicitly for such activities whenever it is profitable (and, therefore, in this model, socially desirable). In the absence of a monitoring capability, the monopolist could conceivably reward the retailer for achieving a target sales level, but if the retailers differ exogenously in size and these differences are unobservable by the supplier, then the appropriate target level for a given retailer may not be known and therefore may not be contractible. Mills provides an example where merchandising activities affect sales of the supplier's product proportionately to the retailer's size. In such circumstances, a *market share* target level may be sufficient to induce the retailer to take the appropriate actions. This efficiency based motive for market share discounts relies heavily on the requirement that, at the contracting stage, the supplier be unable to recognize whether the retailer is large or small relative to the market and that the retailer's optimal activities be directly proportionate to its size.

VII CONCLUSIONS

We began with the case where quantity forcing in the target market is implemented via a tied discount off a second monopoly product. The economic literature shows that tying can be used to extract additional rent beyond what could be obtained solely through per unit pricing (linear pricing) of the monopoly good. Since this role for tying is present under the assumed pricing conditions whether or not foreclosure is possible in the tied market, a more accurate characterization of the motive is rent extraction rather than exclusion. Moreover, tying in this setting can improve economic efficiency, by increasing the monopolist's benefit from expanding output. Building on this analysis, we identified why an *Ortho* type test could condemn welfare increasing (and consumer neutral) tying as predatory.

However, there is a serious difficulty with the above rent extraction argument for tying. The underlying premise that the monopolist can charge only linear pricing is at odds with the ability to impose tying. A tie-out (or a tie that requires significant purchases of the tied product) requires greater contracting power than a requirement also to purchase some small amount of the tied product from that firm. A minimal tie-in, coupled with a suitably high price for the tied good, would suffice to levy a fixed fee for the right to buy the monopoly good. Furthermore, if buyers' demands are known, the

ability to charge a fixed fee — or differing fixed fees if buyers are heterogeneous — avoids the inefficiency of a tie-out, and therefore can extract more rents. If the monopolist is imperfectly informed about demands, tying can help with rent extraction in certain settings: the traditional one where a tied *complementary* product serves to meter the intensity of demand for the tying good, and perhaps also where the products are unrelated in consumption but are statistically dependent (so a buyer's demand for one good provides a signal about his level of demand for the other). These explanations, however, do not apply when demands for the goods are unrelated and independent, nor when the goods are consumed in fixed proportions. In both cases, the demand for one good then conveys no added information about the demand for another.

Thus, in many situations tying is likely to conflict with optimal rent extraction, because the pricing contracts that are plausibly available whenever tying is feasible are likely to induce smaller consumption distortions. By contrast, inducing a customer to buy all or a high share of its tied good requirements from the tying good monopolist is consistent with a desire to exclude rivals from the tied market when economies of scale are significant, because diverting demand can then threaten their viability. But why would the excluder prefer to implement quantity forcing by providing the inducement via tied discounts rather than directly via nonlinear pricing of the tied good? Having deployed its available contracting instruments optimally to extract rents from the other markets, there should not remain 'cheap money' in the form of unexploited rents that might be used to "bribe" the buyer into accepting quantity forcing in the target market.

One reason for preferring tied discounts might be to make the inducements less transparent to antitrust enforcers, especially if the discounts are provided on numerous tied products. This transparency observation brings us to a central message: the antitrust concern with bundled discounts should center on the quantity forcing aspect and whether it poses a serious risk of exclusion, not on *how* quantity forcing is implemented — be it through tying or nonlinear pricing in the target market.

Turning to nonlinear pricing in the contested market, such contracts make exclusion less costly to the perpetrator in the presence of scale economies than having to rely on uniform price cuts. This fact alone, however, clearly does not justify condemnation or even greater scrutiny of nonlinear pricing than of per-unit pricing. Nonlinear pricing makes it cheaper for the firm to expand output whatever the purpose, exclusion *or legitimate*. Unfortunately, our analysis suggests there is no simple test that will identify the main purpose and likely effect of all nonlinear pricing schemes.

Indeed, formulating an economically justified safe harbor is likely to be even harder than for simple per-unit pricing. There, setting price above marginal cost might be taken as a proxy for lack of profit sacrifice and an absence of predatory intent. With nonlinear pricing, implementing such an incremental revenue / incremental cost test poses added difficulties. (a) The incremental price or revenue will often not be directly

observable, because it must be computed net of the discounts, which themselves may be somewhat opaque to outsiders. (b) In addition, the calculations will depend on the size of the output increment being considered; for instance, as noted earlier , all-units-discounts inherently imply a *negative* marginal revenue for small output increments that take the buyer just past a discount threshold. (c) Finally, there can be a profit sacrifice even if price equals marginal cost. For instance, in BW's [1988] analysis, inefficient foreclosure through quantity forcing can entail choosing the output level that is jointly efficient for the firm and buyers given that the rival is excluded, so at the margin, price is set equal to marginal cost. Yet there is profit sacrifice, taking the form of collecting a smaller fixed fee relative to the unobservable non-exclusion benchmark. In the current state of knowledge, we are not hopeful about the prospects of crafting an economically grounded safe harbor for nonlinear pricing, at least not one that would cover all such contracts.

The prudent course at this stage, we believe, is to conduct the analysis in two broad steps: (i) use structural screens to gauge if the risk of exclusion is significant; (ii) if and only if the answer is yes, proceed to a more detailed inquiry to determine whether the only or the predominant motive for the practice was exclusion.[44] A compelling reason for focusing on intent, once the above structural conditions have been met, is that it provides a strong signal about likely effects.[45] As a market insider, the firm is likely to possess superior knowledge than an outsider about the likely effects of its action, so an ex post inquiry into the firm's rationale for adopting a practice can shed light also on the likely prospects for success — does the practice pose a serious risk to competition?

Structural Screens. Given the strong efficiency potential of nonlinear pricing, we would set the bar quite high before entertaining allegations of exclusion. To be useful, screens must be based on information that is fairly readily available. Thus, we would confine the inquiry to questions such as:

Concentration: Does the alleged excluder possess a high market share? Is the plaintiff one of only very few strong competitors, such that excluding it would have a significant adverse effect on competition?

Scale Economies and Volume Denied: Are there significant scale economies so that a competitor incurs a significant cost penalty per unit if forced to operate at a low scale? If so, has the incumbent through its forcing contracts locked up enough of the demand that the competitor's ability to realize scale economies is seriously jeopardized? These conditions are likely to be less observable than concentration, so we would not demand

[44] Spector [2005] also offers a structured rule of reason, but differs somewhat from ours in the order of, and relative emphasis on, various steps.

[45] Thus, intent conveys relevant information even when the sole issue is whether to enjoin the practice going forward. Intent is obviously necessary when the issue is whether to penalize the firm for its past willful actions.

detailed information or set the bar too high for the plaintiff at this screening stage. However, we would require some showing that these conditions are met. For example, the scale economy hurdle is failed if one observes other firms operating successfully at fairly small scale.

Conduct Inquiry. If the structural screens are passed, we turn to a more detailed and nuanced analysis of the particular conduct and the specific market context. Price-cost tests can be informative but are subject to added difficulties in the case of nonlinear pricing. Recall, for example, that exclusion through quantity forcing can arise even when the firm's marginal price equals its marginal cost. The form of the particular contracts and the circumstances of their adoption are likely to be just as revealing.

Quantity Forcing vs. More Flexible Contracts: Contracts that induce a customer to purchase a very high share of its total requirements from the defendant have greater exclusionary potential than, for example, two-part tariffs. In BW's [1988] analysis, two-part tariffs offered by both firms will suffice to implement the efficient solution — whether it entails both being active or only one of them — but inefficient exclusion requires use of quantity forcing.

Divide and Conquer: Profitable exclusion through denying scale economies to a rival is facilitated by offering quantity-forcing contracts to only a subset of customers. Thus, concern is heightened if the contracts are not offered uniformly to all comparably situated customers, but only to some. Of course, the term "comparably situated" is key, because with customer heterogeneity, there are non-exclusionary reasons for differential offers. Transaction costs could explain, for example, why a manufacturer would only engage in complex contracts with larger customers and sell on simple terms to small ones. We would allow defenses based on transaction costs, or on price discrimination that reflects demonstrable differences across customers in their willingness to pay. However, suspicion is raised if discrimination seems driven by an intent to divide and conquer.

Calibrating the Quantity Forcing: Suspicion is further heightened if there is evidence that the defendant chose its quantity forcing targets with an eye to denying the rival scale economies, rather than for its own internal reasons. The timing of when such contracts were adopted can also be informative: did the disputed contracts appear to have been adopted in response to an increased in the perceived entry threat?

Efficiency Motives: Our starting position is that firms should not be required to explain the business reasons for their actions; those should be presumed legitimate barring evidence to the contrary. However, as evidence of exclusionary motive and likely effect accumulates, based on the above inquiry, the burden increases on the defendant to show an alternative reason. We recognize that there could be non-exclusionary purposes for market-share contracts and the like; but at this stage of the inquiry, we would require more than superficial assertions about such purposes.

In sum, quantity forcing requirements accounting for a large share of purchases, in a concentrated market, and where operating on a small scale seriously threatens the rival as a robust competitor will raise a yellow flag. The flag *may* turn red if the quantity targets and the number of affected customers are calibrated with an eye on denying the rival scale economies and there is other evidence of a concerted plan to exclude. We recognize that this is not a simple inquiry, and we would therefore impose a fairly stringent threshold at the screening stage. However, such an inquiry seems unavoidable in monopolization cases, whether the affected conduct includes price or non-price terms.

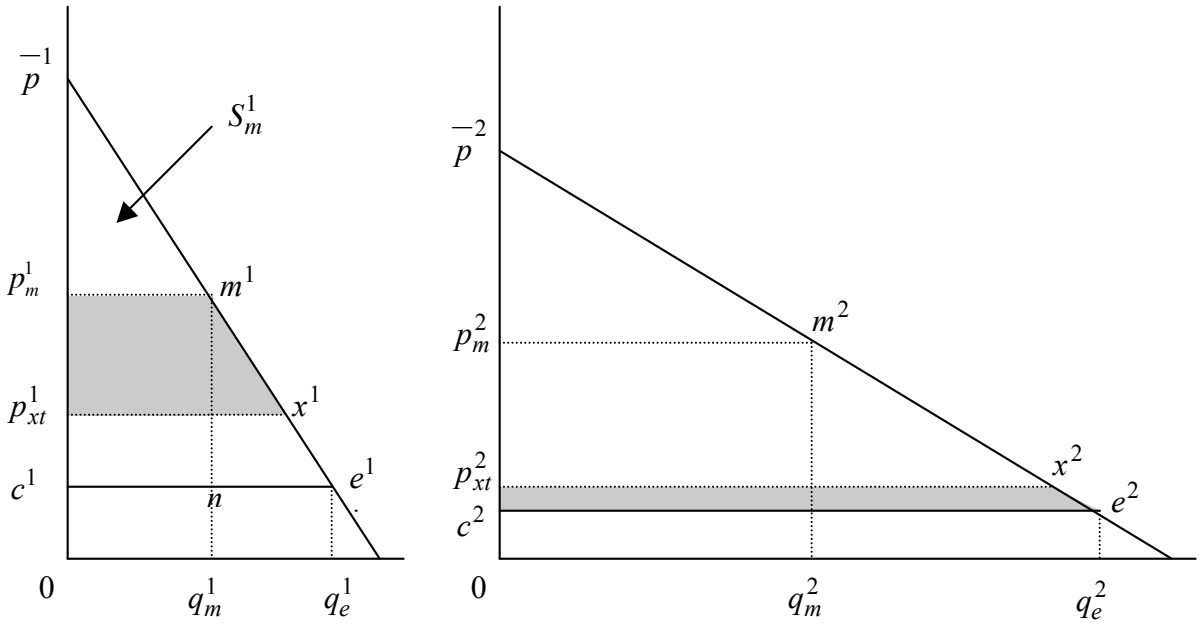
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Figure 1

APPENDIX 1: *Ortho* Test

Failing the *Ortho* Price Test under Mixed Tying

Firm *A* is a monopolist over good 1 and faces perfect competition in 2. Demand for each good, under unbundling, depends only on its own price. Cost and demand parameters are:

- Marginal cost is *c* for firm *A* in both markets, and also *c* for rivals in market 2.
- Demand in market 1 is linear: $q = D^1(p) = a - p$
- Demand in market 2 also is linear: $q = D^2(p) = sD^1(p)$,

where *s* is a number that reflects the size of market 2 relative to 1. Geometrically, the demand curve $D^2(p)$ is simply a horizontal multiple of $D^1(p)$. This implies that at any common price *p*, the demand elasticities are equal: $E^1(p) = E^2(p)$.

Recall that the *Ortho* test in the case of mixed tying can be written as

$$[(p^1_{xt} + p^1_{xt}) - (c^1 + c^1)] \; < \; (p^1_m - c^1) \tag{4}$$

The simple monopoly price in market 1 is $p^1_m = c + (a - c)/2$, independent of *s*. The mixed-tying prices satisfy the Ramsey conditions for maximizing profit subject to a specified level *u* of consumer surplus. Given that demand for each good depends only on its own price, the prices are implicitly defined by the following conditions:

$$\frac{p^j - c^j}{c^j} = \frac{k}{E^j},$$

where *j* denotes any market (*j* = 1, 2), and *k* is a common number across markets, ranging from 0 to 1 (*k* = 0 corresponds to marginal-cost pricing; *k* = 1 corresponds to simple monopoly pricing). The size of *k* will depend on the relative size parameter *s*.

Since marginal costs and demand elasticities are assumed equal in both markets, the above equation implies that firm 1's tied prices also will be equal: $p^1_{xt} = p^1_{xt} = p_{xt}(s)$. Therefore, test (4) becomes:

$$2[p_{xt}(s) - c] \; < \; (p^1_m - c).$$

Finally, recall that $p_{xt}(s)$ is set to equate (i) the gain in consumer surplus on good 1 due to cutting price from the monopoly level to $p_{xt}(s)$ with (ii) the loss in consumer surplus on good 2 due to the price increase from the competitive level c^2 to $p_{xt}(s)$. (Any higher tied price would be rejected.) Therefore, $p_{xt}(s)$ lies in the range

$$c \; < \; p_{xt}(s) \; < \; p^1_m.$$

Moreover, $p_{xt}(s)$ is a decreasing function of *s*, the size of market 2 relative to 1, and $p_{xt}(s) - c$ becomes arbitrarily close to 0 for *s* sufficiently large. Thus, for large *s*, the inequality in (4) will hold, i.e., the *Ortho* test is failed.

Revenue Version of the *Ortho* Test under Mixed Tying

Applied to goods 1 and 2, our revenue version of the *Ortho* test finds a violation if:

[revenue from 2 – revenue sacrifice on 1] < (total variable cost of 1) (1')

Consider the following scenario. Firm *A* is initially an unconstrained monopolist in both markets, charging the monopoly prices. Now a fringe of competitors enter into market 2 and set prices equal to marginal cost, c^2. A common situation is where firm *A* specifies a target quantity in the tied market, 2. Suppose, in particular, that firm *A* responds with following offer to each consumer:

> "Continue buying from me at least your old monopoly quantity (q_m^2) at the original price (p_m^2), and on good 1 you will get a discount *d* from its monopoly price (p_m^1) on all the quantity you purchase of good 1, q^1."

There is ambiguity about which level of q^1 should be used when applying the test (1'). We will consider two alternative levels, the old monopoly output or the new higher level.

The above contract lets the consumer buy incremental units of good 2 from competitors at cost, so the consumer's loss on good 2 from accepting the tie equals the price differential times the unchanged quantity bought from firm *A*, $(p_m^2 - c^2)q_m^2$. Firm *A* sets the discount *d* on good 1 such that gain in consumer surplus. including the output expansion from q_m^1 to the new level q_d^1 (a trapezoid), equals the loss on good 2.

Compared to no tying, this contract unambiguously raises firm *A*'s profit. If consumption of good 1 had remained unchanged, the contract would be neutral, since the revenue gained at the consumer's expense on god 2 would be exactly matched by the revenue reduction on good 1, without causing any consumption distortion in 2 or improvement in 1. But the tied discount on good 1 increases its consumption, which raises overall welfare since initially the quantity was at the suboptimal monopoly level. This efficiency gain implies that firm *A* can tailor the size of the discount *d* to yield the same overall consumer surplus as under no tying and competitive entry into 2, but increase its profit relative to this same benchmark.[46]

Applied to our scenario, test (1') becomes

$$[p_m^2 q_m^2 - q^1 d] < c^2 q_m^2. \qquad (2')$$

We consider two interpretations: q^1 is taken to be either the initial monopoly quantity q_m^1 or the new higher one q_d^1. Denote the expansion by $\Delta = q_d^1 - q_m^1 > 0$.

[46] Essentially, the markup on the fixed quantity of good 2 is a way to levy a fixed fee, in exchange for which firm *A* cuts the price of the monopoly good 1 and reduces the inefficiency. Of course, the ability to charge a fixed fee in this manner, by fixing both price and quantity, begs the question of why firm *A* does not use good 2 to *eliminate* inefficiency in prior to entry. We return to this important point in section IV.

Old output: $q^1 = q_m^1$. In this interpretation, the test ignores the profit gain to firm *A* from the output expansion Δ (the gain is positive as long as the post discount price remains above marginal cost: $p_m^1 - d < c^1$). Even so, if firm *A* prices as described above, it will still pass the test. On good 2, it continues to earn the simple monopoly profit $\pi_m^2 = p_m^2 q_m^2 - c^2 q_m^2 = (p_m^2 - c^2) q_m^2 > 0$. The imputed sacrifice on good 1 is less than π_m^2, because only part of consumer's "compensation" for giving up $(p_m^2 - c^2) q_m^2$ — by continuing to buy q_m^2 from firm *A* at the monopoly price p_m^2 instead of from competitors at c^2 — comes from the discount on the initial quantity ($q_m^1 d$), the remainder comes from the "triangle" *T* (> 0) of increased consumer surplus generated by increasing consumption of good 1 at the post-discount price. Thus, $\pi_m^2 = p_m^2 q_m^2 - c^2 q_m^2 = q_m^1 d + T$ implying $[p_m^2 q_m^2 - q_m^1 d] > c^2 q_m^2$ so test (2') is passed.

New output: $q^1 = q_m^1 + \Delta$. In this case, the test still ignores the gain to firm *A* from the expansion in sales of good 1. But in addition, it *overstates the revenue sacrifice* on good 1 — since the price cut *d* is applied in the test also on the output expansion Δ, an expansion that is made possible only because of the discount. This additional bias makes it possible for the firm to fail the test. The imputed sacrifice on good 1 is now $q_m^1 d + \Delta d$. As above, firm *A* sets the discount *d* so that $\pi_m^2 = q_m^1 d + T$. The test is therefore necessarily failed, $\pi_m^2 = q_m^1 d + T < q_m^1 d + \Delta d$, because $T < \Delta d$. That is, with downward-sloping demand, the consumer surplus "triangle" *T* gained due to the output expansion is less than the imputed sacrifice term Δd (for linear demand, $\Delta d = 2T$).

Summarizing, in our example the *Ortho* test will always be passed if the revenue sacrifice on good 1 is assessed on the pre-tying output, but can be failed if assessed on the post-tying, higher output. Yet mixed tying increases total surplus without harming consumers.

APPENDIX 2: Bernheim and Whinston [1998] (to be added)

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