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JEL Classification: D42, D82, L42

Keywords: Exploitation, foreclosure, Market-share discounts, Exclusive dealing

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Exploiting rivals' strengths*

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Abstract

Contracts that reference rivals' volumes (RRV contracts), such as exclusive dealing or market-share rebates, have been a long-standing concern in antitrust because of their possible exclusionary effects. We show, however, that it is more profitable to use these contracts to exploit rivals rather than to foreclose them. By optimally designing RRV contracts, a dominant firm may, indeed, obtain higher profits than if it were an unchallenged monopolist. In the most favorable cases, it can earn as much as if it could eliminate the competition and acquire the rivals' specific technological capabilities free of charge.

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1 Introduction

In antitrust cases of monopolization or attempted monopolization, the main policy concern is that a dominant firm may use its power to foreclose competitors that are more efficient in some respects, and hence ought not to be excluded. In this paper, we consider the possibility that the dominant firm may instead let such competitors stay active so as to take advantage of their specific capabilities. We show that such *exploitative* strategies can be more profitable than the *exclusionary* strategies that antitrust policy usually focuses on, and their competitive effects more benign.

In particular, the exploitative strategies that we consider rely on the use of contracts that reference rivals' volumes (RRV contracts). These are contracts whose terms depend on what the buyer purchases from the firm's competitors. Exclusive dealing is perhaps the best-known example in this class. It is also the most parsimonious from an observational point of view, as its enforcement requires only that one can verify whether the buyer makes any purchase from rivals or not. But firms can sometimes observe not only whether but also how much buyers purchase "abroad."[1] When this is so, a whole range of contractual possibilities opens up. For example, a firm may request, as a condition for obtaining its product, that the buyer purchase from the firm itself at least a certain share of his total demand, but not necessarily one hundred percent. Such market-share requirement contracts are frequently observed and have spurred considerable antitrust controversy.[2]

Conventional wisdom views these requirements as a surrogate of exclusive dealing arrangements, more softly designed so as to circumvent the antitrust prohibition against those practices.[3] But the contention of this paper is that market-share requirements are generally more profitable than exclusive dealing and thus would be the dominant firm's elective choice whenever feasible.

In the hands of dominant firms, market-share requirement contracts are in fact a surprisingly powerful tool that can produce even higher profits than if the firm were an unchallenged monopolist. This is possible precisely because these contracts allow the dominant firm to positively exploit its rivals. The mechanism of exploitation relies on a careful combination of on-path and off-path contractual offers. On path, the dominant firm offers a market-share requirement contract that ties the rival products to its own product, effectively creating a bundle of the products. Off path, it offers an exclusive dealing contract that serves as an outside option for the buyer. The existence of this outside option disciplines the rivals, inducing them to reduce the price of their components of the bundle. This allows the dominant firm to increase the price of its own component, thereby extracting rents from rivals. In the most favorable cases, the dominant firm can obtain the same profits as if it could eliminate

[1] This is particularly true when the buyers are downstream firms, and the product is an input used in fixed proportions to manufacture or deliver a final good. In these cases, an upstream firm that observes the final output of the downstream firm can infer the amount of the input that the downstream firm must have procured elsewhere.

[2] See e.g. Kobayashi (2005). Market-share requirements are often cast in the form of rebates that are granted to the buyer if the target market share is reached (so-called market-share rebates).

[3] Other explanations have however been proposed. After developing our results, we discuss the related literature more fully in section 7.

the competition and acquire the rivals' technological capabilities free of charge.[4]

The possibility of using RRV contracts to exploit rivals relies on the combination of two types of contractual externalities: (i) the direct externalities that arise when the dominant firm can contract on the rival's quantity, and (ii) the indirect externalities that arise when firms, in response to various kinds of market imperfections, charge marginal prices in excess of their marginal costs. Both externalities are necessary. If there are no contractual externalities of the second type, firms can extract their profits efficiently, by charging a fixed fee on top of their costs. In this case, even if the dominant firm can contract on the rival's volume, it cannot obtain more than its marginal contribution to the social surplus,[5] and hence more than if it were an unchallenged monopolist; in other words, it cannot exploit the rival. But, as we show, this conclusion can be reversed when marginal prices are distorted.

Since price distortions are probably ubiquitous,[6] this implies that dominant firms have strong incentives to use market-share requirement contracts when they are feasible. Obviously, the feasibility of these contracts is limited both by the difficulties of enforcement and by the risk of antitrust intervention. However, the difficulties of enforcement are not insurmountable,[7] and antitrust intervention is a matter of policy choice. In this respect, we show that exploitative equilibria are generally more efficient than exclusionary ones, which may indeed justify a more lenient treatment by antitrust authorities and the courts.

The rest of the paper proceeds as follows. After presenting the analytical framework (section 2), we analyze the baseline case where the dominant firm acts as a price leader and is restricted to tariffs of a simple form (section 3). In sections 4 and 5, we show the robustness of our results to these specific modelling assumptions. Section 6 presents the welfare analysis. We conclude the paper with a more extended discussion of the related literature and a summary of our results.

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[4] Our mechanism is different from the *contractual commitment* theory of Aghion and Bolton (1987). In this theory, the incumbent and the buyer sign a contract before the buyer can be approached by an entrant. The contract is then designed so as to strengthen the buyer's bargaining position vis-a-vis the entrant. In this way, rents can be shifted from the entrant to the buyer and hence, eventually, to the incumbent. But the assumption that the incumbent and the buyer are committed to the signed contract raises a number of well known difficulties (see the literature review in section 7 below). In our framework, in contrast, the buyer chooses which contracts to sign after both firms have made their offers.

[5] See for instance O'Brien and Shaffer (1997) and Bernheim and Whinston (1998).

[6] Price distortions arise whenever fixed fees are an imperfect means of rent extraction, and this may be so for a variety of different reasons. For example, buyers may be risk-averse retailers who face uncertain demand, as in Rey and Tirole (1986). In this setting, fixed fees expose retailers to the risk of making large payments even if demand turns out to be low. As another example, fixed fees may create distortions at the extensive margin by excluding some low-demand buyers, as in the adverse selection model of Mussa and Rosen (1978) and Maskin and Riley (1984). In these cases, sellers optimally respond to these market imperfections by reducing the fixed fees and distorting marginal prices upwards. Even if this is done only to a limited extent, it suffices for our mechanism to apply.

[7] The observability of rivals' volumes has risen with the advent of information technologies and may continue to rise in the future.

2 Framework

The focus of our analysis is on markets where (i) a dominant firm faces one or more weaker competitors, (ii) the dominant firm is potentially able to foreclose the weak competitors, but (iii) this would be inefficient as rivals possess specific technological or marketing capabilities that are valuable to the buyers. In this section, we describe a modelling framework that exhibits these properties.

Without loss of insights, we restrict attention to the case of duopoly. We denote the dominant firm by 1 and its rival by 2. Firms produce substitute products with weakly increasing cost functions $C_i(q_i)$, where q_i is firm i's output. We assume that marginal costs are weakly increasing and average costs weakly decreasing.[8] When marginal costs are constant, they will be denoted by c_i.

There is a single buyer (equivalently, firms can make personalized offers and buyers do not interact strategically with each other). The buyer is endowed with a payoff function (gross of any payment to the firms) $u(q_1, q_2)$ with $u(0,0) = 0$ (a normalization).[9] The function $u(q_1, q_2)$ is smooth, increasing in both arguments up to satiation points $\bar{q}_i$ where $u_{q_i}(\bar{q}_i, 0) = 0$, and weakly concave: $u_{q_iq_i}(q_i, q_j) \leq u_{q_iq_j}(q_i, q_j) \leq 0$. This implies that the goods are substitutes.

Firms compete in prices. As noted, a crucial assumption of our analysis is that marginal prices be distorted upwards. To ease exposition, initially we assume that firms are restricted to linear pricing, which automatically produces such distortions. Below we show that the same qualitative results hold when firms may use non-linear tariffs, but marginal prices are distorted due to some kind of market imperfections.

With linear prices p_i, the inverse demand functions are

$$p_i = u_{q_i}(q_i, q_j).$$

The direct demand functions, which are obtained by inverting the system of inverse demands, are denoted by $q_i = f_i(p_i, p_j)$. The elasticity of demand is denoted by $\varepsilon_i(p_i, p_j) = \frac{\partial f_i}{\partial p_i}\frac{p_i}{q_i}$. Define the buyer's indirect payoff function as

$$v(p_1, p_2) = u\left[f_1(p_1, p_2), f_2(p_2, p_1)\right] - \sum_{i=1,2} p_i f_i(p_i, p_j).$$

This function is decreasing and convex. For notational convenience, assume finite

[8] With fixed costs, marginal costs can be strictly increasing and average costs strictly decreasing. The assumption that average costs are weakly decreasing serves to rule out competitive quasi-rents. However, the assumption could be relaxed, as the existence of such rents would not be a problem for our analysis if firms could transfer the rents to the buyer. This can be done, for instance, by means of lump-sum subsidies, or by committing to serve some demand even if the price is lower than the marginal cost. Likewise, the assumption that marginal costs are weakly increasing serves only to guarantee that the profit functions considered below are well behaved and can be relaxed.

[9] If the buyer is a final consumer, $u(q_1, q_2)$ can be interpreted as a utility function in monetary terms. If instead the buyer is a retailer or a downstream firm that uses the good as an input of production, $u(q_1, q_2)$ can be thought of as the maximum profit (gross of any payment to the upstream firms) that can be obtained by procuring q_1 units from firm 1 and q_2 units from firm 2.

choke prices $\bar{p}_i = u_{q_i}(0,0)$.[10] When contractual restrictions force the buyer to purchase only product i, the indirect payoff function then becomes $v(p_i, \bar{p}_j)$.

We focus on a common class of RRV contracts, namely, *market-share requirement* contracts. These are contracts where the price is affordable if the firm's market share $s_i = \frac{q_i}{q_i+q_j}$ is at least as large as a certain target value and is prohibitively large if the market share is below the target. With finite choke prices, a market-share requirement can be represented as follows:

$$P_i(q_i) = \begin{cases} \hat{p}_i q_i & \text{if } s_i \geq \hat{s}_i \\ \\ \bar{p}_i q_i & \text{if } s_i < \hat{s}_i, \end{cases} \tag{1}$$

where $P_i(q_i)$ is the total payment requested by firm i in exchange for q_i units of its product. Effectively, the firm is requesting the buyer, as a condition for obtaining the product, to purchase from the firm itself at least a certain share $\hat{s}_i$ of his total demand. Exclusive dealing is a market-share requirement with $\hat{s}_i$ set to 100%.

We allow firms to offer menus of contracts such as (1), so in principle the price can be conditioned on the market share smoothly. As it turns out, however, the equilibrium can be sustained with a finite menu that comprises two market-share requirement contracts only (one of which is destined not to be accepted).

We now formalize the notion that the dominant firm is capable of foreclosing its competitor.[11] Consider a hypothetical battle for exclusives. Since firm 2 is being foreclosed, it must stand ready to make the most attractive offer that does not entail losses. Thus, it will set the lowest price that meets its break-even constraint:

$$\begin{aligned} p_2^E &= \min p_2 \\ \text{s.t.} \qquad p_2 f_2(\bar{p}_1, p_2) &\geq C_2[f_2(\bar{p}_1, p_2)]. \end{aligned} \tag{2}$$

For example, with constant marginal costs and no fixed costs, we have $p_2^E = c_2$. This offer guarantees the buyer a reservation payoff of

$$v^R = v(\bar{p}_1, p_2^E). \tag{3}$$

Our assumption is that the dominant firm can always match this offer and still make a positive profit. Let $\tilde{p}_1(v^R)$ be implicitly defined as

$$v(\tilde{p}_1, \bar{p}_2) = v^R. \tag{4}$$

The assumption then is (omitting the dependence of $\tilde{p}_1$ on v^R):

Condition 1 $\tilde{p}_1 f_1(\tilde{p}_1, \bar{p}_2) > C_1[f_1(\tilde{p}_1, \bar{p}_2)]$.

[10] Both the assumption of finite satiation points and finite choke prices are made just for expositional convenience and could be relaxed.

[11] The assumption is presented here for the case of linear pricing, but it can be easily adapted to the richer pricing patterns considered later.

Next, we formalize the notion that foreclosing the competitor is inefficient. To this end, define the efficient quantities as

$$\{q_1^{\text{eff}}, q_2^{\text{eff}}\} = \arg\max_{q_i \geq 0} \left[u(q_1, q_2) - \sum_{i=1}^{2} C_i(q_i) \right].$$

We then assume:

Condition 2 $q_2^{\mathit{eff}} > 0.$

Finally, we posit the following regularity conditions:

Condition 3 *For* $p_j = \bar{p}_j$,

$$\frac{d}{dp_i} \left[\frac{p_i - C_i'(f_i(p_i, p_j))}{p_i} \varepsilon_i(p_i, p_j) \right] > 0.$$

Condition 4 *For all* p_j,

$$\frac{d}{dp_i} \left[\frac{p_i - C_i'(f_i(p_i, p_j))}{p_i} \varepsilon_i(p_i, p_j) \right] \Bigg|_{v(p_1, p_2) = \bar{v}} > 0.$$

These conditions guarantee that certain profit functions considered below are well behaved. They both hold when the demand functions are weakly concave and may fail only when the functions are strongly convex.

3 Baseline model

Within the general framework outlined in the previous section, different models may be obtained by making specific assumptions about the timing of moves and the form of feasible contracts. In this section, we assume that both firms are restricted to price schedules such as (1) (which ensures that marginal prices are distorted upwards), and that the dominant firm acts as a price leader. Thus, the dominant firm offers a price p_1 that can depend on its market share s_1; the rival, after observing the dominant firm's offer, offers in turn its own contract; and, finally, the buyer chooses which contracts to sign and how much to purchase from each supplier. These assumptions constitute our baseline model.

In the next sections, we shall show that our results extend to more general price schedules and are robust to changes in the timing of moves. But it is worth pausing here to explain why we start from the case of price leadership. The reason for this is that we are especially interested in equilibria where RRV contracts are offered only by the dominant firm. Now, RRV contracts tend to be relatively long term,[12] implying that a firm that offers such contracts must commit to the stipulated contractual

[12] Apart from other possible strategic motives, this serves to avoid opportunistic behaviours: if exclusivity or market-share provisions applied, say, on a daily basis, they could be easily circumvented by the buyer, by purchasing the good from the dominant firm on certain days and from its

terms for some time. Rivals that just set their prices without any special contractual requirements, in contrast, can change their prices more easily and frequently. The hypothesis of simultaneous pricing overlooks this important difference. We therefore believe that when only one firm offers RRV contracts in equilibrium, the elective choice regarding the timing of moves should be that that firm acts as a price leader.

At any rate, the reader should keep in mind that being a price leader does not confer any particular strategic advantage in the absence of either price distortions or RRV contracts, or both. It is indeed well known that with linear prices, but without RRV contracts, firms would rather prefer to act as followers than as leaders (Gal-Or, 1985). In addition, Prat and Rustichini (1998) have shown that with general contracts but no market imperfections, the price leader never gets more than it could obtain in a simultaneous-move equilibrium.[13] It is the combination of RRV contracts and price distortions, and not the timing of moves in itself, that creates the possibility of exploiting the rival.

3.1 Preliminaries

To characterize the equilibrium we need a few preliminaries. First, consider the equilibrium that would prevail if the firms engaged in a war for exclusives. As noted, firm 2 must offer the lowest price that satisfies the break-even constraint, which we denote by p_2^E. This guarantees to the buyer a reservation payoff of $v^R = v(\bar{p}_1, p_2^E)$. The dominant firm then charges

$$p_1^E(v^R) = \min[\tilde{p}_1(v^R), p_1^M],$$

competitors on others. (Many goods can be stocked, and the cost of maintaining inventories over short periods of time is often negligible.) A similar logic explains why exclusivity or market-share provisions are often implemented by means of retro-active rebates, which are granted to the buyer at the end of the contractual period only if the market-share requirement is met over the entire period. This prevents the buyer from purchasing from the dominant firm at the beginning of the contractual period, and from its competitors towards the end of the period.

[13] The follower, in contrast, may obtain more than its marginal contribution (which is the highest possible payoff in a simultaneous move game) in the equilibrium that Prat and Rustichini call *thrifty*. But the extra rents that the follower may obtain in this equilibrium are extracted from the buyer and not from the leading firm. To illustrate this point in a simple way, suppose that the good is homogeneous and that the payoff function is $u = q - \frac{1}{2}q^2$, so demand is linear: $q = 1 - p$. Suppose also that the dominant firm has a constant marginal cost $c_1 = \frac{1}{4}$, whereas the rival has zero costs but faces a capacity constraint $q_2 \leq k$ where $k = \frac{1}{4}$. (This is a special case of Example 1 presented below.) The efficient allocation then is $q_1 = \frac{1}{2}$ and $q_2 = k = \frac{1}{4}$ with an associated price of $\frac{1}{4}$. This allocation is obtained both in the most profitable simultaneous-move equilibrium, which is the truthful equilibrium of Bernheim and Whinston (1986), and in all sequential equilibria (Prat and Rustichini, 1998). In the truthful equilibrium, firm 1 offers a two-part tariff with a marginal price equal to the marginal cost, $\frac{1}{4}$, and a fixed fee of $\frac{1}{8}$ (firm 1's marginal contribution). Firm 2 instead offers a three-part tariff with a marginal price of 0 up to capacity and arbitrarily large above capacity, and a fixed fee of $\frac{1}{16}$ (firm 2's marginal contribution). The buyer's net payoff is $\frac{5}{32}$. In the thrifty equilibrium, in contrast, firm 1 offers a quantity forcing contract with $q_1 = \frac{1}{2}$ and a total payment of $\frac{1}{4}$, netting again its marginal contribution of $\frac{1}{8}$. This however gives the buyer a reservation payoff of $\frac{1}{8}$ only (whereas the truthful schedule gives a reservation payoff of $\frac{5}{32}$.) As a result, firm 2 can now offer its entire capacity $q_2 = \frac{1}{4}$ for a total payment of $\frac{3}{32}$, obtaining $\frac{1}{32}$ more than its marginal contribution and leaving the buyer with a net surplus of $\frac{1}{8}$ only.

where $\tilde{p}_1(v^R)$ is given by (4) and $p_1^M = u_{q_1}(q_1^M, 0)$ where $q_1^M = \arg\max_{q_1}[u_{q_1}(q_1, 0)q_1 - C_1(q_1)]$.[14] We denote the dominant firm's output in this case by $q_1^E = f_1(p_1^E, \bar{p}_2)$ and its profit by $\pi_1^E(v^R) = p_1^E q_1^E - C_1(q_1^E)$. By Condition 1, $\pi_1^E(v^R) > 0$.

Another benchmark which we shall refer to in what follows is the solution to the Ramsey-Boiteux problem:

$$\begin{aligned} \pi^{RB}(\bar{v}) &= \max_{p_1,p_2} [p_1 q_1 + p_2\ q_2 - C_1(q_1) - C_2(q_2)] \\ \text{s.t.} \qquad q_i &= f_i(p_i, p_j) \\ \text{and } v(p_1, p_2) &\geq \bar{v} \end{aligned} \tag{5}$$

In words, the problem is to maximize the profits of a multi-product monopolist that faces a buyer with a reservation payoff of $\bar{v}$.[15] We shall refer to the solution as the Ramsey-Boiteux prices, which we shall denote by $p_i^{RB}(\bar{v})$ to emphasize their dependence on the buyer's reservation payoff. The associated quantities are denoted by $q_i^{RB}(\bar{v})$, and the Ramsey-Boiteux market share by

$$s_1^{RB}(\bar{v}) = \frac{q_1^{RB}(\bar{v})}{q_1^{RB}(\bar{v}) + q_2^{RB}(\bar{v})}.$$

3.2 Exploitative equilibrium

The equilibrium of the baseline model is characterized in the following proposition.

Proposition 1 *If the dominant firm acts as a price leader and can offer market-share requirement contracts, then in equilibrium it earns a profit of* $\pi^{RB}(v^R)$.

Proof. The proof is divided into two parts. We first demonstrate that the dominant firm can make a profit of $\pi^{RB}(v^R)$ by using market-share requirement contracts, and we then show that $\pi^{RB}(v^R)$ is the highest profit that the dominant firm can possibly reach.

To make a profit of $\pi^{RB}(v^R)$, the dominant firm offers a menu comprising two market-share requirement contracts: the contract that is accepted in equilibrium, with a price of $\hat{p}_1$ and a target market share of $\hat{s}_1$, and an exclusive-dealing contract that is not accepted in equilibrium. The "on-path" contract is

$$\hat{p}_1^* = p_1^{RB}(v^R) + \frac{1 - \hat{s}_1^*}{\hat{s}_1^*}\left[p_2^{RB}(v^R) - \frac{C_2[q_2^{RB}(v^R)]}{q_2^{RB}(v^R)}\right] \tag{6}$$

and

$$\hat{s}_1^* = s_1^{RB}(v^R). \tag{7}$$

The "off-path," exclusive-dealing price is $\tilde{p}_1(v^R)$ if the participation constraint in the Ramsey-Boiteux problem (5) binds; otherwise, it is the price that gives to the buyer,

[14] The monopoly price p_1^M exists and is unique by Condition 3.

[15] To be precise, this is the dual Ramsey-Boiteux problem. The primal problem is to maximize the buyer's net payoff under the constraint that a multi-product monopolist makes a pre-determined level of profits $\bar{\pi}$ (which is often taken to be nil). Condition 4 ensures that these problems have a unique solution.

under exclusive dealing, the same payoff as he obtains in the unconstrained solution to problem (5).

In response, firm 2 offers a price

$$p_2^* = \frac{C_2[q_2^{RB}(v^R)]}{q_2^{RB}(v^R)},$$

with no contractual restrictions.

We now show that the buyer accepts the contract (6)-(7), that pricing at p_2^* is a best response for firm 2, and that the dominant firm makes a profit of exactly $\pi^{RB}(v^R)$. To lighten notation, in the rest of the proof we shall suppress the dependence of relevant variables on v^R when this does not cause confusion.

Suppose that the buyer accepts the market-share contract offered by the dominant firm. (We shall confirm in a moment that he can do no better.) In the Ramsey-Boiteux solution, the price-cost margin is non-negative on both products. This implies that $p_2^{RB} \geq p_2^*$ and $\hat{p}_1^* \geq p_1^{RB}$. Faced with prices $\hat{p}_1^*$ and p_2^*, the buyer would then like to buy a share of product 1 lower than $\hat{s}_1^* = s_1^{RB}(v^R)$, as the products are substitutes. Thus, the market-share requirement is binding and constrains the buyer's demand. As a result, when the buyer purchases one unit of product 1, he will also purchase $\frac{1-\hat{s}_1^*}{\hat{s}_1^*}$ units of product 2 at a price of p_2^*. That is, the buyer effectively purchases a bundle of products, where each unit of the bundle comprises $\hat{s}_1^*$ units of product 1 and $(1 - \hat{s}_1^*)$ units of product 2.

With the market-share contract (6)-(7), the price of the bundle is

$$\hat{s}_1^*\hat{p}_1^* + (1 - \hat{s}_1^*)\, p_2^* = s_1^{RB} p_1^{RB} + \left(1 - s_1^{RB}\right) p_2^{RB}.$$

Thus, the price of the bundle is exactly the same as with the Ramsey-Boiteux prices. Since the composition of the bundle is the one that the buyer would have autonomously chosen with these prices, the buyer must demand exactly $\frac{q_1^{RB}}{s_1^{RB}} = \frac{q_2^{RB}}{1-s_1^{RB}}$ units of the bundle; that is, q_1^{RB} units of product 1 and q_2^{RB} units of product 2. Therefore, the dominant firm makes a profit of

$$\hat{p}_1^* q_1^{RB} - C_1\left(q_1^{RB}\right) = p_1^{RB} q_1^{RB} + p_2^{RB} q_2^{RB} - C_1\left(q_1^{RB}\right) - C_2\left(q_2^{RB}\right).$$

This is precisely the value of the maximand of problem (5) at the optimum, $\pi^{RB}(v^R)$.

We next show that the buyer can do no better than accepting the market-share contract (6)-(7). To show this, note first of all that the buyer's equilibrium payoff is exactly what he could get by refusing the dominant firm's market-share contract and accepting instead its latent, exclusive-dealing contract. Note also that by construction firm 2 cannot guarantee to the buyer, under exclusive dealing, a higher payoff without making losses. Thus, accepting the market-share contract is an optimal choice for the buyer. (As usual, a small price discount would make the buyer definitely prefer the dominant firm's market-share contract.)

To complete the first part of the proof, it remains to show that pricing at p_2^* without imposing any contractual restrictions is an optimal strategy for firm 2. This follows immediately from the observation that faced with the menu of contracts offered by the dominant firm, the on path market-share contract and the off path exclusive-dealing contract, there is no way in which firm 2 can make positive profits. This is true both on path (i.e., in the anticipation that the buyer will accept the dominant firm's market-share contract), and off path (i.e., anticipating that the buyer will reject the dominant firm's market-share contract, and in the hope that it would then accept an exclusive dealing offer by firm 2). In both cases, if firm 2 tried to price above cost, the buyer would switch to the dominant firm's off-path offer. Thus, the rival must content itself with breaking even. (To break ties, the dominant firm can price just below $\hat{p}_1^*$ so as to leave a positive margin to the rival, and also slightly increase the exclusive price to provide some inducement to the buyer to choose precisely the market-share contract.)

Next we show, turning to the second part of the proof, that the dominant firm cannot get more than $\pi^{RB}(v^R)$. Since $\pi^{RB}(v^R)$ is the maximum joint profit of firm 1 and 2 when the buyer's net payoff is v^R, and it is decreasing in v^R, the only way in which the dominant firm could earn more than $\pi^{RB}(v^R)$ is by making the buyer get less than v^R. Thus, consider any possible equilibrium in which the buyer obtains strictly less than v^R, say $v^R - x$ for some $x > 0$. In any such equilibrium, firm 2 must make a positive profit that is at least as large as

$$\begin{aligned} \pi_2^E(v^R - x) &= \max\nolimits_{p_2} \{p_2 f_2(\bar{p}_1, p_2) - C_2[f_2(\bar{p}_1, p_2)]\} \\ \text{s.t.} \qquad & v(\bar{p}_1, p_2) \geq v^R - x, \end{aligned} \tag{8}$$

i.e., the profit that firm 2 could make by offering an exclusive dealing contract that gives to the buyer the net payoff of $v^R - x$, which is what he would obtain in this candidate equilibrium. This implies that the dominant firm's profit cannot exceed $\pi^{RB}(v^R - x) - \pi_2^E(v^R - x)$.

Now, $\pi_2^E(v^R - x)$ increases with x at a rate that is equal to the Lagrange multiplier $\lambda(\bar{p}_1, x) \leq 1$ of problem (8), which is

$$\lambda(\bar{p}_1, x) = 1 + \frac{p_2 - C_2'\left[f_2(\bar{p}_1, p_2)\right]}{p_2} \varepsilon_2(p_2, \bar{p}_1).$$

(The Lagrange multiplier is less than 1 as transferring rents from the buyer to firm 2 involves deadweight losses when $p_2 > C_2'(q_2)$.) On the other hand, the Ramsey-Boiteux profit $\pi^{RB}(v^R - x)$ is increasing in x. To conclude the proof, it thus suffices to show that $\pi^{RB}(v^R - x)$ increases with x less rapidly than $\pi_2(v^R - x)$, as this implies that $\pi^{RB}(v^R - x) - \pi_2^E(v^R - x)$ decreases with x and thus is highest when $x = 0$.

Denote the Lagrange multiplier of the Ramsey-Boiteux problem (5) with reservation payoff $\bar{v} = v^R - x$ by $\lambda(p_1^{RB}, x) \leq 1$. This is also the rate of change of the maximized profit with respect to the buyer's net payoff. We have

$$\lambda(p_1^{RB}, x) = 1 + \frac{p_2 - C_2'\left[f_2(p_1^{RB}, p_2)\right]}{p_2} \varepsilon_2(p_2, p_1^{RB}).$$

It follows that

$$\lambda(\bar{p}_1, x) - \lambda(p_1^{RB}, x) = \int_{p_1^{RB}}^{\bar{p}_1} \frac{d}{dp_1} \left[\frac{p_2 - C_2'\left[f_2(p_1, p_2)\right]}{p_2} \varepsilon_2(p_2, p_1) \right] \Bigg|_{v(p_1, p_2) = v^R} dp_1.$$

The integrand is positive by Condition 4, so we have $\lambda(\bar{p}_1, x) > \lambda(p_1^{RB}, x)$, which implies

$$\frac{d\pi_2^E(v^R - x)}{dx} > \frac{d\pi^{RB}(v^R - x)}{dx}.$$

Thus, the dominant firm cannot gain by reducing the buyer's payoff below v^R. This completes the proof of the proposition. ■

Clearly, $\pi^{RB}(v^R)$ is always at least as large as $\pi_1^E(v^R)$, with a strict inequality when $s_1^{RB}(v^R) < 1$.[16] Thus, Proposition 1 says that when RRV contracts are feasible, the dominant firm generally prefers to let the competitor stay active rather than foreclosing it.

In fact, $\pi^{RB}(v^R)$ may even exceed the profit of an uncontested monopoly, $\pi_1^M = [p_1^M q_1^M - C_1(q_1^M)]$. If this is so, the equilibrium is *exploitative*, in the sense that the dominant firm obtains more than if it could eliminate the rival at no cost.[17] In particular, when v^R is so small that the constraint in the Ramsey-Boiteux problem is slack, the dominant firm makes exactly the same profit as an unchallenged multi-product monopolist. That is, the dominant firm can exploit the rival's specific capabilities efficiently (from the viewpoint of profit maximization) and then steal all of its rents.

3.3 Examples

We now illustrate Proposition 1, and in particular the possibility of exploiting rivals, by means of two examples.

Example 1. The product is homogeneous, so the payoff function $u(q)$ depends on the total quantity $q = q_1 + q_2$ and the indirect payoff function $v(p)$ depends on the one price. There are no fixed costs. The dominant firm has a constant marginal cost $c_1 > 0$. The rival's cost is lower, and is normalized to zero. However, the rival has a limited production capacity of k units. In this case, firm 1 would prevail in a battle for exclusives, and thus Condition 1 holds, when $v(c_1) > u(k)$. Condition 2 instead always hold: the efficient output of firm 2 is $k > 0$.

To obtain closed-form solutions, we assume that $u(q) = q - \frac{q^2}{2}$, which yields a linear demand function $q = 1 - p$ and a quadratic indirect payoff function $v(p) = \frac{(1-p)^2}{2}$. Condition 1 then requires that $k < 1 - \sqrt{(2 - c_1)c_1}$.

[16] This follows from the fact that

$$\begin{array}{rcl} \pi_1^E(v^R) & = & \max\limits_{p_1} \{p_1 f_1(p_1, \bar{p}_2) - C_1[f_1(p_1, \bar{p}_2)]\} \\ \text{s.t.} \quad v(p_1, \bar{p}_2) & \geq & v^R. \end{array}$$

This maximization problem is more constrained than problem (5); in particular, $\pi_1^E(v^R)$ can always be obtained in the Ramsey-Boiteux problem by setting $p_2 = \bar{p}_2$. However, if Condition 2 holds, it is generally optimal to set $p_2 < \bar{p}_2$, obtaining more than $\pi_1^E(v^R)$. (Note, however, that Condition 2 is not exactly equivalent to condition $s_1^{RB}(v^R) < 1$.)

[17] Note the difference between exploitative equilibrium and *exploitative abuse*. The latter refers to situations where consumers rather than rivals are harmed. In the equilibrium of Proposition 1, in contrast, the rival makes zero profits and thus is definitely harmed.

The Ramsey-Boiteux profit, which is what the dominant firm earns in equilibrium, is depicted in Figure 1 along with some relevant benchmarks: the profit π_1^L that the dominant firm could earn by acting as a price leader without using RRV contracts, the monopoly profit π_1^M, the exclusive dealing profit π_1^E, and the profit of a multi-product unconstrained monopolist, π^{MP}.[18] It appears that the dominant firm always earns more then under exclusive dealing, and that for a range of values of k it earns more than the monopoly profits. Over this range, the equilibrium is exploitative: the dominant firm takes advantage of the rival's ability to produce some units of output at a lower cost and earns more than if it could foreclose the rival costlessly.

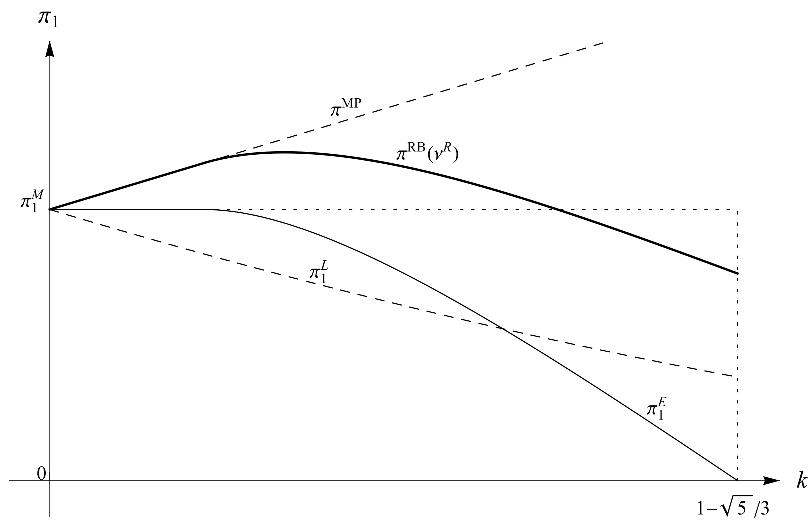

Figure 1: Firm 1's profits in Example 1. The profit earned by the dominant firm with RRV contracts is $\pi^{RB}(v^R)$. The figure is drawn for the case $c_1 = \frac{1}{3}$, so Condition 1 is satisfied when $k < 1 - \frac{\sqrt{5}}{3}$.

A distinctive sign of exploitative equilibria is that the dominant firm's profits initially increase with k, i.e., as the rival becomes more efficient. Intuitively, the more efficient is the rival, the higher are the rents that can be extracted from it. This is, indeed, what happens in this example when k is relatively small.

As k increases further, however, a countervailing effect arises. A more efficient rival can guarantee to the buyer a higher reservation payoff v^R, and this reduces the profits that can be made by the dominant firm. This is why the profit eventually decreases with k. Intuitively, RRV contracts allow the dominant firm to eliminate the competition *in the market* but not that *for the market*. The dominant firm can exploit the rival only insofar as the competition for the market does not become too intense.

[18]The explicit formulas for these profits are reported in the Appendix, both for Example 1 and Example 2.

Example 2. Products are differentiated and marginal costs are constant. There are no fixed costs. The payoff function $u(q_1, q_2)$ is symmetric, so demand is symmetric. However, firm 2 has a higher marginal cost than firm 1. Therefore, we now normalize to zero the marginal cost of the dominant firm. Condition 1 holds provided that $c_2 > c_1 = 0$.

To obtain closed-form solutions, we assume that the payoff function is

$$u(q_1, q_2) = q_1 + q_2 - \frac{1}{2}\left(q_1^2 + q_2^2\right) - \gamma q_1 q_2, \tag{9}$$

where the parameter γ represents the degree of product substitutability and ranges in between 0 (independent products) and 1 (perfect substitutes). In this case, Condition 2 holds provided that $c_2 < 1 - \gamma$.

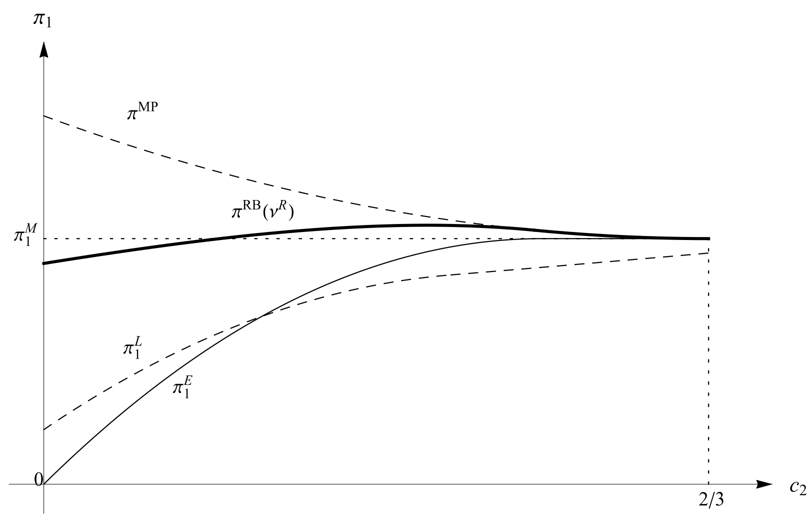

Figure 2: Firm 1's profits in Example 2. The figure is drawn for $\gamma = \frac{1}{3}$, in which case the efficient quantity of product 2 is positive for $c_2 < \frac{2}{3}$.

Results are similar to Example 1. The equilibrium is exploitative as long as c_2 is sufficiently large. When the equilibrium is exploitative, the dominant firm's profit may increase as the rival becomes more efficient (that is, as c_2 decreases). But, again like in Example 1, when c_2 gets so small that the competition for the market becomes very intense, the dominant firm's profit decreases if the rival becomes even more efficient.

3.4 The mechanism of exploitation

We now discuss in greater detail the mechanism that allows the dominant firm to extract profits from the buyer *and* from the rival.

The demand boost. The first element of the mechanism is the tying effect created by market-share requirements, and the consequent boost in the demand for the dominant firm's product.

To understand this effect, note that a market-share requirement of less than 100% increases the demand for the dominant firm's output, which becomes (omitting the arguments of the function)

$$p_1 = u_{q_1} + \frac{1-\hat{s}_1}{\hat{s}_1}\left(u_{q_2} - p_2\right). \tag{10}$$

The first term on the right-hand side of (10) is the standard willingness to pay for product 1. A market-share requirement increases this term by reducing q_2, which raises u_{q_1} as the goods are substitutes.

The second term instead captures the tying effect that arises when the market-share requirement is binding. In this case, the buyer would like to buy additional units of product 2 at the prevailing price, so $u_{q_2} > p_2$. But the only way to obtain more units of product 2 without violating the market-share requirement is to increase the quantity of product 1. Thus, the marginal value of product 1 is now the sum of the direct value u_{q_1} and the "option" value $\frac{1-\hat{s}_1}{\hat{s}_1}\left(u_{q_2} - p_2\right)$, which is the extra surplus that the buyer obtains when he can purchase $\frac{1-\hat{s}_1}{\hat{s}_1}$ additional units of product 2 without violating the market-share requirement. This option value further boosts the demand for the dominant firm's product.

The latent contract. The boost in demand allows the dominant firm to raise its price so as to extract rents from the rival. To extract all of these rents, however, the dominant firm must induce the competitor to price at cost. The second notable element of the mechanism is the latent contract that effectively forces the competitor to price at cost.

The latent contract is necessary because just setting the target market share (7) and the price (6) does not suffice to make firm 2 price at cost, as p_2 could be raised while still leaving a positive surplus to the buyer.[19] With the dominant firm's latent contract in place, in contrast, firm 2 would lose all of its sales the moment it tried to price above cost.[20]

The fact that the latent contract, which is not signed by the buyer and hence may not be observable, is essential for the working of our mechanism may raise doubts about the verifiability (or falsifiability) of the theory. In fact, however, the existence of the latent contracts postulated by the theory can be verified indirectly. If the dominant firm set a market-share requirement without offering any latent contract, and the requirement were binding for the buyer (i.e., $p_2 < u_{q_2}$), the rival could increase its price without losing volumes. Thus, in the absence of the latent contract the rival would price in such a way that $p_2 = u_{q_2}$. But this implies that the buyer should not perceive the dominant firm's market-share requirement as binding. If he

[19] This follows from the fact that if firm 2 prices at cost, by construction the buyer obtains at least $v^R > 0$.

[20] Furthermore, firm 2 cannot induce the buyer to purchase only product 2 without incurring into losses. Thus, firm 2 cannot do any better than pricing at cost.

does, it must be the case that $p_2 < u_{q_2}$, and hence that a latent contract is in place. Any evidence that the buyer perceives the market-share requirement as binding is therefore indirect proof of the presence of latent contracts.[21]

3.5 Quantity requirements

It might be interesting to contrast market-share requirements with other RRV contracts that the dominant firm might offer. Consider, in particular, *quantity-requirement* contracts, i.e. contracts that place an upper bound on the quantity of the rival product that the buyer can purchase. With a quantity requirement $q_2 \leq \hat{q}_2$ in place, the inverse demand for product 1 is

$$p_1 = u_{q_1}(q_1, \hat{q}_2).$$

Like market-share requirements, constraint $q_2 \leq \hat{q}_2$ may increase the demand for product 1, as the products are substitutes. However, quantity requirements do not produce any tying effect and thus do not create any option value.[22] As a result, while the dominant firm can re-produce the Ramsey-Boiteux quantities (it suffices to set $\hat{q}_2 = q_2^{RB}$ and $p_1 = p_1^{RB}$), it cannot extract all rents from the rival. In fact, if the dominant firm insists on re-producing the Ramsey-Boiteux quantities, it can extract no rents at all. This implies that, in a second best, the dominant firm will distort $\hat{q}_2$ downwards, and q_1 upwards.[23] As a result, the dominant firm's profits are lower than in the Ramsey-Boiteux solution, implying that quantity-requirement contracts are dominated by market-share requirements.[24]

4 Simultaneous moves

In this section, we assume that both firms make their contractual offers simultaneously. The analysis clarifies that the exploitation mechanism uncovered above is not an artifact of the timing of the baseline model.

[21] In many antitrust cases involving market-share rebates, there is indeed plenty of circumstantial evidence to this effect.

[22] A tying effect similar to ours is instead created by all-units discounts (Chao et al, 2018). However, all-units discounts necessarily leave some profit to the dominant firm's rival and hence are less profitable than RRV contracts.

[23] In Example 1, for instance, with quantity-requirement contracts the dominant firm cannot do any better than setting $\hat{q}_2 = 0$, obtaining just the exclusive dealing profit $\pi_1^E(v^R)$. In Example 2, in contrast, the optimal quantity requirement is positive if c_2 and γ are sufficiently low.

[24] This result may help explain why requirements cast in term of rivals' output are rarely observed in real life, even if they are not observationally more demanding than market-share requirements. Note, however, that market-share requirements are not unique in allowing the dominant firm to get the Ramsey-Boiteux profit $\pi^{RB}(v^R)$. The dominant firm can reach this level of profit by setting a requirement, similar to (1), in terms of any function that is strictly increasing in q_1 and strictly decreasing in q_2. Like market-share requirements, this would create a tying effect that can be exploited strategically. The only difference is that the "bundle" that such requirements implicitly create may contain the two products in variable proportions, off the equilibrium path. But this does not prevent the dominant firm from attaining the Ramsey-Boiteux solution.

4.1 Equilibrium characterization

With simultaneous moves, the equilibrium is no longer unique. However, the following proposition shows that in a simultaneous-move equilibria, the dominant firm generically obtains more than under exclusive dealing. Furthermore, it shows that when the price-leadership equilibrium is exploitative (in the sense that the dominant firm obtains more than the monopoly profit), there exists a continuum of exploitative simultaneous-move equilibria.

Proposition 2 *In all simultaneous-move equilibria, the dominant firm's profit π_1 lies in the interval $\left[\pi_1^E(v^R), \pi^{RB}(v^R)\right]$. Moreover, for any point in that interval, there exists a simultaneous-move equilibrium in which the dominant firm earns exactly that level of profit.*

Proof. The first part of the proposition is easy to prove. First, we have already shown in the course of the proof of Proposition 1 that the dominant fim can never obtain more than $\pi^{RB}(v^R)$. Second, whatever contract firm 2 offers, if the dominant firm obtains a profit lower than $\pi_1^E(v^R)$ it can increase its payoff by offering only an exclusive dealing contract at the price $p_1^E(v^R)$, which guarantees itself a profit of $\pi_1^E(v^R)$. These observations establish the first part of the proposition.

To prove the second part, we start by showing that there exists an equilibrium where the dominant firm obtains exactly $\pi^{RB}(v^R)$. In this equilibrium, the dominant firm offers the same menu of market-share requirement contracts as in the case of price leadership. By construction, offering the linear price p_2^* is then a best response for firm 2. However, if firm 2 offers only this contract, the dominant firm can raise its price, reducing the buyer's net payoff and increasing its profit. To prevent such a deviation, firm 2 must offer a menu of two contracts: a contract with no special requirements and a price of p_2^*, and an exclusive-dealing contract at price p_2^E. This latter contract is destined not to be accepted. With this latent contract in place, however, the dominant firm cannot earn more than $\pi^{RB}(v^R)$, as shown in the proof of Proposition 1. Thus, the above strategies form a simultaneous move equilibrium that generates the same outcome as that of Proposition 1.

Next, we show how to construct a continuum of equilibria where the dominant firm obtains any payoff in the interval $\left[\pi_1^E(v^R), \pi^{RB}(v^R)\right]$. First, both firms offer a latent, exclusive-dealing contract which, if accepted, would give to the buyer the same payoff as in the equilibrium of Proposition 1. (To fix ideas, in the rest of the proof we suppose that the participation constraint in the Ramsey-Boiteux problem is binding, and hence that that payoff is v^R.)

Second, firm 2 offers offers a price

$$\tilde{p}_2 \in [p_2^*, \bar{p}_2],$$

with no contractual restrictions. Given that price, define a fictitious Ramsey-Boiteux problem with $C_2(q_2) = \tilde{p}_2 q_2$:

$$\begin{aligned} \tilde{\pi}^{RB}(v^R, \tilde{p}_2) &= \max_{p_1, p_2} \left[p_1 q_1 + p_2\, q_2 - C_1(q_1) - \tilde{p}_2 q_2\right] \\ \text{s.t.} \qquad q_i &= f_i(p_i, p_j) \\ \text{and } v(p_1, p_2) &\geq v^R, \end{aligned}$$

and denote all variables pertaining to the solution to this fictitious problem with a notation similar to that used for the profit, i.e. $\tilde{\pi}^{RB}(v^R, \tilde{p}_2)$.

Third, the dominant firm offers a market-share requirement contract with

$$\hat{p}_1 = \tilde{p}_1^{RB}(v^R, \tilde{p}_2) + \frac{1-\hat{s}_1}{\hat{s}_1}\left[\tilde{p}_2^{RB}(v^R, \tilde{p}_2) - \tilde{p}_2\right]$$

and

$$\hat{s}_1 = \tilde{s}_1^{RB}(v^R, \tilde{p}_2).$$

Proceeding as in the proof of Proposition 1, one can show that the buyer accepts the market-share contract offered by the dominant firm, that pricing at $\tilde{p}_2$ is a best response for firm 2, and that the dominant firm makes a profit of exactly $\tilde{\pi}^{RB}(v^R, \tilde{p}_2)$. One can also show that, given the price $\tilde{p}_2$ offered by firm 2, the dominant firm cannot obtain more than $\tilde{\pi}^{RB}(v^R, \tilde{p}_2)$.

Finally, to complete the proof it suffices to note that when $\tilde{p}_2 = \bar{p}_2$, the solution to the fictitious Ramsey-Boiteux problem involves $\tilde{q}_2^{RB}(v^R, \tilde{p}_2) = 0$ and hence $\tilde{\pi}^{RB}(v^R, \tilde{p}_2) = \pi_1^E(v^R)$. By continuity, letting $\tilde{p}_2$ vary between p_2^* and $\bar{p}_2$ one can then generate a continuum of equilibria where the dominant firm obtains any profit level in the interval $\left[\pi_1^E(v^R), \pi^{RB}(v^R)\right]$. ■

4.2 The profit frontier

To get a sense of which equilibrium is most likely to prevail, we now analyze in greater detail the source of the multiplicity of equilibria and the structure of the equilibrium payoffs of both firms.

Off-path competition. To begin with, consider the equilibria where the latent contracts are the same as if the firms were engaged in a batlte for exclusives and thus guarantee to the buyer the same payoff as in the price-leadership equilibrium. As argued in the proof of Proposition 2, these equilibria can be parametrized by the equilibrium price of product 2, $\tilde{p}_2$. This price may vary in equilibrium for the same reason why the prices of different components of a bundle may vary, for a given total price of the bundle. In our case, the bundle is the one implicitly created by the dominant firm's market-share requirement, and the total price of the bundle is pinned down by the buyer's outside option (which is to sign one of the latent contracts). However, the proportion of the products in the bundle (i.e., the target market share) here is endogenous. In particular, when firm 2 raises the price of its component of the bundle, the dominant firm optimally responds by both reducing its own price *and* increasing the target market share.

This implies that profits cannot be tranferred from one firm to the other on a one-to-one basis. The profit frontier is therefore non-linear (see Figure 3). As the price of product 2 increases, the dominant firm's profit decreases. The profit of firm 2, in contrast, first increases and then decreases, as the dominant firm responds to the increase in $\tilde{p}_2$ by increasing the target market share. In Example 2, for instance, the target market share is set at

$$\hat{s}_1 = \frac{1-(1-\tilde{p}_2)\gamma}{(2-\tilde{p}_2)(1-\gamma)}.$$

Thus, π_2 vanishes both when firm 2 prices at cost (as it does in the price leadership equilibrium, where the dominant firm gets $\pi^{RB}(v^R)$) and when $\tilde{p}_2 = 1-\gamma$, as in the latter case the target market share is 100% (and thus the dominant firm gets $\pi_1^E(v^R)$).

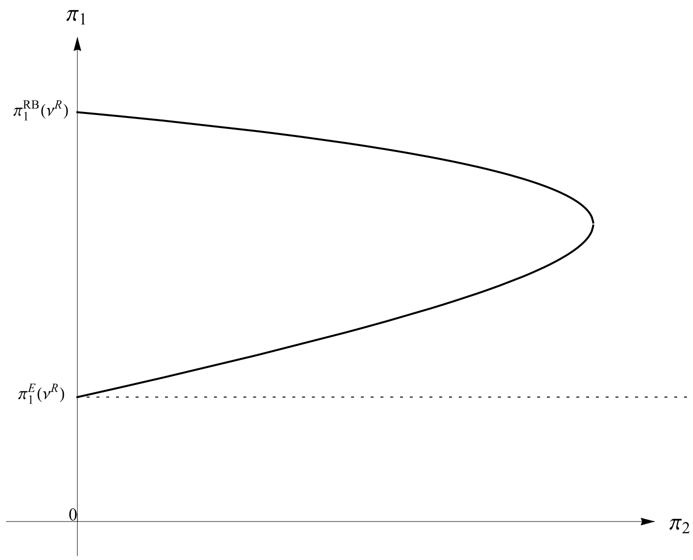

Figure 3: The profit frontier obtained by varying the equilibrium price of product 2, $\tilde{p}_2$, for given latent contracts. The figure is drawn for Example 2 with $c_2 = \frac{1}{10}$ and $\gamma = \frac{1}{5}$.

Plainly, the equilibria on the lower branch of the frontier are Pareto dominated from the viewpoint of the firms. Firms are therefore more likely to coordinate on a point of the upper branch than of the lower one.[25] Moreover, for the purposes of antitrust policy the most relevant part of the upper branch is perhaps the one closest to the y-axis, as antitrust cases are typically brought by dominant firms' rivals, and thus, presumably, when rivals are harmed most severely. If this is so, then the equilibria that are most likely to arise (and prompt antitrust litigation) with simultaneous moves are not very different from the price-leadership equilibrium.

Off-path cooperation. When the dominant firm's rival makes a positive profit in equilibrium, the latent contracts need not be as aggressive as in the price-leadership equilibrium. To see why this is so, note that the reason why the buyer must obtain at least v^R in the equilibrium of Proposition 1 is that if he obtained less, firm 2 would

[25] Unless, of course, the dominant firm had exclusionary intents (in which case, however, a safer strategy would be to engage in exclusive dealing).

have the possibility of making positive profits by deviating to exclusive dealing. But if firm 2 is making positive profits in equilibrium, its incentive to deviate is weaker.

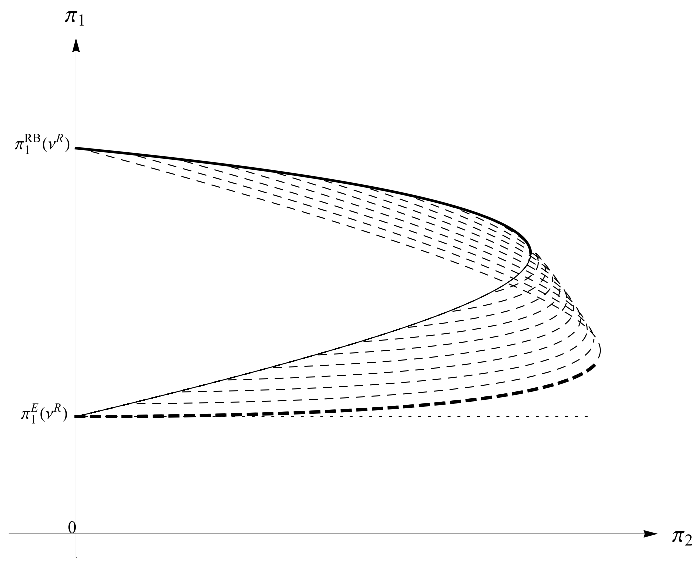

Figure 4: The profit frontier in Example 2 when firms coordinate their latent contracts. The frontier is the outer envelope of those corresponding to any fixed payoff of the buyer that is achievable in equilibrium. The figure is drawn for $c_2 = \frac{1}{10}$ and $\gamma = \frac{1}{5}$.

This creates the possibility of reducing the buyer's payoff by increasing the latent, exclusive-dealing prices of the two firms above p_2^E and $\tilde{p}_1(v^R)$, respectively. Note that this multiplicity hinges on a delicate coordination of the firms' strategies: the buyer's reservation payoff depends on the most favorable of the two latent contracts, so no firm can reduce this payoff unilaterally. The buyer's payoff can be lowered only if both firms raise their latent, exclusive prices in a coordinated fashion. Such a joint move increases the rents that can potentially be extracted from the buyer. However, the division of profits becomes more highly constrained.[26] Moreover, rent extraction becomes less efficient, as the market share is more highly distorted towards 100%. As a result, there exists a lower bound to the payoff that the buyer must obtain in a non-cooperative equilibrium: the competition among the firms cannot be lessened any further.

This is illustrated in Figure 4, which shows the profit frontier under the assumption that firms can coordinate their latent contracts. Qualitatively, the frontier is similar to that of Figure 3, so the same remarks apply.

[26]The reason for this is that each firm must obtain at least what it would get under exclusive dealing, given the buyer's reservation payoff. These constraints on the division of profit get tighter as the reservation payoff decreases.

5 Non-linear pricing

In this section, we allow for non-linear pricing. As discussed in the introduction, for our mechanism to work it is necessary that marginal prices be distorted upwards. Such price distortions may arise endogenously for a variety of reasons.[27] Market-share requirements are not profitable only in the limiting case where the price distortions vanish.

To keep the analysis simple, we assume that marginal costs are constant, and that firms compete in two-part tariffs $p_i q_i + F_i$, where p_i is the marginal price and F_i is the fixed fee. With constant marginal costs, two-part tariffs in principle allow for efficient rent extraction: firms can set marginal prices at cost and extract the buyer's rent by means of fixed fees only. However, we generate endogenous price distortions assuming that extracting rents by means of fixed fees creates deadweight losses: with a lump-sum payment of F_i, the firm earns F_i but the retailer loses $(1+\mu)F_i$, with $\mu \geq 0$.

The parameter μ may capture different costs associated with the use of fixed fees. Here we do not take a view on the underlying reason why the costs arise but explore, in a reduced-form approach, the consequences of the ensuing price distortions.[28] The case of efficient pricing is obtained for $\mu = 0$, that of linear pricing in the limit as $\mu \to \infty$.[29] We assume that the cost μ appears only when $F_i > 0$. This guarantees that whereas fixed fees are costly, lump-sum subsidies do not entail any special benefit.

With these assumptions, firm i's profits are

$$\pi_i = (p_i - c_i)q_i + \mathbf{1}_i F_i,$$

where $\mathbf{1}_i$ is and indicator function which is 1 when $q_i > 0$ and 0 when $q_i = 0$, and the buyer's payoff is

$$u(q_1, q_2) - \sum_{i=1}^{2} p_i q_i - (1+\mu)\sum_{i=1}^{2} \mathbf{1}_i F_i.$$

Like in the baseline model, we assume that firms can offer market-share requirement contracts in which the payment requested $P_i(q_i)$ is prohibitively high unless the buyer purchases from the firm at least a certain share of his total demand:

$$P_i(q_i) = \begin{cases} \hat{F}_i + \hat{p}_i q_i & \text{if } s_i \geq \hat{s}_i \\ \bar{p}_i q_i & \text{if } s_i < \hat{s}_i. \end{cases}$$

For most of the analysis, we revert to our baseline assumption that the dominant

[27] See footnote 6 above.

[28] Calzolari, Denicolò and Zanchettin (2020) demonstrate that this reduced-form model captures in a stylized way the pricing distortions that arise in more highly structured models with moral hazard, adverse selection and other market imperfections, being exactly equivalent in some cases and providing a close approximation in others.

[29] In fact, the optimal fixed fee may vanish for finite values of μ.

firm acts as a price leader.

Consider the following modified Ramsey-Boiteux problem:

$$\begin{aligned} \pi^{RB}(\bar{v},\mu) = \max\nolimits_{p_1,p_2,F}\, [(p_1-c_1)f_1(p_1,p_2) + (p_2-c_2)\ f_2(p_1,p_2) + F] \\ \text{s.t.} \quad v(p_1,p_2) - (1+\mu)F \geq \bar{v}. \end{aligned} \tag{11}$$

Proposition 1 can then be generalized as follows:

Proposition 3 *If the dominant firm acts as a price leader and can offer market-share requirement contracts, for any given μ it makes a profit of $\pi^{RB}(v^R,\mu)$.*

Proof. The first part of the proof, which demonstrates how the dominant firm can make a profit of $\pi^{RB}(v^R,\mu)$, is practically identical to the corresponding part of the proof of Proposition 1 and will not be repeated here. The second part, that shows that the dominant firm cannot obtain more than $\pi^{RB}(v^R,\mu)$, follows a similar logic but with a few changes that are worth spelling out.

Like in the proof of Proposition 1, the only way in which the dominant firm could earn more than $\pi^{RB}(v^R,\mu)$ is by making the buyer get less than v^R. Thus, consider any possible outcome in which the buyer obtains strictly less than v^R, say $v^R - x$ for some $x>0$. To prevent firm 2 from deviating to exclusive dealing, firm 2 must make profits at least as large as

$$\begin{aligned} \pi_2^E(v^R - x,\mu) = \max\nolimits_{p_2,F_2}\, \{(p_2-c_2)f_2(\bar{p}_1,p_2) + F_2\} \\ \text{s.t.} \qquad v(\bar{p}_1,p_2) - (1+\mu)F_2 \geq v^R - x. \end{aligned} \tag{12}$$

This lower bound on firm 2's profits, $\pi_2^E(v^R-x,\mu)$, increases with x at a rate equal to the Lagrange multiplier of problem (12). The Lagrange multiplier is now $\max[\lambda(\bar{p}_1,x),\frac{1}{1+\mu}] \leq 1$. To be more precise, it is $\frac{1}{1+\mu}$ as long as $F_2>0$, as with positive fixed fees one dollar of extra surplus of the buyer costs $\frac{1}{1+\mu}$ dollars of profit to the firm, and is $\lambda(\bar{p}_1,x)$, as in the case of linear pricing, when $F_2=0$.

By the same logic, the Lagrange multiplier of problem (11), which is the rate at which the Ramsey-Boiteux profits increase with x, is $\max[\lambda(p_1^{RB},x),\frac{1}{1+\mu}] \leq 1$. We know from the proof of Proposition 1 that $\lambda(\bar{p}_1,x) > \lambda(p_1^{RB},x)$. This implies that the Lagrange multiplier of problem (12) is at least as large as that of problem (11), so that

$$\frac{d\pi_2^E(v^R-x,\mu)}{dx} \geq \frac{d\pi^{RB}(v^R-x,\mu)}{dx}. \tag{13}$$

Like in the proof of Proposition 1, this inequality implies that the dominant firm cannot gain by reducing the buyer's payoff below v^R. ■

In equilibrium, firm 2 prices at cost both on path, setting $p_2^*=c_2$ and $F_2^*=0$, and off path (i.e., in a hypothetical battle for exclusives), setting $p_2^E=c_2$ and $F_2^E=0$. (As in the baseline model, the dominant firm forces firm 2 to price at cost by means of a latent contract that matches the most attractive exclusive dealing contract that firm 2 can offer.) Thus, the possibility of using a two-part tariff is irrelevant for firm 2, and hence it does not affect the buyer's reservation payoff v^R either. However, insofar as fixed fees are a more efficient tool for extracting rents from the buyer, the Ramsey-Boiteux profits are now higher than in the case of linear pricing.

But RRV contracts are not necessarily better in relative terms, as the possibility of using fixed fees increases also the profits in all relevant benchmarks. In particular, when $\mu = 0$ fixed fees do not entail any cost, and thus firms may price efficiently setting $p_i = c_i$ and extracting their profits by means of the fixed fees. In this case, since v^R is the social surplus that can be produced when firm 1 is not active, the Ramsey-Boiteux profit is firm 1's marginal contribution to the social surplus. Now, the dominant firm can obtain its marginal contribution even without RRV contracts, by simply offering an unconditional two-part tariff with $p_1 = c_1$ and F_1 set to its marginal contribution. Prat and Rustichini (1998) have shown that in fact, in all equilibria in which the dominant firm acts as a price leader, it obtains exactly this payoff.[30]

However, the case $\mu = 0$ is special. As soon as $\mu > 0$, so that marginal prices are even just minimally distorted upwards, market-share requirement contracts allow the dominant firm to earn more than with unconditional tariffs.

Proposition 4 *If $\mu > 0$, then $\pi^{RB}(v^R, \mu)$ is strictly higher than the profit that the dominant firm could make by not using RRV contracts.*

Proof. Calzolari et al. (2020) have shown that in any equilibrium where the dominant firm offers an unconditional tariff, it must set $p_1 \geq c_1$ and $F_1 \geq 0$. With a marginal price not lower than c_1, the efficient quantity of product 2 is strictly positive by Condition 2. This implies that in any equilibrium where the dominant firm offers an unconditional tariff, the profit of firm 2 is strictly positive.

Next, remember that $\pi^{RB}(v^R, \mu)$ is the maximum joint profit of firm 1 and 2 when the buyer obtains a net payoff of v^R, and that it is decreasing in v^R. Therefore, $\pi^{RB}(v^R, \mu)$ is strictly higher than the profit that the dominant firm may make in any equilibrium where the buyer's payoff is at least v^R and the profit of firm 2 is strictly positive.

The last possibility to consider is that the buyer's payoff is less than v^R. We now show that even in this case, the dominant firm obtains strictly less than $\pi^{RB}(v^R, \mu)$ when $\mu > 0$. In the proof of Proposition 3, we have shown that it cannot earn more. To show that it obtains strictly less, it suffices to prove that inequality (13) is strict when x lies in a non-empty right interval of 0. Consider again problem (12). At $x = 0$, we must have $\pi_2^E(v^R - x, \mu) = 0$ for any μ, so the best exclusive-dealing contract that firm 2 may offer involves $p_2 = c_2$ and $F_2 = 0$. Since $f_2(c_2, \bar{p}_1)$ is the efficient quantity under exclusive representation, the Lagrange multiplier of problem (12) is 1. Intuitively, raising the marginal price p_2 slightly above c_2 creates deadweight losses that are second-order compared to the increase in firm 2's profits. On the other hand, the Ramsey-Boiteux profit is strictly positive at $x = 0$, implying that the price-cost margins are positive on both

[30] As noted in footnote 14, however, firm 2 can obtain more than its marginal contribution. In particular, firm 2's payoff is highest in the thrifty equilibrium in which the dominant firm offers a quantity forcing contract with the quantity set at q_1^{eff} and the total payment set at a level that covers the costs and yields a profit equal to the marginal contribution.

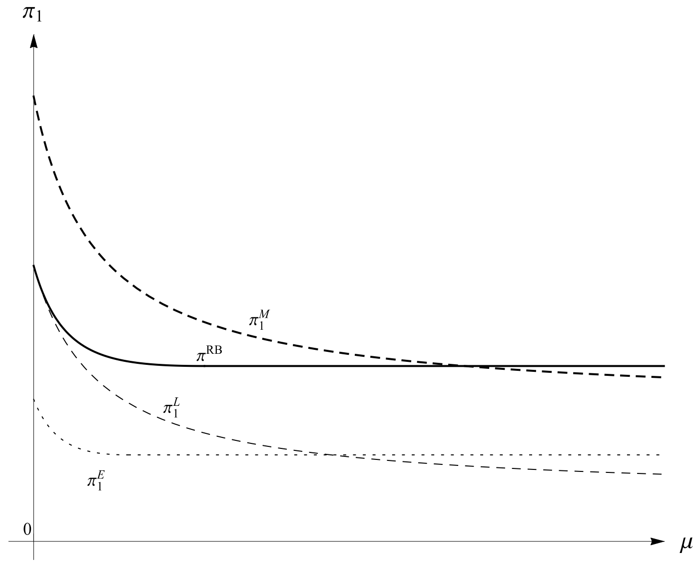

Figure 5: Firm 1's profits with two-part tariffs as functions of the parameter μ, which determines the magnitude of the price distortions. The figure represents Example 2 with $c_2 = \frac{1}{3}$ and $\gamma = \frac{1}{4}$.

goods and hence that the Lagrange multiplier of problem (11) is strictly lower than 1. This implies that

$$\left.\frac{d\pi_2^E(v^R - x, \mu)}{dx}\right|_{x=0,\mu>0} > \left.\frac{d\pi^{RB}(v^R - x, \mu)}{dx}\right|_{x=0,\mu>0}.$$

This completes the proof of the proposition. It may be useful, however, to clarify why the assumption that $\mu > 0$ is necessary for the conclusion to hold. If $\mu = 0$, the fixed fees are always positive in both problems (11) and (12), so the Lagrange multipliers are both $\frac{1}{1+\mu}$. This implies that the dominant firm's profit stays constant as x increases, and hence that there can be equilibria where the dominant firm offers only an unconditional tariff and still obtains $\pi^{RB}(v^R, 0)$. ■

Figure 5 illustrates the result using again Example 2. When $\mu = 0$, the Ramsey-Boiteux profits coincide with the profits that the dominant firm could make with unconditional tariffs. Both are lower than the monopoly profits and higher than the profits made by the dominant firm under exclusive dealing. As μ increases, however, the Ramsey-Boiteux profits decrease less rapidly than the relevant benchmarks. As a result, as soon as $\mu > 0$ the Ramsey-Boiteux profits become strictly greater than those achievable with unconditional tariffs. Furthermore, when the equilibrium with linear pricing is exploitative in the sense that $\pi^{RB}(v^R) > \pi_1^M$, the equilibrium with two-part tariffs becomes exploitative for μ large enough. Note that the gain from using RRV contracts increases with μ, and hence with the magnitude of the price distortions.[31]

6 Welfare

In this section, we discuss the welfare effects of the exploitative strategies analyzed above.

We start by comparing the exploitative equilibrium of Proposition 1 with the exclusive dealing equilibrium. In both cases, firm 2 makes zero profits. However, firm 2's output vanishes under exclusive dealing, whereas it is positive in the exploitative equilibria. As a result, social welfare is higher.[32] The dominant firm captures the lion's share of the efficiency gain, but even the buyer may gain in some cases.[33]

It may also be interesting to compare the exploitative equilibria with that arising if RRV contracts are not feasible, or are not permitted. Relative to this latter benchmark, market-share requirements tend to be anti-competitive when the dominant firm has a big competitive advantage over its rival, pro-competitive when the competitive advantage is small. This is true both if the welfare criterion is the social surplus, and if one focuses instead on the buyer's payoff only.

Qualitatively, this pattern is similar to the one arising under exclusive dealing,[34] but the competitive effects of exploitative strategies are generally more benign. To illustrate, Figures 6 and 7 represent the frontiers separating the pro- and anti-competitive regions in Example 1 and Example 2, respectively. The figures use the social surplus as a welfare criterion, but the frontiers would be qualitatively similar using the buyer's payoff instead.

[31] Similar changes apply to the analysis of the case of simultaneous moves. Like with linear pricing, there is a multiplicity of equilibria. When $\mu = 0$, the profit frontier is a rectangle where the length of each side is the firm's marginal contribution to the social surplus, as in Chiesa and Denicolò (2009). If one firm obtains less than its marginal contribution, this benefits the buyer but not the rival. As soon as $\mu > 0$, however, the profit frontier is qualitatively similar to the linear pricing case. In particular, starting from the point where $\pi_1 = \pi^{RB}(v^R, \mu)$ and $\pi_2 = 0$, a small increase in π_2 makes π_1 decrease. This implies that even with simultaneous moves, there are equilibria where the dominant firm earn strictly more than with unconditional tariffs, and even strictly more than under monopoly.

[32] Moving beyond the baseline model, however, paints a more nuanced picture. In certain simultaneous-move equilibria, the buyer may obtain strictly less than v^R. In this case, the buyer obtains less with market-share requirements than under exclusive dealing. The welfare comparison then depends on the specific welfare criterion chosen. It may be interesting to note that the buyer's payoff falls below v^R only if firm 2 may make positive profits. Thus, the interests of the buyer are opposite to those of the dominant firm's rival. This runs counter to current antitrust practice, which often implicitly assumes that these interests tend to be aligned.

[33] This happens, in particular, when the constraint in the Ramsey-Boiteux problem is slack so that the buyer gets more than v^R. In this case, the rents left to the buyer by a multi-product monopolist are greater than those left by a single-product monopolist.

[34] For the competitive effects of exclusive dealing, see Mathewson and Winter (1987) and Calzolari et al. (2020).

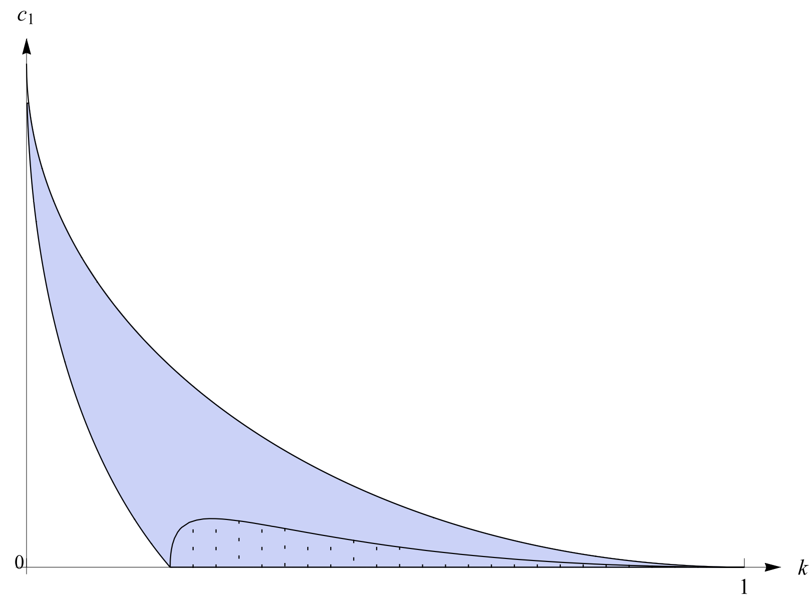

Figure 6: The welfare effect of RRV contracts in Example 1. Condition 1 holds below the upper curve. Market-share requirements are pro-competitive in the light blue region, that is, when the dominant firm's competitive advantage is small (c_1 and k large). The dotted region is where exclusive dealing would be pro-competitive as well.

The figures show that market-share requirements are more likely to be pro-competitive than exclusive dealing arrangements. Moreover, exclusive dealing arrangements tend to be pro-competitive only when they are unprofitable for the dominant firm, in which case they are probably unlikely to persist, as the dominant firm must try to escape from the prisoner's dilemma in which it is caught.[35] Market-share requirements, in contrast, are always profitable for the dominant firm, which therefore has no incentive to alter the equilibrium outcome. From this viewpoint, the pro-competitive effects of market-share requirements are more robust than those produced by exclusive-dealing arrangements.

7 Related literature

Our analysis relates most directly to the rent shifting literature and the literature on market-share discounts. In this section, we discuss the relationships with these literatures in greater detail.

[35] A prisoner's dilemma may arise as the dominant firm has a unilateral incentive to enter into exclusive dealing arrangements but is eventually harmed by the intensity of the competition for the market. Such disruptive competition could however be avoided in various ways. For example, Mathewson and Winter (1987) posit that firms can commit, in a first stage of the game, not to offer exclusive dealing contracts. With this assumption, exclusive dealing is observed only if it is profitable for the dominant firm, and hence, essentially, only if it is anti-competitive. In the same spirit, Calzolari et al. (2020) show that the pro-competitive effects of exclusive dealing are attenuated (even if they do not vanish altogether) when firms can coordinate their latent contracts.

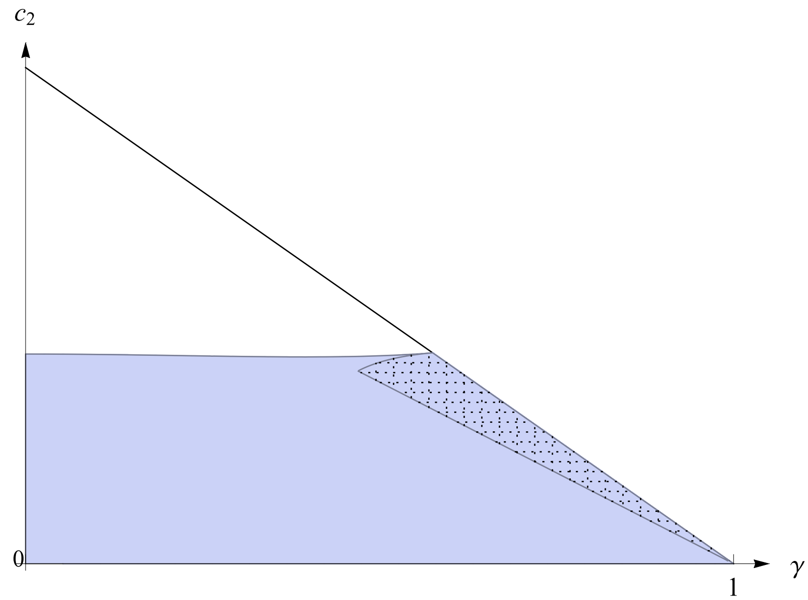

Figure 7: The welfare effect of RRV contracts in Example 2. Condition 2 holds below the line $c_2 = 1 - \gamma$. Market-share requirements are pro-competitive in the light blue region, that is, when the dominant firm's competitive advantage is small. The dotted region is where exclusive dealing would be pro-competitive.

The rent shifting literature was initiated by the seminal contribution of Aghion and Bolton (1987). These authors study a model where the dominant firm and the buyer can sign a contract before the buyer is approached by an entrant, whose cost is a random variable. They analyze exclusive-dealing contracts that allow the buyer to breach the exclusivity clause upon payment of a penalty. While their main focus is on the exclusionary effects of these contracts, in equilibrium foreclosure is partial and arises only when the entrant's realized cost is relatively high. In the limiting case of complete information, the foreclosure effect vanishes, and the contract between the dominant firm and the buyer serves only to shift rents to the dominant firm.

This rent-shifting mechanism has been further analyzed by Marx and Shaffer (1999, 2004).[36] In particular, Marx and Shaffer (2004) allow for market-share contracts and show that with efficient pricing the dominant firm can capture all of the social surplus when the buyer has no bargaining power.

However, this rent-shifting mechanism crucially hinges on the assumption that the dominant firm and the buyer are committed to the signed contract. This as-

[36] See also Choné and Linnemer (2015, 2016), who extend Marx and Shaffer's analysis to the case of incomplete information.

sumption raises various issues. First, under uncertainty the equilibrium may not be re-negotiation proof (Dewatripont, 1988).[37] Second, contractual commitments may not be feasible as contracts can be breached, and the expectation damages awarded by the courts for breach of contracts may fall below the stipulated penalty (Masten and Snyder, 1989; Simpson and Wickelgren, 2007). Third, if contractual commitments were feasible, then the buyer could potentially contract with many different third parties. This would strengthen his bargaining position with both firms, not only with the entrant, making the dominant firm lose much of its power.[38]

Differently from this literature, we assume that the buyer chooses which contracts to sign only after both firms have submitted their offers. Therefore, in equilibrium there is no incentive to breach the contracts.[39] Incidentally, this makes our theory immune from the critique of Ide, Montero and Figueroa (2016), who have forcefully argued that contractual commitments are necessary for most existing theories of exclusive dealing.[40] Their critique rests on the assumption that firms can extract their profits efficiently, whereas we assume that marginal prices are distorted upwards.

Exploitative equilibria may also arise in models of price discrimination. The general idea is that price discrimination may be facilitated by the presence of rivals that provide alternatives perceived as more attractive by some of the buyers. For example, Chen and Rey (2012) model a dominant firm that supplies two products and would like to reduce the price only for those buyers who have high shopping costs. This is not possible if the firm is a monopolist, though, as the price reduction would be claimed also by buyers with low shopping costs. However, if the dominant firm faces a rival that can supply one of the products at a lower cost, the dominant firm can reduce the price of that product only, pricing it below cost. Low shopping cost buyers prefer to purchase the product from the rival and thus are not subsidized. The more efficient is the rival, the more room the dominant firm has to price discriminate.[41]

[37] Spier and Whinston (1995) modify the Aghion and Bolton model allowing for re-negotiation. They focus on a different commitment device, i.e., investment in cost-reducing activities. Since the initial contract between the incumbent and the buyer can be re-negotiated after the entrant materializes, it cannot serve to strengthen the buyer's bargaining position vis-a-vis the entrant. Rather, it now serves to induce the incumbent to over-invest, and this over-investment in turn reduces the entrant's bargaining power. However, the equilibrium of Spier and Whinston's model is not exploitative, as the incumbent would always prefer to be an unchallenged monopolist.

[38] To illustrate, suppose that the buyer's willingness to pay for an indivisible product is 1, that the incumbent can supply the product at a cost of $c_1 = \frac{1}{2}$, and that the entrant's cost c_2 is uniformly distributed over $[0, 1]$, as in Aghion and Bolton's original example. Suppose however that before contracting with the firms, the buyer signs a contract with a third party that stipulates a penalty of $\frac{1}{2}$ if the buyer purchases from the incumbent and of $\frac{3}{4}$ if he purchases from the entrant. The incumbent could then obtain no rents, while the entrant would get only the same informational rents as in the original model. With many third parties potentially available to contract with, the buyer might then reap all the remaining surplus.

[39] Even in the price-leadership case, the dominant firm has no incentive to change its contractual offers after observing those of the rival, provided that the rival offers also a latent exclusive-dealing contract, as it does in the simultaneous-move equilibrium.

[40] The critique of Ide, Montero and Figueroa (2016) applies not only to the Aghion and Bolton model but also to the naked exclusion model of Rasmusen, Ramseyer and Willig (1991) (as noted also by Spector, 2011), and the "donwstream accommodation" theory of Asker and Bar-Isaac (2013).

[41] In a similar vein, Calzolari and Denicolò (2015) consider a dominant firm that engages in non-linear pricing. Under monopoly, such a form of price discrimination requires distorting the quantity

Our analysis is different in that it considers a single buyer, eliminating any price discrimination effect.

This paper is also related to the literature on market-share discounts, which has suggested various explanations for this practice. For example, Inderst and Shaffer (2010) argue that market-share discounts may be used to lessen both intra- and inter-brand competition simultaneously. Our mechanism, in contrast, abstracts from intra-brand competition, as in our model buyers do not compete with each other. Majumdar and Shaffer (2007) and Calzolari and Denicolò (2013) view market-share contracts as a screening device in models where firms are incompletely informed about demand. Here instead we assume complete information. Chen and Shaffer (2014, 2019) analyze the use of market-share contracts in models of naked exclusion. They show that market-share contracts may serve to address problems of integer numbers better than exclusive dealing.[42] None of these papers however recognizes the possibility of exploiting rivals by combining market-share requirements and exclusive dealing offers.

8 Conclusions

We have shown that a dominant firm can gain more by exploiting its rivals than by foreclosing them. The exploitation is executed by means of contracts whose terms depend on what the buyer purchases from the firm's competitors,

The analysis has focused, in particular, on market-share requirement contracts, whereby a firm requests a buyer, as a condition for obtaining its product, to purchase from the firm itself at least a certain share of his total demand. We have shown that when these contracts are feasible, the dominant firm can gain more than if it were an unchallenged monopolist. In the most favourable cases, it may earn as much as if it could eliminate the competition and costlessly acquire the rival's specific technological and marketing capabilities.

The exploitative strategies studied in this paper should be scrutinized by antitrust authorities and the courts, as they tend to be anti-competitive when the dominant firm has a big advantage over its rivals. However, they can be pro-competitive when the dominant firm's competitive advantage is small and are generally more efficient than exclusionary practices. As such, they may warrant a more lenient antitrust treatment.

purchased by low-demand buyers below the efficient level (Maskin and Riley, 1984). When a rival supplies a substitute product, however, the dominant firm may distort the quantity of the rival product rather than the own quantity, reducing the cost of separating low-demand buyers from high-demand ones.

[42] Suppose for example that the entrant needs to serve more than 60% of total demand in order to cover its entry costs. With 10 symmetric buyers, the incumbent could foreclose the rival with exclusive dealing contracts by signing up 4 buyers. With two buyers only, however, the optimal foreclosure strategy is to have one buyer sign a contract with a market-share requirement set to 80%.

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Appendix

We provide explicit formulas for the profit levels in Example 1 and 2.

Example 1. Without RRV contracts, by acting as a price leader the dominant firm earns

$$\pi_1^L = \left(\frac{1-k-c_1}{2}\right)^2.$$[43]

This is always decreasing in the rival's capacity k. The monopoly profit, which is achieved when $k=0$ and is

$$\pi_1^M = \left(\frac{1-c_1}{2}\right)^2,$$

is therefore the maximum profit that the dominant firm can possibly make.

The Ramsey-Boiteux profits depend on whether the participation constraint in problem (5) binds or not, given that $\bar{v} = v^R = k - \frac{k^2}{2}$. When it does not bind (i.e., for $k \leq 1 - \frac{\sqrt{(3-c_1)(1+c_1)}}{2}$), the Ramsey-Boiteux solution entails selling the monopoly output $q_1^M = \frac{1-c_1}{2}$, of which k units are produced at zero cost using firm 2's technology, and the rest at a unit cost of c_1 with firm 1's technology. The Ramsey-Boiteux prices are both equal to the monopoly price $p_1^M = \frac{1+c_1}{2}$. The profits obtained in this way are $\pi^{RB} = \pi_1^M + c_1 k$, the same as that of a multi-product monopolist, π^{MP}.[44]

If instead the constraint is binding (i.e., for $k > 1 - \frac{\sqrt{(3-c_1)(1+c_1)}}{2}$), the profit-maximizing total output is $\sqrt{2k-k^2}$ and the Ramsey-Boiteux prices are both $1-\sqrt{2k-k^2}$. Again, k units are produced using firm 2's technology and the rest using that of firm 1. The Ramsey-Boiteux profits in this case are $\pi^{RB}(v^R) = \sqrt{2k-k^2}\left(1-c_1-\sqrt{2k-k^2}\right)+c_1 k$ and can be fully captured by the dominant firm with a strategy similar to the unconstrained case.

The exclusive dealing profit is always equal to

$$\pi_1^E(v^R) = \pi^{RB}(v^R) - c_1 k.$$

Example 2. The Ramsey-Boiteux profits are:

$$\pi_1^{RB} = \begin{cases} (1-c_2)\left[\sqrt{\frac{2(1-c_2)(1-\gamma)+c_2^2}{1-\gamma^2}} - (1-c_2)\right] & \text{if } c_2 \leq \frac{3+\gamma(1-4\gamma)+\sqrt{3(1-\gamma^2)}}{3-4\gamma^2} \\ \frac{2(1-c_2)(1-\gamma)+c_2^2}{4(1-\gamma^2)} & \text{if } c_2 \geq \frac{3+\gamma(1-4\gamma)+\sqrt{3(1-\gamma^2)}}{3-4\gamma^2}. \end{cases}$$

[43] Anticipating that it will always be undercut by the rival, the dominant firm faces a residual demand of $q = 1-k-p$. With a marginal cost of c_1, the profit-maximizing price then is $\frac{1-k+c_1}{2}$, which results in an output of $\frac{1-k-c_1}{2}$ and the profit level reported in the text.

[44] To be precise, in this example a "multi-product" monopolist is a hypothetical firm that can use the production plants of both firms.

The monopoly profits are $\pi_1^M = \frac{1}{4}$, the profits of a multi-product monopolist are

$$\pi^{MP} = \frac{2(1-\gamma)(1-c)+c^2}{4(1-\gamma^2)},$$

the exclusive-dealing profits are

$$\pi_1^E = \begin{cases} c_2(1-c_2) & \text{if } c_2 \leq \frac{1}{2} \\ \\ \frac{1}{4} & \text{if } c_2 \geq \frac{1}{2}, \end{cases}$$

and the profits gained when the dominant firm does not make use of RRV contracts are

$$\pi_1^L = \frac{[2-(1-c_2)\gamma-\gamma^2]^2}{8(2-3\gamma^2+\gamma^4)}.$$