

# 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 dominant firms may prefer to use these contracts to exploit rivals rather than to foreclose them. By designing RRV contracts so that rivals stay active but are marginalized, a dominant firm may earn as much as if it could eliminate the competition and acquire the rivals' specific technological capabilities free of charge. Besides being more profitable, these partially exclusionary strategies have also more benign competitive effects than fully exclusionary ones.

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# 1 Introduction

This paper deals with contracts that reference rivals' volumes (RRV), i.e., contracts whose terms depend on what the buyer purchases from the firm's competitors. The best-known example in this class is probably *exclusive dealing* – a practice that has long been controversial for its potential to foreclose competitors that are more efficient, at least in some respects, than the dominant firm. However, exclusive dealing is not the only example. Often, firms request, as a condition for obtaining their products, that the buyer purchase from the firm itself at least a certain share of his total demand, but not necessarily one hundred percent.

These *market-share contracts* have also spurred considerable controversy.<sup>1</sup> Conventional wisdom views them as a surrogate of exclusive dealing arrangements, more softly designed so as to circumvent the antitrust prohibition against those practices.<sup>2</sup> However, it is the contention of this paper that market-share requirements are actually superior to exclusive dealing and thus would be the dominant firm's elective choice, if feasible.<sup>3</sup> Rather than foreclosing its competitors, that is to say, the dominant firm may prefer to let them stay active so as to take advantage of their specific capabilities. This goal is achieved precisely by setting a market-share requirement below one hundred percent. Besides being more profitable, this *exploitative* strategy has also more benign competitive effects than fully *exclusionary* strategies. This may suggest a more lenient antitrust treatment.

The mechanism of exploitation relies on a 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 the competition and acquire the rivals' technological capabilities free of charge.

This rent-shifting mechanism may be reminiscent of the *contractual commitment* theory of Aghion and Bolton (1987), but there are important differences. In Aghion and Bolton's theory, the dominant firm 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, eventually, to the dominant firm.

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<sup>1</sup>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).

<sup>2</sup>Other explanations have however been proposed: see the literature review in section 7 below.

<sup>3</sup>The enforceability of market-share contracts requires that one can verify not only whether but also how much buyers purchase "abroad." With the advent of information technologies, this has become increasingly possible. 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.

In our framework, in contrast, the buyer chooses which contracts to sign after both firms have made their offers. Thus, our mechanism does not rely on contractual commitments.<sup>4</sup> Rather, it 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,<sup>5</sup> and hence more than if it were an unchallenged monopolist; in other words, it cannot exploit the rival. But, as we show, this conclusion does not hold when marginal prices are distorted.

Since price distortions are probably ubiquitous,<sup>6</sup> dominant firms have strong incentives to use market-share requirement contracts. 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, as the prevalence of market-share requirements shows, and antitrust intervention is a matter of policy choice. In this respect, our analysis suggests a more lenient approach 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 the timing of moves and the form of the price schedules. Section 6 presents the welfare analysis. We conclude the paper with a more detailed discussion of the related literature (section 7) and a summary of our results (section 8).

## 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

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<sup>4</sup>After presenting our results, we discuss the differences with Aghion and Bolton more fully in section 7 below.

<sup>5</sup>See for instance O'Brien and Shaffer (1997) and Bernheim and Whinston (1998).

<sup>6</sup>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.

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.<sup>7</sup> When marginal costs are constant, they will be denoted by  $c_i$ .

There is a single buyer,<sup>8</sup> who is endowed with a payoff function  $u(q_1, q_2)$ , gross of any payment to the firms, with  $u(0, 0) = 0$  (a normalization).<sup>9</sup> 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:  $u_{q_i q_i}(q_i, q_j) \leq u_{q_i q_j}(q_i, q_j) \leq 0$ . This implies that the goods are substitutes.

Firms compete in prices. As noted, a crucial assumption of our analysis is that marginal prices are 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  $\varepsilon_i(p_i, p_j) = \frac{\partial f_i}{\partial p_i} \frac{p_i}{q_i}$ . The buyer's indirect payoff function is defined as

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

This function is decreasing and convex. For notational convenience, assume finite choke prices  $\bar{p}_i = u_{q_i}(0, 0)$ .<sup>10</sup> When contractual restrictions force the buyer to purchase only product  $i$ , the indirect payoff function is denoted by  $v(p_i, \bar{p}_j)$ .

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

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<sup>7</sup>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.

<sup>8</sup>Equivalently, firms can make personalized offers and buyers do not interact strategically with each other.

<sup>9</sup>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.

<sup>10</sup>Both the assumption of finite satiation points and finite choke prices are made just for expositional convenience and could be relaxed.

share  $s_i = \frac{q_i}{q_i + q_j}$  is at least as large as a certain target value and is prohibitively high if the market share is below the target. With finite choke prices, a market-share requirement can be represented as follows:

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

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. 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:

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

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

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

Firm 1 is dominant in the sense that it can always match this offer and still make a positive profit. Let  $\tilde{p}_1(v^R)$  be implicitly defined as

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

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

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

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**  $q_2^{\text{eff}} > 0$ .

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  $p_j$ ,

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

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. In particular, the assumption of price leadership simplifies the exposition because it selects a unique equilibrium, the one most favorable for the dominant firm,<sup>11</sup> but is not essential for our results. With simultaneous moves there are multiple equilibria, but in all of them market-share requirements are more profitable than exclusive dealing.<sup>12</sup>

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<sup>11</sup>This is not a foregone property, as it is well known that without RRV contracts firms would rather prefer to act as followers than as leaders. This is true when firms are restricted to linear pricing (Gal-Or, 1985) and also with more general contracts. Indeed, Prat and Rustichini (1998) have shown that, in the absence of market imperfections, the price leader never gets more than it could obtain in a simultaneous-move equilibrium. 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*.

<sup>12</sup>Even if we start from the case of price leadership mainly for expositional reasons, one might argue that when only one firm offers RRV contracts, as is the case in our equilibrium, the elective choice regarding the timing of moves should indeed be that that firm acts as a price leader. The reason for this is that RRV contracts tend to be relatively long term. 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 competitors on others. (Many goods

### 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

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

where  $\tilde{p}_1(v^R)$  is given by (4) and  $p_1^M = u_{q_1}(q_1^M, 0)$  where  $q_1^M = \arg \max_{q_1} [u_{q_1}(q_1, 0)q_1 - C_1(q_1)]$ .<sup>13</sup> 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:

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

with  $q_i = f_i(p_i, p_j)$ . In words, the problem is to maximize the profits of a multi-product monopolist that faces a buyer with a reservation payoff of  $\bar{v}$ .<sup>14</sup> 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.

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can be stocked, and the cost of maintaining inventories over short periods of time is often negligible.) This implies that a firm that offers RRV contracts must commit to the stipulated contractual 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.

<sup>13</sup>The monopoly price  $p_1^M$  exists and is unique by Condition 3.

<sup>14</sup>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.

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

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

and

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

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

In response, firm 2 offers a price

$$p_2^* = \frac{C_2[q_2^{RB}(v^R)]}{q_2^{RB}(v^R)}, \quad (8)$$

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  $p_2^* \leq p_2^{RB}$  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  $\hat{s}_1^* = s_1^{RB}$ , 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) and the rival’s price (8), the price of the bundle is

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

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

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

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). Consider what else the buyer might do. A first possibility is that he takes the dominant firm's latent, exclusive-dealing contract. By so doing, however, by construction the buyer would obtain no more than the equilibrium payoff. Another possibility is that the buyer deals exclusively with firm 2. But by assumption firm 2 alone cannot guarantee to the buyer a higher payoff than  $v^R$  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

$$\begin{aligned} \pi_2^E(v^R - x) &= \max_{p_2} \{p_2 f_2(\bar{p}_1, p_2) - C_2[f_2(\bar{p}_1, p_2)]\} \\ \text{s.t.} \quad &v(\bar{p}_1, p_2) \geq v^R - x, \end{aligned} \tag{9}$$

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 (9), which is

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

(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

$$\lambda(p_1^{RB}, x) = 1 + \frac{p_2 - C'_2[f_2(p_1^{RB}, p_2)]}{p_2} \varepsilon_2(p_2, p_1^{RB}).$$

It follows that

$$\lambda(\bar{p}_1, x) - \lambda(p_1^{RB}, x) = \int_{p_1^{RB}}^{\bar{p}_1} \frac{d}{dp_1} \left[ \frac{p_2 - C'_2[f_2(p_1, p_2)]}{p_2} \varepsilon_2(p_2, p_1) \right] \Big|_{v(p_1, p_2) = v^R} dp_1.$$

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  $s_1^{RB}(v^R) < 1$ .<sup>15</sup> Thus, Proposition 1 implies that when market-share requirement 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 dominant firm obtains more than if it could eliminate the rival at no cost. In particular, when  $v^R$  is so small that the constraint in the Ramsey-Boiteux problem is slack at  $\bar{v} = v^R$ , 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.<sup>16</sup>

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<sup>15</sup>This follows from the fact that

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

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  $s_1^{RB}(v^R) < 1$ .)

<sup>16</sup>The exploitation of rivals is different from the exploitation of buyers, which is the key concern in cases of *exploitative abuses*.

### 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 lower 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 holds: 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  $k < 1 - \sqrt{(2 - c_1)c_1}$ .

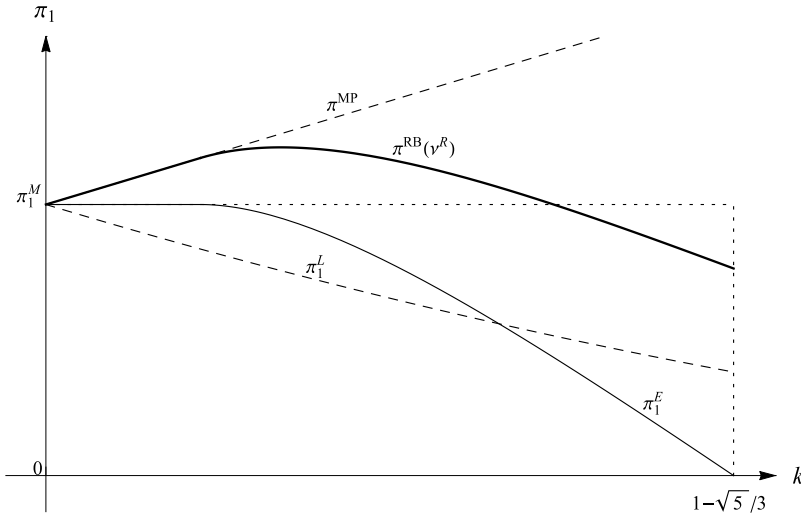


Figure 1: Firm 1's profits in Example 1. The profit earned by the dominant firm with RRV contracts is  $\pi^{RB}(v^R)$ . The figure is drawn for the case  $c_1 = \frac{1}{3}$ , so Condition 1 is satisfied when  $k < 1 - \frac{\sqrt{5}}{3}$ .

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  $\pi_1^L$  that the dominant firm could earn by acting as a price leader without using RRV contracts, the monopoly profit  $\pi_1^M$ , the exclusive dealing profit  $\pi_1^E$ , and the profit of a multi-product unconstrained monopolist,  $\pi^{MP}$ .<sup>17</sup> It appears that the dominant firm always earns more than under exclusive dealing. For a range of values of  $k$ , it actually earns more than the monopoly profits. Over this range, the dominant firm

<sup>17</sup>The explicit formulas for these profits are reported in the Appendix, both for Example 1 and Example 2.

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.

This explains why 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 the dominant firm can extract 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.

**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 as well. 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

$$u(q_1, q_2) = q_1 + q_2 - \frac{1}{2}(q_1^2 + q_2^2) - \gamma q_1 q_2, \quad (10)$$

where the parameter  $\gamma$  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  $c_2 < 1 - \gamma$ .

Results are similar to Example 1. When  $c_2$  is sufficiently large, the dominant firm earns more than the monopoly profit. In this case, 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 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

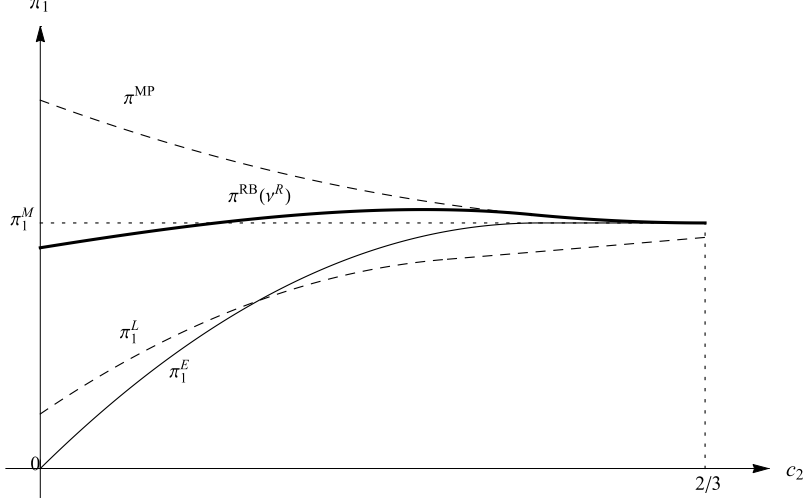


Figure 2: Firm 1’s profits in Example 2. The figure is drawn for  $\gamma = \frac{1}{3}$ , in which case the efficient quantity of product 2 is positive for  $c_2 < \frac{2}{3}$ .

arguments of the function)

$$p_1 = u_{q_1} + \frac{1 - \hat{s}_1}{\hat{s}_1} (u_{q_2} - p_2). \quad (11)$$

The first term on the right-hand side of (11) 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  $\frac{1-\hat{s}_1}{\hat{s}_1} (u_{q_2} - p_2)$ . This term represents 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. Such 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 and extract rents from the rival. To extract as much as possible of these rents, however, the dominant firm must discipline the competitor’s pricing. 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.<sup>18</sup> With the dominant firm’s latent contract in place, in contrast, firm 2 would lose all of its sales the moment it tried

<sup>18</sup>This follows from the fact that if firm 2 prices at cost, by construction the buyer obtains at least  $v^R > 0$ .

to price above cost.<sup>19</sup>

Three remarks are in order. First, the latent contract is essential but may not be observable. This may raise doubts about the verifiability (or falsifiability) of the theory. But in fact, 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. In the absence of the latent contract, the rival would indeed 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 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.<sup>20</sup>

Second, the mechanism of exploitation is delicate. Even small mistakes in the design of the dominant firm's contractual offers might lead the buyer to deal exclusively with the rival. This risk would be particularly acute if demand and rival's costs were uncertain. To manage the risk, the dominant firm would have to leave some extra rents to the buyer. However, similar risks would also arise with exclusive dealing contracts, so these considerations may not necessarily affect the comparison with exclusive dealing.

Third, small mistakes in the design of the contractual offers might lead the buyer to opt for the dominant firm's latent contract. This is also a problem, as the latent contract is less profitable than the equilibrium one.<sup>21</sup> And again the dominant firm might have to give up some extra rents to reduce the risk. But in any case the latent contract is precisely what the dominant firm would offer under exclusive dealing, so the possibility that such contract is accidentally accepted does not affect the superiority of the exploitative strategy.

### 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 binding quantity requirement  $q_2 \leq \hat{q}_2$ , 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

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<sup>19</sup>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.

<sup>20</sup>In many antitrust cases involving market-share rebates, there is indeed plenty of circumstantial evidence to this effect.

<sup>21</sup>If one insisted that all contractual offers must guarantee the same level of profits, the firm would effectively be restricted to *truthful* strategies. With this restriction, RRV contracts cannot possibly be profitable.

produce any tying effect and thus do not create any option value.<sup>22</sup> 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.<sup>23</sup> 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.<sup>24</sup>

## 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.

### 4.1 Equilibrium characterization

With simultaneous moves, the equilibrium is no longer unique. However, the following proposition shows that in any simultaneous-move equilibrium, the dominant firm generically obtains more than under exclusive dealing. Furthermore, it shows that when in the price-leadership equilibrium the dominant firm obtains more than the monopoly profit, there exists a continuum of simultaneous-move equilibria where this property continues to hold.

**Proposition 2** *In all simultaneous-move equilibria, the dominant firm’s profit  $\pi_1$  lies in the interval  $[\pi_1^E(v^R), \pi^{RB}(v^R)]$ . 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.* To prove the first part of the proposition, remember that we have already shown in the course of the proof of Proposition 1 that the dominant firm can never obtain more than  $\pi^{RB}(v^R)$ . Note also that whatever contract firm 2 offers, if the dominant firm obtains a

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<sup>22</sup>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.

<sup>23</sup>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  $\gamma$  are sufficiently low.

<sup>24</sup>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.

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 suffice to 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  $[\pi_1^E(v^R), \pi^{RB}(v^R)]$ . 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  $v^R$ , but the same construction applies to the case where the buyer obtains more than  $v^R$ .)

Second, firm 2 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  $C_2(q_2) = \tilde{p}_2 q_2$ :

$$\begin{aligned} \tilde{\pi}^{RB}(v^R, \tilde{p}_2) &= \max_{p_1, p_2} [p_1 q_1 + p_2 q_2 - C_1(q_1) - \tilde{p}_2 q_2] \\ \text{s.t.} \quad v(p_1, p_2) &\geq v^R \end{aligned}$$

with  $q_i = f_i(p_i, p_j)$ , 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

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

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  $[\pi_1^E(v^R), \pi^{RB}(v^R)]$ . ■

## 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 firms do not coordinate their off-path offers, and thus the latent contracts are those that would arise if the firms were engaged in a battle for exclusives. These latent contracts guarantee to the buyer the same payoff as in the price-leadership equilibrium.

With simultaneous moves, however, there can be other equilibria because the buyer's outside option pins down the total price of the bundle implicitly created by the dominant firm's market-share requirement, but not the division of the price among the two components of the bundle. The different equilibria can thus be parametrized by the equilibrium price of product 2,  $\tilde{p}_2$ . As  $\tilde{p}_2$  increases,  $p_1$  must decrease and thus the dominant firm's profits must decrease.

Note, however, that the proportion of the products in the bundle (i.e., the target market share) is not fixed but is chosen by the dominant firm. When  $\tilde{p}_2$  increases,, the dominant firm optimally responds by both reducing its own price *and* increasing the target market share. This implies that profits are not transferred from one firm to the other on a one-to-one basis, as it would be the case if the structure of the bundle were exogenous. Therefore, the profit frontier is not a straight line of slope  $-1$  but is non-linear (see Figure 3). In particular, while the dominant firm's profit always decreases as  $\tilde{p}_2$  increases, the profit of firm 2 first increases and then decreases.

The reason for this is, to repeat, that 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,  $\pi_2$  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  $\pi_1^E(v^R)$ ).<sup>25</sup>

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. Note also that the dominant firm's rival is more severely harmed, the closer is the equilibrium to the price-leadership one.

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<sup>25</sup>The online appendix develops a detailed analysis of the multiplicity of equilibria in Example 2. It is available at this link.

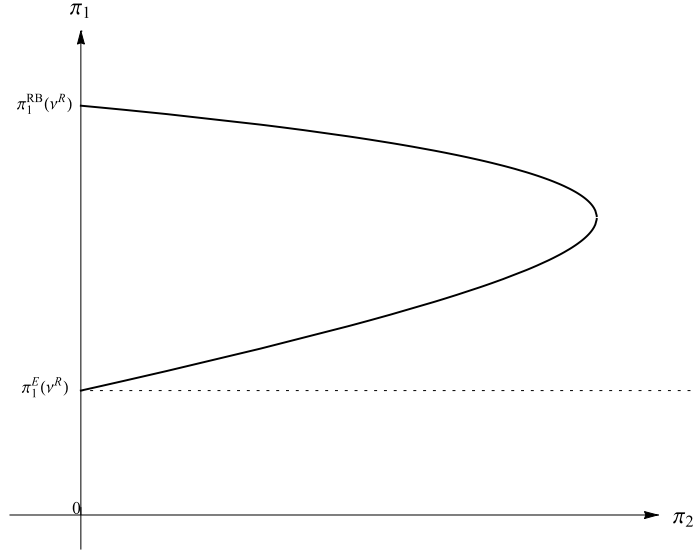


Figure 3: The profit frontier obtained by varying the equilibrium price of product 2,  $\tilde{p}_2$ , for given latent contracts. The figure is drawn for Example 2 with  $c_2 = \frac{1}{10}$  and  $\gamma = \frac{1}{5}$ .

Since antitrust cases are typically brought by dominant firms' rivals, the equilibria that are most likely to prompt antitrust litigation should be those closest to 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 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.

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 only be lowered 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.<sup>26</sup> 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

<sup>26</sup>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.

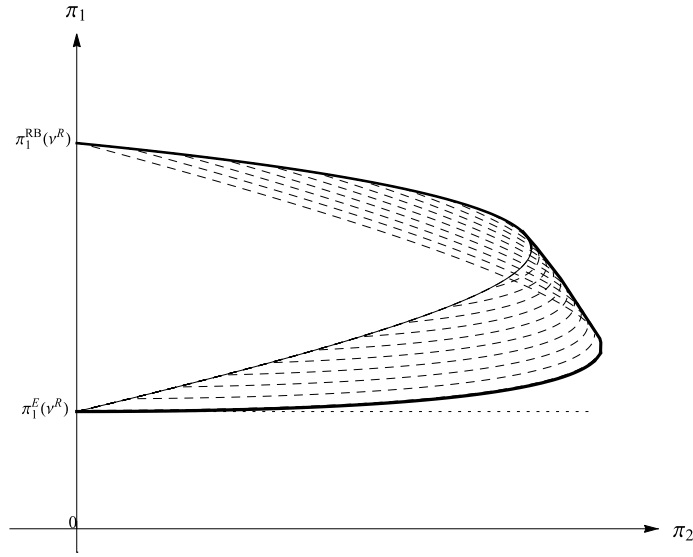


Figure 4: The profit frontier in Example 2 when firms coordinate their latent contracts. The frontier is the outer envelope of those corresponding to any fixed payoff of the buyer that is achievable in equilibrium. The figure is drawn for  $c_2 = \frac{1}{10}$  and  $\gamma = \frac{1}{5}$ .

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.

## 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.<sup>27</sup> We now show that market-share requirements are always profitable except in the limiting case where the price distortions vanish.

To keep the analysis simple, 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. To generate endogenous price distortions, here we assume 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  $\mu \geq 0$ .

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<sup>27</sup>See footnote 6 above.

The parameter  $\mu$  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.<sup>28</sup> The case of efficient pricing is obtained for  $\mu = 0$ , that of linear pricing in the limit as  $\mu \rightarrow \infty$ .<sup>29</sup> We assume that the cost  $\mu$  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 an 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 firm acts as a price leader.

Consider the following modified Ramsey-Boiteux problem:

$$\begin{aligned} \pi^{RB}(\bar{v}, \mu) = \max_{p_1, p_2, F} & [(p_1 - c_1)f_1(p_1, p_2) + (p_2 - c_2)f_2(p_1, p_2) + F] \\ \text{s.t.} & \quad v(p_1, p_2) - (1 + \mu)F \geq \bar{v}. \end{aligned} \tag{12}$$

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  $\mu$  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.

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<sup>28</sup>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.

<sup>29</sup>In fact, the optimal fixed fee may vanish for finite values of  $\mu$ .

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

$$\begin{aligned} \pi_2^E(v^R - x, \mu) &= \max_{p_2, F_2} \{(p_2 - c_2)f_2(\bar{p}_1, p_2) + F_2\} \\ \text{s.t.} \quad &v(\bar{p}_1, p_2) - (1 + \mu)F_2 \geq v^R - x. \end{aligned} \tag{13}$$

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 (13). 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 (12), 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 (13) is at least as large as that of problem (12), so that

$$\frac{d\pi_2^E(v^R - x, \mu)}{dx} \geq \frac{d\pi^{RB}(v^R - x, \mu)}{dx}. \tag{14}$$

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 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, fixed fees do not entail any cost when  $\mu = 0$ , 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.<sup>30</sup>

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<sup>30</sup>However, firm 2 can obtain more than its marginal contribution in the equilibrium that Prat

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 (14) is strict when  $x$  lies in a non-empty right interval of 0. Consider again problem (13). At  $x = 0$ , we must have  $\pi_2^E(v^R - x, \mu) = 0$  for any  $\mu$ , 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 (13) 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 goods and hence that the Lagrange multiplier of problem (12) 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 (12) and (13), 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

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and Rustichini call *thrifty*. In this equilibrium, the dominant firm offers a quantity forcing contract with the quantity set at  $q_1^{\text{eff}}$  and the total payment set at a level that covers the costs and yields a profit equal to the marginal contribution. This is the equilibrium where firm 2's payoff is highest.

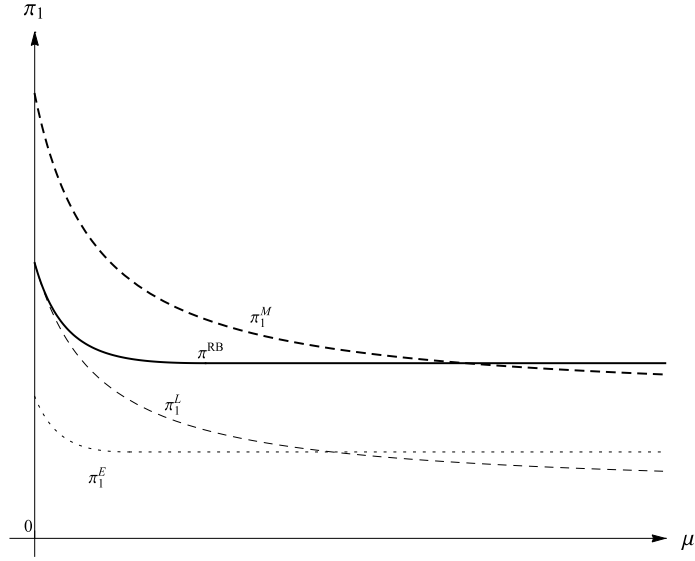


Figure 5: Firm 1's profits with two-part tariffs as functions of the parameter  $\mu$ , which determines the magnitude of the price distortions. The figure represents Example 2 with  $c_2 = \frac{1}{3}$  and  $\gamma = \frac{1}{4}$ .

unconditional tariffs. Both are lower than the monopoly profits and higher than the profits made by the dominant firm under exclusive dealing. As  $\mu$  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  $\mu$  large enough. Note that the gain from using RRV contracts increases with  $\mu$ , and hence with the magnitude of the price distortions.<sup>31</sup>

## 6 Welfare

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

<sup>31</sup>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  $\pi_2$  makes  $\pi_1$  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.

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.<sup>32</sup> The dominant firm captures the lion's share of the efficiency gain, but even the buyer may gain in some cases.<sup>33</sup>

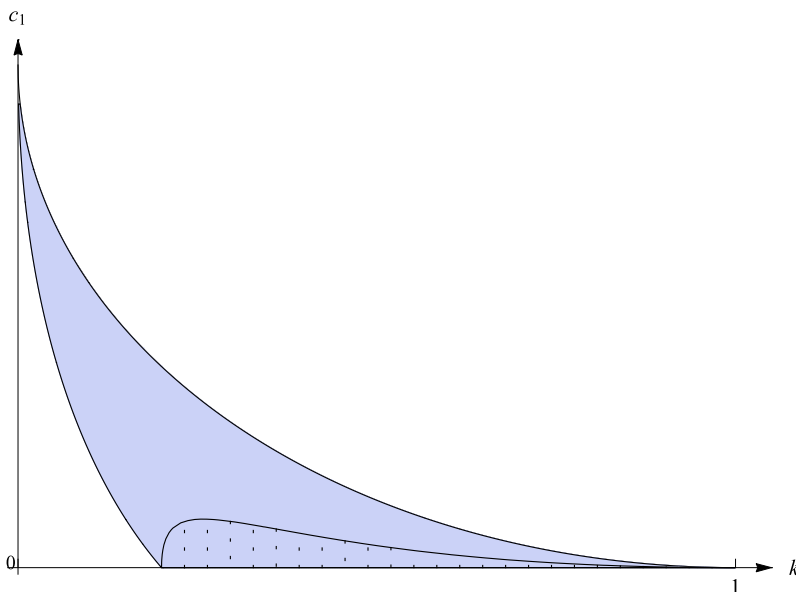


Figure 6: The welfare effect of RRV contracts in Example 1. Condition 1 holds below the upper curve. Market-share requirements are pro-competitive in the light blue region, that is, when the dominant firm's competitive advantage is small ( $c_1$  and  $k$  large). The dotted region is where exclusive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

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.

<sup>32</sup>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.

<sup>33</sup>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.



Qualitatively, this pattern is similar to the one arising under exclusive dealing,<sup>34</sup> 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.

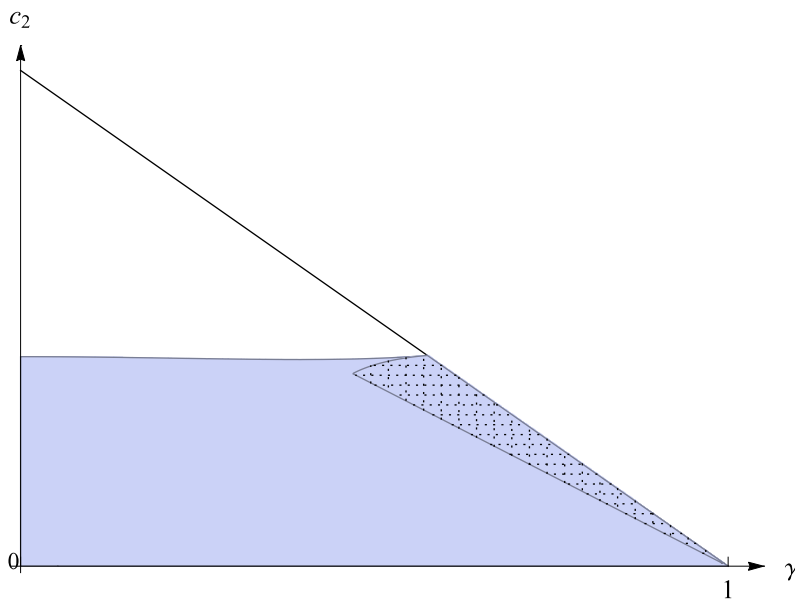


Figure 7: The welfare effect of RRV contracts in Example 2. Condition 2 holds below the line  $c_2 = 1 - \gamma$ . Market-share requirements are pro-competitive in the light blue region, that is, when the dominant firm’s competitive advantage is small. The dotted region is where exclusive dealing would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

The figures show that market-share requirements are more likely to be pro-competitive than exclusive dealing. Moreover, it is well known that exclusive dealing arrangements tend to be pro-competitive precisely when they are unprofitable for the dominant firm. If this is so, however, then these exclusive-dealing equilibria are probably unlikely to persist, as the dominant firm must try to escape from the

<sup>34</sup>For the competitive effects of exclusive dealing, see Mathewson and Winter (1987) and Calzolari et al. (2020).

prisoner’s dilemma in which it is caught.<sup>35</sup> 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

In this section, we discuss the relationships between our analysis and relevant branches of the economic literature.

First, our analysis is related to the rent-shifting literature 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).<sup>36</sup> 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 (as is the case in our model).

Aghion and Bolton’s rent-shifting mechanism hinges on the assumption that the dominant firm and the buyer are committed to the signed contract. Differently from this literature, we assume that the buyer chooses which contracts to sign only after both firms have submitted their offers. Our mechanism therefore does not rely on contractual commitments.<sup>37</sup>

The contractual-commitment assumption raises various problems, which have been extensively discussed in the literature (see e.g. Dewatripont, 1988; Spier and Whinston, 1995; Masten and Snyder, 1989; and Simpson and Wickelgren, 2007). To further clarify the difference with our approach, we mention a further issue that has

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<sup>35</sup>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.

<sup>36</sup>See also Choné and Linnemer (2015, 2016), who extend Marx and Shaffer’s analysis to the case of incomplete information.

<sup>37</sup>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.

received little attention so far: if contractual commitments were feasible, then the buyer could potentially contract with many different third parties, strengthening his bargaining position with all suppliers (including the dominant firm).

To illustrate the point, consider Aghion and Bolton’s original example where the buyer’s willingness to pay for an indivisible product is 1, the dominant firm can supply the product at a cost of  $c_1 = \frac{1}{2}$ , and the entrant’s cost  $c_2$  is uniformly distributed over  $[0, 1]$ . 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 dominant firm and of  $\frac{3}{4}$  if he purchases from the entrant. The dominant firm could then obtain no profits, 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.

In our model, in contrast, adding dummy players with no technological capabilities cannot change the equilibrium. The dominant firm’s ability to engage in rent shifting does not rest on the fact that it can contract with the buyer before the rival, but on the fact that it would win a hypothetical battle for exclusives, thanks to its superior technology.

Our theory is therefore immune from the critique of Ide, Montero and Figueroa (2016), who have forcefully argued that contractual commitments are necessary for most existing theories of RRV contracts.<sup>38</sup> Their critique holds as long as firms can extract their profits efficiently. Our model is different, as marginal prices are distorted upwards.

A second strand of the literature which this paper contributes to is the one on “exploitative equilibria,” where dominant firms obtain more than the monopoly profits. Such exploitative equilibria also arise in models of price discrimination. The general idea is that discrimination may be easier when rivals 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 optimally reduce the price of that product, pricing it below cost, and increase the price of the uncontested product. 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.<sup>39</sup> Our mechanism is different in that it does not rely on price discrimination.

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<sup>38</sup>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 “downstream accommodation” theory of Asker and Bar-Isaac (2013).

<sup>39</sup>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 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.

Finally, the paper is related to the literature on market-share discounts. This literature 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. 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; in particular, the dominant firm requests the buyer, as a condition for obtaining its products, 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 with exclusive dealing arrangements. In the most favorable cases, the dominant firm may earn as much as if it could eliminate the competition and costlessly acquire the rival's specific technological and marketing capabilities.

The strategies analyzed in this paper are anti-competitive when the dominant firm has a big advantage over its rivals but tend to be pro-competitive when the competitive advantage is small. Moreover, they are generally more efficient than exclusionary practices. As such, they may warrant a more lenient antitrust treatment.

The mechanism of exploitation is delicate, however: even small mistakes in the design of the contractual offers may lead to significant profit losses. With perfect knowledge of demand and rivals' costs, this is not a problem. With uncertainty, however, the dominant firm may have to leave extra rents to the buyer and the rivals. Extending the analysis to the case of uncertainty is therefore important to assess the robustness of the mechanism.

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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

$$\pi_1^L = \left( \frac{1 - k - c_1}{2} \right)^2. \quad 40$$

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,  $\pi^{MP}$ .<sup>41</sup>

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  $\pi^{RB}(v^R) = \sqrt{2k - k^2} (1 - c_1 - \sqrt{2k - k^2}) + c_1 k$  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:

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

<sup>40</sup> 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.

<sup>41</sup> 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

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