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Vertical Relations in the Presence of Competitive Recycling

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Abstract

This paper studies the vertical relations between a manufacturer and one or more retailers over two periods in the presence of a competitive recycling sector. In a bilateral monopoly, contracting is (generally) efficient, i.e. the manufacturer will produce the joint-profit-maximizing output. However, both competition downstream and upstream may lead to inefficient outcomes: Under retailer competition, some rent will be siphoned off by the recycling sector, and so the manufacturer will either overproduce in the second period or underproduce in the first period. If instead upstream entry occurs and full rent extraction is not possible, then the incumbent may overproduce in the pre-entry period. Vertical restraints that restore profit maximization (e.g. loyalty rebates) will harm consumers whenever the manufacturer would overproduce otherwise.

JEL classification: L12, L14, L42.

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1 Introduction

The potential anti-competitive effects of vertical restraints in general, and loyalty rebates in particular, have been a major concern to antitrust authorities. Loyalty rebates encompass a wide range of business practices, such as pure quantity discounts (which may be all-units discounts or incremental-units discounts), bundled discounts, and market-share discounts. So far, US authorities and courts have refrained from interfering with the use of loyalty rebates, primarily to avoid setting adverse precedents. Instead, the European Commission has consistently found such rebates to be anti-competitive when employed by a dominant firm. In fact, market-share discounts and discounts based on purchase growth are per-se illegal. The only admissible type of rebate used to be a standardized quantity discount. However, in its surprising *Michelin II* decision of 2003, the European Commission even found such standardized quantity discounts to be unlawful.

The *Michelin II* case concerned the market for replacement truck tires in France. If a truck owner needs to replace the tires of her truck, she basically has two options: either buy new tires or buy secondary ("retreaded") tires (where "retreaded" means that the tread of a worn tire casing was renewed). The retreading technology is available both to manufacturers of new tires and to a competitive sector of middle-sized firms specialized in retreading. While retreaded tires are considered inferior substitutes to new ones, they account for half of the market for replacement tires. Michelin is the dominant manufacturer of new truck tires in France, and sells its output partly through its own retail network (Euromaster), and partly through a number of independent dealers.

Michelin's vertical relations with its dealers where characterized by a number of rebate and bonus programs for which retailers could qualify. In one of them (the "club des amis Michelin"), the "club" members (some 375 outlets covering about 20% of the market) would guarantee for a certain "Michelin temperature", i.e. for certain sales volumes and market shares. In return, Michelin would contribute to investment and training of the retailer's staff, and also provide financial contributions.

In its decision, the European Commission found Michelin's rebate schemes to be exclusionary, in the sense that Michelin tried to monopolize the retail network in order to deter entry by competing truck tire manufacturers (like Goodyear or Continental). In particular, the "club des amis" was found to amount to a (per-se illegal) loyalty rebate scheme, i.e. a discount based on market shares rather than absolute sales thresholds. But there are good reasons to doubt whether Michelin's intention was really to exclude. The fact that Michelin's own retail network, Euromaster, also carried competing brands is clearly at odds with the allegation of exclusion. This paper proposes an alternative explanation for Michelin's loyalty rebates: that of restoring efficiency within the vertical chain in the presence of a competitive retreading sector. I will identify conditions under which such vertical restraints - while not exclusionary - are still welfare-detrimental, and where they may instead be efficiency-enhancing.

The tire industry is not the only industry where primary good producers coexist with a competitive recycling sector. Another case in point is the internet-based retailer Amazon; on the one hand, Amazon sells *new* books and CDs to final consumers, and on the other, it serves as a platform for peer-to-peer and business-to-consumer retail trade of *used* books, CDs and similar items. More often than not, the same title will be available both "new" and "used", and Amazon lists them next to each other. Amazon's relations with publishers and record labels, i.e. the "primary output" producers, cannot but take this supply of secondary goods into account.

Another example that comes to mind are car dealers who carry the new models of a particular car manufacturer along with used cars of the same brand. Similarly, many stationery retailers will offer original color cartridges for various printer brands along with cartridge refills produced by no-name manufacturers (or they may directly offer the refill service to consumers who bring their empty cartridges).

The goal of this paper is to study the use of vertical restraints in such industries where output produced today will reappear on the market as recycled output tomorrow. I consider a two-period model where a manufacturer of a recyclable good has to decide how much to produce of its primary good in each period, and at which price to sell its output to one or more retailers. A competitive recycling sector will recover and recondition first-period output (either partially or fully). In period 2, the retailer(s) will then sell the recycled quantity along with the second-period quantity of the manufacturer's primary good.

As a benchmark, I start with the analysis of the bilateral monopoly. I assume that the efficient outcome (i.e. the outcome that maximizes industry profits) calls for the retailer to carry both the primary and the recycled good in period 2 ("multi-product retailing"). At the beginning of each period, the manufacturer can make a take-it-or-leave-it offer to the retailer. In the second period, the retailer can reject the manufacturer's offer and sell the recycled good only, where period-2's supply of recycled output depends on how much of the primary good was produced in the first period (I assume that there is no supply of the recycled good in the first period). The retailer's payoff from this outside option determines its share in the second-period multi-product profits. I show that in this setup, contracting will always be efficient: If the retailer can make upfront payments in the first period (i.e. payments that exceed first-period profits), then the retailer's share in the second-period profits will be extracted by the manufacturer in the first period, thus neutralizing any possible distortion due to the retailer's bargaining power in the second period.

This efficiency result is in contrast with most of the early literature on the impact of recycling on monopoly (Swan (1980), Martin (1982)), which found that the monopolist's first-period output is likely to be distorted downward; the rationale for this first-period output contraction is that in the second period, the recycling sector would steal some of the demand for the monopolist's primary good output. Thus, by reducing first-period output, the monopolist can soften competition from the recycling sector in the next period.

Instead, in my setting, there is no immediate competition between the manufacturer and the recycling sector: rather, the retailer's marketing recycled output in the second period is very similar - if not equivalent - to upstream entry by another strategic agent. As was shown by Aghion and Bolton (1987), in a model with sequential contracting, the buyer and the first seller can extract all the surplus from the second seller by agreeing to an exclusive-dealing contract in which the buyer must pay a lump-sum penalty to the first seller if it buys from the second seller. The penalty is set high enough to extract all rent, but not so high as to discourage entry altogether; thus, inefficient exclusion will never arise. This reasoning carries over to our setting: the manufacturer has no incentive to pre-empt the entrant-retailer or distort output choices as long as the manufacturer can fully extract the entrant's rent at an early contracting stage. The major difference to the Aghion and Bolton setting is that, here, the parts of retailer and entrant are played by the same agent; however, the retailer cannot afford to reject the manufacturer's contract in the first period because failing to market the incumbent's primary output in the first period implies that there will be no supply of the recycled good (and hence no rent for the retailer) in the second period.

In the second major section of this paper, I introduce downstream competition into the model. I assume that there are two undifferentiated retailers who first contract with the manufacturer, and then compete for the acquisition of the recycled good, before offering their supplies on the final consumer market. The interaction on the recycled good market is modelled as a split-award auction following Anton and Yao (1989). I argue though that the results do not depend on this particular allocation mechanism; for instance, when retailers compete à la Bertrand rather than in bidding functions (a setup similar to the one studied in Stahl (1988)), the same results can be obtained.

Now, a rather different picture emerges: Through the auction mechanism, some of the rent generated by the vertical structure will be siphoned off by the recycling sector. This rent leakage can only be prevented if the manufacturer can use vertical restraints which allocate primary and recycled output efficiently across retailers. Otherwise, the manufacturer will either overproduce the primary good in the second period, or underproduce in the first period. The contraction of early period output is reminiscent of the early literature on monopoly and recycling discussed above. There, too, the output distortion was a reaction to the threat of rent being competed away in the future. In my setting, however, it is the downstream competition among retailers through which rent leeks out, not upstream competition between the manufacturer and the recycling sector. Consequently, the manufacturer may resort to various vertical restraints to eliminate competition between its retailers. The welfare effects of such vertical restraints are ambiguous: they are efficiency-enhancing whenever recycled output is in short supply (because they promote early-period production in this case), but they will harm consumers when recycled output is abundant, as they lead to contraction of output in later periods. The latter result is particularly interesting in a policy context, because most research on loyalty rebates has so far only found efficiency defenses, but rarely offered a rationale for the skepticism displayed by most antitrust authorities regarding loyalty rebates.

The last major section of this paper studies the effects of upstream entry by another manufacturer of primary output in the second period (the retailer remains a monopolist in both periods). I assume that all players fully anticipate that entry will occur, and that common agency is the efficient market structure in this case. Now, the analogy to the Aghion and Bolton (1987) framework is even stronger. My treatment of the upstream entry case builds on Marx and Shaffer (2004), who generalize the Aghion and Bolton model along several dimensions and study the impact of the contracting environment on the degree of rent extraction. They find that bans on below-cost pricing and on market share contracts lead to imperfect rent extraction, but leave the first seller's (contemporaneous) output decisions unaffected. My paper complements these findings by showing how limits on rent shifting affect the incumbent's pre-entry output decision. It is straightforward that if rent extraction is complete, the incumbent's first-(and second-) period output decision will remain unaffected by future entry. However, if rent extraction is incomplete, and the entrant's share in second-period profits depends on the supply of recycled output (because the latter is in short supply), then the incumbent manufacturer has an incentive to overproduce in the pre-entry period. Therefore, vertical restraints that emove the incentive to overproduce harm consumers in the first period, because they lead to a lower pre-entry output level. However, the effect is short-lived: once the entrant is established in the market, common agency arises at efficient quantities, so that the use of (or ban on) vertical restraints only affects the distribution of these common agency rents among manufacturers, but not the supply to - and hence the welfare of - consumers.

My results contribute to the recent literature on loyalty rebates, which takes a contract theoretic approach and shows how the various types of loyalty rebates can be used to overcome some of the standard problems in vertical relations, like double marginalization (Kolay, Shaffer, and Ordover (2004)), asymmetric information about the state of demand (Majumdar and Shaffer (2007), risk-aversion (Chioveanu and Akgun (2007)), and asymmetric information about product quality (Mills (2004)).

Apart from Marx and Shaffer (2004), there are very few papers which study the use of loyalty rebates in a dynamic setting. Ordover and Shaffer (2006) analyze a two-period model with two sellers and one buyer where the buyer incurs switching costs: purchasing a unit from a seller in period 1 locks-in the buyer to purchasing a unit from the same seller in period 2. In this setting, a dominant firm can profitably exclude an equally efficient, but financially constrained rival, monopolizing the market when the efficient outcome would have the buyer purchase one unit from each seller in each period. This paper is among the very few in this literature to find an anti-competitive effect of loyalty rebates.

To my knowledge, the only other formal model of exclusionary rebates is Karlinger and Motta (2007). There, an incumbent and a more efficient entrant simultaneously make offers to a number of buyers who differ in size. Network externalities among these buyers imply that the entrant can profitably serve the market only if it reaches a certain minimum size. The incumbent can then use rebates to play a "divide-and-conquer" strategy, thereby breaking entry equilibria that would exist under uniform linear prices.

The paper proceeds as follows: Section 2 presents the key elements of our two-period model and studies contracting in the bilateral monopoly structure. In Section 3, I introduce retailer competition and show that contracts will generally be inefficient. Finally, Section 4 discusses contracting when a new manufacturer enters in the second period, and Section 5 concludes.

2 The Benchmark Model of Bilateral Monopoly

2.1 The Model Setup

Consider a monopoly manufacturer, denoted M, and a monopoly retailer, R, who both operate for two periods, $t = 1, 2$. In each period, M produces a certain output level of primary good A, denoted q_a in period 1 and q_A in period 2. M incurs total production cost of $C(q_a)$ and $C(q_A)$, respectively, where $C'(\cdot)$ is well-defined and $C'(\cdot) > 0$. In the first period, M sells output q_a to R, who then resells it to final consumers. After $t = 1$, consumers scrap M's first-period output. Figure 1 illustrates first-period transactions.

The scrap material collected in $t = 1$ can be recycled and offered in $t = 2$ as secondary (or recycled) good B. There is a competitive recycling sector which retrieves M's first-period output and transforms it into good B at marginal cost of zero. To accommodate possible technological constraints in the recycling technology, denote by $\sigma \in (0, 1)$ the share of q_a that can be recovered, so that the quantity of recycled good available in $t = 2$ is $q_B \leq \sigma q_a$. (Note that there is no supply of recycled good in $t = 1$). The retailer can buy this supply of good B from the competitive recycling sector at price $c_B = 0$. For simplicity, let's assume that R does not incur any other retailing costs (apart from the payments R has to make to M and to the recycled good sector).

A consumer in $t = 2$ will either buy one unit of good A or one unit of good B (or neither of them). The primary good is unanimously considered to be of higher quality than the recycled good. Consumers can observe the quality level of the goods before buying, but they differ in their willingness-to-pay (WTP) for quality: If the price difference between goods A and B is sufficiently large, some consumers prefer to buy A, and others prefer to buy B. The following paragraph formalizes this assumption, where $D_A(p_a)$ denotes aggregate (i.e. market) demand for good A in $t = 1$, and market demand for goods A and B

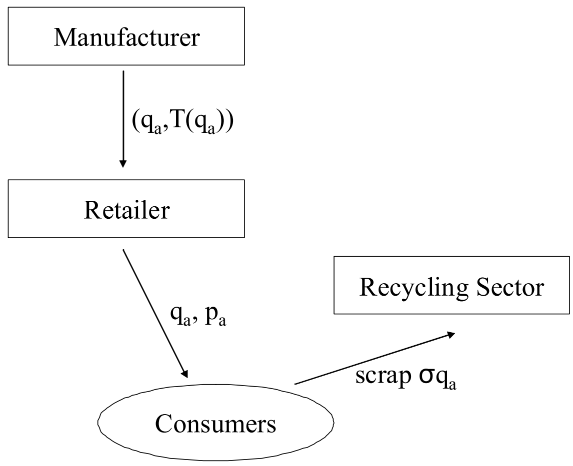

Figure 1: Transactions in Period 1

in $t = 2$ is denoted by $D_A(p_A, p_B)$ and $D_B(p_A, p_B)$; p_a is good A's retail price in period 1 (p_A in period 2), and p_B is B's retail price in $t = 2$. All consumers face the same flat prices, i.e. we rule out price discrimination by R.

Assumption 1: *(i) Consumption decisions in $t = 1$ are completely independent from consumption decisions in $t = 2$. Thus, $D_A(p_a)$ is not a function of (p_A, p_B).*

(ii) There is a range of prices $P \in R^2_+$ at which demand for both goods in $t = 2$ is strictly positive: $D_A(p_A, p_B) > 0$ and $D_B(p_A, p_B) > 0$ for all *$(p_A, p_B) \in P$.*

Assumption 1 (i) can be interpreted in several ways: one can think of consumers as having a discount factor of zero (future utility enters present purchasing decisions with a weight of zero), or that there are two consumer cohorts that do not overlap, each cohort maximizing contemporaneous utility. This assumption eliminates intertemporal considerations at the consumer choice level, in particular the formation of expectations regarding future goods prices, strategic deferral of consumption to later periods, or hoarding in early periods. Thus, we can focus on the impact of the recycling sector on the behavior of the vertical structure without strategic interference from the consumer side.

Assumption 1 (ii) implies that in $t = 2$, the retailer can choose between (1) selling good A only, or (2) selling good B only, or (3) selling both goods (we will refer to this case as the *multi-product retailing* solution). Define industry profits in period 1 as retail revenue generated by good A minus the cost of producing good A:

$$\Pi(q_a) \equiv p_a q_a - C(q_a) \tag{1}$$

while industry profits in period 2 are defined as total revenue generated by goods A and B minus the production cost of A minus the cost of acquiring good B from the recycling sector (the bid price for q_B, denoted $B(q_B)$):

$$\Pi(q_A, q_B) \equiv p_A q_A + p_B q_B - C(q_A) - B(q_B) \tag{2}$$

For the case where $B(q_B) = C(q_B) = c_B q_B = 0$, we denote the quantity pair that maximizes industry profits under multi-product retailing by (q_A^*, q_B^*), where

$$(q_A^*, q_B^*) \in \arg\max_{q_A, q_B} \Pi(q_A, q_B) \text{ s.t. } q_B \leq \sigma q_a \tag{3}$$

and the maximum profit that can be obtained under multi-product retailing is

$$\Pi(q_A^*, q_B^*) = \max_{q_A, q_B} \Pi(q_A, q_B) \text{ s.t. } q_B \leq \sigma q_a$$

Analogously, define the maximum profit if either good A or good B is sold as:

$$\Pi_i \equiv \max_{q_i} \Pi(q_i, 0) \text{ for } i \in \{a, A\} \tag{4}$$

$$\Pi_B \equiv \max_{q_B} \Pi(0, q_B) \text{ s.t. } q_B \leq \sigma q_a \tag{5}$$

In period 1, the output level which maximizes the present discounted value of industry profits over both periods is defined as:

$$q_a^e \in \arg\max_{q_a} \{\Pi(q_a, 0) + \delta \Pi(q_A^*(q_a), q_B^*(q_a))\} \tag{6}$$

where $\delta \in (0, 1)$ denotes the firms' common discount factor on period-2 profits. Note that the available scrap from $t = 1$ imposes an upper bound on the quantity of good B that can be sold in $t = 2$, so that the output choice in period 1 turns into an intertemporal optimization problem. We will assume that multi-product retailing is more profitable than selling only one of the two goods.

Assumption 2: $\Pi_A < \Pi(q_A^*, q_B^*)$ *and* $\Pi_B < \Pi(q_A^*, q_B^*)$

Offering both goods allows R to indirectly discriminate among consumers: the high-WTP consumers will prefer to pay a high price to obtain the primary (high-quality) good, while low-WTP consumers prefer to pay a low price to buy the recycled (low-quality) good. Now, offering the low-quality good along with the high-quality good allows R to serve some (low WTP) consumers who would not have bought the good otherwise, at the cost of cannibalizing some demand for the high-quality good (medium-WTP consumers who would buy good A if there is no alternative, but who switch to B if they have the choice). Thus, Assumption 2 states that the first effect dominates the second one, so that offering good B along with good A increases profits.[1]

Figure 2 illustrates transactions in Period 2.

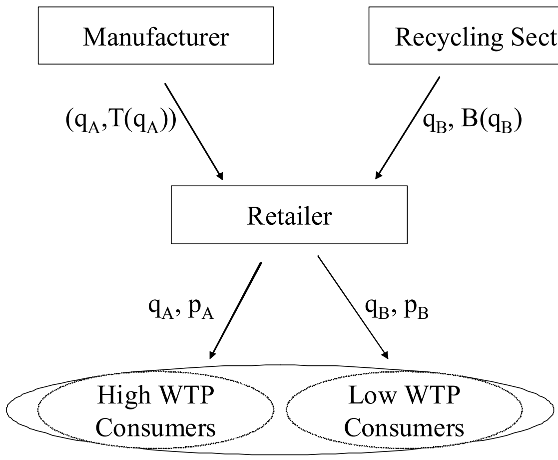

Figure 2: Transactions in Period 2

2.2 Equilibrium Contracts

M can make a take-it-or-leave-it offer to R at the beginning of each period. Let a contract signed in period t specify (i) the quantity of good A to be traded in this period (i.e. either q_a or q_A), and (ii) the payment to be made to M in period t, $T(q_a)$ or $T(q_A)$. Denote such a contract by $\{q_i, T(q_i)\}$, where $i \in \{a, A\}$. Note that we do not allow contracts signed in $t = 1$ to include provisions regarding period-2 quantities of either good A or B, or regarding payments to be made in

[1] To be more precise, this discriminatory strategy can only be profitable if offering a second good raises revenue *and* this increase in revenue is not outweighed by the extra cost of providing the second good. Therefore, Assumption 2 imposes constraints not only on the demand structure, but also on the cost structure of the two goods.

period 2. I will argue that, under a bilateral monopoly structure, such contracts can in general implement the efficient outcome.[2]

Proposition 1: *(bilateral monopoly) If R can make upfront payments in $t = 1$, then contracting is efficient: M will produce the joint-profit maximizing output levels in both periods.*

Proof: see Appendix

Discussion of Proposition 1 The efficiency result of Proposition 1 is in contrast with most of the early literature on the impact of recycling on monopoly (Swan (1980), Martin (1982)), which found that the monopolist's first-period output is likely to be distorted downward; the rationale for this first-period output contraction is that in the second period, the recycling sector would steal some of the demand for the monopolist's primary good output. Thus, by reducing first-period output, the monopolist can soften competition from the recycling sector in the next period.

Instead, in my setting, there is no immediate competition between the manufacturer and the recycling sector: rather, the retailer's marketing recycled output in the second period is very similar - if not equivalent - to upstream entry by another strategic agent. As was shown by Aghion and Bolton (1987), in a model with complete information in which the buyer purchases at most one unit from one of the two sellers and there is sequential contracting, the buyer and the first seller can extract all the surplus from the second seller by agreeing to an exclusive-dealing contract in which the buyer must pay a lump-sum penalty to the first seller if it buys from the second seller. Full rent extraction implies that inefficient exclusion will never arise.

This reasoning carries over to our setting: the manufacturer has no incentive to pre-empt the entrant-retailer or distort output choices as long as the manufacturer can fully extract the entrant's rent at an early contracting stage. The major difference to the Aghion and Bolton setting is that, here, the parts of retailer and entrant are played by the same agent; however, the retailer cannot afford to reject the manufacturer's contract in the first period because failing to market the incumbent's primary output in the first period implies that there will be no supply of the recycled good (and hence no rent for the retailer) in the second period. Of course, the more M produces of good A in period 1, the better is R's outside option in period 2, and this in turn implies that the share M can claim in the period-2 profits decreases. However, if the retailer can make upfront payments (and the result crucially hinges on this assumption), then such upfront payments allow M to appropriate the retailer's second-period payoff already in the first period, thus neutralizing any distortive effect that the latter could have on period 1's output choice.

[2] Note that I will use the term "efficient" in the sense of "maximizing joint profits" (not in the sense of maximizing social welfare).

3 Retailer Competition

The structure of bilateral monopoly is very special, if not artificial, and we may wonder if and to what extent the efficiency result obtained for this benchmark case carries over to other market structures featuring competition either upstream or downstream. In this Section, we will study the impact of retailer competition. Our setup as introduced in Section 2.1 readily accommodates this case. The extended model is presented in the following.

3.1 New Setup

Let there be two undifferentiated retailers, R_1 and R_2. In $t = 1$, each retailer receives a take-it-or-leave-it offer from the manufacturer to buy output levels q_{a1} and q_{a2}, respectively. (In the following, subscript 1 (2) refers to retailer 1 (2)). Offers are public and simultaneous. In $t = 2$, the manufacturer will again offer contracts, this time for second-period output levels q_{A1} and q_{A2}, respectively.

After observing the outcome of this contracting stage in $t = 2$, the two retailers turn to the recycling sector to acquire the recycled good B. The question arises how to model the competitive interaction between the two retailers on this recycled good market. In the case of the monopoly retailer, it seemed natural that with all buyer power concentrated in a single buyer, the latter would be able to obtain marginal cost prices. With two retailers competing for the recycled good, and this good being in fixed supply (recall that $q_B \leq \sigma q_a$), prices will necessarily rise above marginal cost.

I assume that the recycled good is allocated through a split-award auction as studied in Anton and Yao (1989). In the split-award auction, each retailer can acquire a share from 0 to 1 of the total supply of σq_a, where Retailer 1 buys $\alpha \sigma q_a$, and Retailer 2 buys the remaining $(1 - \alpha) \sigma q_a$. Each retailer bids a price for every possible value of $\alpha \in [0, 1]$, so that competition between the two retailers is in bid functions (not in prices). Denote Retailer 1's bid function by $B_1(\alpha)$, and Retailer 2's bid function by $B_2(\alpha)$. The auctioneer then chooses the share $\alpha^* \in [0, 1]$ that maximizes the revenue of the suppliers of the recycled good, i.e.

$$\alpha^* \in \arg\max \alpha \{B_1(\alpha) + B_2(\alpha)\} \tag{7}$$

When there are ties and the award choice from (7) is not unique, the appropriate tie-breaking rule is to select from among the splits in the set $\arg\max \alpha \{B_1(\alpha) + B_2(\alpha)\}$ the α with the highest joint payoffs for both retailers, $\Pi_{R1} + \Pi_{R2}$, where

$$\Pi_{Ri} \equiv \max_{q_{Ai}, q_{Bi}} \{p_A q_{Ai} + p_B q_{Bi} | q_{Aj}, q_{Bj}\}$$

is the maximum revenue that Retailer i generates on the final consumer market (given own stocks and the rival's supplies). As discussed in Milgrom (1986), this procedure mimics the outcome that occurs when bid prices are discrete instead of continuous because a higher-payoff retailer will avoid a tie by increasing its bid by a small amount. If there is a tie in joint payoffs as well, choose the highest among all α^* with maximal joint payoffs, i.e. allocate as much as possible to Retailer 1 (this is wlog).

Once the supply of the recycled good is allocated among the two retailers, the latter decide how much to place on the final consumer market, each retailer being constrained by its own supply of the primary good, q_{A1} and q_{A2}, and of the recycled good, $\alpha^* \sigma q_a$ and $(1-\alpha^*)\,\sigma q_a$. Note that we study the case where the strategic variable is quantity; results are qualitatively the same if we let retailers compete in prices given their stocks, rather than in quantities. In this case, equilibria downstream would be analogous to the ones identified in the price competition stage of Kreps and Scheinkman (1983). Apart from the complication that equilibria may only exist in mixed strategies, the main insights developed below carry over to Bertrand competition.

Figure 3 illustrates the second stage of the retailer competition game.

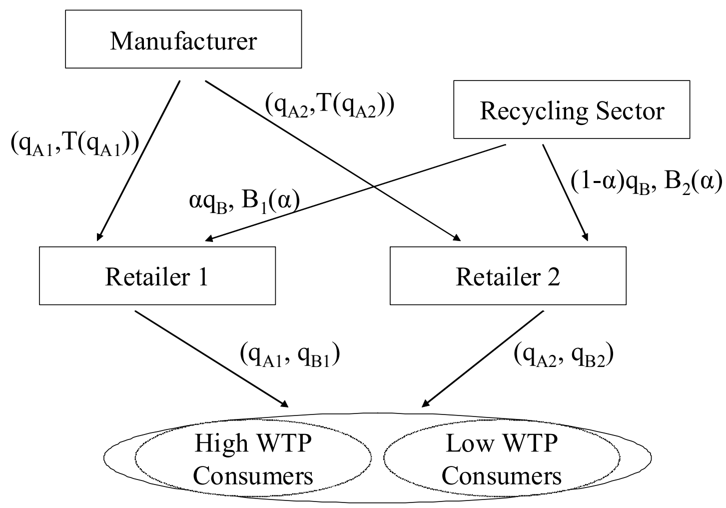

Figure 3: Period 2 of the retailer competition game

Note that there is a subtle but important change in the sequence of moves: In the previous section, the retailer first decided on how much to sell on the final market, and then acquired the necessary volumes of good A and B accordingly; the manufacturer and the recycling sector produced to order. Now, the retailers choose their stocks independently from - and prior to - their decision on sales levels. Stocks no longer coincide with sales, but only impose an upper bound on the latter. This has important implications for the retailers' objective function at the last stage of the game: Since payments to the suppliers are sunk, retailers simply maximize revenue subject to the constraints implied by their stocks.

3.2 Equilibrium Contracts under Retailer Competition

To characterize the equilibrium outcome of the game defined above, let us first identify the equilibria in the split-award auction, and then analyze the implications of this allocation for the contracts between manufacturer and retailers.

Lemma 2: *(split-award auction) If the following two conditions are satisfied:*

(i) q_A is small enough so that the residual demand for good B is positive even if all of good A is placed on the market; and

(ii) wlog $q_{A1} \geq q_{A2}$, i.e. Retailer 1 holds more of good A than Retailer 2.

Then, the unique equilibrium allocation of the split award auction has Retailer 1 acquire the entire supply of good B, i.e. $\alpha^* = 1$. Retailer 1's equilibrium bid for this allocation is equal to Retailer 2's bid for the monopoly over good B, i.e. $B_1^*(1) = B_2^*(0)$, and Retailer 2 will bid

$$B_2^*(0) = \Pi_{R2}(q_{A1}, q_{A2}, 0, q_{B2}) - \Pi_{R2}(q_{A1}, q_{A2}, q_{B1}, 0)$$

Proof: see Appendix

Discussion of Lemma 2 Figure 4 shows how all possible outcomes of the split award auction map into equilibrium supplies on the final consumer market. The dotted lines denote the retailers' Cournot best response functions. The two retailers are asymmetric in their stocks of good A, which determines the locus of their reaction functions in the supply of good B: Retailer 1 holds more of good A, which implies that R_1's reaction function for good B is closer to the origin than Retailer 2's. The grey hatched represents the set of all possible levels of downstream supply of good B for any given level of σq_a. Interior solutions will arise if both retailers are quantity constrained, i.e. if the upstream supply of good B, σq_a, is not sufficient to play an allocation on the borders of the hatched area, i.e. a point on (one or both of the) reaction functions.

Consider instead a level of σq_a that is everywhere outside the grey hatched area. The thin black line denoted "upstream supply of B" shows one such level. Each point on this line represents a possible allocation of this output across the two retailers. The point where this line intersects the x-axis represents the allocation where Retailer 1 wins the entire supply, i.e. when $\alpha = 1$. This allocation maps into a downstream supply of good B identified by the point where R_1's reaction function intersects the x-axis, i.e. $q_B(\alpha = 1)$. At this point, aggregate downstream supply of good B reaches its minimum. As we move up along the upstream supply line, i.e. as we reallocate supplies away from R_1 and towards R_2, downstream equilibrium allocations move up along R_1's reaction function, and aggregate supply expands. One such case is represented by the horizontal arrow connecting the upstream supply line and R_1's reaction function. At the upstream allocation identified as point B, the downstream game reaches the unconstrained Cournot equilibrium, point C. Any allocation on the segment $A - B$ will map into the same downstream equilibrium C. As we increase R_2's stocks even beyond point A, R_1 will now be quantity constrained, and the downstream equilibrium will lie on the corresponding point of R_2's reaction function. One such case is represented by the vertical arrow connecting the upstream supply line and R_2's reaction function.

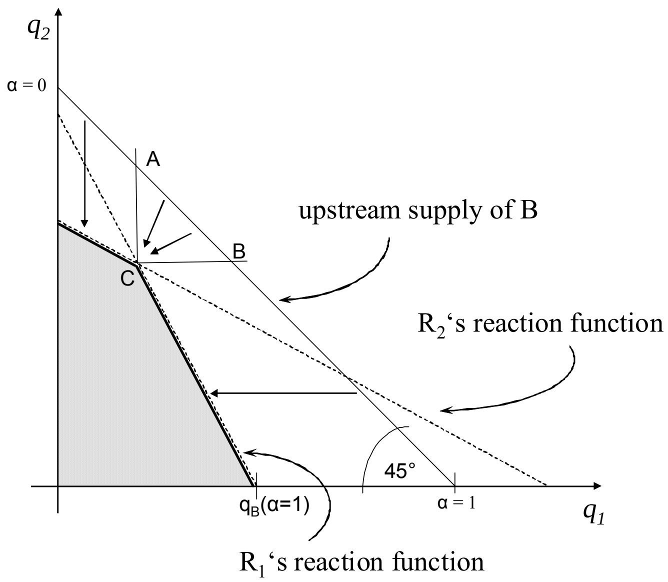

Figure 4: How upstream allocations of good B translate into downstream equilibrium supply

Figure 5 shows how all possible upstream allocations translate into downstream equilibrium payoffs, which in turn determine upstream bids. Each point on the x-axis represents a particular value of α, i.e. a particular split of the upstream supply of good B among retailers, while the solid black line shows the corresponding aggregate payoffs (i.e. the sum of both retailers' downstream revenues), holding the supply and allocation of good A constant.

When $\alpha = 0$, Retailer 2 acquires the entire supply of good B and makes profits $\Pi_2(\alpha = 0) = \Pi_{R2}(q_{A1}, q_{A2}, 0, q_{B2})$, while Retailer 1 makes $\Pi_1(\alpha = 0) = \Pi_{R1}(q_{A1}, q_{A2}, 0, q_{B2})$. As α increases, downstream supply of good B will increase, and so aggregate payoffs will fall. Recall that for values of α corresponding to allocations on the segment $A - B$ in Figure 4, the downstream equilibrium is the unconstrained Cournot equilibrium, and so aggregate payoffs are constant and minimal in this range. As we move beyond point B, aggregate

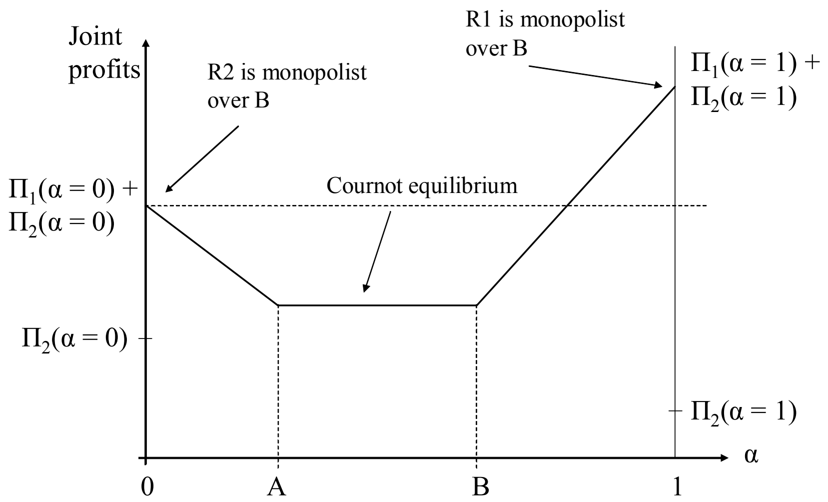

Figure 5: Industry profits as a function of the upstream split α

payoffs rise again because Retailer 2 is now capacity constrained, and they reach their maximum at $\alpha = 1$, when all supplies of good B are held by the retailer who also holds more of good A, i.e. Retailer 1. Figure 5 illustrates the case where the inequality in expression (10) is strict, so that Retailer 1 can always outbid Retailer 2 in the auction. We see that there the only possible equilibrium is $\alpha = 1$: If bids on any other allocation $\tilde{\alpha} \neq 1$ yielded higher revenue for the auctioneer, $B_1(\tilde{\alpha}) + B_2(\tilde{\alpha}) > B_1(1) + B_2(1)$, then Retailer 1 could always profitably deviate by reducing the own bid on allocation $\tilde{\alpha}$ and/or increasing $B_1(1)$ sufficiently to induce allocation $\alpha = 1$ while increasing own payoffs.

Let us now study the implications of the split award auction for contracts within the vertical chain.

Proposition 3: *(retailer competition) If there are two competing retailers, then contracting is inefficient: (i) Either M overproduces in period 2, (ii) or M underproduces in period 1.*

Proof: see Appendix

Discussion of Proposition 3 It emerges clearly from Lemma 2 that the best way for M to allocate q_A across retailers in the second period is to concentrate the entire stock on one retailer, in our case Retailer 1. This maximizes profits for two reasons: (i) Since Retailer 1 will also win the split award auction and hence be the monopoly seller of the recycled good, concentrating all of q_A on the same retailer ensures that the latter takes into account the *full* externalities of good B on good A when deciding on how much to sell of good B; (ii) If the losing retailer, here Retailer 2, does not hold any of good A, its profitability of marketing good B is minimized (again because of the externality argument), and so Retailer 2's bid in the split award auction is reduced for any level of α. This implies that the price at which the winning retailer can acquire the recycled output is minimized. Now, Retailer 2's bid price will either be a (decreasing) function of q_A (because q_A determines how much residual demand is left for good B), in which case M will have an incentive to overproduce in period 2, or Retailer 2's bid price is an (increasing) function of σq_a (because the resource constraint is binding), in which case M will want to underproduce in period 1.

If we compare the result of Proposition 3 to the benchmark case of bilateral monopoly, we see that retailer competition gives rise to inefficient output choices. Through the auction mechanism that allocates the recycled output among retailers, some of the rent generated by the vertical structure will be siphoned off by the recycling sector. To reduce this rent loss, the manufacturer may therefore either overproduce the primary good in the second period, or underproduce in the first period. The contraction of early period output is reminiscent of the early literature on monopoly and recycling discussed in the previous section. In those studies, too, the output distortion was a reaction to the threat of rent being competed away in the future. In my setting, however, it is the downstream competition among retailers through which rent leaks out, not upstream competition between the manufacturer and the recycling sector.

Interestingly, it may also be the case that early output is completely unaffected by retailer competition. Instead, the prospect of having part of the rent extracted by the recycling sector will lead the manufacturer to overproduce in the second period: the more primary output is available in the second period, the lower the residual demand for good B. This in turn lowers the price that the losing retailer is willing to pay, and hence the price at which the winning retailer can acquire the stock of recycled output. This effect can only arise if we allow the manufacturer to set second-period output levels and contract with retailers *before* the latter meet in the split award auction. Having the first-mover advantage, our manufacturer can commit to a high primary output level in the second period, thereby favorably manipulating the outcome of the recycled good auction.

It is also worth noting that the results of Lemma 2 and Proposition 3 do not depend on the particular auction format analyzed there. Analogous results can be obtained in a more common setting where retailers compete in flat prices rather than in bid functions. Similarly to the case of the split award auction, the existence of a Nash equilibrium when retailers compete for supplies in flat prices crucially depends on a careful definition of tie-breaking rules. This point was first highlighted by Stahl (1988). Stahl considers a two-stage model where two retailers (or merchants) first compete à la Bertrand for the acquisition of stocks. Then, provided they both hold positive stocks, they play a capacity-constrained Bertrand game on the final consumer market. If the merchants' bid prices upstream are such that $p_i > p_j$, then merchant i acquires the entire supply at price p_i, $S(p_i)$, and is the monopolist on the final consumer market, where it sells up to $S(p_i)$ (or the monopoly quantity, if its stocks exceed the monopoly quantity). If instead there is a tie in bid prices upstream, $p_i = p_j$, then each merchant acquires half of the entire supply $S(p_i)$, and faces competition from the other merchant on the final consumer market. The equilibrium on the final consumer market will then be of the type analyzed by Kreps and Scheinkman (1983).

Stahl (1988) shows that if the revenue-maximizing price on the final consumer market is above the Walrasian price, then this two-stage game does not have a Nash equilibrium (neither in pure nor in mixed strategies): The two merchants will bid up the price on the supply market to the level where the monopoly merchant could just break even downstream. But since both merchants will bid this same price, both will obtain positive stocks. This implies that their expected payoffs from sales downstream will fall short of monopoly profits, as some rent will be competed away. In other words, merchants are bound to make losses, and this cannot be an equilibrium. As shown in Stahl (1988), one way out of the non-existence problem is to adjust the tie-breaking rule so that in case of a tie, the entire stock is randomly assigned to one of the two merchants, rather than allocating half of it to each merchant.

In the richer setting of a split award auction chosen here, bid prices are contingent on the quantity that the retailer wants to acquire at this price. In particular, the offer to pay the monopoly price is only valid if the auctioneer assigns the *entire* stock of the recycled good to this bidder. Thus, in our setup it can never happen that a retailer pays a price upstream that can only be covered by monopoly rents downstream, only to discover that it will instead face a Bertrand competitor downstream.

Vertical Restraints and Welfare Effects We can now identify the welfare effects of vertical restraints that allow the manufacturer to implement the joint profit maximizing outputs in both periods. For instance, the manufacturer could require Retailer 1 to sell output levels $(\gamma q_A^*, q_B^*)$, while Retailer 2 is induced to sell $((1-\gamma) q_A^*, 0)$, where $\gamma \in [0,1]$. Since Retailer 2 is not allowed to sell any of the recycled good, it will not participate in the split award auction, so that Retailer 1 can buy the recycled output at the competitive price $c_B = 0$. Thus, the manufacturer ensures that the profit-maximizing outputs are sold to final consumers, and that none of the rent generated by the vertical structure leaks out to the recycling sector. It is quite intuitive that consumers will benefit from such vertical restraints as long as the available output increases as a result, while consumers are harmed if output contracts. The following corollary argues that if recycled output is abundant, vertical restraints are likely to harm consumers because they remove the manufacturer's incentive to overproduce in the second period. Therefore, Corollary 4 identifies possible anti-competitive effects of vertical restraints (e.g. fidelity rebates), in contrast to most of the recent literature on fidelity rebates, which generally produces efficiency results and do not provide a rationale for policy intervention.

Corollary 4: *Suppose the manufacturer imposes quantity targets which restore joint profit maximization. Then, such vertical restraints will*

(i) harm consumers and reduce welfare if there is abundant supply of the recycled output;

(ii) benefit consumers and enhance welfare if the recycled output is in short supply.

Proof: see Appendix

4 Upstream Entry

In this section, we will revisit the question of upstream entry that we alluded to in our discussion of the exclusionary allegations against Michelin (see Introduction). We consider a situation where the manufacturer anticipates entry of a differentiated rival manufacturer, and we ask how the manufacturer's vertical relations with a monopoly retailer will be affected by the prospect of upstream entry in the future.

4.1 New Setup

Again, firms operate for two periods. In the first period, the incumbent manufacturer, denoted M_1, offers a contract to the monopoly retailer R regarding first-period output q_a. In period 2, a second manufacturer, denoted M_2, enters the industry. The two manufacturers are differentiated, and Π^{CA} denotes industry profits under common agency, while Π_i^{ED} denotes the joint payoff of the $M_i - R$ pair when excluding M_j. We make the following assumption:

Assumption 3: *Common agency yields higher industry profits than exclusion of either of the two manufacturers:* $\Pi^{CA} > \Pi_i^{ED}$ *for* $i = 1, 2$

After M_2 entered, each manufacturer offers a contract to R regarding second-period output levels q_{A1} and q_{A2} (where subscripts 1,2 now refer to Manufacturer 1 and 2, respectively). Contracting in the second period is sequential: First the incumbent moves, the retailer accepts or rejects, then the entrant proposes a contract, and again the retailer has to decide whether to accept or not. Then, the retailer buys recycled output q_B from the recycling sector, and chooses the output levels q_{A1} and q_{A2} and to sell along with q_B on the final consumers, given the retailer's contracts with the manufacturers. This sequence of moves is chosen on purpose to allow for rent extraction by the incumbent, thus ruling out inefficient exclusion where it can be prevented if appropriate contracts can be written.

Figure 6 illustrates the second stage of the common agency game.

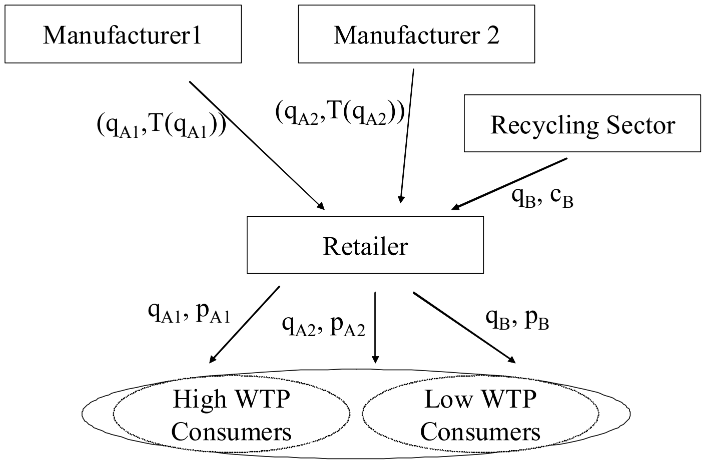

Figure 6: Transactions after upstream entry occurred

4.2 Equilibrium Contracts under Vertical Entry

Consider the market structure that will arise in period 2. We know from Bernheim and Whinston (1985) that two-part tariffs are sufficient to achieve common agency. Moreover, with sequential contracting, there is scope for rent extraction by the incumbent, which - if successful - will prevent inefficient exclusion. Aghion and Bolton (1987) showed that under complete information, the buyer and the first seller can extract all the surplus from the second seller by agreeing to an exclusive-dealing contract in which the buyer must pay a lump-sum penalty to the first seller if it buys from the second seller. Full rent extraction implies that inefficient exclusion will never arise. Now, this result was obtained for a very special environment: the buyer purchases at most one unit from one of the two sellers, the sellers have all the bargaining power, and the first seller can perfectly predict the entrant's efficiency. Relaxing the assumption of complete information with respect to the entrant's production cost generates cases where inefficient exclusion may arise as a result of rent-shifting contracts between the buyer and the first seller.

Subsequent research generalized the Aghion and Bolton (1987) model to general demand functions (instead of unit demands) and general distributions of bargaining power, and highlighted the importance of the contracting environment for the rent-shifting mechanism. In particular, Marx and Shaffer (2004) study the impact of various constraints on the structure of supply contracts (no below-cost prices, no market share contracts) on the degree of rent extraction under complete information. They find that both bans on below-cost pricing and on market share contracts can lead to imperfect rent extraction, but will leave the first seller's contemporaneous output decisions unaffected (corresponding to second-period outputs in my setting). Now, my findings complement their results in showing how incomplete rent extraction affects pre-entry output decisions, i.e. the supply of recycled material in the post-entry period.

Proposition 5: *(upstream entry) Suppose that a second manufacturer enters in period 2 and a common agency equilibrium arises.*

(i) If rent extraction in period 2 is complete, or the supply of the recycled good is so abundant that it does not affect the entrant's minmax payoff, then contracting is efficient in both periods.

(ii) If rent extraction in period 2 is incomplete and the recycled good is in short supply, then the incumbent has an incentive to overproduce in the pre-entry period.

Proof: see Appendix

Discussion of Proposition 5 Applying this result to the Michelin case discussed in the Introduction, our analysis suggests that the purpose of Michelin's vertical restraints was not to exclude other tire manufacturers, but rather to appropriate as much as possible of their rents. The question then is what the likely effects of such rent extraction clauses are on consumers and total welfare. Proposition 5 suggests that such clauses lead to a reduction in pre-entry output. The reason is that absent vertical restraints, an abundant supply of the recycled good becomes a powerful instrument in extracting additional rents from the entrant. But if the incumbent can use market share contracts, pre-entry output loses its strategic role, and so the incumbent will reduce it to its "non-strategic" level. Since pre-entry output distortions only go in one direction, namely overproduction, even partially successful vertical restraints will reduce pre-entry output and therefore unambiguously harm consumers in this period. However, the effect is only short-lived: in the post-entry period, the "strategic" supply of the recycled good only matters along the off-equilibrium path. In equilibrium, common agency arises at efficient quantities, so that the use of (or ban on) vertical restraints only affects the distribution of these common agency rents among manufacturers, but not the supply to - and hence the welfare of - consumers.

5 Conclusion

The purpose of this paper was to study the vertical relations in an industry where a monopoly manufacturer of a recyclable good has to decide how much to produce of its primary good in each period, and how much to charge its retailer(s) for it. The presence of a competitive recycling sector affects contractual relations in two ways: on the one hand, it allows the vertical structure to increase its profits through quality discrimination on the consumer market. On the other hand, it may lead to output distortions if the monopolist cannot appropriate the full rent generated by its output in both periods.

Whether or not an inefficiency arises depends on the industry structure: In the benchmark case of bilateral monopoly, contracting will always be efficient: If the retailer can make upfront payments in the first period, then the retailer's share in the second-period profits will be appropriated by the manufacturer in the first period, thus neutralizing any possible distortion due to the retailer's bargaining power in the second period. The intermediation of a monopoly retailer ensures that the manufacturer does not compete neck-and-neck with the competitive recycling sector; therefore, all profits will be absorbed by the $M-R$ chain, and the efficient quantities of both goods are sold.

When there are two undifferentiated retailers who first contract with the manufacturer, and then compete for the acquisition of the recycled good, the outcome changes significantly: Since retailers now compete for the supplies of the recycled good, they will bid up the price of this good, so that some of the rent generated by the vertical structure will be siphoned off by the recycling sector. To reduce this rent loss, the manufacturer may therefore either overproduce the primary good in the second period, or underproduce in the first period. Vertical restraints which restore the joint profit maximizing outcome have ambiguous welfare effects: they are efficiency-enhancing to the extent that they promote early-period production, but they will harm consumers when they lead to contraction of output in later periods.

Finally, the paper addresses upstream entry in the second period, assuming that common agency is the efficient market structure in this case. Now, if the incumbent-retailer pair can extract all the rent generated in the post-entry period, the incumbent's first-period output decision will remain unaffected by future entry. However, if the entrant receives a positive share in second-period profits, and this share depends on the supply of recycled output (because the latter is in short supply), then the incumbent manufacturer has an incentive to produce more than the industry-profit maximizing level in the pre-entry period. Therefore, vertical restraints harm consumers in the first period, to the extent that they remove the incentive to overproduce, and therefore lead to a lower pre-entry output level. However, the effect is short-lived: once the entrant is established in the market, common agency arises at efficient quantities, so that the use of (or ban on) vertical restraints only affects the distribution of these common agency rents among manufacturers, but not the supply to - and hence the welfare of - consumers.

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6 Appendix

Proof of Proposition 1 The proof is constructive and fully characterizes the optimal contracts.

Contracting in Period 2

Let us first consider the retailer's problem in period 2. (i) Multi-product retailing: Suppose the retailer accepted M's offer to buy good A under tariff $T(q_A)$. Then, being the monopoly buyer of the recycled good, the retailer can acquire up to the entire supply of good B at marginal cost, i.e. $B(q_B) = c_B q_B = 0$. Therefore, the retailer's problem is to maximize its payoff $\Pi_R(q_A, q_B)$ by choosing how much to sell of goods A and B:

$$\begin{array}{l} \max_{q_A, q_B} \Pi_R(q_A, q_B) = p_A q_A + p_B q_B - T(q_A) - c_B q_B \\ \text{s.t. } q_B \leq \sigma q_a \end{array} \tag{8}$$

The manufacturer can always induce the retailer to choose the quantity levels that maximize industry profits, (q_A^*, q_B^*), offering the appropriate tariff $T(q_A)$, for instance a two-part tariff $T(q_A) = wq_A + F$, where $w = C'(q_A^*)$, and F determines how these profits are distributed within the vertical chain.

(ii) Outside option: If instead R rejects M's offer, R's outside option is to sell good B only. Thus, R's disagreement payoff is Π_B as defined in expression (5); this is the minimum payoff that M must offer for R to accept M's contract. Note that R's payoff Π_B may or may not depend on M's first-period output level q_a: If the resource constraint $q_B \leq \sigma q_a$ is not binding in the off-equilibrium scenario where only good B is traded, i.e. if $\arg\max_{q_B} \Pi(0, q_B) < \sigma q_a$, then Π_B will be a function of demand and cost parameters. If instead the constraint is binding, then Π_B is a function of q_a. Of course the level of q_a is predetermined in period 2 (and can no longer be changed by either of the two parties). But whenever q_a also determines the retailer's disagreement payoff, period-2 contracting outcomes will be linked to period-1 output decisions.

(iii) Equilibrium contracts: Turning back to the multi-product retailing scenario, with total industry profits being $\Pi(q_A^*, q_B^*)$ as defined in expression (3), it follows that M can appropriate at most $\Pi(q_A^*, q_B^*) - \Pi_B(q_a)$ out of these profits. For completeness, we have to allow for the resource constraint to be binding also under multi-product retailing.[3] If this is the case, then we have a corner solution in the second period, and so the optimal levels of q_A^* and q_B^* will both be functions of q_a. Otherwise, q_A^* and q_B^* only depend on the demand and cost parameters in period 2.

Trade will occur under the following terms:

$$\left\{ \begin{array}{c} q_A = q_A^*(q_a) \\ T(q_A^*, q_a) = \Pi(q_A^*(q_a), q_B^*(q_a)) + C(q_A^*(q_a)) - \Pi_B(q_a) \end{array} \right\} \tag{9}$$

[3] Note that we have $q_B^* < \arg\max_{q_B} \Pi(0, q_B)$, i.e. the retailer will want to expand its supply of good B whenever R does not sell any of good A; thus, if the resource constraint is binding in the multi-product retailing scenario, it is also binding under the outside option, but the reverse need not hold.

R will sell q_A^* units of good A and q_B^* units of good B, and generate total profits of $\Pi\left(q_A^*\left(q_a\right), q_B^*\left(q_a\right)\right)$. Note that M's choice of period-2 output is not affected by the payment of $\Pi_B\left(q_a\right)$ to R, because the latter only depends on last period's output q_a. Thus, M has no incentive to distrot period-2 output levels away from the joint industry profit maximizing ones.

Contracting in Period 1

Without any recycled good available, R's only outside option in $t = 1$ is not to sell anything at all. However, rejecting M's contract in $t = 1$ also implies reducing the disagreement payoff in $t = 2$ to zero: If none of the primary good is produced and sold today, there is no supply of the recycled good tomorrow, and so the retailer has no fall-back option tomorrow. Given the optimal first-period output level, q_a^* (to be determined below), M can therefore extract from R the full first-period revenue plus the discounted disagreement payoff in period 2:

$$\left\{ \begin{array}{c} q_a = q_a^* \\ T\left(q_a^*\right) = \Pi\left(q_a^*, 0\right) + C\left(q_a^*\right) + \delta \Pi_B\left(q_a^*\right) \end{array} \right\}$$

This rent extraction mechanism will only work if the retailer has access to external funds, because $T\left(q_a^*\right)$ exceeds the retailer's period-1 revenue: The difference between the two is the retailer's upfront payment $\delta \Pi_B\left(q_a^*\right)$, which the retailer can recoup in the second period.

Now, what is the optimal first-period output level for M? M seeks to maximize the present discounted value of its payoffs over both periods, so that M's profit maximization problem reads

$$\max_{q_a} \left\{T\left(q_a\right) - C\left(q_a\right) + \delta\left[T\left(q_A^*, q_a\right) - C\left(q_A^*\right)\right]\right\}$$

Note that the term $\delta \Pi_B\left(q_a\right)$ in $T\left(q_a\right)$ cancels with the term $-\Pi_B\left(q_a\right)$ in the discounted second-period payment $T\left(q_A^*, q_a\right)$, so that M's problem reduces to

$$\max_{q_a} \left\{\Pi\left(q_a, 0\right) + \delta \Pi\left(q_A^*\left(q_a\right), q_B^*\left(q_a\right)\right)\right\}$$

But this expression is identical to the joint profit maximization problem solved by

$$q_a^e \in \arg\max_{q_a} \left\{\Pi\left(q_a, 0\right) + \delta \Pi\left(q_A^*\left(q_a\right), q_B^*\left(q_a\right)\right)\right\}$$

as defined in expression (6) and will therefore yield the same, i.e. the efficient, output level, q_a^e.

Thus, we showed that both in period 1 and in period 2 the manufacturer will produce the joint profit maximizing output level of the primary good, so that contracting in the bilateral monopoly is shown to be efficient.□

Proof of Lemma 2 At the last stage of the game, retailers have to decide how much to sell of both goods to consumers, given their stocks. Since good A is of superior quality and hence commands a higher price than good B, a revenue-maximizing retailer will always sell all its stocks of A before starting to offer good B. If condition (i) of Lemma 2 is satisfied, there is still positive demand for good B even if all of q_A is placed on the market. When choosing their supplies q_{B1} and q_{B2}, retailers play a capacity-constrained Cournot game over good B. We have to distinguish two cases:

(i) the joint profit maximizing level of good B exceeds the available quantity of it, i.e. $q_B^* > \sigma q_a$; in this case, it does not matter how σq_a is distributed among the retailers (i.e. how the split award auction allocated σq_a), as they will always place their entire stocks - and hence the constrained optimal quantity - on the market: If the supply of good B downstream is competitive, then the individual supplier undervalues the effect of the marginal unit it supplies on the price of all inframarginal units (own and competitor's units). If unconstrained, aggregate supply will exceed monopoly supply; but since monopoly supply is already unfeasible (because $q_B^* > \sigma q_a$), we can be sure that retailers will place the entire σq_a on the market.

(ii) the resource constraint is not binding at the joint profit maximizing level of good B, i.e. $q_B^* < \sigma q_a$; then, the distribution of σq_a across retailers as induced by the split award auction will matter for the final outcome: If all supplies of good B are concentrated on one retailer, i.e. if $\alpha^* = 0$ or $\alpha^* = 1$, the retailer who has the monopoly on good B will internalize all the effects that an additional unit of good B has on the price of the latter and on that retailer's supply of good A. If instead an ε of the very same total supply of good B is redistributed to the other retailer, the total amount of good B offered on the final consumer market cannot but increase.

Aggregate payoffs of the capacity-constrained Cournot game are continuous in quantities and locally maximized at monopoly outcomes $\alpha = 0$ and $\alpha = 1$. Thus, there are only two candidate equilibria for the split-award auction: $\alpha^* = 0$ and $\alpha^* = 1$. To determine the overall equilibrium, we have to find the global maximum of the aggregate payoff function. By condition (ii) of Lemma 2, Retailer 1 holds (weakly) more of good A than Retailer 2, which implies that Retailer 1 will also make (weakly) higher profits on marketing good B, because Retailer 1 internalizes more externalities of the supply of B on the price of A than Retailer 2 does. Therefore:

(i) If Retailer 1 holds *strictly* more of good A, $q_{A1} > q_{A2}$, then aggregate profits generated downstream are (weakly) higher if Retailer 1 markets good B rather than Retailer 2:

$$\Pi_{R1}(q_{A1}, q_{A2}, q_{B1}, 0) + \Pi_{R2}(q_{A1}, q_{A2}, q_{B1}, 0) \geq \Pi_{R1}(q_{A1}, q_{A2}, 0, q_{B2}) + \Pi_{R2}(q_{A1}, q_{A2}, 0, q_{B2}) \tag{10}$$

where the inequality is strict whenever $q_{B1} < q_{B2} \leq \sigma q_a$, i.e. whenever Retailer 1 resells strictly less of good B than would Retailer 2, because Retailer 1 wants to "protect" demand for good A. Note that this is more likely to happen the more the available stocks of good A are concentrated on Retailer 1, and that $q_{B1} > q_B^*$ as long as $q_{A1} < q_A^*$.

Rearranging inequality (10), we obtain a ranking of the upper bounds on both Retailer's bids, with each retailer being willing to bid up to the additional profits it can generate on good B if winning the total supply:

$$\Pi_{R1}(q_{A1}, q_{A2}, q_{B1}, 0) - \Pi_{R1}(q_{A1}, q_{A2}, 0, q_{B2}) \geq \Pi_{R2}(q_{A1}, q_{A2}, 0, q_{B2}) - \Pi_{R2}(q_{A1}, q_{A2}, q_{B1}, 0)$$

If the inequality is strict (again, this is the case whenever $q_{B1} < q_{B2} \leq \sigma q_a$), Retailer 1 can always outbid the other retailer, offering $B_1(1) = B_2(0) + \varepsilon$ to induce $\alpha = 1$, where ε can be arbitrarily small. In equilibrium, the losing retailer, R_2, will bid:

$$B_2^*(0) \equiv \Pi_{R2}(q_{A1}, q_{A2}, 0, q_{B2}) - \Pi_{R2}(q_{A1}, q_{A2}, q_{B1}, 0) \tag{11}$$

and Retailer 1 exactly matches Retailer 2's bid: $B_1^*(1) = B_2^*(0)$; of course, retailers offer zero for the allocation in which they get nothin of good B: $B_1^*(0) = B_2^*(1) = 0$. With two allocations yielding the same maximal aggregate revenue, we have to invoke our tie-breaking rule: If the set $\arg\max \alpha \{B_1(\alpha) + B_2(\alpha)\}$ is not a singleton, the auctioneer picks the α at which retailers' joint payoffs are highest, in this case $\alpha = 1$. (There are also equilibria in which Retailer 2's bid exceeds $B_2^*(0)$ as defined in expression (11) - such bids can sustain an equilibrium as long as they are matched by Retailer 1 - but in these equilibria, Retailer 2 clearly plays a strategy that is dominated by $B_2^*(0)$.)

(ii) If there is a tie in the stocks each retailer holds of good A, $q_{A1} = q_{A2}$, or if inequality (10) holds with equality, then the two retailers are perfectly symmetric in the split-award auction, and aggregate payoffs are exactly the same at $\alpha = 0$ and $\alpha = 1$, so that none of them can outbid the other. In this case, each of them will bid up to its entire payoff from obtaining the entire stock, $B_1^*(1) = B_2^*(0)$, and our tie-breaking rule calls for the auctioneer to choose the highest of all α's in the set $\arg\max \alpha \{B_1(\alpha) + B_2(\alpha)\}$, which is $\alpha = 1$. Again, Retailer 1 obtains the entire supply, as claimed in Lemma 2.□

Proof of Proposition 3 We already argued in the Proof of Lemma 2 that retailers are revenue-maximizers at the last stage of the game, and so they will always sell all of their supplies of good A before selling any of good B: If there is a consumer willing to buy one unit of good B at a positive price, the same consumer would also be willing to buy a unit of good A instead, and even at a higher price. Thus, if the retailer still has positive stocks of both goods, it is more profitable to sell good A until stocks are depleted, and then start selling good B.

(i) Suppose the manufacturer supplies so much of good A that residual demand for good B drops to zero; call this output level $\hat{q}_A$. Then, the retailers' equilibrium bids in the split award auction are

$$B_1(\alpha) = B_2(\alpha) = 0 \text{ for all } \alpha \in [0, 1]$$

By Assumption 2, $\Pi_A < \Pi(q_A^*, q_B^*)$. Since $\Pi_A \equiv \max_{q_A} \Pi(q_A, 0) \geq \Pi(q_A, 0)$ for all q_A, we have that

$$\Pi(\hat{q}_A, 0) > \Pi(q_A^*, q_B^*)$$

i.e. the industry profits at output level $\hat{q}_A$ fall short of the maximal multi-product retailing profits $\Pi(q_A^*, q_B^*)$. The reason is that manufacturer overproduces in period 2, $\hat{q}_A > q_A^*$. If, under retailer competition, multi-product retailing is not feasible, and the manufacturer finds it optimal to produce $\hat{q}_A$ instead (thus foreclosing the recycling sector), then contracting is clearly inefficient because the manufacturer overproduces in period 2, as claimed in part (i) of Proposition 3.

(ii) Next, consider the case where the manufacturer instead supplies a quantity of good A small enough to leave some demand for good B. Then, the conditions of Lemma 2 are satisfied, and a forward-looking manufacturer will anticipate the outcome of the auction as characterized in Lemma 2. Given any level of $q_A < \hat{q}_A$, how should the manufacturer allocate good A across retailers? M will optimally concentrate the entire supply of good A on *one* retailer (in this case on Retailer 1). This increases profits in two ways: first of all, it ensures that the retailer who will market good B does so taking into account the *full* externalities good B has on the price of good A: if Retailer 1 only holds a fraction of q_A, it will only internalize a fraction of the externalities of good B, i.e. good B will be oversupplied; second, withdrawing all supplies of good A from Retailer 2 (the losing retailer in the split-award auction) reduces the profitability of the latter under all possible outcomes of the auction, i.e. for all values of α, and in particular for $\alpha = 0$ (the reason being again the lack of internalization of externalities on good A). Now, Retailer 2's payoff along the off-equilibrium path where it wins the entire supply of good B will determine its bid for this quantity in the auction:

$$B_2^*(0) = \Pi_{R2}(q_{A1}, 0, 0, q_{B2}) - \Pi_{R2}(q_{A1}, 0, q_{B1}, 0) = \Pi_{R2}(q_{A1}, 0, 0, q_{B2})$$

The last equality follows from $\Pi_{R2}(q_{A1}, 0, q_{B1}, 0) = 0$: If Retailer 2 has zero supplies of both goods, it can only make zero revenue downstream. By Lemma 2, this value sets the threshold for the winning retailer's equilibrium bid, $B_1^*(1) = B_2^*(0)$.

To summarize, we can write M's problem in period 2 as:

$$\max_{q_A} \Pi(q_A) = p_A q_A - C(q_A) + p_B q_B(q_A) - B_2^*(0) \tag{12}$$

where q_A as offered by M coincides with the downstream supply of Retailer 1, while the retailer's choice of good B, $q_B(q_A)$, will depend on the level of good A imposed by q_A. We see immediately that this expression differs from the one underlying joint profit maximization as in (3) because the bid price for good B has increased from $c_B q_B^* = 0$ to $\Pi_2(0, q_{B2})$. This implies that the profits appropriated by the $M - R_1$ chain will be lower than under bilateral monopoly, because competition for the supplies of the recycled good will bid up their price, thus generating rents for the recycling sector. How does this "leakage" affect M's choice of good A?

The answer to this question lies in the terms that enter

$$B_2^*(0) = \max_{q_{B2} \leq \sigma q_a} \Pi_{R2}(q_{A1}, 0, 0, q_{B2})$$

Again, we have to distinguish two cases:

(i) Suppose that $\arg\max_{q_{B2 \leq \sigma q_a}} \Pi_{R2}(q_{A1}, 0, 0, q_{B2}) < \sigma q_a$, i.e. the resource constraint is not binding in the optimization problem underlying Retailer 2's equilibrium bid in the split award auction. Then, Retailer 2's optimal choice of q_{B2} will be a function of Retailer 1's supply of good A, i.e. $q_{B2}(q_{A1})$: The higher is q_{A1}, the lower is the residual demand that Retailer 2 receives for its supply of good B along the off-equilibrium path where Retailer 2 wins the split-award auction, and hence the lower the price Retailer 2 would bid for good B. Thus, by expanding period-2 output of good A beyond the joint-profit maximizing level q_A^*, the $M - R_1$ chain can reduce the payoff made to the recycling sector, though at the expense of distorting the market shares of primary to recycled good. This completes the proof of part (i) of Proposition 3.

(ii) Suppose instead that $\arg\max_{q_{B2}} \Pi_{R2}(q_{A1}, 0, 0, q_{B2}) = \sigma q_a$, i.e. the resource constraint *is* binding in the optimization problem underlying Retailer 2's equilibrium bid in the split award auction. Then, $B_2^*(0)$ is a function of q_a: The more recycled output is available, the higher are Retailer 2's profits along the off-equilibrium path where Retailer 2 wins the split-award auction, and hence the higher the payment that the $M - R_1$ chain will have to make to buy good B. This introduces a distortion of a different kind: M will want to underproduce in period 1, thereby reducing supply of the recycled good in period 2, and hence reducing the $M - R_1$ chain's price of acquiring good B. This completes the proof of part (ii) of Proposition 3.□

Proof of Corollary 4 follows immediately from Proposition 3

(i) If the recycled output is supplied in abundance, then the "losing" retailer would not be constrained in its downstream supply of the recycled good along the off-equilibrium path where it wins the split award auction. Then, $B_2^*(0)$ is a function of q_A, because the residual demand for the recycled good is a function of the contemporaneous supply of the primary good. In this case, absent vertical restraints, the manufacturer would overproduce in period 2 in order to lower the profitability of selling any given amount of the recycled good, thus reducing the "losing" retailer's bid in the split award auction. Any quantity target which removes the manufacturer's incentive to overproduce in the second period will therefore increase the manufacturer's market power and thus lower consumer surplus.

(ii) If instead the recycled output is in short supply, then $B_2^*(0)$ is a function of q_a, the early period output, because the resource constraint binds along the off-equilibrium path where the "losing" retailer wins the split award auction. In this case, the manufacturer will underproduce in the first period in order to lower the "losing" retailer's bid in the second period auction. This underproduction harms both firms and consumers: therefore, both the vertical structure and consumers are better off if the manufacturer's incentive to underproduce is removed by the appropriate vertical restraints.□

Proof of Proposition 5 Marx and Shaffer (2004) show that there are two reasons why rent extraction may fail:

(i) The buyer has bargaining power, so that rent extraction requires the first seller's offering a below-cost price for the off-equilibrium case where negotiations between the buyer and the second seller fail. The entrant will then be forced to match this "reward" to obtain a contract with the buyer, and this reward will then be shared among buyer and first seller. In our case, the buyer has no bargaining power at all (recall that manufacturers make take-it-or-leave-it offers); in other words, we are in the Aghion and Bolton (1987) setting where it is sufficient for the first seller to impose penalties on the buyer in case of successful contracting with the entrant (instead of "rewards" for *not* contracting with the entrant). In this case, the entrant must compensate the buyer for the penalty in order to obtain a contract, and the penalty is then shared among buyer and first seller. Thus, if the buyer has no bargaining power, the constraint of above-cost-pricing is never binding.

(ii) Contracts cannot be contingent on competitor's output. If market share contracts are not admissible (and this is the case for dominant firms in the European Union), then the first seller's contract with the buyer cannot discriminate between exclusivity and common agency. In other words, the first seller must offer the same price for a certain level of q_{A1}, independently of whether the buyer also carries the rival brand or not, i.e. whether $q_{A2} > 0$ or $q_{A2} = 0$.

If this is the case, then there is a lower bound on the second-period payoffs that the entrant can appropriate. Denote by R^{CA} the revenue generated under common agency, by $T_i(q_{Ai})$ the contract between retailer and manufacturer $i = 1, 2$, by $c_i(q_{Ai})$ the production cost of manufacturer $i = 1, 2$, and by Π_R^{ED} the retailer's disagreement payoff[4]:

$$\Pi_R^{ED} = R\left(q_{A1}^{ED}, 0, q_B^{ED}\right) - T_1\left(q_{A1}^{ED}, 0, q_B^{ED}\right) - c_B q_B^{ED} \geq \Pi_B$$

Then, the entrant's payoff under common agency in the second period is:

$$\Pi_2^{CA} = R^{CA} - T_1\left(q_{A1}^{CA}, q_{A2}^{CA}, q_B^{CA}\right) - c_2\left(q_{A2}^{CA}\right) - c_B q_B^{CA} - \Pi_R^{ED} \qquad (13)$$

The common-agency rent to be shared among entrant and retailer, $R^{CA} - T_1\left(q_{A1}^{CA}, q_{A2}^{CA}\right) - c_2\left(q_{A2}^{CA}\right)$, must be at least what the retailer-entrant pair can get if the retailer, instead of q_{A1}^{CA}, purchases the "exclusivity" quantity q_{A1}^{ED} from

[4] Note that the retailer's disagreement payoff in period 2 can always be extracted by the incumbent through the first-period contract with the retailer.

the incumbent, and then maximizes residual profits with the entrant:

$$R^{CA} - T_1\left(q_{A1}^{CA}, q_{A2}^{CA}\right) - c_2\left(q_{A2}^{CA}\right) - c_B q_B^{CA} \geq \\ \geq \max_{q_{A2}, q_B \leq \sigma q_a} R\left(q_{A1}^{ED}, q_{A2}, q_B\right) - T_1\left(q_{A1}^{ED}, 0, q_B^{ED}\right) - c_2\left(q_{A2}\right) - c_B q_B \tag{14}$$

If this incentive constraint is satisfied, the entrant has no incentive to act opportunistically, i.e. to let the retailer buy q_{A1}^{ED} at the favorable rate $T_1\left(q_{A1}^{ED}, 0\right)$ that the incumbent only offers if no trade with the entrant occurs, although the retailer will then carry positive levels of the entrant's output as well.

If the incentive constraint is binding, we can insert the right-hand side terms into expression (13) to obtain:

$$\Pi_2^{CA} = \max_{q_{A2}, q_B \leq \sigma q_a} \left\{\Pi\left(q_{A1}^{ED}, q_{A2}, q_B\right) - \Pi\left(q_{A1}^{ED}, 0, q_B^{ED}\right)\right\}$$

Now, the optimal contract between the incumbent and the retailer will minimize the rent that must be left to the entrant:

$$\min_{\left\{q_{A1}^{ED}, q_B^{ED} \leq \sigma q_a\right\}} \max_{\left\{q_{A2}, q_B \leq \sigma q_a\right\}} \left\{\Pi\left(q_{A1}^{ED}, q_{A2}, q_B\right) - \Pi\left(q_{A1}^{ED}, 0, q_B^{ED}\right)\right\} \tag{15}$$

(i) If $\left\{q_{A1}^{ED}, q_B^{ED} \leq \sigma q_a\right\}$ can be set so as to reduce Π_2^{CA} to zero, then full rent extraction is possible even without market share contracts, and so there will be no distortion in either first- or second-period output.

If the entrant's minmax payoff at the solution to (15) is strictly positive but the resource constraint is not binding anywhere, then there will be no distortion in either first- or second-period output even though full rent extraction is not possible. This completes the proof of part (i) of Proposition 5.

(ii) If the entrant's minmax payoff is strictly positive, then the q_{A2} that solves (15) is strictly positive, which in turn implies that the entrant's choice of q_B is strictly lower than the incumbent's choice of q_B^{ED}. Thus, we can either have $\left\{q_B^{ED} = \sigma q_a \text{ and } q_B < \sigma q_a\right\}$, or $\left\{q_B^{ED} = \sigma q_a \text{ and } q_B = \sigma q_a\right\}$, but not $\left\{q_B^{ED} < \sigma q_a \text{ and } q_B = \sigma q_a\right\}$.

If $\left\{q_B^{ED} = \sigma q_a \text{ and } q_B < \sigma q_a\right\}$, then the entrant's minmax payoff is decreasing in σq_a: A marginal increase in q_a relaxes the constraint on the incumbent's part of the minmax problem, whithout affecting the choice set of the entrant's part, so that the minmax payoff can only decrease, but not increase. In other words, expanding first-period output will allow the incumbent manufacturer to extract a larger share of the entrant's second-period rent. This creates an incentive to overproduce in the pre-entry period.

If instead $\left\{q_B^{ED} = \sigma q_a \text{ and } q_B = \sigma q_a\right\}$, then relaxing the resource constraint will increase both $\Pi\left(q_{A1}^{ED}, q_{A2}, q_B\right)$ and $\Pi\left(q_{A1}^{ED}, 0, q_B^{ED}\right)$, so that it is not obvious what the net effect on the entrant's minmax profits will be. Suppose for a moment that following a marginal increase in q_a, the incumbent leaves q_{A1}^{ED} unchanged and only adjusts q_B^{ED}. The entrant will also adjust q_B, but the effect of this adjustment on $\Pi\left(q_{A1}^{ED}, q_{A2}, q_B\right)$ is likely to be smaller than the net effect of the same increase in q_B^{ED} on $\Pi\left(q_{A1}^{ED}, 0, q_B^{ED}\right)$. The reason is that the entrant's own primary output, q_{A2}, partially compensates for the shortage in q_B. Therefore, an expansion in q_B will not translate 1:1 into an increase in profits, but it will first trigger a (downward) adjustment of q_{A2}, so that the net effect on $\Pi\left(q_{A1}^{ED}, q_{A2}, q_B\right)$ is smaller than for $\Pi\left(q_{A1}^{ED}, 0, q_B^{ED}\right)$. Of course, the incumbent's choice of q_{A1}^{ED} will not remain unaffected by the increase in q_a, but this only creates an additional instrument for the incumbent to reduce the entrant's minmax profits after the resource constraint on good B was relaxed. Again, a higher level of first-period output allows the incumbent to extract more rent in the second period, and therefore creates an incentive to overproduce.

This completes the proof of Proposition 5.□