Vertical Restraints and Horizontal Control

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Abstract: This paper considers vertical restraints in a multi-market retail setting in which each retailer sells the complete line of manufactured goods. Vertical restraints by one manufacturer on the retailers of its product serve as an instrument to exert horizontal control over the retail price of a rival manufactured good. Applications are developed for supermarket retailing, where the manufacturer of a national brand sold at both supermarkets can employ vertical restraints to control the pricing of the retailer's competing private labels, and for the personal computer industry, where the manufacturer of an essential computer component can use vertical restraints to control the pricing of complementary components bundled with the essential component by original equipment manufacturers (OEMs).

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Vertical Restraints and Horizontal Control

1. Introduction

Vertical restraints imposed by manufacturers on retailers of their products continue to be a source of policy debate. The traditional explanation for vertical restraints is that the practice serves to align private incentives between a manufacturer and its retailers in the sale of the manufacturer's good. Various externalities exist that can distort retail prices from the collective optimum level, for instance intensive price competition among retailers may lead to an inadequate level of pre-sales retail services (Telser, 1960; Mathewson and Winter, 1984; Marvel and McCafferty, 1984; Klein and Murphy, 1988; Winter, 1993) or facilitate excessive post-sale quality differentiation (Bolton and Bonanno, 1988), and vertical restraints can resolve these distortions. Doing so generally produces pro-competitive effects, and this point has been strongly argued as a case for non-interventionist policy by many economists following Bork (1966) and Posner (1976).[1]

This paper considers vertical restraints in a multi-product retail environment. In this setting, a more pernicious role emerges for vertical restraints. We demonstrate that a vertical restraint on a manufacturer's own good serves as a mechanism to control the retail pricing of a *rival* manufactured good.

Our analysis is framed around a successive oligopoly market structure with a dominant firm-competitive fringe configuration in the upstream manufactured goods industry and a downstream duopoly retail market. Manufactured goods in the retail market are "bundled" in the sense that each retailer sells both manufactured goods. This framework has several interpretations. For the case of substitute products, the manufacturer of a national brand may

[1] There are two main counterpoints to the pro-competitive view. Rey and Tirole (1986) demonstrate that conflicts between private and social objectives can emerge when delegation takes place under market uncertainty, and the reason for this is that, under uncertainty, the manufacturer must balance the goal of aligning private incentives in supply with the need to provide adequate insurance to retailers. Shaffer (1991a) considers oligopolistic retailers who use resale price maintenance (RPM) to dampen downstream competition in individual contracts with competitive manufacturers.

employ vertical restraints to control the retail pricing of private labels (store brands) in a supermarket. For the case of complementary products, the manufacturer of an essential computer component may employ vertical restraints to control the retail pricing of commoditized components that are bundled together with the essential component by Original Equipment Manufacturers (OEMs). In each cases, vertical restraints serve to increase the retail price of the rival good, producing clear, anti-competitive effects.

The model builds on several recent papers in the literature on vertical restraints. In Winter (1993), which is the model closest to ours, a single manufacturer imposes vertical restraints on its duopoly retailers to elicit the optimal mix of prices and non-priced retail services. Absent contracts, retailers compete excessively in price and fail to provide a sufficient level of service, and a vertical restraint (e.g., RPM) combined with an elevated wholesale price above marginal cost simultaneously resolves both distortions. Here, vertical restraints likewise serve to resolve retail market externalities; however, the essential effect at work in a multi-product retail environment is the positive externality a retailer creates on others when raising his price. Vertical restraints on one good resolve the "business-stealing" externality between retailers in the *rival* good, thereby providing an aspect of horizontal control.

A distinguishing feature of a multi-product retail setting is that each manufactured good is acquired (at least potentially) from an independent supplier. Accordingly, our analysis of vertical restraints takes into account the potential for vertical separation to occur between retailers and suppliers of the rival good and allows for contracts with nonlinear prices to emerge, as in Shaffer (1991a). Unlike the case of non-priced retail service provision, retailers acquire rents from the sale of rival manufactured goods, and this makes contract enforceability important.

Our paper also relates to the substantial literature on the extension of monopoly power to other products through the use of tying arrangements in vertical contracts (e.g., Whinston, 1990; Carbajo, et al., 1990; Shaffer, 1991b). This literature focuses on multi-good producers who seek to extend the advantage enjoyed by a monopoly-supplied good to a full line of products.[2] This contrasts with the distinct focus here on how a vertical restraint imposed on a manufacturer's own good can be used to extract rents from the market for another manufacturer's good.

Several recent papers have considered retailer-manufacturer contracts that are designed to extract rent from rival manufacturers. Marx and Shaffer (1999) consider a sequential contracting game with duopoly manufacturers and a monopoly retailer in which below-cost pricing by the first manufacturer increases the retailer's disagreement payoff in its negotiation with the second manufacturer. The present model has a similar element of "horizontal accommodation". By imposing a vertical restraint on its retailers, the dominant manufacturer is free to adjust the retail margin on its own good through its choice of the wholesale price. Doing so alters the optimal mix of retail prices across manufactured goods, and this facilitates cross-product control without market foreclosure.

Several notable symptoms emerge when vertical restraints are employed to exert horizontal control over rival manufactured goods. First, vertical restraints induce retailers to engage in contracts with suppliers of rival manufactured goods that involve fixed fees paid to the retailer, for instance through vendor participation in retail service functions or through slotting allowances for shelf-space.[3] Second, in the case of weak substitutes, vertical restraints result in negative retail margins on the dominant manufactured good. Hence, the model provides a novel explanation for loss-leader retail pricing that does not rely on coordination failures.[4]

The remainder of the paper is organized as follows. Section 2 develops the basic framework of the multi-product oligopoly model. Section 3 derives the collective optimum and demonstrates that this outcome cannot be supported though a combination of wholesale pricing and lump-sum transfers alone. Section 4 considers vertical restraints in a sequential contracting environment in which the dominant manufacturer selects contracts with the retailers that induce

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[2]Shaffer (1991b), for example, studies how a contract between a multi-product monopolist and a single retailer can be used by the monopolist to ensure that the retailer stocks the monopolist's full line of products.
[3] The practice of charging slotting allowances to suppliers has drawn recent regulatory attention in the U.S. (FTC 2001), although no explicit linkage was made with the use of vertical restraints.
[4] For more on loss-leader pricing, see Bagwell and Ramey (1994) and Lal and Matutes (1994).

the retailers to negotiate with fringe suppliers for an arrangement that maximizes collective rents. Section 5 of the paper extends the model to consider its application to supermarket retailing and OEMs and Section 6 concludes with a discussion of policy implications and extensions.

2. The Model

Consider a product category that contains two goods. Each good is produced independently by manufacturers and sold to retailers in an upstream market. The goods are bundled in the downstream market in the sense that each retailer carries both goods. Good 1 is a "name brand" produced by a dominant manufacturer and good 2 is a "generic brand" supplied to the retailers by a competitive fringe. The generic brand may be either a substitute of a complement to the name brand. Production of each good involves constant unit cost, denoted c^1 and c^2, respectively.

The market friction that justifies the use of vertical restraints occurs along the interretailer margin. This friction is represented in the model by consumer travel costs.[5] Retailers differ because of location and the time it takes consumers to travel or search among stores for their products. Goods in the product category are assumed to be separable in consumption from all other retail goods and the problem of retailer location choice is suppressed.[6]

Under incomplete contracts, two types of distortion limit the ability of the dominant firm to fully appropriate the rents from its good. On the *inter*retailer margin, price competition between retailers generates a business-stealing externality. Each retailer fails to account for the effect of his prices on his rival's sales, and this externality jointly impacts both retail goods. On the *intra*retailer margin, each retailer selects positive retail margins on the manufactured goods and adjusts these margins mutually to account for the effect of sales of one brand on sales of the other brand within the store. When a manufacturer changes its wholesale price, the retailers respond by altering the mix of retail prices to shift consumption between brands.

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[5] A search-theoretic model would be an alternative framework to produce the same motivation.

[6] Retailer location choice could be added to the model without changing the essential results; however, doing so would provide a greater apparatus to sift through.

An important role of contracts is to align private incentives through nonlinear pricing. We consider the standard contracting environment in which a manufacturer and a retailer reach an agreement both over the wholesale price and over how the surplus from successive transactions is to be divided. Since two-part tariffs are the simplest contract form that captures these elements, we confine our attention to contracts that stipulate a wholesale price, w^i, and a tariff f^i, for manufactured goods i=1,2. In addition, the contract between the retailer and manufacturer 1 may stipulates a vertical restraint, which is taken here to be resale price maintenance at the level $p^1 = p^{1*}$.[7] For analytic convenience, the retail industry is characterized by symmetric duopoly and the wholesale prices negotiated in the contracts are assumed to be observable to both retailers.[8]

Consider a representative consumer who purchases a consumption bundle (y^1, y^2) from a single retailer. (The choice of retailer by the representative consumer is determined according to a preference parameter θ to be discussed shortly.) Given a consumer's choice of retailer, $j \in \{1,2\}$, and consumption bundle, the consumer obtains the utility,

$$u(y^1, y^2) - \sum_{i=1}^{2} p_j^i y^i, \tag{1}$$

where y^i is the quantity of good i purchased, and p_j^i is the price of good i at retail location j.

We assume $u(.)$ is increasing and concave with bounded first derivatives and that own product effects dominate cross-effects, $|\mathrm{dln}u_i / \mathrm{dln}y^i| \geq |\mathrm{dln}u_i / \mathrm{dln}y^j|$ for $j \neq i$. The products can be either substitutes, $\partial^2 u(.)/\partial y^1 \partial y^2 \leq 0$, or complements $\partial^2 u(.)/\partial y^1 \partial y^2 \geq 0$. The optimal consumption choice of the representative consumer at retailer j provides the indirect utility,

$$u_j^* \equiv u^*(p_j^1, p_j^2) = \max_{\{y^1, y^2\}} u(y^1, y^2) - \sum_{i=1}^{2} p_j^i y^i . \tag{2}$$

The representative consumer decides whether to purchase goods from retailer 1 or retailer 2, and this decision is based on location. Retailer choice is determined by the preference

[7] Equivalently, the vertical restraint can involve a good 1 quantity provision (e.g., at the level $y^1 = y^1(p^{1*}, p^{2*})/2$ in the symmetric two retailer case) in place of RPM (see Reiffen, 1999). For more on the equivalence between various forms of vertical restraints in a deterministic setting, see Mathewson and Winter (1984).

[8] Additional assumptions would be required to define the outcomes of these contract negotiations if w^1 and w^2 were not observed by each retailer (see, e.g., Crémer and Riordan (1987) and O'Brien and Shaffer (1992)).

parameter θ, which represents the consumer's net preference for retailer 2. For analytic convenience, we assume θ to be uniformly distributed on the support $[-\bar{\theta},\bar{\theta}]$. Thus, a θ-type consumer obtains the utility $u_1^*(p_1^1, p_1^2)$ from retailer 1 and $u_2^*(p_2^1, p_2^2)+\theta$ from retailer 2. Given a set of retail prices for each brand at each store, a representative consumer of type $\theta^*(u_1^*,u_2^*) = u_1^* - u_2^*$ is indifferent between the retailers, and the market is partitioned into consumer types $\theta \le \theta^*(u_1^*,u_2^*)$, who purchase both goods from retailer 1, and consumer types $\theta > \theta^*(u_1^*,u_2^*)$, who purchase both goods from retailer 2.

Absent contracts, the dominant firm sets a wholesale price w^1 and the competitive fringe prices at cost, $w^2=c^2$. Given these wholesale prices, duopoly retailers then compete in retail prices. In what follows, we examine how such an outcome departs from the collective optimum, and then characterize the role of vertical restraints in aligning the incentives of producers.

3. Collective Optimum and No Contract Outcomes

A vertically integrated monopolist solves:

$$\max_{p^1,p^2} \sum_{i=1}^{2} (p^i - c^i) y^i(p^1,p^2) \equiv \Pi(p^1,p^2) \quad \Rightarrow \quad \{p^{1*}, p^{2*}\} \tag{3}$$

where $y^i(.) \equiv \arg\max \left\{ u(y^1,y^2) - \sum_i p^i y^i \right\}$. The solution to this problem yields the maximum profit available in this market, $\Pi^* \equiv \Pi(p^{1*},p^{2*})$, which we refer to as the collective optimum.

In this section, we first establish that wholesale pricing, absent vertical restraints, cannot give rise to the collective optimum. This motivates our study of vertical restraints. Consider the choice problem of retailer 1:[9]

$$\begin{aligned} \max_{p^1,p^2} \pi_1(p^1,p^2;\bar{u}_2,w^1,w^2) &\equiv \sum_{i=1}^{2} (p^i - w^i) y^i(p^1,p^2)\phi(p^1,p^2;\bar{u}_2) \\ &= \Pi(p^1,p^2)\phi(p^1,p^2;\bar{u}_2) - \sum_{i=1}^{2} (w^i - c^i) y^i(p^1,p^2)\phi(p^1,p^2;\bar{u}_2) \end{aligned} \tag{4}$$

where Π is defined in equation (3), and $\phi(p^1,p^2;\bar{u}_2)$ is the market share of retailer 1, given the prices set by retailer 2 (and the attendant utility level $\bar{u}_2$). Absent contracts, the wholesale price of the fringe good is given by $w^2=c^2$. Normalizing the number of consumers to one, the market

[9]Choices of retailer 2 are symmetric and thus omitted.

share of retailer 1 satisfies

$$\phi(p^1, p^2; \bar{u}_2) = \frac{\bar{\theta} + \theta^*(u^*(p^1, p^2), \bar{u}_2)}{2\bar{\theta}} = \frac{\bar{\theta} + u^*(p^1, p^2) - \bar{u}_2}{2\bar{\theta}}.$$

The first-order necessary conditions for a solution to (4) are:

(5) $$\frac{\partial \pi_1}{\partial p^1} = \phi\left(\frac{\partial \Pi}{\partial p^1}\right) + \Pi\left(\frac{\partial \phi}{\partial p^1}\right) - \sum_{i=1}^{2}(w^i - c^i)\left[\phi\left(\frac{\partial y^i}{\partial p^1}\right) + y^i\left(\frac{\partial \phi}{\partial p^1}\right)\right] = 0$$

(6) $$\frac{\partial \pi_1}{\partial p^2} = \phi\left(\frac{\partial \Pi}{\partial p^2}\right) + \Pi\left(\frac{\partial \phi}{\partial p^2}\right) - \sum_{i=1}^{2}(w^i - c^i)\left[\phi\left(\frac{\partial y^i}{\partial p^2}\right) + y^i\left(\frac{\partial \phi}{\partial p^2}\right)\right] = 0$$

where

(7) $$\frac{\partial \phi}{\partial p^i} = \frac{\left(\partial u^* / \partial p^i\right)}{2\bar{\theta}} = \frac{-y^i(p^1, p^2)}{2\bar{\theta}} < 0$$

holds by Roy's identity.

Notice that the collective optimum (p^{1*}, p^{2*}) is achieved when the first term in each of these equations is equal to zero. The individual incentives of a retailer therefore are compatible with the collective interest only when the sum of the final three terms in both (5) and (6) is zero. These terms correspond to two distortions. First, higher prices by retailer 1 prompt consumers on the interretailer margin to switch to the rival retailer (the business stealing effect). This loss of store traffic is costly to the retailer, but of no concern to the vertically integrated chain. The second terms in (5) and (6) capture this effect for good 1 and 2, respectively. The business-stealing effect provides the retailer with an incentive to set each retail price below the level which maximizes joint profits. Second, to the extent that the retailer pays above-cost wholesale prices to its suppliers ($w^i > c^i$), retail price effects on demand have a smaller impact on retailer profit than on the profit of the vertically integrated chain, which faces true cost c^i. This "double-marginalization" effect induces the retailer to set prices above the level which maximizes joint profits. The third set of terms in expressions (5) and (6) capture these effects.

If the manufacturer of good 1 writes a contract with each retailer that does not include vertical restraints, the wholesale price of good 1 can be selected so that the business-stealing and double-marginalization effects exactly offset *for the good 1 retail price*. That is, if w^1 is chosen so that

$$(8) \qquad w^1 - c^1 = \frac{\Pi(.)(\partial\phi/\partial p^1)}{\left(\phi(\partial y^1/\partial p^1) + y^1(\partial\phi/\partial p^1)\right)} > 0,$$

the last terms in (5) vanish, and retailer 1 selects p^{1*}. A wholesale price for good 1 set above marginal cost balances the double-marginalization effect with the business-stealing externality for good 1. Nevertheless, this choice of wholesale price is sufficient to achieve the collective optimum only when it induces the retailers to simultaneously select p^{2*}. But this is not so. The retailers vie to attract custom by jointly selecting prices for both goods, and the business-stealing motivation leads to selective price discounts on good 2. With w^1 set as in equation (8), the last terms in (6) do not vanish when p^2 is set equal to its integrated optimum, p^{2*}. Namely,

$$(9) \qquad \left.\frac{\partial\pi_1(p^{1*}, p^{2*}; \bar{u}_2, w^1, c^2)}{\partial p^2}\right|_{\text{eq. (8)}} = \frac{\phi\Pi^*\left[(\partial\phi/\partial p^2)(\partial y^1/\partial p^1) - (\partial\phi/\partial p^1)(\partial y^1/\partial p^2)\right]}{\phi(\partial y^1/\partial p^1) + y^1(\partial\phi/\partial p^1)}.$$

In the case of substitute products, $\partial y^1/\partial p^2 \geq 0$, this expression is negative, because $\partial y^1/\partial p^1 < 0$, $\partial\phi/\partial p^i < 0$ (i=1,2), $\Pi^* > 0$, and $\phi > 0$: The retailer sets the price of good 2 below p^{2*}. In the case of complementary goods, $\partial y^1/\partial p^2 \leq 0$, the sign of the right-hand side of (9) is ambiguous (the retailer may set the price of good 2 above or below p^{2*}).

The individual retailer's choice of p^2 differs from the collective optimum due to a divergence of incentives on both interretailer and intraretailer margins. To see this, consider the case of substitutes. On the intraretailer margin, a price discount on brand 2 lowers the retailer's sales of brand 1. The opportunity cost of this is smaller for the individual retailer than it is for the integrated chain, and retailers consequently discount brand 2 too deeply. On the interretailer margin, reducing the price of good 2 serves to bid custom from its rival, which is attractive to the individual retailer but of no consequence to an integrated chain. Both distortions work on price in the same direction, and it follows that $p^2 < p^{2*}$. In the case of complements, the distortions work on the retail price in opposite directions. Reducing the price of brand 2 attracts custom on the interretailer margin, but this now increases sales of complementary brand 1 on the intraretailer margin. Because $w^1 > c^1$, the marginal private benefit of a brand 1 sale is lower for the retailer than for the integrated chain, and this distortion now works against the retailer's business-stealing incentive to select a price below p^{2*}.

4. Contracts

In this section we consider contracts between the dominant manufacturer and its retailers. Throughout, we follow the standard approach in the bargaining literature and consider contract terms determined by bargaining (see, for example, Macleod and Malcomson, 1995). Because the issue of interest here is the contract form that attains the collective optimum, we do not describe the precise form of the bargaining game. Instead, we simply assume that the game has a unique subgame perfect bargaining equilibrium that splits collective gains from contract implementation according to a known rule (as in Rubinstein, 1982; Shaked, 1987; and others).

We consider contracts between the dominant manufacturer and its retailers that provide the retailers with the necessary *incentive* to set an optimal price for the fringe product. This task would be relatively straightforward if the manufacturer's contracts with its retailers could stipulate the retail price for the fringe product ($p^2= p^{2*}$) and punish any defections from this price. However, the overtly anti-competitive nature of such a direct cross-product vertical restraint almost certainly rules out these contracts in practice. We therefore consider contracts that make no explicit ties to the fringe market and instead have only three terms: resale price maintenance (RPM) for the dominant manufacturer's good (requiring $p^1= p^{1*}$), a wholesale price (w^1) and a tariff (f^1) to redistribute rents.

To understand the basic logic of a vertical restraint as an instrument for horizontal control, suppose for the moment that the retailers were unable to form independent contracts with fringe suppliers, for instance if each retailer was integrated with a fringe manufacturer so that $w^2=c^2$. If the dominant manufacturer imposes a vertical restraint on its retail price of $p^1= p^{1*}$, then the integrated optimum then could be achieved provided a wholesale price, w^1, can be found to induce the duopoly retailers to select $p^2= p^{2*}$ in (6). By inspection, the wholesale price that achieves this integrated optimum is

$$(10) \qquad w^1 - c^1 = \frac{\Pi(.)(\partial\phi/\partial p^2)}{\left(\phi(\partial y^1/\partial p^2) + y^1(\partial\phi/\partial p^2)\right)}.$$

With a vertical restraint on the retail price of its own good, the manufacturer need only select a wholesale price that provides retail pricing incentives for the rival manufactured good. The wholesale price in (10) is selected to counterbalance the distortions on the interretailer and intraretailer margins for the rival good. Doing so involves $w^1>c^1$ unless the goods are sufficiently strong substitutes. To see this, consider the outcome with symmetric retailers, $\phi = ½$, in which case (10) reduces to

$$(11) \qquad w^1 - c^1 = \Pi^* y^{2*}/\delta$$

where $\delta = y^{1*}y^{2*} - \overline{\theta}(\partial y^1/\partial p^2)$ and $y^{i*} = y^i(p^{1*}, p^{2*})$, i=1,2, is the equilibrium quantity of brand i sold by each retailer in the collective optimum. Notice that $\delta > 0$ in the case of complementary goods, whereas, in the case of substitute goods, $\delta > 0$ when the goods are sufficiently *weak substitutes* and $\delta \leq 0$ when the goods are sufficiently *strong substitutes*.

In the case of independent retail goods, $\partial y^1/\partial p^2 = 0$, the wholesale price in (11) is selected so that $(w^1 - c^1)\, y^{1*} = \Pi^*$. This is an intuitive result. With marginal-cost wholesale pricing of the fringe brand, each retailer departs from the collective optimum due only to the business-stealing motivation, and this incentive is entirely eliminated when the dominant manufacturer selects its wholesale price to fully extract variable profit from its retailers. Sales of brand 1 are now made below invoice ($w^1>p^{1*}$) –a "loss leader" outcome— and the retailer's loss on brand 1 is chosen to exactly offset the retailer's gain on brand 2 from acquiring additional custom at the monopoly prices.

When the retail goods are not independent, the wholesale price must also correct for the intraretailer distortion. For substitute goods, each retailer wishes to select relative prices across brands to encourage consumption of his high margin retail good. Since p^1 cannot be adjusted under the manufacturer's vertical restraint, a higher wholesale price of good 1 favors relative price adjustments by retailers that shift consumption towards good 2. To correct for this, the manufacturer reduces its wholesale price from the level that would arise with independent demands. The opposite is true for the case of complementary goods.

A vertical restraint can serve to control the retail pricing of rival manufactured goods. In a single-product retail setting, such a restraint would be unnecessary; wholesale pricing would be sufficient to obtain the collective optimum. In a multi-product retail setting, an additional instrument is necessary to control the retailer's incentive to attract custom through selective price discounts on the rival good. The use of a vertical restraint on the manufacturer's own good frees his wholesale price to be used to offset the business-stealing externality for the rival good. The underlying logic is similar to that of Winter (1993), who demonstrates that vertical restraints can be used to align incentives when retailer service inputs are jointly provided with a single market good. However, unlike the case of retail service provision, rival manufactured goods here are procured through arms-length transactions in the wholesale market, and the manufacturer cannot prevent its retailers from engaging in contracts with rival manufacturers.

Vertical separation generally is a desirable outcome for a retailer. When a retailer writes an observable contract with a manufacturer that stipulates a wholesale price above unit production cost, the high contract price signals rival retailers the intent to set a correspondingly high price in the retail market, and this softens downstream price competition (Shaffer, 1991a). A similar incentive for separation between retailer and fringe emerges in a multi-product retail environment when the dominant manufacturer imposes a vertical restraint.

Can a dominant manufacturer exert horizontal control over fringe production in the presence of contracts between retailers and fringe suppliers? To address this question, consider the following three stage game. In the first stage, the dominant manufacturer selects a contract with each retailer of the form considered above. In the second stage, each retailer engages in independent contracts with the fringe that stipulate a wholesale price (w^2) and a tariff (f^2), and, in the third stage, production and exchange occur.

The analytical challenge is to show that a wholesale price, w^1, exists under the vertical restraint that prompts the duopoly retailers to sign contracts with fringe suppliers that yield the collective optimum (p^{1*}, p^{2*}) under terms of a two-part tariff (w^2, f^2). Vertical separation occurs in this setting whenever $w^2 \neq c^2$.

Consider, first, the retailer's contract with fringe suppliers. Each supplier in the fringe is willing to accept the contract proposed by a retailer provided she receives a payment no less than her opportunity costs. With a competitive fringe, these opportunity costs can be normalized to zero without loss of generality. Accordingly, if a retail contract stipulates that the supplier pay a lump-sum tariff of $f^2 > 0$, the retailer then faces fringe suppliers who compete in wholesale prices (w^2) to acquire the contract. The retailer selects among suppliers with the lowest prices on offer, so that, in equilibrium, the terms of the contract must satisfy the zero-profit condition,

$$(w^2 - c^2)y^2(p^1, p^2)\phi(.) = f^2 . \tag{12}$$

Given that the dominant manufacturer imposes a vertical restraint on its own good, the retail price of good 1 is $p^1 = p^{1*}$, the retailer's contract choice is determined by a two-stage subgame in which the retailer selects the contract terms (w^2 and f^2) in the first stage to satisfy (12), and then sets the retail price of good 2 in the second-stage. Given the contracted wholesale price with the supplier of good 2, the optimal retail price for good 2 is defined as follows:

$$\max_{p^2} \ \Pi(p^{1*}, p^2; w^1, w^2)\ \varphi(p^{1*}, p^2; \bar{u} = \mathrm{u}^*(p^{1*}, \hat{p}^2)) \ \Rightarrow \ p^2(w^1, w^2; \hat{p}^2) \tag{13}$$

where $\hat{p}^2$ is the rival retailer's price selection and the retail profit function is defined by

$$\Pi(p^1, p^2; w^1, w^2) = \sum_{i=1}^{2} (p^i - w^i)\, y^i(p^1, p^2).$$

Proceeding similarly with the rival retailer and equating the reaction functions gives the equilibrium prices from the retail pricing stage,

$$p^{2,e} = p^{2,e}(w^1, w^2; \hat{w}^2) \quad , \quad \hat{p}^{2,e} = \hat{p}^{2,e}(w^1, \hat{w}^2; w^2) \tag{14}$$

where $\hat{w}^2$ is the wholesale price selected by the rival retailer. In order for the equilibrium in (14) to be locally stable at the integrated optimum, the following regularity restriction must hold:

Assumption 1. At $p^{2,e} = \hat{p}^{2,e} = p^{2*}$, $\partial p^2(w^1, w^2; \hat{p}^2 = p^{2*})/\partial \hat{p}^2 < 1$.[10]

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[10]Sufficient conditions for Assumption 1 to hold is that $\partial^2\Pi(p^{1*}, p^{2*}; w^1(w^2), w^2)/\partial(p^2)^2 < 0$ and $p^{2*}y^2(p^{1*}, p^{2*}) + \bar{\theta}\ (d\ln y^2(p^{1*}, p^{2*})/d\ln p^2) \geq 0$, where $w^1(w^2)$ solves equation (16) below.

Turning to the contract stage, each retailer chooses the fringe wholesale price w^2 to maximize profit subject to the subsequent price responses in (14). Given that supplier profits are rebated to the retailer in the retailer-fringe contract (12), the retailer's problem is

(15) $\max_{w^2} J = \Pi(p^{1*}, p^{2,e}(w^1, w^2; \hat{w}^2); w^1, c^2)\ \varphi(p^{1*}, p^{2,e}(w^1, w^2; \hat{w}^2); \bar{u} = u^*(p^{1*}, \hat{p}^{2,e}(w^1, \hat{w}^2; w^2))$

The symmetric contract equilibrium solves (15), with $\hat{w}^2 = w^2$.

Now consider the problem of the dominant manufacturer. The challenge for the dominant manufacturer is to select a wholesale price w^1 to each retailer such that, with the resulting equilibrium w^2 established by the retail contracts that solve (15), retailers set good 2 retail prices to maximize integrated profit at $p^2 = p^{2*}$. To characterize this solution, we seek a wholesale price pair (w^1, w^2) that simultaneously satisfies two conditions in the symmetric retail equilibrium: (*i*) w^2 solves (15) when $\hat{w}^2 = w^2$, and (*ii*) the resulting $p^2 = p^{2*}$ in the pricing stage solves (13) when $\hat{p}^2 = p^{2*}$. Assuming the requisite second order conditions hold, differentiating (13) with respect to p^2 and evaluating at $p^2 = \hat{p}^2 = p^{2*}$ gives

(16) $F_1(w^1, w^2) = -\Pi(p^{1*}, p^{2*}; w^1, w^2)\, y^2(p^{1*}, p^{2*}) - \bar{\theta} \sum_{i=1}^{2} (w^i - c^i)\, \partial y^i(p^{1*}, p^{2*})/\partial p^2 = 0.$

Equation (16) has the closed form solution $w^1(w^2)$ that yields the collectively optimal price selection for good 2, $p^2 = p^2(w^1, w^2; \hat{p}^2 = p^{2*}) = p^{2*}$.

Similarly, to solve (15), we write the first order condition,

(17) $dJ/dw^2 = [\partial\Pi(.\,; w^1, c^2)\varphi()/\partial p^2]\ [\partial p^{2,e}(w^1, w^2; \hat{w}^2)/\partial w^2]$

$\qquad + \Pi(.\,; w^1, c^2)\ [\partial\varphi()/\partial \bar{u}][\partial u^*(p^{1*}, \hat{p}^2())/\partial p^2][\partial \hat{p}^{2,e}(w^1, \hat{w}^2; w^2)/\partial w^2] = 0.$

Next use (13) and (14) to expand terms in (17), and evaluate when $w^2 = \hat{w}^2$ and $p^{2,e}() = p^{2*}$ (by (16)). For the symmetric case (with $\varphi = 1/2$), this gives [11]

(18) $F_2(w^1, w^2) = \Pi(p^{1*}, p^{2*}; w^1, w^2)\, y^2(p^{1*}, p^{2*})(\partial p^2()/\partial \hat{p}^2)$

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[11]From (2) and the definition of φ in (4), $[\partial\varphi()/\partial \bar{u}][\partial u^*(p^{1*}, \partial\hat{p}^2())/\partial p^2] = y^2()/2\bar{\theta}$. With $\Pi(.; w^1, c^2) = \Pi(.; w^1, w^2) + (w^2 - c^2)\, y^2(p^{1*}, p^2)$, we have from (13), $\frac{d}{dp^2}[\Pi(.\,; w^1, c^2)\varphi()] = (w^2 - c^2)\ \{\partial y^2()/\partial p^2\ \varphi + y^2()(\partial\varphi/\partial p^2)\}$, where $\partial\varphi/\partial p^2 = -y^2()/2\theta$. Differentiating (14), $\partial\hat{p}^{2,e}(w^1, \hat{w}^2; w^2)/\partial w^2 = [\partial p^{2,e}(w^1, w^2; \hat{w}^2)/\partial w^2](\partial p^2(w^1, w^2; \hat{p}^2)/\partial\hat{p}^2)$. Substituting into (17) when $w^2 = \hat{w}^2$ and $p^{2,e}() = p^{2*}$ gives (18).

$$+ (w^2 - c^2) \{[\overline{\theta}\ \partial y^2(p^{1*}, p^{2*})/\partial p^2] - y^2(p^{1*}, p^{2*})^2(1-\partial p^2()/ \partial \hat{p}^2)\}= 0,$$

where $\partial p^2()/ \partial \hat{p}^2 = \partial p^2(w^1, w^2; \hat{p}^2 = p^{2*})/ \partial \hat{p}^2$.

Inspection of conditions (16) and (18) results in the following:

Proposition 1. If the two goods are independent in consumption ($\partial y^1(p^{1*}, p^{2*})/\partial p^2 = 0$), then the collective optimum is supported by $w^2=c^2$ and $w^1>p^{1*}$ such that $\Pi(p^{1*}, p^{2*}; w^1, c^2)=0$.

After correcting for the retailers pricing externalities for the manufacturer's own good with the vertical restraint, p^{1*}, the remaining externality is the incentive of each retailer to steal business from its rival by discounting the retail price of the fringe product. This incentive is eliminated when the manufacturer imposes vertical restraints on his retailers that eliminate variable profit per customer ($\Pi()=0$). The intuition for this is precisely that in the case discussed earlier without the possibility of retailer-fringe contracts. When faced with zero variable profit per customer, the retailer gains no advantage by engaging in contracts with fringe suppliers. Manipulating the wholesale price of the fringe good in a contract can shift custom between retailers, but shifting custom no longer shifts rent.

An interesting feature of this outcome is that vertical restraints to control the retailer's pricing incentives for the rival manufactured good leads to a loss-leader outcome ($w^1>p^{1*}$) for the dominant manufacturer's good. Because the dominant manufacturer cannot prevent the retailers from selecting a positive retail margin for the fringe product ($p^2>w^2$), the retailer's loss on the manufacturer's own good is necessary to counterbalance the business stealing externality.

Now consider a more general retail environment in which the goods are not independent in consumption, $\partial y^1(p^{1*}, p^{2*})/\partial p^2 \neq 0$. For this case, we prove the following result – the key result of this paper—in the appendix.

Proposition 2. There is a bounded $w^{2*}>c^2$ such that $(w^{1*}, w^{2*})=(w^1(w^{2*}), w^{2*})$ solve equations (16) and (18). Hence, the collective optimum can be achieved by vertical restraints on the retailers of the dominant manufacturer's own good. The optimal contract prompts the retailers to select positive tariffs ($f^{2*}>0$) on the products of rival manufacturers.

The basic reasoning for the vertical restraint is to control the retail pricing of the fringe good. Because retailers compete to attract custom, each retailer selects a retail price for the fringe good that leads to a smaller retail margin than the one which maximizes collective rents. A vertical restraint corrects this distortion by inducing the retailers to impose positive tariffs on fringe suppliers that support higher good 2 wholesale prices. The higher wholesale prices, in turn, prompt the retailers to select higher retail prices for the fringe product. For a sufficiently high wholesale price, the retail price of the fringe good equates with the integrated monopoly price p^{2*}. Moreover, the existence of such a wholesale price is guaranteed, because it is bounded from above by the retail price.

To understand how the dominant firm provides its retailers with incentives to sign such contracts with fringe suppliers, it is helpful to substitute (16) into (18). This gives the necessary condition for (w^{1*}, w^{2*}) to support the integrated optimum:

(19) $$(w^1 - c^1)(\partial y^1(p^{1*}, p^{2*})/\partial p^2)(\partial p^2()/\partial \hat{p}^2)$$
$$= (w^2 - c^2)(1 - \partial p^2()/\partial \hat{p}^2)[(\partial y^2(p^{1*}, p^{2*})/\partial p^2) - (y^2(p^{1*}, p^{2*})/\bar{\theta})].$$

Next, define the retailer's profit per-customer under the optimal contract as

$$\Pi^{**} = \Pi(p^{1*}, p^{2*}; w^{1*}, w^{2*}),$$

and note the following:

Lemma 1. $\partial p^2(w^1, w^2; \hat{p}^2)/\partial \hat{p}^2 \overset{s}{=} \Pi(p^{1*}, p^2; w^1, w^2)$, where "$\overset{s}{=}$" denotes "equals in sign."

By Assumption 1 ($\partial p^2()/\partial \hat{p}^2 < 1$) and Proposition 2 ($w^{2*} > c^2$), the term on the right-hand side of (19) is negative at the optimum. Hence, the term on the left-hand side of (19) must be negative. Making use of Lemma 1, this requirement yields the following characterization of the optimal monopoly wholesale price:

Lemma 2. w^{1*} is above or below c^1, depending upon whether Π^{**} is positive or negative, and whether the two goods are complements ($\partial y^1(p^{1*}, p^{2*})/\partial p^2<0$) or substitutes ($\partial y^1()/\partial p^2>0$) as follows:

	Retail Goods Are	
	Complements	Substitutes
$\Pi^{**}>0$	$w^{1*}>c^1$	$w^{1*}<c^1$
$\Pi^{**}<0$	$w^{1*}<c^1$	$w^{1*}>c^1$

To see the intuition for Lemma 2, consider the case in which customers are profitable to retailers in equilibrium ($\Pi^{**}>0$) and the products are substitutes goods. Because $\Pi^{**}>0$, the retailers' good 2 price selections are strategic complements. Setting a higher p^2 provides a strategic benefit to a retailer, because doing so prompts the rival retailer to raise its good 2 price in response. The retailer can thus obtain the benefit of a reciprocal price increase by committing himself to a higher good 2 wholesale price ($w^2>c^2$), as this signals his rival the intent to set a correspondingly high good 2 retail price (Shaffer's (1991a) insight). In a multi-product retail setting, the strategic benefit to a retailer from raising p^2 by contracting for an elevated wholesale price for good 2 depends also on the relationship between the two goods in the retail market. When the products are substitutes, setting a higher p^2 increases the retailer's sales of good 1, and the return to this to the retailer is greater the larger is his good 1 retail margin, $p^{1*}-w^1$. The dominant manufacturer thus elevates the retailer's incentive to raise p^2 by lowering w^1 below c^1. The converse holds when the goods are complements.

It remains to determine the sign of per-customer retail profit (Π^{**}) at the collective optimum. To this end, it is helpful to make use of the parameter δ defined in (11). The sign of this parameter is given by

$$\delta = [y^1(p^{1*}, p^{2*})\, y^2(p^{1*}, p^{2*}) - \overline{\theta}\,[\partial y^1(p^{1*}, p^{2*})/\partial p^2] \overset{s}{=} \partial F_1(w^2,w^2)/\partial w^1$$
$$\overset{s}{=} d\Pi(p^{1*}, p^{2*}; w^1(w^2), w^2)/dw^2 \overset{s}{=} - dw^1(w^2)/dw^2.$$

Recall that $\delta > 0$ in the case of complementary goods, but that, for substitute goods, $\delta > 0$ when the goods are sufficiently *weak substitutes* and $\delta \leq 0$ when the goods are sufficiently *strong* *substitutes*. For these three cases, we have:

Proposition 3. (*i*) When the retail goods are complements ($\partial y^1(p^{1*}, p^{2*})/\partial p^2<0$), Π****>0 and $w^{1*}>c^1$; (*ii*) when the retail goods are weak substitutes ($\partial y^1(p^{1*}, p^{2*})/\partial p^2>0$), Π****<0 and $w^{1*}>c^1$; and (*iii*) when the retail goods are strong substitutes ($\partial y^1(p^{1*}, p^{2*})/\partial p^2>0$), Π****>0 and $w^{1*}<c^1$.

To understand Propositions 2 and 3, suppose the dominant manufacturer were to "pick" a wholesale price pair (w^1, w^2) to elicit optimal pricing of the fringe good, $p^2 = p^{2*}$. Given optimal pricing of the manufacturer's own brand under the vertical restraint, $p^1 = p^{1*}$, numerous wholesale price combinations exist that are capable of achieving the collective optimum. For any choice of w^1, a wholesale price exists for the fringe good –namely $w^2(w^1)$ that solves (16)—to elicit $p^2 = p^{2*}$. One such a solution was demonstrated earlier for the case of $w^2 = c^2$; however, unless the two retail goods have independent demands, the retailer would respond to the $w^1(w^2=c^2)$ that implicitly solves (16) by contracting with the fringe for some $w^2 \neq c^2$ to maximize retail profits in (18). This would lead to retail prices for good 2 that fail to maximize collective rents. Under what conditions on the dominant manufacturer's choice of w^1 would the retailers willingly *choose* the requisite w^2 to support p^{2*} in their contracts with the fringe?

Consider the case of substitute goods and suppose, as a benchmark, that w^2 is fixed at $w^2= c^2$. In this case, if the dominant manufacturer selects $w^1= c^1$, the retailers would then receive positive profits per-customer and set the retail price of the fringe good below p^{2*} to attract them. If the manufacturer increases w^1, this produces two effects: (*i*) the increase in w^1 curtails the business stealing externality on the interretailer margin, which favors a higher p^2; and (*ii*) the increase in w^1 decreases the retail margin on good 1 under the vertical restraint, $p^1 = p^{1*}$, which reduces the opportunity cost of shifting consumption from brand 1 to brand 2 on the intraretailer margin and favors a lower p^2. In the case of *strong* substitutes, the latter effect dominates and an increase in w^1 stimulates the retailers to lower p^2. The dominant manufacturer must lower w^1 below c^1 to induce the retailers to raise the price of good 2 to p^{2*}, and the collective optimum is achieved with positive variable profits for retailers ($\Pi>0$). In the case of *weak substitutes*, the former effect dominates. The business stealing incentive on the interretailer margin is stronger than the brand switching incentive on the intraretailer margin, and the dominant manufacturer now must raise w^1 above c^1 to induce the retailers to raise the price of good 2. Because retailers have an incentive to steal business from their rivals by setting $p^2 < p^{2*}$ as long as per-customer retail profit is positive, the dominant manufacturer must continue to raise w^1 above p^{1*}, and the collective optimum is achieved with negative variable profits for retailers ($\Pi<0$).

It is worthwhile to note that, in both cases, retailers have the incentives to contract for above-cost wholesale prices for the fringe good, $w^2 > c^2$. By (12), this implies that vertical restraints imposed by a manufacturer on the retailers of its product induce the retailers to levy positive tariffs ($f^{2*}>0$) on fringe suppliers. When per-customer profit is positive in the retail market ($\Pi>0$), a positive tariff commits the retailer to pay a higher good 2 wholesale price, which is advantageous because the rival responds with a higher retail price. A positive tariff is also advantageous when per-customer profit is negative in the retail market ($\Pi<0$). This is because the rival now responds to a higher wholesale price with a *lower* retail price, which rids the contracting retailer of costly customers on the interretailer margin.

Because the dominant firm's "pick" of $w^2 = c^2$ leads retailers to "choose" $w^2 > c^2$, consider an alternative "pick" of $w^2 > c^2$. To do so, it is helpful to examine the outcome when w^2 is raised, with w^1 adjusting to preserve retailer incentives to set $p^2 = p^{2*}$. For the case of *weak substitutes*, the business-stealing externality is the dominant one, and per-customer profit is negative in the retail market at the collective optimum. Now suppose the retailer's contract with a fringe supplier raises w^2 sufficiently far above c^2 that per-customer retail profit rises to zero. With $\Pi=0$, a retailer no longer has the strategic incentive to charge tariffs to the fringe, because stimulating a retail price response from his rival no longer shifts rent. A "pick" of $w^2 > c^2$ such that $\Pi=0$ by the dominant firm would lead retailers to "choose" $w^2 = c^2$. Thus, a pick of $w^2 = c^2$

(where $\Pi<0$) is "too low" and a pick of $w^2 > c^2$ (where $\Pi=0$) is "too high". An intermediate pick with $w^2 > c^2$ and $\Pi<0$ must therefore exist that prompts the retailers to choose the optimal wholesale price w^{2*}.

A similar argument applies in the case of *strong substitutes*. In this case, recall that a "pick" of $w^2= c^2$, yields $w^1< c^1$ and $\Pi>0$, because brand switching effects on the intraretailer margin dominate business stealing incentives. A wholesale price of $w^1<c^1$ fixes a high retail margin for good 1 under the restraint, and makes brand switching from good 1 to good 2 sufficiently unattractive to retailers to counter the business-stealing motivation for reducing p^2. Nonetheless, because $\Pi>0$, retailer contracts with the fringe that set $w^2 >c^2$ are advantageous in the sense that a higher wholesale price softens price competition (and consequently the need to reduce p^2). Now consider an alternative "pick" $w^2>c^2$. As w^2 rises from c^2, the business-stealing externality tempered, so that w^1 need not be set as low to preserve $p^2= p^{2*}$; that is, w^1 rises with w^2 at the collective optimum. If w^2 is set sufficiently high that w^1 rises to c^1 (i.e., $w^1= w^1(w^2) = c^1$), then the only departure from marginal cost wholesale pricing is for good 2. With $w^2>c^2$, this departure provides an incentive to raise p^2 above the collective optimal level, because the retailer would now bear a smaller cost in lost sales than would the integrated chain. To counteract the retailer's incentive to over-price the fringe good, a positive business-stealing incentive becomes necessary, and this requires that per-customer retail profit be positive. Thus, the monopolist's "pick" of $w^2>c^2$ (such that $w^1(w^2)=c^1$ and $\Pi>0$) is too high, while its pick of $w^2= c^2$ (with $\Pi>0$) is too low, and there is an intermediate "pick" with $w^2>c^2$ and $\Pi>0$ that prompts retailers to choose the optimal wholesale price w^{2*}.

5. Applications

This section considers applications of the model. For the case of substitute products, we consider a product category comprised of a national brand and a private label in the supermarket industry.[12] For complementary goods, we consider a product category comprised of an essential computer component and a number of commoditized components bundled with the essential component by Original Equipment Manufacturers (OEMs) in the personal computer industry.

Private Labels

Supermarkets, drug chains and mass merchandisers frequently offer private labels that are close substitutes to national brands. Private labels are a significant industry –representing 22 percent of total retail sales in Europe and 16 percent of total retail sales in North America (AC Nielsen, 2003). In U.S. supermarkets, private label products have a greater market share than the leading manufactured brand in nearly 30 percent of all categories, and private label brands account for over 40 percent of the products sold at Wal-Mart.

Private labels are supplied to retailers through one of three types of arrangement: (*i*) by the retailer himself (e.g., an in-store bakery); (*ii*) by the manufacturer of a national brand (e.g., Coca Cola produces ASDA Cola in the U.K.); and (*iii*) by contract manufacturers specializing in private label production (e.g., Ralcorp cereal and crackers). In the first two cases, horizontal control could be achieved directly, either by wholesale pricing or by vertical restraints without third party contracts; however, the latter type of arrangement is the most common. The private label market is dominated by small, independent suppliers (Supermarket News, 1995).

In most cases, private label procurement at supermarkets occurs through an in-house broker. An in-house broker (IHB) assists supermarkets with their private label programs by selecting suppliers and providing services such as label design, procurement, inventory management, quality control, retail pricing and merchandising. Nearly 80 percent of private label purchases by U.S. supermarkets are brokered through IHBs at a cost ranging from 1 percent to 6 percent of sales (PLBroker, 2004).

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[12] In general, the term "private label" refers to any product in which a manufacturer enters into a relationship with a buyer to use the buyer's name on its product. Under this definition, private labels are sold in a wide variety of product categories including wine, credit cards, medical equipment, electronics, software, and website content (both graphics and text). Here we choose to use the terms "private label" and "store brand" synonymously and focus on the case of supermarket private labels that are close substitutes for a national brand.

Our model predicts: (*i*) retailer contracts for private labels involving lump-sum payments from the suppliers to retailers and elevated wholesale prices ($w^2 > c^2$); (*ii*) a "loss-leader" outcome for the national brand ($w^1 > p^1$) in the case of independent goods and weak substitutes; and (*iii*) below-cost wholesale pricing of the national brand ($w^1 < c^1$) in the case of strong substitutes.[13] With regard to private labels, evidence suggests that IHBs rebate a significant share of their brokerage commission to retailers. IHBs either provide cash payments directly or provide "in kind" rebates to supermarkets by renting office space, by placing store employees on their payrolls, by purchasing retailer reports, and by performing service functions previously performed by supermarket personnel. Indeed, Marion (1998) estimates that up to 80-95 percent of the brokerage commission collected from private label suppliers by IHBs is rebated back directly to retailer accounts. Moreover, to the extent that brokerage commissions on private label sales pass through to price, this also raises the wholesale price, $w^2 > c^2$.

The model suggests that loss leader prices arise for national brands in categories with weak substitution possibilities, for instance among products with a high degree of quality differentiation such as canned soup. In product categories with strong substitution possibilities, for instance consumer staples such as butter, eggs, flour, milk, and sugar, the wholesale price of the national brand is set below marginal cost, leading to increased retailer margins.[14]

Original Equipment Manufacturers (OEMs)

Original Equipment Manufacturers (OEMs) design and sell equipment comprised of individual components made by other companies, for instance a personal computer manufacturer who bundles RAM, processing units, and operating software from various suppliers together under a brand. Typically, there are complementarities between components, and an important role for OEMs is to resolve coordination problems in pricing the individual components.

Throughout the computer and electronics fields, numerous companies operate as contract

[13] In all cases there is a tariff between manufacturer of the national brand and its retailers. This payment is made from retailers to the manufacturer in the case of strong substitutes.
[14] Chintagunta, Bonfrer and Song (2002) examine the effect of the introduction of store brand oats on wholesale and retail prices of Quaker Oats and find private label introduction caused wholesale prices to fall and facilitated higher retailer margins for the national brand.

manufacturers that specialize in OEM manufacturing. In the case of personal computers, OEMs produce an essentially modular product which can be assembled from standard parts available from a variety of contract manufacturers (CMs). The supply of components for the personal computer industry is dominated by Intel and Microsoft, and the remainder of the industry produces components that are widely recognized to be commoditized. By 2000, profits had essentially disappeared in components industries such as DRAM, hard disks and flat-panel displays, and profits from Microsoft and Intel accounted for 80 percent of industry profit (Dedrick and Kraemer, 2002).

Suppose consumers face the choice of buying a product from one of two OEMs. Each OEM offers a menu of computer components comprised of an essential component produced by a dominant manufacturer and a set of differentiated, commoditized components produced by a competitive fringe of CMs at a unit cost of c. Non-branded components are complementary to the essential component, and enter the utility function of the representative consumer symmetrically in the sense of Spence (1976).[15] With symmetric retail pricing of commoditized components, the relevant choice for the consumer is the number of components to purchase (or, for the case of a menu of components with differing quality, the quality level).

Our model predicts OEM relationships: (*i*) with the dominant manufacturer that involve above-cost wholesale pricing ($w^1 > c^1$) and a lump-sum transfer (paid either by the supplier or by the OEM); and (*ii*) with CMs that involve lump-sum payments ($f^2 > 0$) in exchange for elevated wholesale prices ($w^2 > c^2$). In the personal computer industry, it is widely known that Microsoft charged OEMs a license fee and a unit price for its Windows Operating System. Economides (2001) reports wholesale prices paid by OEMs for Windows in the range of \$40-60, an amount above marginal cost (which are negligible), but considerably lower than the static monopoly price. Contracts between OEMs and their CMs are closely-held; however, to the extent that two-

[15] Alternatively, the representative consumer could choose the quality level of a single, complementary component from a menu of products supplied by contract manufacturers, provided product quality can be measured in such a way that increasing quality involves unit cost.

part tariffs exist in the personal computer industry, the model suggests careful scrutiny of the practice is warranted under prevailing anti-trust laws.

6. Conclusion

The ability of a vertical restraint to serve as an instrument to exert horizontal control arises from three features of the retail environment: (*i*) retailers are imperfectly competitive; (*ii*) consumers are heterogeneous in terms of their preferences for retailers, for instance due to the presence of travel or search costs; and (*iii*) manufactured goods are bundled by retailers in the sense that each retailer sells multiple manufactured goods. Under these conditions, the manufacturer of a product sold in common by all retailers can employ vertical restraints as a mechanism to exert horizontal control over rival manufacturers.

Vertical restraints in multi-product retail environments produce symptoms both for the product sold by the controlling firm and for the product brought under horizontal control. For a dominant manufactured good, the vertical restraint involves below-cost wholesale pricing in the case of strong substitutes and wholesale prices set above the level of the restraint in the case of weak substitutes.

For commoditized goods sold under contract to the retailer, the symptom of a cross-product vertical restraint is a positive lump-sum transfer paid to retailers. Transfers in the form of contract manufacturers providing discounted loans, technology, and demonstration equipment to retailers are common in a variety of industrial settings, and, in the case of supermarket retailing, there is evidence that direct cash transfers occur through rebates paid to retailers by in-house-brokers of their private labels.[16]

In the literature following Telser (1960), vertical restraints serve to encourage retailer provision of services. It is interesting to note that, here, vertical restraints by one manufacturer can precipitate contracts by retailers that force rival manufacturers to provide them. The anti-

[16] Slotting allowances, a related form of cash payment by manufacturers to retailers for shelf-space in supermarkets, has drawn recent regulatory attention in the U.S. (FTC 2001).

competitive effect of such a practice suggests careful scrutiny under prevailing anti-trust laws.

An assumption of the model is that only two goods are traded in the product category. If this assumption was relaxed, vertical restraints could be used to achieve the collective optimum only in the case in which partial merger occurs into horizontal markets. Partial merger into horizontal markets by dominant manufacturers has occurred in several important industries (e.g., the entry of Microsoft into the browser market), and, to the extent that this practice is combined with the use of vertical restraints, further inquiry by antitrust authorities would appear to be justified.

The central assumption that supports our analysis is an element of product bundling at the retail level. This is certainly true in many retail settings, including supermarkets and personal computers. However, there are also limits to which retail bundling occurs, for instance supermarkets typically do not sell personal computers. Nonetheless, the underlying dynamics of the retail industry reveal a trend away from specialized shops and towards retail “superstores”, and an interesting area for future research is the potential for vertical restraints to stimulate such an agglomeration of products at the retail level.

Appendix

Proof of Lemma 1. Differentiating the first order condition (FOC) associated with problem (13) at $p^2 = p^2(w^1, w^2; \hat{p}^2)$ and making use the second order condition gives:

$$\partial p^2(\ )/\partial\hat{p}^2 \overset{s}{=} (\partial\Pi()/\partial p^2)\,[\partial\varphi()/\partial\bar{u}\,][\partial u^*(p^{1*},\ \hat{p}^2)/\partial\hat{p}^2\,]$$
$$= \Pi()\{y^2(p^{1*}, p^2)/2\bar{\theta}\varphi\}\{y^2(p^{1*}, \hat{p}^2)/2\bar{\theta}\} \overset{s}{=} \Pi(),$$

where the equality substitutes from the FOC and expands relevant partial derivatives. QED.

Proof of Proposition 2. First note the following (given Assumption 1):

Claim 1. At $w^2 = c^2$, $F_2(w^1(w^2), w^2) > 0$ in (16) (where $w^1(w^2)$ solves (14)).

Proof of Claim 1. First note that, if $\Pi=0$ and $w^2= c^2$, then (14) implies that $w^1=c^1$ and, hence, $\Pi>0$, a contradiction. Therefore, at $(w^1,w^2)=(w^1(c^2),c^2)$, $\Pi\neq0$. With $\Pi\neq0$, Lemma 1 implies that the first set of right-hand terms in (16) is positive; with $w^2= c^2$, the second set of right-hand terms in (16) is zero. QED Claim 1.

Claim 2. There is a bounded $\hat{w}^2 > c^2$ such that $F_2(w^1(\hat{w}^2), \hat{w}^2) < 0$ in (18).

Proof of Claim 2. Define $\hat{w}^2$ by $w^1(\hat{w}^2)= c^1$; that is, from (16),

(A1) $\hat{w}^2 - c^2 = \Pi(p^{1*}, p^{2*}; c^1, c^2)\{y^2(p^{1*},p^{2*})/\bar{\theta}\} \,/\, \{[y^2(p^{1*}, p^{2*})^2/\bar{\theta}]-[\partial y^2(p^{1*},p^{2*})/\partial p^2]\} > 0.$

Also from (14), we have

(A2) $\Pi(p^{1*}, p^{2*}; c^1, w^{2*}) \overset{s}{=} \hat{w}^2 - c^2 > 0.$

Hence, by Lemma 1 and Assumption 1, $0 < \partial p^2(\ )/\ \partial\hat{p}^2 < 1$ at $(w^1,w^2) = (c^1, \hat{w}^2)$, which implies (together with $\Pi>0$ and $\hat{w}^2 > c^2$):

(A3) $F_2(c^1, \hat{w}^2) < \Pi()\, y^2() + (\hat{w}^2 - c^2)\ \bar{\theta}\ [\partial y^2()/\partial p^2] = - (w^1- c^1)(\partial y^1()/\partial p^2) = 0,$

where the first inequality evaluates the right-hand-side of (16) at $\partial p^2(\ )/\partial\hat{p}^2 = 1$; the first equality substitutes from (14); and the final equality id due to $w^1(\hat{w}^2)= c^1$. QED Claim 2.

Claim 3 (Proposition 4). There is a $w^{2*}\in(c^2, \hat{w}^2)$: $(w^1,w^2)=(w^1(w^{2*}),w^{2*})$ solve (14) and (16).

Proof of Claim 3. Follows directly from Claim 1, Claim 2, continuity of $F_2(w^1(w^2),w^2)$ in w^2, and the Intermediate Value Theorem (IVT). QED.

Proof of Proposition 3. For part (i), first note:

Claim 4. If the goods are complements, $\Pi(p^{1*}, p^{2*}; w^1(c^2), c^2)>0$.

Proof of Claim 4. Suppose not, $\Pi\leq 0$ at $(w^1,w^2)=(w^1(c^2),c^2)$. Then in order to satisfy (14),

(A4) $$F_1(w^1,c^2) = \Pi()\, y^2() - (w^1 - c^1)\ \overline{\theta}\ [\partial y^1()/\partial p^2] = 0.$$

Given $[\partial y^1()/\partial p^2] <0$ (complements), (A4) requires that $w^1\leq c^1$; however, with $w^2=c^2$ and $w^1\leq c^1$, $\Pi>0$, a contradiction. QED Claim 4.

Proposition 4(i) now follows from Claim 4 ($\Pi>0$ at $w^2=c^2$), $d\Pi(.;w^1(w^2),w^2)/dw^2 > 0$ (by $\delta>0$ for complements), and $w^{2*}>c^2$ (Proposition 3), which together imply $\Pi^{**}>0$ and hence (by Lemma 2), $w^{1*}>c^1$.

For part (ii), first note:

Claim 5. If the goods are weak (strong) substitutes, $\Pi(p^{1*},p^{2*};w^1(c^2),c^2) < (>)\ 0$.

Proof of Claim 5. At $(w^1,w^2)=(c^1,c^2)$, $\Pi(c^1,c^2)>0$ and $F_1(c^1,c^2)<0$ (from (14)/(A4)); moreover, $\partial F_1(w^1,c^2)/\partial w^1 = \delta > (<)\ 0$ (for weak (strong) substitutes); hence, $F_1(w^1,c^2)<0$ for all $w^1 \leq (\geq)\ c^1$ and, in order to satisfy (14)/(A4), $w^1(c^2) > (<)\ c^1$. With $[\partial y^1()/\partial p^2] >0$ (substitutes) and $w^1>(<)c^1$, satisfaction of (A4) (and hence, (14)) requires that $\Pi(.;w^1(c^2),c^2)$ be negative (positive). QED Claim 5.

From (A2), we have that $\Pi(.;w^1(\hat{w}^2), \hat{w}^2) >0$ for $\hat{w}^2 >c^2$. With $\Pi(.;w^1(c^2),c^2)<0$ (Claim 5 for weak substitutes) and $\Pi(.;w^1(\hat{w}^2), \hat{w}^2)> 0$, there is a $\hat{w}^{2+} \in(c^2, \hat{w}^2)$: $\pi(.;w^1(\hat{w}^{2+}), \hat{w}^{2+})=0$ (by continuity of $\Pi(.;w^1(w^2),w^2)$ in w^2 and the IVT). Moreover, at $w^2= \hat{w}^{2+}$, $F_2(w^1(w^2),w^2)<0$ (because $\Pi()=0$ and $w^2=\hat{w}^{2+}>c^2$); hence, given Claim 1, continuity of $F_2(w^1(w^2),w^2)$ in w^2, and the IVT, $w^{2*}\in(c^2,\hat{w}^{2+})$ and $w^{1*}= w^1(w^{2*})$ solve (14) and (16). With $\Pi(.;w^1(\hat{w}^{2+}), \hat{w}^{2+})=0$, $w^{2*} < \hat{w}^{2+}$, and $d\Pi(.;w^1(w^2),w^2)/dw^2>0$ (by $\delta>0$ for weak substitutes), we have $\Pi^{**}<0$ and hence (by Lemma 2), $w^{1*}> c^1$.

For part (iii), $\Pi^{**}= \Pi(.;w^1(w^{2*}),w^{2*})>0$ follows from: (a) $\Pi(.;w^1(c^2),c^2)>0$ (Claim 5 for strong substitutes); (b) $\Pi(.;w^1(\hat{w}^2), \hat{w}^2)>0$ (from (A1)-(A2)); (c) $w^{2*}\in(c^2, \hat{w}^2)$ (Claim 3 of Proposition 3) ; and (d) $d\Pi(.;w^1(w^2),w^2)/dw^2\leq 0$ (by $\delta\leq 0$ for strong substitutes). Hence, $w^{1*}< c^1$ follows from Lemma 2. QED.

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