# Unobservable Vertical Restraints and Interbrand Competition

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**Abstract**

This paper presents a model of vertical restraints with unobservable contracts in a market where retailers compete in price and service. The equilibrium contracts under the *franchise* and the *resale price maintenance* arrangements are shown to differ in the way they lessen competition between retailers. The franchise contract is more effective for lessening competition in price while the RPM for collusion in service. Consequently, the equilibrium of the manufacturers' vertical restraint selection game depends on the nature of their strategic interaction. An increase in retailer's risk aversion and/or demand uncertainty favors RPM.

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# 1 Introduction

The vertical contractual relationship between two parties in the chain of production or marketing has long been a subject of study by economists for its economic logic and its potentially anti-competitive nature. On the one hand, most of the existing literature on vertical restraints has studied the delegation problem between a single manufacturer and one or several retailers who sell the manufacturer's goods, which stems from the externalities in *intrabrand* competition[1] However, since these vertical structures[2] usually compete with other manufacturers or retailers in actual markets, the strategic aspect of this *interbrand* competition can play as important a role in the choice of vertical arrangement as the delegation problem.

On the other hand, those models that explicitly consider strategic interaction have focused on the strategic value of contract as a commitment device.[3] In these models with risk-neutral agents, as Katz (1991) showed, it is crucial that the contracts be observable to the competing hierarchies to serve any strategic purpose. Vertical arrangements, however, do not necessarily take the form of observable, non-renegotiable contracts. Typically, the financial terms of a vertical contract are not disclosed at all to the outside parties, and even in the case they are announced, the contract can be easily modified through renegotiation as in Caillaud, Jullien and Picard (1995).

In this paper, we study the strategic effect of unobservable vertical restraints in the context of two competing vertical structures, each consisting of a risk-neutral manufacturer and a risk-averse retailer, and obtain different types of equilibrium vertical restraint depending on the nature of retail competition. By an unobservable vertical restraint, we mean a vertical arrangement in which the manufacturer can commit herself to a particular type of vertical restraint but cannot credibly commit to the exact terms of arrangement such as prices and transfer payment, vis-a-vis outside parties. For example, while a manufacturer may announce in advance that her retailer will sell the product at a certain retail

[1]For a comprehensive survey, see Katz (1989).

[2]We will use such terms as vertical structure, manufacturer-retailer pair, and hierarchy interchangeably.

[3]See Brander and Lewis (1986) for the determination of a firm's capital structure, and Rey and Stiglitz (1986), Fershtman and Judd (1987), and Kühn (1993) in the context of oligopoly.

price, she and her retailer cannot be credibly prevented from charging actually a different price in retail competition if they agree to do so.

Specifically, we consider a game in which each manufacturer first announces simultaneously which type of vertical restraint to use and then proceeds to sign a contract of the chosen type with her retailer, who in turn competes with the other retailer in the downstream market, in two dimensions—price and service, before the uncertain demand is realized. In solving for equilibrium, we restrict the feasible contracts to a set of most commonly used vertical restraints: franchise and resale price maintenance.[4] A *franchise* (FR) contract between a manufacturer and a retailer consists of a wholesale price and a fixed franchise fee, whereas a *resale price maintenance* (RPM) contract specifies a retail price in addition to the above two terms.

A vertical restraint in this context plays three roles:

(i) to give the retailer incentives to provide service,

(ii) to provide the retailer with insurance, and

(iii) to influence strategic interaction among competing vertical structures.

In the standard principal-agent model, providing insurance for an agent is often in conflict with providing proper incentives for him. However, in the context of interbrand competition, manufacturers may take advantage of this conflict to affect the strategic interaction, for example, to facilitate collusion between the retailers. That is, retailers' risk aversion may not necessarily hurt manufacturers. The purpose of our paper is to pursue this intuition in the case of unobservable contracts to find the equilibrium vertical restraint.

We find that unobservable vertical restraints are strategically relevant in two respects. First, the equilibrium wholesale price is strictly higher than the marginal cost so that retailers will behavior differently in retail competition than manufacturers would, which is a key insight of Katz (1991) who argues that even unobservable contracts matter in the case of risk-averse agents. Second, a different vertical restraint obtains in equilibrium depending on the nature of retail competition, as well as the risk aversion of retailers and the uncertainty in the retail market. In this sense, unobservable vertical restraints do matter

[4]Our focus here is not so much what the optimal vertical restraint of a given type looks like as why and how different types of vertical restraint obtain in equilibrium as we observe in different markets.

strategically since franchise would be weakly dominated by RPM for a monopoly manufacturer in our formulation.[5] In particular, franchise is the equilibrium vertical restraint when price competition is dominant in retail market, while resale price maintenance is the equilibrium when service competition is dominant.

A higher wholesale price makes each retailer a less aggressive player in retail competition either in price or service, and consequently, can induce a more collusive outcome. Since gains from collusion are greater the more intense is competition, a manufacturer will choose such a type of vertical restraint that better facilitates collusion in whichever dimension of competition is more intense. On the one hand, a franchise contract induces the retailer to charge a higher retail price, which lessons retail competition in price. On the other hand, a resale price maintenance contract induces the retailer to provide lower service, which lessons competition in service. This is in contrast to the models of intrabrand competition where RPM functions as a price floor to give retailers a stronger incentive to provide service. Under interbrand competition, RPM functions as if a price ceiling in equilibrium to lessen service competition. The use of RPM as price ceiling also appears in Gal-Or (1991), in which the "maximum retail price maintenance" agreement, or "forcing" contract, arises in equilibrium to limit the informational rents enjoyed by the retailers.

Finally, we find that with an increase in risk aversion or demand uncertainty, RPM becomes more likely to be the equilibrium vertical restraint, since it is more effective in providing insurance than franchise. In this sense, our model is an extension of Rey and Tirole (1986) to the case of interbrand competition, at least for manufacturers' choice. The welfare implications of equilibrium vertical restraints wait for future analysis.

A vertical restraint in our model is essentially a publicly observable way to allocate *decision-makings* between manufacturer and retailer without making public the *decision* itself. With risk-neutral retailers, any allocation of decision-making would not have a strategic effect since the retailer's incentive can be perfectly aligned with the manufac-

[5]To see this, note that retailers choose their action before the uncertain demand is realized, so that the agency problem between manufacturer and retailer in our model is that of pure moral hazard. Therefore, a monopoly manufacturer can do at least as well with RPM as with franchise because RPM provides her with more control variables.

turer's interests. With risk-averse retailers, however, there remains an intrinsic conflict of interests between the two parties due to risk aversion, and consequently the choice of vertical restraint can be a credible commitment to a particular behavior in retail competition. In this regard, an important assumption is that the type of vertical restraint is observed by the competing hierarchy *before* retail competition, and that it cannot be renegotiated to the other type later on. In other words, the parties can renegotiate over the terms of contract but not over the form of contract. This will be the case when the choice of vertical restraint must be accompanied by an observable, and irreversible, "investment."[6] If, on the other hand, the renegotiation over the contractual form were to be feasible, franchise contract would not obtain in equilibrium because RPM can always do better *given* the rival's action in retail competition (See footnote 5). This will be the case when the "retailer" is the manager of sales department of a manufacturing firm, who is given an incentive contract but is still under the authority of the firm's owner or CEO.

In this respect, our results provide an explanation for why a manufacturer would like to sign up an independent retailer, rather than rely on their own sales department, even when the retailer does not have a superior information on the demand: an independent retailer provides for the manufacturer a more credible way of commitment to a strategically advantageous action in retail competition. They are also consistent with the intuition of Caillaud, Jullien and Picard (1995) that a publicly announced contract can have precommitment effects when it can be secretly renegotiated, only if it induces a more desirable behavior from the agent.

Among the other related literature, Rey and Stiglitz (1994) also explicitly analyze the equilibrium vertical restraint in the strategic context and show that franchise is preferred to "competition," i.e., no vertical restraint, if the cross price elasticity of demand is high enough. Kühn (1993) studies duopolistic competition where each manufacturer designs a wholesale price schedule for her retailer who then competes in quantity, and obtains a quantity-discounted wholesale price in equilibrium even with a constant marginal cost of production, for example, which makes retailers more aggressive and leads to a more com-

[6]For example, franchise contract would require the retailer to set up an elaborate marketing operation of his own, whereas RPM contract would require the manufacturer to set up a monitoring system to police retail price.

petitive outcome. However, as noted above, both of the works depend for their results on observable contracts and risk neutral retailers. In another paper that is closely related to our model in its emphasis on the unobservability of contracts, Martimort (1996) considers two competing principal-agent pairs who sign "secret" contracts which specify payment to the principal and the capacity choice according to the agent's report of observed state of the world. Then he finds equilibrium truth-telling mechanisms in exclusive dealing and common agency settings, and goes on to show that the choice between exclusive dealing and common agency will depend on the degree of uncertainty and the substitutability of the action. In the standard terminology, the incentive problem of his model is adverse selection while ours is moral hazard. Since his contract is in the more general form of mechanism, it is not as easy to interpret the equilibrium contract in terms of commonly observed vertical restraints.

The paper is organized as follows. Section 2 presents the formal model and derives a benchmark case of vertically integrated firms. Section 3 derives the equilibrium vertical contracts given a configuration of vertical restraints. Section 4 considers the manufacturers' vertical restraint selection game to determine the equilibrium vertical restraint, and the final section concludes.

## 2 The Model

We consider two upstream manufacturers, each of whom produces a differentiated product at a constant marginal cost $c$ and hires one retailer to sell the product in the downstream market. The demand for each manufacturer's product ($Q_1$ and $Q_2$) is determined by the price charged by the retailers ($p_1$ and $p_2$), the service the retailers provide ($s_1$ and $s_2$), and a common demand shock $\theta$, which is realized after the retailers have chosen their price and level of service. We regard the "service" as a measure of the activities of the retailers that constitute non-price competition, such as advertisement, promotional activities, in-store sales pitch and customer relations, and therefore an increase in the rival's service will decrease the demand for one's own product.[7] We assume that the level of service is not

[7]This is in contrast to the *positive* externalities of service among retailers in the context of intrabrand competition.

contractible, because it is not observable to the manufacturers and is too complex to be *ex-post* verifiable. Therefore, contracts must be contingent only on wholesale and retail quantities and prices.

Of such contracts, we restrict attention to two subclasses, which are the two most commonly observed vertical arrangements: franchise and resale price maintenance. A *franchise* (FR) contract is a pair $(w_i, A_i)$, where $w_i$ is the wholesale price that the manufacturer charges to her retailer, and $A_i$ is the fixed fee that the retailer pays to his manufacturer upfront. A *resale price maintenance* (RPM) contract is a triplet $(p_i, w_i, A_i)$, where $p_i$ is the retail price enforced by the manufacturer.

The timing of sequence of events is as follows:

> At time $t = 0$, each manufacturer decides on vertical restraint by simultaneously announcing the *type* of vertical contracts, $\mathcal{C} \in \{\mathcal{C}^{FR}, \mathcal{C}^{RPM}\}$, which she will sign with her retailer. This determines a *configuration* of vertical restraints.[8]
>
> At time $t = 1$, each manufacturer signs an unobservable vertical contract $C_i \in \mathcal{C}$ with her own retailer.[9]
>
> At time $t = 2$, each retailer then chooses $p_i$ and $s_i$ to maximize his own expected utility given his own contract.
>
> At time $t = 3$, the common demand shock $\theta$ is realized, and the quantity demanded is determined.

We will analyze the equilibrium vertical contracts under given vertical configurations (from time $t = 1$ on) in the next section, and then analyze the equilibrium configuration of vertical restraints in Section 4.

The following assumptions on the demand, the utility and the cost of service functions are imposed so that an equilibrium exists and can be characterized:

[8]We will subsequently use a (vertical) configuration whenever there is no possibility of confusion. In our model with 2 types of vertical restraints, there will be 4 different vertical configurations.

[9]Each retailer is assumed to be given an exclusive territory under an exclusive dealing arrangement, as in the case of a fast food chain, since our goal is to analyze the non-cooperative aspect of interbrand competition. See Bernheim and Whinston (1992) and Martimort (1993) for extensive analysis of common agency.

**Assumption 1** The demand for manufacturer $i$'s product is

$$Q_i(p_i, s_i, p_{-i}, s_{-i}, \theta) = M + \theta - p_i + a_p p_{-i} + s_i - a_s s_{-i} \text{ for } i = 1, 2,$$

where $0 < a_p < 1$, $0 < a_s < 1$, and $\theta$ is normally distributed with the mean 0 and the variance $\sigma_\theta^2$.

**Assumption 2** The cost of production is given by a constant marginal cost $c$ for both manufacturers. We assume that $M$ and $c$ are such that the expected demand is always positive in relevant ranges of price and service.

**Assumption 3** The cost of service is given by $G(s_i) = {s_i}^2$ for $i = 1, 2$.

**Assumption 4** For a given profit $\pi_i$ and a service $s_i$, the retailer's utility is given by $U(\pi_i - G(s_i))$ for $i = 1, 2$, where $U$ is a CARA utility function: $U(x) = -e^{-rx}$, where $r$ is the constant degree of absolute risk aversion. The manufacturer is risk-neutral.

The parameters $a_p$ and $a_s$ represent the sensitivity of the demand for one's product to a change in the rival's price and service, and will be interpreted as the intensity of competition in price and service, respectively. Together, they determine the strategic property of price and service, as we will see shortly. The cost of service can be either non-pecuniary in the form of personal effort or pecuniary in the form of expenditure on advertising, promotional drive, etc. What matters for our purpose is that it is noncontractible because it is an unobservable effort or nonverifiable expenditures.

**Vertically Integrated Firms** Before concluding this section, we derive, as a benchmark, the equilibrium of a game where manufacturers themselves compete with each other in the retail market. The equilibrium prices and services of this benchmark will be useful for studying the implication of the retailers' risk aversion for the choice of vertical contract in the subsequent sections. $(p_i, s_i)$ are a Nash equilibrium of this benchmark game if they solve the following program for each $i$:

$$\max_{p_i, s_i} E\left[(p_i - c)\, Q_i(\theta) - G(s_i)\right]. \qquad (\mathbf{F})$$

The first-order conditions for equilibrium price and service for $i = 1, 2$ are given by

$$p_i - c = M - p_i + a_p p_{-i} + s_i - a_s s_{-i}, \quad (1)$$

$$p_i - c = 2s_i, \quad (2)$$

which can be simplified as

$$3p_i - (2a_p - a_s)p_{-i} = 2M + (1 + a_s)c. \quad (3)$$

In contrast to a game where price is the only strategic variable, price can be either a strategic complement or substitute depending on the nature of retail competition in our model where retailers compete in two dimensions. When the price competition is intense enough compared to service competition ($a_p > a_s/2$), price is a strategic complement. On the other hand, when the service competition is intense enough ($a_p < a_s/2$), price becomes a strategic *substitute*. This comes about because an increase in the rival's price induces a decrease in one's own demand in this case, to which the best response is a lower price.[10] Finally, the symmetric Nash equilibrium of the benchmark game is given by

$$p^F = \frac{2M + (1 + a_s)c}{3 - 2a_p + a_s} \quad \text{and} \quad s^F = \frac{M - (1 - a_p)c}{3 - 2a_p + a_s}. \quad (4)$$

# 3 Equilibrium Vertical Contracts

In this section, we analyze vertical contracts in a given configuration by studying the subgame subsequent to the announcement of vertical structure, in which feasible vertical contracts are restricted to the announce type. An equilibrium of this four-player game, *vertical equilibrium*, consists of vertical contracts chosen by the manufacturers and retail prices and services chosen by their retailers. The important implication of the unobservability of contracts in solving for equilibrium is that, in deciding on the contract with her retailer, each manufacturer considers only its effect on her own retailer's action while regarding the rival's contract and actions as fixed.

[10]Service in our model turns out to be not a direct strategic variable. However, since it is positively correlated with price, we can say that it has the same strategic property as price indirectly.

### 3.1 Vertical Equilibrium under Franchise

A *franchise* contract specifies a wholesale price $w_i$ and a fixed franchise fee $A_i$, and the retailer decides the price and service levels after observing the market demand. The equilibrium contracts $\{(w_i^{FR}, A_i^{FR}),\ i = 1, 2\}$ and equilibrium retail prices and services $\{p_i^{FR}, s_i^{FR},\ i = 1, 2\}$, therefore, simultaneously solve the following program for each manufacturer:

$$\begin{aligned} \max_{w_i, A_i;\ p_i, s_i} \quad & E\left[(w_i - c)Q_i + A_i\right] \\ \text{subject to} \quad & (p_i, s_i) \in \operatorname{argmax} E\left[U((p_i - w_i)Q_i - G(s_i) - A_i)\right], \qquad (5) \\ & E\left[U((p_i - w_i)Q_i - G(s_i) - A_i)\right] \geq U(0) \qquad (6) \end{aligned}$$

The objective function is the manufacturer's expected profit, and (5) represents the equilibrium in retail competition, under franchise. (6) is the retailer's individual rationality (IR) constraint, guaranteeing his reservation utility level which is set to 0.

Note Assumption 1 implies that the net profit to the retailer, once the vertical contract, the retail price and service are chosen, is normally distributed. Since the retailer's utility function is exponential, his expected utility in (5) can be represented in terms of certainty equivalent:

$$E\left[U((p_i - w_i)Q_i - G(s_i) - A_i)\right] = U((p_i - w_i)Q_i^e - s_i^2 - A_i - \frac{1}{2}r\sigma_\theta^2(p_i - w_i)^2), \qquad (7)$$

where $Q_i^e = E[Q_i] = M - p_i + a_p p_{-i} + s_i - a_s s_{-i}$.

Then the retail competition equilibrium condition (5) can be replaced by the first-order conditions with respect to price and service choices by the retailer, and the individual rationality condition (6) should be binding in equilibrium because the fixed fee $A_i$ can be adjusted without affecting the retailer's choice, as we will see below. Now we can characterize the equilibrium franchise contract and the retail equilibrium in the following lemma.

**Lemma 1** *A pair of franchise contracts and a pair of retail prices and services,* $\{(w_i^{FR}, A_i^{FR}); (p_i^{FR}, s_i^{FR}),\ i = 1, 2\}$, *constitute a vertical equilibrium if and only if they satisfy*

$$(w_i - c)\left[-\frac{2(1 + r\sigma_\theta^2)}{3 + 2r\sigma_\theta^2}\right] + (p_i - w_i)r\sigma_\theta^2 = 0, \qquad (8)$$

$$(p_i - w_i)(1 + r\sigma_\theta^2) - Q_i^e = 0, \tag{9}$$

$$p_i - w_i - 2s_i = 0, \tag{10}$$

$$(p_i - w_i)Q_i^e - s_i^2 - \tfrac{1}{2}r\sigma_\theta^2(p_i - w_i)^2 - A_i = 0. \tag{11}$$

*Proof.* First, note that the retailer's objective function in (7) is concave so that the necessary and sufficient conditions for retail equilibrium are characterized by the first-order conditions (9) and (10) with respect to price and service choices, respectively.[11]

Second, since $A_i$ does not appear in the retailer's first-order conditions, the manufacturer can adjust the fixed fee without affecting the retailer's choice so that she will extract all the surplus from him. Therefore, the binding IR condition (11) determines the fixed fee $A_i$.

Finally, the manufacturer's program can be rewritten as

$$\max_{w_i} \quad E\left[(w_i - c)Q_i(p_i(w_i), s_i(w_i)) + A_i(w_i)\right],$$

since the conditions (9), (10), and (11) together define $p_i$, $s_i$, and $A_i$ as functions of $w_i$. By using the Envelope Theorem, we can write the first-order condition for the wholesale price as follows:

$$(w_i - c)E\left[\frac{dQ_i}{dw_i}\right] + (p_i - w_i)r\sigma_\theta^2 = 0,$$

where $E\left[dQ_i/dw_i\right] = -2(1 + r\sigma_\theta^2)/(3 + 2r\sigma_\theta^2)$. Furthermore, it is simple to check that this manufacturer's objective function is indeed concave, and therefore the condition (8) is necessary and sufficient for equilibrium.

*Q.E.D.*

The direct effect of risk aversion on retail competition can be immediately seen by comparing (9) and (1) for the integrated firm. A risk-averse retailer would choose a lower price, *given the same wholesale price*, since it would result in a lower risk premium. This does not necessarily mean the retail price will be lower *in equilibrium* because an equilibrium wholesale price can be different from the marginal cost under vertical contracts. In fact, (8) implies that the wholesale price will be strictly above the marginal cost, as long as the expected demand is positive as assumed. This positive wholesale markup is

[11] The first-order derivative of utility function $U'$ is suppressed since it is strictly positive.

an example of a more general proposition, first articulated by Katz (1991), that unobservable contracts can be manipulated for strategic purposes in equilibrium when agents are risk averse. How it affects the choice of vertical restraint will be investigated in the next section.

We conclude this subsection with the derivation of symmetric vertical equilibrium.

**Proposition 1** *In the symmetric vertical equilibrium under franchise, the equilibrium wholesale price, retail price and service are given as follows, respectively:*

$$\begin{aligned} w^{FR} &= c + \frac{(3+2r\sigma_\theta^2)r\sigma_\theta^2}{3-2a_p+a_s+(8-5a_p+a_s)r\sigma_\theta^2+2(2-a_p)r^2\sigma_\theta^4}\left[M-(1-a_p)c\right], \\ p^{FR} &= \frac{1}{3-2a_p+a_s+2r\sigma_\theta^2}\left[2M+(1+a_s+2r\sigma_\theta^2)w^{FR}\right], \\ s^{FR} &= \frac{1}{3-2a_p+a_s+2r\sigma_\theta^2}\left[M-(1-a_p)w^{FR}\right]. \end{aligned}$$

The intuition for the positive wholesale markup is easier to understand when we rewrite the manufacturer's payoff function, by substituting (11), as follows:

$$E\left[(w_i-c)Q_i+A_i\right] = (p_i-c)Q_i^e - s_i^2 - \frac{1}{2}r\sigma_\theta^2(p_i-w_i)^2, \tag{12}$$

that is, the manufacturer's expected payoff is the expected retail profits (first two terms) minus the risk premium that has to be compensated to the retailer. When $w_i$ is set equal to $c$, a small increase in $w_i$ has no marginal effect on the retail profits, but a negative effect on the risk premium (a gain for the manufacturer). It is this private incentive due to reduction in the risk premium that makes it credible for a manufacturer to raise her wholesale price above the marginal cost under unobservable vertical contracts.

### 3.2 Vertical Equilibrium under RPM

Under resale price maintenance arrangement, a contract will specify not only a wholesale price and a fixed fee but a fixed retail price as well.[12] The retailer will, in this case, choose only the optimal service level given the specified retail price and the market demand. Then the equilibrium contracts $\{(p_i^{RPM}, w_i^{RPM}, A_i^{RPM}),\ i=1,2\}$ and retail service $\{s_1^{RPM}, s_2^{RPM}\}$

[12]We can think of the RPM contract as a simplest form of price-based contract.

will simultaneously solve the following program for each manufacturer:

$$\begin{aligned} \max_{w_i, p_i, A_i;\ s_i} \quad & E\left[(w_i - c)Q_i + A_i\right] \\ \text{subject to} \quad & s_i \in \operatorname{argmax} E\left[U((p_i - w_i)Q_i - G(s_i) - A_i)\right], \\ & E\left[U((p_i - w_i)Q_i - G(s_i) - A_i)\right] \geq U(0) \end{aligned}$$

By applying essentially the same argument as in the franchise case, we get the following necessary and sufficient conditions, corresponding to Lemma 1, for a vertical equilibrium under resale price maintenance:

$$(w_i - c)\left[-\tfrac{1}{2}\right] + (p_i - w_i) r\sigma_\theta^2 = 0, \tag{13}$$

$$(p_i - c) - Q_i^e = 0, \tag{14}$$

$$p_i - w_i - 2s_i = 0, \tag{15}$$

$$(p_i - w_i)Q_i^e - s_i^2 - \tfrac{1}{2} r\sigma_\theta^2 (p_i - w_i)^2 - A_i = 0. \tag{16}$$

As in the previous subsection, (13) implies the wholesale price under RPM will be strictly above the marginal cost, while (15) and (16) determine the service and the fixed fee, respectively.

In comparison to franchise contract, we note on the one hand that (13) implies a manufacturer under RPM contract would set a higher wholesale price *given the same retail margin*, $p_i - w_i$, and on the other hand that (14) implies she would set a lower retail price *given the same wholesale price*.[13] Furthermore, given the two observations, (15) implies that a retailer under RPM would provide less service. To be sure, these observations may not necessarily hold true for the actual equilibrium prices or service, since wholesale prices will be determined endogenously in equilibrium and may be indeed different. But they do indicate how different types of vertical contract affect the competition in the retail market by changing behaviors of manufacturer and retailer. This difference will play a crucial role in determining equilibrium vertical restraints in the next section.

The following proposition summarizes the vertical equilibrium under RPM.

[13]The condition (14) looks as if the manufacturer were choosing her retail price as an integrated firm which cares about the net profits alone. The retail price's indirect effect on net profits through service and its effect on risk premium turn out to cancel each other out in equilibrium. This property does not depend on any of our assumptions other than that service enters the demand function additively.

**Proposition 2** *In the symmetric vertical equilibrium under RPM, the equilibrium wholesale price, retail price and service are given as follows, respectively:*

$$\begin{aligned} w^{RPM} &= c + \frac{4r\sigma_\theta^2}{3 - 2a_p + a_s + 4(2 - a_p)r\sigma_\theta^2}\left[M - (1 - a_p)c\right], \\ p^{RPM} &= \frac{1}{3 - 2a_p + a_s + 4r\sigma_\theta^2}\left[2M + (1 + a_s + 4r\sigma_\theta^2)w^{RPM}\right], \\ s^{RPM} &= \frac{1}{3 - 2a_p + a_s + 4r\sigma_\theta^2}\left[M - (1 - a_p)w^{RPM}\right]. \end{aligned}$$

### 3.3 Vertical Equilibrium under Mixed Configuration

Finally, we consider an asymmetric situation of mixed vertical contract types: one manufacturer has chosen a franchise contract while the other a RPM contract.[14] Note that our previous analyses of manufacturer's problem for equilibrium conditions under the identical type of contract did not need to presume the type of her rival's contract, and consequently, can be applied here to the corresponding manufacturer.

In a vertical equilibrium under the mixed configuration, therefore, Manufacturer 1's franchise contract and her retailer's price and service, $(w_1^{FR}, A_1^{FR}; p_1^{FR}, s_1^{FR})$, satisfy (8) – (11), and Manufacturer 2's RPM contract and her retailer's service, $(w_2^{RPM}, p_2^{RPM}, A_2^{RPM}; s_2^{RPM})$, satisfy (13) – (16), simultaneously. The actual equilibrium is derived in Appendix A.

Before we move on, let us briefly remark on how unobservable vertical contracts can play any strategic role. The problem for a manufacturer who is to design a vertical contract is, if and how she can influence her rival's retail price and service just by announcing her commitment to a type of vertical restraint when the actual terms of contract, $w_i$ or $p_i$ for example, are not observable to the rival. The answer lies in the fact that choosing a different type of vertical restraint essentially amounts to committing to a *different behavior* both in terms of wholesale and retail prices, and of service. Then the rival will take the different behaviors into account when he designs his own vertical contract or chooses price and service.

[14] Without loss of generality, we assume Manufacturer 1's contract is franchise, and Manufacturer 2's RPM.

| | | Manufacturer 2 | |
|---|---|---|---|
| | | FR | RPM |
| Manufacturer 1 | FR | $(V^{FR}, V^{FR})$ | $(V_1^{FR}, V_2^{RPM})$ |
| | RPM | $(V_1^{RPM}, V_2^{FR})$ | $(V^{RPM}, V^{RPM})$ |

Figure 1: Vertical Restraint Selection Game

The difference in pricing and servicing behavior is due to the fact that decision making on strategic variables is differently distributed between the manufacturer and her retailer under franchise than under RPM, who have divergent incentives. These conflicts are, in turn, induced by risk aversion of the retailer and the demand uncertainty. The "commitment" to a different behavior is credible because the rival knows that the manufacturer and her retailer would behave in the same way even in his absence.

# 4 Equilibrium Vertical Restraints

We now complete the analysis of equilibrium vertical restraints by studying the manufacturers' choice of vertical contract type. Given the timing of the game, their decision will depend on the payoffs at vertical equilibrium from the resulting configuration of vertical restraints. Therefore, it can be represented by a 2×2 matrix game in Figure 1.

The diagonal corners represent a configuration of vertical restraints in which each manufacturer has chosen the identical type of vertical contract, while the off-diagonal corners represents those in which each manufacturer has chosen different types. Therefore, $V^{FR}$ and $V^{RPM}$ are the payoffs to each manufacturer at the symmetric vertical equilibrium under franchise (Subsection 3.1) and under RPM (Subsection 3.2), respectively. On the other hand, $(V_1^{FR}, V_2^{RPM})$ denote the payoffs to Manufacturers 1 and 2 at the mixed vertical equilibrium when the former has chosen franchise and the latter RPM (Subsection 3.3), whereas $(V_1^{RPM}, V_2^{FR})$ represent the opposite case. For these off-diagonal payoff, note that $V_1^{FR} = V_2^{FR}$ and $V_1^{RPM} = V_2^{RPM}$ due to the symmetry.

Generically, there can be four different types of equilibrium (in pure strategy) for this symmetric matrix game.

1. **Franchise Equilibrium**: franchise is the dominant strategy for both manufacturers, and (FR,FR) is a unique equilibrium when $V^{FR} > V_1^{RPM}$ and $V_1^{FR} > V^{RPM}$.

2. **RPM Equilibrium**: RPM is the dominant strategy, and (RPM,RPM) is a unique equilibrium when $V^{RPM} > V_1^{FR}$ and $V_1^{RPM} > V^{FR}$.

3. **Multiple Equilibria**: Both (FR,FR) and (RPM,RPM) are equilibria when $V^{FR} > V_1^{RPM}$ and $V^{RPM} > V_1^{FR}$.

4. **Asymmetric Equilibria**: Both (FR,RPM) and (RPM,FR) are equilibria when $V^{FR} < V_1^{RPM}$ and $V^{RPM} < V_1^{FR}$.

Since the manufacturers and retailers are identical in all respects except for their respective vertical relationship, one would expect symmetric equilibrium to obtain. Moreover, we would like to relate the equilibrium vertical structure to the properties of retail competition, the retailers' risk aversion, and the demand uncertainty.

To find the equilibrium, we need to compare the following payoffs, which are derived in Appendix B.

$$V^{FR} = (1+2r\sigma_\theta^2)\left[M-(1-a_p)c\right]^2 v^{FR}, \qquad V_1^{FR} = (1+2r\sigma_\theta^2)\left[M-(1-a_p)c\right]^2 v_1^{FR},$$
$$V_1^{RPM} = (1+2r\sigma_\theta^2)\left[M-(1-a_p)c\right]^2 v_1^{RPM}, \quad V^{RPM} = (1+2r\sigma_\theta^2)\left[M-(1-a_p)c\right]^2 v^{RPM},$$

where

$$\begin{aligned}
v^{FR} &= \frac{(3+2r\sigma_\theta^2)(1+r\sigma_\theta^2)^2}{\left[3-2a_p+a_s+(8-5a_p+a_s)r\sigma_\theta^2+2(2-a_p)r^2\sigma_\theta^4\right]^2} \\
v^{RPM} &= \frac{(3+8r\sigma_\theta^2)}{\left[3-2a_p+a_s+4(2-a_p)r\sigma_\theta^2\right]^2} \\
v_1^{FR} &= \frac{(3+2r\sigma_\theta^2)\left[(1+r\sigma_\theta^2)(3+2a_p-a_s+4(2+a_p)r\sigma_\theta^2)\right]^2}{\left[9-4a_p^2+4a_pa_s-a_s^2+(48-18a_p^2+11a_pa_s-a_s^2)r\sigma_\theta^2+(76-24a_p^2+6a_pa_s)r^2\sigma_\theta^4+8(4-a_p^2)r^3\sigma_\theta^6\right]^2} \\
v_1^{RPM} &= \frac{(3+8r\sigma_\theta^2)\left[3+2a_p-a_s+(8+5a_p-a_s)r\sigma_\theta^2+2(2+a_p)r^2\sigma_\theta^4\right]^2}{\left[9-4a_p^2+4a_pa_s-a_s^2+(48-18a_p^2+11a_pa_s-a_s^2)r\sigma_\theta^2+(76-24a_p^2+6a_pa_s)r^2\sigma_\theta^4+8(4-a_p^2)r^3\sigma_\theta^6\right]^2}.
\end{aligned}$$

Note that they differ from one another only through $v$'s, and furthermore that $v$'s depend only on $a_p$, $a_s$, and $r\sigma_\theta^2$. That is, for example, $V^{FR} > V_1^{RPM}$ if and only if

$$v^{FR} > v_1^{RPM}. \tag{17}$$

For our purpose, we do not need to explicitly solve the inequality for the four parameters, but instead can find the equilibrium by studying the contour graphs of $v^{FR} - v_1^{RPM}$ and $v^{RPM} - v_1^{FR}$ as in Figures 2 and 3.

First, we fix $r\sigma_\theta^2$ (at 1 in Figure 2), and then the inequalities can be represented on a unit square of $a_s$-$a_p$ plane. Line $\alpha\alpha'$ is implicitly defined by $v^{FR} - v_1^{RPM} = 0$, and Regions $A + C$ represent $v^{FR} > v_1^{RPM}$, while Line $\beta\beta'$ is defined by $v^{RPM} - v_1^{FR} = 0$, and Regions $B + C$ represent $v^{RPM} > v_1^{FR}$. Therefore, Franchise Equilibrium obtains in Region $A$, RPM Equilibrium in Region $B$, and Multiple Equilibria in Region $C$. Furthermore, we argue on account of dominance that the manufacturers are more likely to choose Franchise equilibrium even in Region $C$, because it belongs to a region where $V^{FR} > V^{RPM}$ (with $\gamma\gamma'$ defined by $v^{FR} - v^{RPM} = 0$). Thus we conclude that Franchise will prevail as equilibrium vertical structure in the region above $\gamma\gamma'$ $(A + C)$ and RPM in the region below $(B)$. We can relate these regions to the nature of retail competition in the following way: Given $a_s$, the higher $a_p$ is (more intense price competition), the more likely is Franchise equilibrium. Alternatively, given $a_p$, the higher $a_s$ is (more intense service competition), the more likely is RPM equilibrium.[15]

**Proposition 3** *(The Equilibrium Vertical Restraints) When the demand uncertainty or the risk aversion of retailers are not too small,*

1. *franchise is the equilibrium vertical restraint if price competition is more intense, and*

2. *resale price maintenance is the equilibrium vertical restraint if service competition is more intense.*

One way to interpret this result is to look at how different vertical restraints help lessen competition or facilitate collusion. Intuitively, potential gains from less competition are the greater when competition is more intense to begin with. In our model, the retail competition is two-dimensional, in price and service, and whichever of the two vertical restraints will be favored when it is more effective in lessening in the more intense of

[15]When $r\sigma_\theta^2$ is very close to 0, there appear additional regions in the southeast corner near (1,0), which mirror Region $C$ and Region $A$. However, these regions soon disappears as $r\sigma_\theta^2$ gets larger.

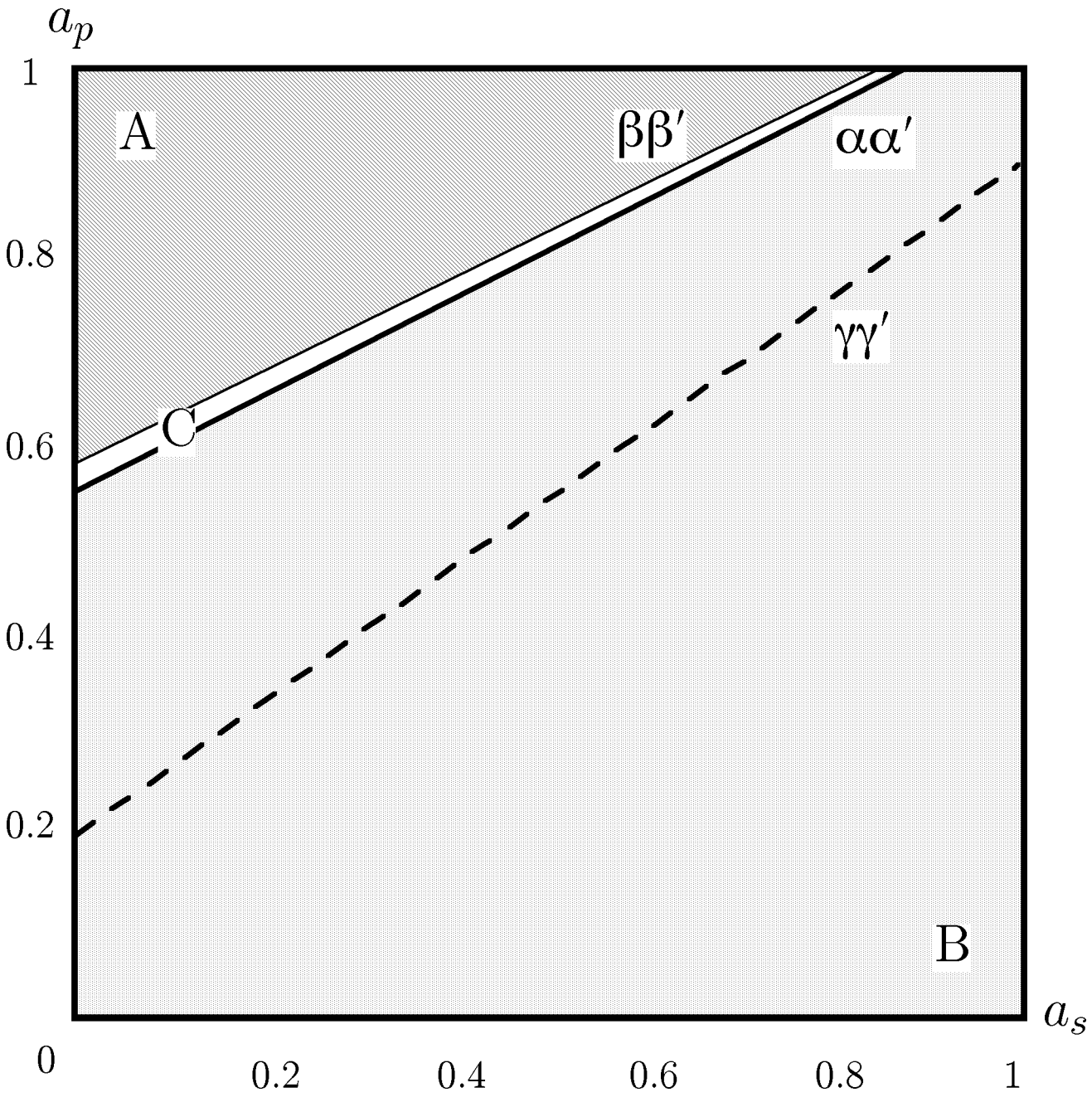


Figure 2: Equilibrium Vertical Restraints ($r\sigma_\theta^2 = 1$)

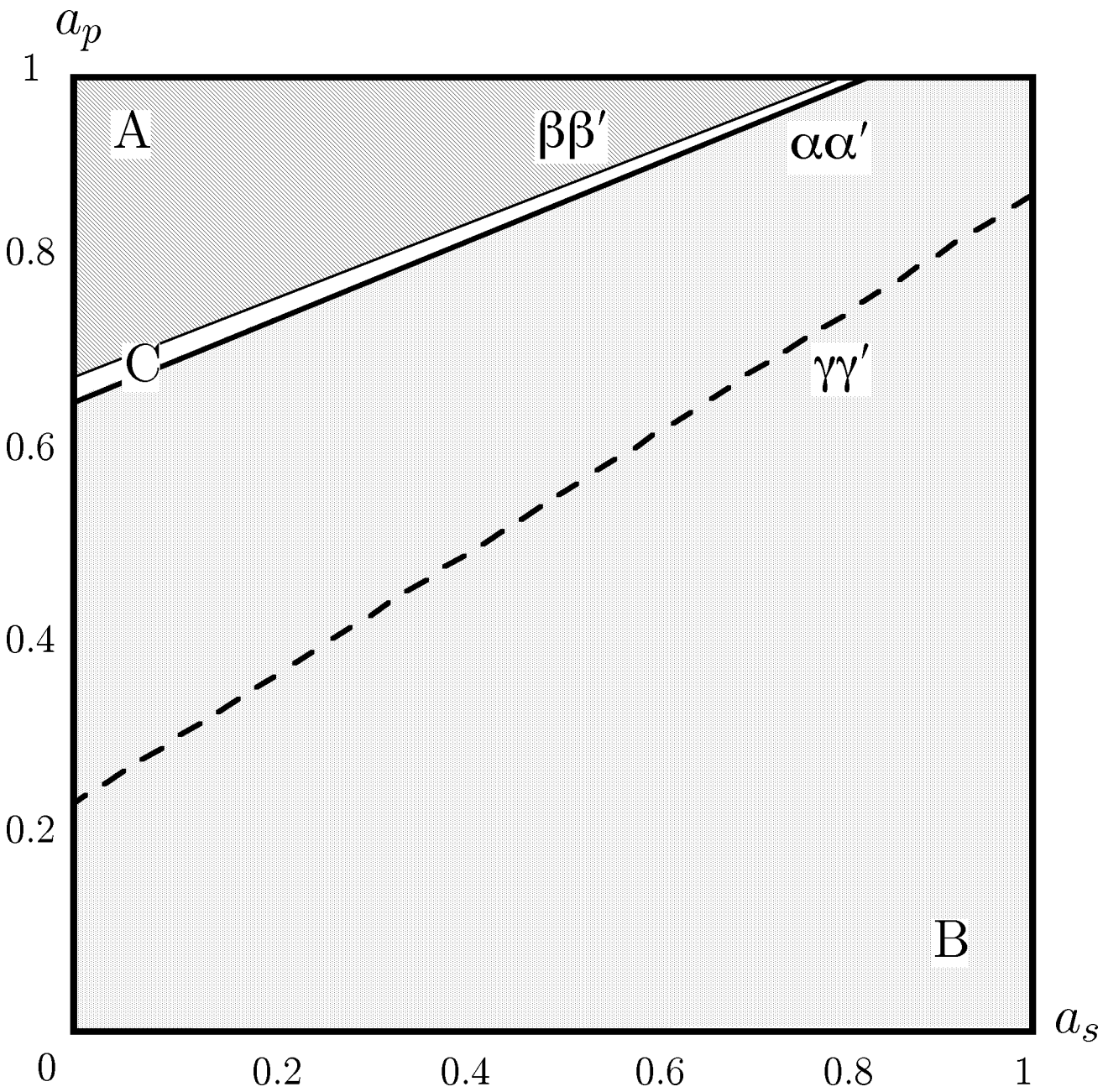


Figure 3: Equilibrium Vertical Restraints ($r\sigma_\theta^2 = 2$)

the two dimensions of competition. Recall from the previous section, on the one hand, that retailers tend to charge a higher price under franchise than manufacturers do under RPM, and on the other hand that retailers tend to have a smaller retail margin and thus provide less service under RPM. A similar reasoning is found in Gal-Or (1991) where "forcing" contract is preferred to "delegation" in equilibrium when products are sufficiently differentiated from each other.[16] With sufficiently differentiated products, gains from collusion in retail price are small, while informational rents to retailers can be limited more efficiently by "forcing" contract.

It is interesting to note that the manufacturers end up in *Prisoners' Dilemma* in the part of Region B above $\gamma\gamma'$ because, although both of them could get a higher payoff in (FR,FR) than in RPM equilibrium, RPM is the dominant strategy. This comes about much for the same reason why cartels are prone to collapse due to individual participant's incentive to deviate. Given that one's rival is committed to a less aggressive pricing behavior through franchise, one can gain more by pricing aggressively herself through RPM unless the potential gain from collusion in price is so large as to outweigh any gain from "cheating" (i.e., when $a_p$ is relatively a lot higher than $a_s$).

We now turn to the effect of retailers' risk aversion and demand uncertainty. As can be seen in the manufacturer's payoff (12), risk aversion/uncertainty affects the payoff in two ways: directly through risk premium and indirectly through $p$, $s$, and $w$. Note in particular that the direct (negative) effect of an increase in $r\sigma_\theta^2$ will be greater when the retail margin is larger. In this respect, RPM can be said to be more effective in providing insurance for retailers since it incurs a smaller risk premium. Therefore, presuming that this first-order direct effect would outweigh whatever second-order effect may be, one would expect an increase in $r\sigma_\theta^2$ to favor RPM equilibrium.

Figure 3 shows the equilibrium regions with $r\sigma_\theta^2 = 2$, in which both $\alpha\alpha'$ and $\beta\beta'$ has shifted upward, thereby expanding Region $C$ of RPM equilibrium and contracting Regions $A + C$ of Franchise equilibrium. This pattern of expanding RPM equilibrium region continues as risk aversion/uncertainty further increase. At $r\sigma_\theta^2 = \infty$, $\beta\beta'$ still remains in the interior of the unit square (franchise equilibrium still exists), but $\alpha\alpha'$

[16]The "forcing" and "delegation" contracts are equivalent to RPM and franchise, respectively, in our model.

coincides with $\beta\beta'$.

**Proposition 4** *When retailers are more risk averse or/and the demand is more uncertain, RPM equilibrium is more likely.*

This result is in line with Rey and Tirole (1986) who found that a monopolist prefers RPM to Exclusive Territories, which is equivalent to franchise in our model, when retailers are extremely risk averse and the uncertainty is on market demand (Proposition 2). RPM turns out to be a better tool for providing insurance under interbrand competition as well as under intrabrand competition.

# 5 Conclusion

We have presented a model of vertical restraints which is based on their effect on the *interbrand* competition and their unobservability to the rival hierarchy. The unobservable vertical contracts are strategically relevant because they imply different pricing behaviors for both wholesale and retail prices even though the actual prices on the contract are not observed by competitors. Commitment to those different behaviors is made credible by the risk aversion of retailers and the demand uncertainty. Then the equilibrium vertical restraints depend on the nature of interbrand competition in retail market as well as on the above two factors.

In terms of the three functions of vertical restraint, stated in Introduction, franchise is more effective in alleviating price competition while resale price maintenance is more effective in lessening service competition and providing insurance. On the other hand, both are equally good in inducing retailers to provide service in the sense that they give the same incentive to retailers, *ceteris paribus*. Propositions 3 and 4 show that the equilibrium is consistent with the relative effectiveness of vertical restraints.

Thus our model provides an alternative way of explaining vertical restraints, based on the fundamental parameters of the market, and complements the existing literature based on the intrabrand competition and the externalities among retailers.

The agenda for future research include extending the set of feasible vertical contracts to include more general types of vertical contract, and investigating a situation where the

type of vertical restraint itself is unobservable. From the anti-trust policy's standpoint, it will yield most immediate dividends to analyze the implications of different equilibrium vertical restraints for social welfare.

# APPENDIX

## A Vertical Equilibrium under Mixed Configuration

The vertical equilibrium under mixed configuration is the solution to the simultaneous equation system (8) – (10) and (13) – (15).

$$
\begin{aligned}
w_1^{FR} &= c + \frac{r\sigma_\theta^2(3+2r\sigma_\theta^2)\{3+2a_p-a_s+4(2+a_p)r\sigma_\theta^2\}}{9-4a_p^2+4a_pa_s-a_s^2+(48-18a_p^2+11a_pa_s-a_s^2)r\sigma_\theta^2+(76-24a_p^2+6a_pa_s)r^2\sigma_\theta^4+8(4-a_p^2)r^3\sigma_\theta^6}[M-(1-a_p)c], \\
w_2^{RPM} &= c + \frac{4r\sigma_\theta^2\{3+2a_p-a_s+(8+5a_p-a_s)r\sigma_\theta^2+2(2+a_p)r^2\sigma_\theta^4\}}{9-4a_p^2+4a_pa_s-a_s^2+(48-18a_p^2+11a_pa_s-a_s^2)r\sigma_\theta^2+(76-24a_p^2+6a_pa_s)r^2\sigma_\theta^4+8(4-a_p^2)r^3\sigma_\theta^6}[M-(1-a_p)c], \\
p_1^{FR} &= \frac{2M(3+2a_p-a_s+4r\sigma_\theta^2)+w_1^{FR}\{(2a_p-a_s)a_s+(1+2r\sigma_\theta^2)(3+4r\sigma_\theta^2)\}+2w_2^{RPM}\{a_s+a_p(1+4r\sigma_\theta^2)\}}{(3+2r\sigma_\theta^2)(3+4r\sigma_\theta^2)-(2a_p-a_s)^2}, \\
p_2^{RPM} &= \frac{2M(3+2a_p-a_s+2r\sigma_\theta^2)+2w_1^{RPM}\{a_s+a_p(1+2r\sigma_\theta^2)\}+w_2^{FR}\{(2a_p-a_s)a_s+(3+2r\sigma_\theta^2)(1+4r\sigma_\theta^2)\}}{(3+2r\sigma_\theta^2)(3+4r\sigma_\theta^2)-(2a_p-a_s)^2}, \\
s_1^{FR} &= \frac{M(3+2a_p-a_s+4r\sigma_\theta^2)-w_1^{FR}\{3+4r\sigma_\theta^2-(2a_p-a_s)a_p\}+w_2^{RPM}\{a_s+a_p(1+4r\sigma_\theta^2)\}}{(3+2r\sigma_\theta^2)(3+4r\sigma_\theta^2)-(2a_p-a_s)^2}, \\
s_2^{RPM} &= \frac{M(3+2a_p-a_s+2r\sigma_\theta^2)+w_1^{FR}\{a_s+a_p(1+2r\sigma_\theta^2)\}-w_2^{RPM}\{3+2r\sigma_\theta^2-(2a_p-a_s)a_p\}}{(3+2r\sigma_\theta^2)(3+4r\sigma_\theta^2)-(2a_p-a_s)^2}.
\end{aligned}
$$

## B Vertical Equilibrium Payoffs to Manufacturers

### Equilibrium payoff from franchise contract

We first compute the payoff to a manufacturer who uses a franchise contract, regardless of which type of contract his rival uses.

$$
\begin{aligned}
V_1 &= (p_1-c)E[Q_1] - G(s_1) - \frac{1}{2}(p_1-w_1)^2 r\sigma_\theta^2 \quad \text{from (12)}, \\
&= (p_1-w_1+w_1-c)E[Q_1] - (p_1-w_1)^2/4 - (p_1-w_1)^2 r\sigma_\theta^2/2, \\
&= (p_1-w_1)^2\left[(1+r\sigma_\theta^2)+r\sigma_\theta^2(3+2r\sigma_\theta^2)/2\right] - (p_1-w_1)^2(1+2r\sigma_\theta^2)/4, \\
&\qquad \text{using the equilibrium conditions (8) and (9)}, \\
&= (p_1-w_1)^2(1+2r\sigma_\theta^2)(3+2r\sigma_\theta^2)/4.
\end{aligned}
$$

Now we compute the retail margin $p_1 - w_1$, by using the vertical equilibrium outcomes under the configuration (FR,FR) as shown in Proposition 1, and under (FR,RPM) as shown in Appendix A, to complete the derivation. Under (FR,FR)

$$
p^{FR} - w^{FR} = \frac{2(1+r\sigma_\theta^2)[M-(1-a_p)c]}{3-2a_p+a_s+(8-5a_p+a_s)r\sigma_\theta^2+2(2-a_p)r^2\sigma_\theta^4},
$$

while under (FR,RPM)

$$p_1^{FR} - w_1^{FR} = \frac{2(1+r\sigma_\theta^2)\{3+2a_p-a_s+4(2+a_p)r\sigma_\theta^2\}\left[M-(1-a_p)c\right]}{9-4a_p^2+4a_pa_s-a_s^2+(48-18a_p^2+11a_pa_s-a_s^2)r\sigma_\theta^2+(76-24a_p^2+6a_pa_s)r^2\sigma_\theta^4+8(4-a_p^2)r^3\sigma_\theta^6}.$$

## Equilibrium payoff from RPM contract

We compute the payoff to a manufacturer with a RPM contract in the same way as above.

$$\begin{aligned}
V_1 &= (p_1-c)E\left[Q_1\right] - G(s_1) - \frac{1}{2}(p_1-w_1)^2 r\sigma_\theta^2, \\
&= (p_1-w_1+w_1-c)E\left[Q_1\right] - (p_1-w_1)^2/4 - (p_1-w_1)^2 r\sigma_\theta^2/2, \\
&= (p_1-w_1)^2\left[(1+2r\sigma_\theta^2) + 2r\sigma_\theta^2(1+2r\sigma_\theta^2)\right] - (p_1-w_1)^2(1+2r\sigma_\theta^2)/4, \\
&\qquad \text{using the equilibrium conditions (13) and (14),} \\
&= (p_1-w_1)^2(1+2r\sigma_\theta^2)(3+8r\sigma_\theta^2)/4.
\end{aligned}$$

The retail margin is, under (RPM,RPM)

$$p^{RPM} - w^{RPM} = \frac{2\left[M-(1-a_p)c\right]}{3-2a_p+a_s+4(2-a_p)r\sigma_\theta^2},$$

while under (RPM,FR)

$$p_1^{RPM} - w_1^{RPM} = \frac{2\{3+2a_p-a_s+(8+5a_p-a_s)r\sigma_\theta^2+2(2+a_p)r^2\sigma_\theta^4\}\left[M-(1-a_p)c\right]}{9-4a_p^2+4a_pa_s-a_s^2+(48-18a_p^2+11a_pa_s-a_s^2)r\sigma_\theta^2+(76-24a_p^2+6a_pa_s)r^2\sigma_\theta^4+8(4-a_p^2)r^3\sigma_\theta^6}.$$

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