STICKS AND CARROTS: IS RESALE PRICE MAINTENANCE NECESSARY?*

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Abstract

While the existing literature on vertical contractual relations has established that resale price maintenance is sufficient to coordinate the retail network of a manufacturer, this paper asks whether such vertical restraints are necessary. We study the vertical contracting problem between an upstream manufacturer and his downstream retail distribution channel in a setting where appealing to resale price maintenance is not possible due to legal prohibition, and examine whether other forms of contracting can achieve the outcome of vertical integration. We show that a bonus scheme based on retail revenues is sufficient to provide incentives to decentralized retailers to elicit the correct level of both price and service. Interestingly, an incentive scheme based on retail sales is unable to do so. Intuitively, an incentive scheme based on quantity alone will fail because it does not alter the source of incentive incompatibility between manufacturer and retailer, namely retail price competition. On the other hand, an incentive scheme based on retail revenue is able to coordinate the distribution channel because higher bonus levels are attainable not only by increasing sales, but also by increasing price; higher service levels then follow, as there is a sufficient retail margin to underwrite them.

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1 Introduction

Vertical contractual relations, a special case of the more general analysis of single principal - multi agent problems, studies the contracting problem of a vertical supply chain. The general puzzle is to explain why sophisticated contracts, involving both payment terms and also post-contractual control rights and responsibilities, are used to govern the relationship between an upstream firm and his downstream associates. Related to this research, economists have examined the apparent imbalance in anti-trust law with regards to various vertical restraints: whereas the attitude towards non-price restraints is a rule of reason, historically price restraints have been per-se illegal.\(^1\)

Resale price maintenance (RPM) is a contractual provision imposed by a manufacturer defining the choice of retail price to the retailer. Whereas price ceilings seem prima facia benign, price floors are controversial and thought by many to be anti-competitive. The puzzle recognized in the extant literature is: "why would a manufacturer impose a price floor that restricts demand for the manufacturer's product at the retail level?"

The traditional answer to this puzzle lies in the Service Argument of Tesler (1960). This explanation begins with the claim that retail outlets do not simply stock a manufacturer's product for resale, but provide tangible, product-specific, retail service to consumers at the point of sale. In this setting, there are two possibilities: (i) some dealers may free-ride on service-providing outlets, offering no service but discounting prices to attract consumers from other service-providing retailers; (ii) retailers may have a propensity to focus on the "incorrect" marginal consumer, by engaging in price competition for marginal price-sensitive consumers rather then providing high service in order to attract a marginal high-willingness to pay consumer into the market. Technically, then, a decentralized equilibrium may fail to support a sufficiently large price-cost margin to underwrite the appropriate level of promotional activities. By guaranteeing a high retail margin through the use of RPM, the manufacturer can increase the incentive that each retailer has in attracting consumer sales through higher service. In short, this "service argument" maintains that RPM can increase sales by enhancing service to more than offset

\(^1\)In Canada, resale price maintenance was originally prohibited by statutory law when, in 1952, an amendment was made to the Combines Investigation Act (1923) to include vertical price floors. In 1985, when Canada overhauled its anti-trust law, the statute was updated, but for the most part remained unchanged, by Section 61(1) of the Canadian Competition Act. However, in 2009, the statute was repealed by Bill C-10 (The Canadian Budget Implementation Act, 2009), and price maintenance became only a civilly reviewable practice.

In the U.S., the illegality of resale price maintenance was established under common law. In the landmark case of Dr. Miles Medical Co. v. John D. Park Sons Co., 220 US 373 (1911), the U. S. Supreme Court ruled that price maintenance was a violation of Section 1 of The Sherman Antitrust Act (1890). Later, the U.S. Congress passed the Miller-Tydings Resale Price Maintenance Act (1937) which overturned the Dr. Miles ruling, by amending the Sherman Act to allow for retail price floors. However, in 1975 this acts was repealed, and the per-se illegality of resale price maintenance was reestablished. More recently, in the case of Leegin Creative Leather Products, Inc. v. PSKS, Inc., 551 U.S. 877 (2007), the U.S. Supreme Court replace the 96 year old per-se doctrine with a rule of reason.
any negative impact on sales resulting from a higher resale price. Moreover, despite higher prices, consumers as a group can benefit on net, as the market provides more of the service they desire.

The extant literature on resale price maintenance has made great headway towards an economic theory of vertical contractual relations. First, it has formally described the incentive incompatibility between upstream and downstream firms which gives rise to the use of vertical restraints, such as resale price maintenance. Second, it has raised significant questions about the asymmetry in the laws towards price restraints and non-price restraints, providing a justification for price maintenance to be judged according to a rule of reason rather than the current rule of per-se illegality. However, while showing the sufficiency of resale price maintenance, what has been left unanswered by the literature is whether such a contract is necessary to coordinate the downstream network of an upstream firm. Addressing this issue is important to practitioners in the field of vertical contracting: if many vertical restraints are deemed to be quasi-illegal or even illegal, and therefore open to legal challenge, they may be dominated by other contractual instruments that are minimally sufficient and not open to legal challenge. The question remains: is the space of minimally sufficient contracts to achieve joint manufacturer/retailer profit maximization made up only of those contacts that rely on some form of vertical restraints?

Towards providing an answer to this question, I provide a stylized model where RPM is known to be sufficient, a la Winter (1993), and consider alternative solutions to the contracting problem. The paper is biased towards a model which makes explicit assumptions about the environment, in order to provide detailed, yet insightful, analytic expressions for the contracting problem under study. Yet the use of a stylized model by no means limits the applicability of the results; in fact, the main findings of the paper, Propositions 4 and 5, are demonstrated without appealing to the specific functional form assumptions of the model.

The model I examine in the paper is based on four features of retail networks which gives rise to the need for sophisticated contracts beyond a simple spot price. First, retailers are spatially differentiated in terms of location, and it is costly for consumers to travel and shop. Second, retailers provide point-of-sale service, whose levels are not contractible, and this service is valued by consumers. Third, consumers are heterogeneous in the distance they have to travel to retail outlets, as well as in their valuation of retail service; moreover there is a correlation between a consumer’s travel cost and value for service. Finally, retailers compete with each other, in both price and service, for sales.

To maximize total channel profits, the manufacturer would like retailers to provide a high level of service, thereby attracting inconveniently located consumers with high willingness to pay for service
into the market. As these consumers are less price elastic, the manufacturer can extract higher surplus in return. Retailers on the other hand, not only concern themselves with the product margin, but when competing with each other for consumers, take into consideration the inter-retailer margin as well. However, consumers on the inter-retailer margin place lower value on service, and are instead attracted to one retailer over another by lower prices. Competition between retailers drives the resale price of the product down; focusing on the inter-retailer margin drives down the retailers’ level of service.

In this model, a simple wholesale pricing contract fails to coordinate the distribution channel. However, Winter (1993) shows, that, with the introduction of a second instrument, namely that of a vertical restraint, the upstream firm is able to align the incentives of his downstream network with those of his own. Specifically, a resale price floor can serve to guarantee retailers a high enough price-cost margin to elicit the correct level of service. In this paper, I reexamine the contracting problem of the manufacturer to determine whether alternatives to vertical restraints are also elements of the space of minimally sufficient solutions. For, even if resale price maintenance is a solution to the contracting problem, the associated anti-trust implications could make it unappealing.

The first novel result of this paper, Proposition 4, completely characterizes a contract that appeals to a financial incentives scheme to coordinate the retail distribution channel of the monopolist manufacturer. In particular, I show that a linear bonus scheme written on retail sales revenues, together with an ordinary franchise contract, is able to align the interests of distributor and manufacturer; the promise of sufficient financial carrots can provide enough incentive to the retail network to self select the first-best levels of price and service. The manufacturer’s role in such a contract cannot be understated - he serves as the third-party budget breaker which makes such a bonus scheme feasible. Interestingly, a contract involving an incentive scheme written on retail sales volume is unable to coordinate the distribution channel. Thus, not all carrots are created equal.

Intuitively, an incentive scheme based on quantity alone will fail because it does not alter the source of incentive incompatibility, namely retail competition. On the other hand, an incentive scheme based on retail revenue is able to coordinate the distribution channel because higher bonus levels are attainable not only by increasing sales, but also by increasing price; increases in service levels then follow, as there are sufficient price cost margins to support them. The analysis of incentive schemes based on quantity finds an intimate relationship between the such contracts and those based on a

\[\text{We define the first best outcome as that from vertical integration. A contract is said to be minimally sufficient if it replicates the first best outcome with the fewest number of instruments.}\]
wholesale price alone, namely their failure is caused by the same culprit. In particular, the source of
failure is the fact that the ratio of firm to market price elasticities is larger than the ratio of firm to
market elasticities of service. More importantly, however, the analysis of an incentive scheme based on
revenues shows us that the ability of such a bonus scheme to elicit the first-best outcome stems from
exploiting this exact same source.

Having examined contracting options that are based on a retailer’s own targets, I then examine
sharing schemes. If retailers are capital constrained, the manufacturer must restrict his attention to
financial incentives schemes which are budget balanced at the downstream level; by definition, sharing
schemes do this. Proposition 5, characterizes the minimally sufficient revenue sharing scheme. With
a sharing scheme, by giving each a share of their opponents revenues, retailers internalize the benefits
from raising their price and service levels - which arise through mitigating the horizontal pecuniary
externality. Hence, retailers disengage from price competition, as they put less focusing on the marginal
inter-retailer consumer. On the other hand, since a retailer lays claim to less of his own revenues (as
some is taken by his opponent), while still faces the whole cost of service provision, he is less inclined
to increase his level of service and price. Thus, the manufacturer must carefully design the revenues
sharing scheme to balance disincentives with sufficient incentives.

For the economics literature, this paper provides us with a more complete understanding of the
vertical contracting problem between an upstream firm and his downstream associates. First, it for-
manually establishes that the space of minimally sufficient contracts is not monopolized by contracts which
rely on vertical restraints. Thus, while resale price maintenance may be sufficient to coordinate a dis-
tribution channel, it is by no means necessary. Secondly, it helps us better understand the reasons
why sophisticated contracts are needed to coordinate the manufacturer’s distribution channel. At first
glance, it may appear that the driving force behind the call to vertical restraints is a need to limit
horizontal competition amongst downstream retailers. The contract I suggest here shows that this
is not the case: the failure of spot contracts is solely driven by a misalignment of incentives between
upstream and downstream firms. Appealing to vertical restraints is only one way to solve this incentive
incompatibility; an equivalent method would be to implement a bonus incentive scheme or a revenue
sharing scheme. Lastly, it makes clear that the space of solutions to the vertical contracting problem
is quite complex: denying incentive schemes based on quantity, but allowing schemes based on price
(resale price maintenance), and on revenue (the product of price and quantity).

The structure of this paper is as follows: section 2 reviews the related literature on resale price
maintenance and the service argument. Section 3 presents the basic model of a monopolist manufacturer who retails his product through a network of independent retailers, and then reviews some of the known results on resale price maintenance. Section 4 forms the heart of the paper; there, I probe for the existence of alternative contracts, that do not rely on vertical restraints, in the set of contracts that are minimally sufficient to coordinate the distribution channel: Section 4.1 covers incentive schemes based on own variables, Section 4.2 covers sharing schemes. Finally, in section 5, I consider the case of retail price ceilings. Section 6 concludes the paper.

2 RPM: The Economics Literature

Simple linear wholesale price contracts often fail to coordinate a manufacturer’s distribution channel: vertical externalities (between retailer and manufacturer) and horizontal externalities (between retailers) significantly complicate the contracting problem. The economics literature has focused on several contractual provisions, referred to as **Vertical Restraints**, as solutions to the vertical contracting problem. These include: two-part tariffs, general non-linear pricing, quantity fixing, ties, exclusive dealing, exclusive territories and, most importantly, resale price maintenance. Resale price maintenance, in particular, has received a significant amount of attention, primarily because, historically under both Canadian and U.S. anti-trust law, it has been a criminal (in fact a per-se) offense.

Two arguments are often cited to support the anti-trust viewpoint on resale price floors. First, RPM may facilitate the operation of manufacturer cartels (e.g. Tesler (1960), Jullien and Rey (2007)), where each manufacturer provides his product at a common supra-competitive wholesale price. The claim is that a manufacturer cartel can more easily monitor retail prices that are public to determine whether cartel members are adhering to the cartel wholesale price. Second, RPM may facilitate the operation of retailer cartels (e.g., Posner (1976), Rey and Verge (2004)). The claim is that retailer cartels may find it easier to remain cohesive by using an institution (the manufacturer) to “certify” their product and then have this institution imposes RPM. While the manufacturer cartel explanation has some intuitive appeal to explain resale price floors, the critical question for the retailer cartel claim is why a manufacturer would have any interest in facilitating a collusive retail sector.

The traditional economic argument in support of resale price maintenance is the **services argument** of Tesler (1960). Suppose the manufacturer retails his product through multiple retailers. In addition, Rey and Tirole (1986), Katz (1989), and Rey and Verge (2008) offer excellent surveys of the literature on vertical contractual relations. Mathewson and Winter (1998) provide a comprehensive review of the anti-trust law and jurisprudence, as well as the literature on resale price maintenance.
suppose that the demand for the product depends on costly pre-sales service provided by retailers. The provision of service at the downstream may create a horizontal externality amongst retailers, which can lead to a price-cost margin that is too small for retailers to underwrite a large level of service provisions. By imposing a resale price floor, Tesler argues that the manufacturer can provide a large enough retailer margin to give an incentive for all retailers to self-select the correct level of service.

Tesler (1960) relied solely on verbal arguments in his defense of a resale price floor. Mathewson and Winter (1983) were the first to show the ability of resale price maintenance to solve the problem of dealer moral hazard through a formal, though somewhat stylized, economic model. In their model, there is a unit mass of consumers of two types of consumers, high search cost and low search cost, each with downward sloping demand function for the product under consideration. However, consumers have to be "informed" to buy product, this product information coming only at the downstream level. The manufacturer of the product provides his product for resale through two types of retailers: a small number of monopolistically competitive retailers who provide costly service, and a large number of perfectly competitive non-informing retailers. Consumers randomly bump into retail outlets: once there, they can buy from the retailer if it is of the "informing" type, or can "search" for a low cost, non-informing retail store.

Two externalities are at play in the Mathewson and Winter model – a vertical externality of the double marginalization kind, and a horizontal externality arising from non-informing retailers free riding of the sales service of informing outlets. As a result, too few informing outlets exist in a decentralized free-entry equilibrium, and resale price maintenance is needed to achieve the first-best outcome. By setting a price floor at the first-best price, the manufacturer can sustain a large enough retail margin for non-informing stores to become informing stores. A linear wholesale price then serves the role of a franchise fee to transfer profits back to the manufacturer.

Various other papers have also examined vertical restraints arising from dealer moral hazard. Mathewson and Winter (1984) provide a comprehensive examination of vertical restraints in a general framework of retailer spatial differentiation with service spillovers. Perry and Porter (1990) consider the service argument in an environment where free-riding on retail services stems, not from spatial spillovers, but rather from a Dixit-Stiglitz (1977) consumer preference structure. In their model, there is a service externality arising from the assumption that the service a consumer associates with each retailer’s product is a weighted average of the service provided by all retailers. In an extension of the service argument beyond simple pre-sale service, Marvel and McCafferty (1984) consider a model of
free-riding on quality certification. In Marvel and McCafferty (1984), a retail outlet’s brand image is subject to the same sort of free-riding as is retail service provision: consumers can purchase the same goods they see on the shelves of stores with a high brand image from stores with a lower brand image at a discounted price. In these models, free-riding and the inability of a retailer to appropriate all benefits from own his service provisions to consumers leads to the failure of simple wholesale pricing contracts, and the subsequent call to vertical restraints.

The literature reviewed so far presents free-riding on dealer provided service as the basic justification for implementing RPM. This has led some authors (e.g. Scherer and Ross (1990)) to question the empirical importance of Tesler’s argument. However, as Mathewson and Winter (1998) argue, the service argument is much more general then it appears. In fact, as shown in Winter (1993), all that is needed to bring about the failure of simple spot-market contracts, and thus the call to price-restraints, is for the ratio of firm to market price elasticities be larger then the ratio of firm to market service elasticities. While this condition is satisfied by the free-riding explanation, it is also met by many other models of resale price maintenance.

Winter (1993) proposes a model where resale price floor arises because retailers compete for the wrong marginal consumer. In his model, there is a linear city with a unit mass of consumers à la Hotelling. The market is served by a monopolist manufacturer who sells his product through two retailers located at either end of the city. Retailers are oligopolistic, competing in price and in costly service. Each consumer demands a single unit of the monopolist’s good. However, consumers are differentiated according to both their traveling costs and their valuation of service; moreover, their is a correlation between a consumer’s valuation of service and their traveling costs. Taking into consideration their shopping costs, consumers first choose whether to buy, and then from which retailer to buy from, based on their price-service offerings.

In this scenario, price competition to get the marginal consumer between retailers drives down prices. As a result, service is too low since price-cost differentials are too small to sustain higher level of services. However, Winter shows that RPM is sufficient to coordinate the channel: a resale price floor of at the first-best price elicits the correct resale price and frees wholesale price to be used as an instrument to elicit the correct level of service; a franchise fee can then be used to transfer profits back to the manufacturer.

Other authors have also examined the Winter (1993) model of, what has been referred to as, "a correlation between product information costs and price information costs." In a stylized version of
the model, Iyer (1998) examines the assumption of symmetric contracting across retailers, and derives conditions under which conditions a manufacturer would prefer an asymmetric configuration of his retailer outlets to price discriminate by accommodating the tastes of his consumers. However, Iyer shows that, despite the asymmetric configuration, RPM is still needed to coordinate the manufacturer's distribution channel. In another stylized model, Schulz (2004) examines the consequences of RPM on consumer surplus and welfare, and derives conditions where resale price maintenance is welfare improving. Schulz demonstrates that, if consumer preferences for service are sufficiently intense, RPM is indeed socially optimal.

This paper differs from the existing literature on vertical contractual relations in that it attempts to provided an answer to whether resale price maintenance is not only sufficient, but necessary to coordinate the downstream network of an upstream firm. The mathematical model I consider, is a simplified version of the Winter (1993) framework. However, my model can provide analytical expressions for both the equilibrium under vertical integration and under decentralization. I begin my analysis by re-establishing some of the results of the former two papers. I then push further the analysis of the vertical contracting problem, and examine whether the space of minimally sufficient contracts is made up entirely of those that rely on some form of vertical restraints; first looking at incentive schemes base on own targets, and then at sharing schemes. Finally, in Section 5, I look at price ceilings.

3 A Model of Retail Channel Coordination

The formal analysis begins by setting up a basic model of retail competition in a spatial environment. I then show that the basic model has sufficient structure to set the stage; namely, a simple wholesale pricing contract fails to coordinate a manufacturer’s distribution channel, and thus the call for more sophisticated contracts. This section also provides a review of the basic incentive incompatibility between a manufacturer and retailer found in a retail model based on a "correlation of product information costs and price information costs".

3.1 Setting up the Basic Model

Consider a linear city with unit length. The market is served by a monopolist manufacturer, who distributes his product through two independent retailers, call them retailers 1 and 2. These retailers

\footnote{Vertical or horizontal Integration is ruled out by assumption.}
are spatially differentiated, locations fixed, with retailer 1 located at address zero and retailer 2 located at the address one.\textsuperscript{5} We assume the manufacturer has a constant cost technology for production, and we normalize this constant level of marginal cost to zero. The manufacturer’s base contract with his retailers is a franchise contract \(\{F, w\}\), where \(w \geq 0\) is a linear wholesale price at which he sells his product out to retailers and \(F\) is a fixed franchise fee. Additionally, the manufacturer can appeal to contract provisions from the set \(\Omega\), the set of all contracting provisions under the sun. Retailers purchase their inventory from the manufacturer and then compete in both resale price \(p\) and service \(s\). We assume that each retailer offers a single price and service level at his outlet.\textsuperscript{6} A retailer’s cost of providing service is given by the linear function \(c(s) = s\).\textsuperscript{7} A retailer’s outside option, in the event of rejecting a contract, is one providing only a competitive level of returns.

There is a unit mass of potential consumers, uniformly distributed across the city. Every consumer has unit demands for the good in question, which each values at the common reservation price \(R > 0\); utility from non-purchase is set at zero. In addition to this basic value, two other factors affect the utility from consuming the good. First, the consumer must incur some disutility cost traveling to, and then shopping at, a retailer. Second the consumer also receives utility from the point-of-sale service that a retailer adds to the basic product. Thus, this retail service partly offsets shopping costs and partly enhances the product’s appeal. Consumers, however, vary not only in their physical address in the city, but also in their valuation of the service provided by retailers.

At each location, we assume there are two types of consumers, indexed by a taste parameter \(\theta \in \{\theta_L, \theta_H\}\) where \(\theta_H > \theta_L\). Consumers of type \(\theta_L\) have low willingness-to-pay for service, while consumers of type \(\theta_H\) have a high willingness-to-pay for service. As our focus throughout the paper is on symmetric equilibria, we assume that there is an equal number of high and low types in the city. This assumption, though not needed, drastically simplifies the expressions to follow and helps remove any incentive for price discrimination arising from non-uniformity. The utility received by a consumer with taste parameter \(\theta\) when shopping at a retailer offering a service level of \(s\) is given by \(\theta U(s)\), where \(U(s)\) exhibits diminishing returns. For ease of exposition, and to provide closed form

\textsuperscript{5}The model can easily be generalized to the case of \(N\) retailers, by considering a circular city model with retail locations spaced symmetrically around the city.

\textsuperscript{6}The type of service we have envisioned in the model is pre-sale service. As we will see, heterogeneity in consumer tastes may result in an incentive to try and price discriminate across consumers by offering a menu of price-service offerings. However, any attempt to charge higher prices for bundles consisting of the product together with higher levels of pre-sales service will undoubtedly fail. Consumers will acquire the higher level pre-sale service and then simply walk out of the store, only to return an instant later and purchase the product bundled with lower service level at a lower price.

On the other hand, with post-sale service - for example warranties - such price discrimination strategies are feasible; in effect, post-sales service allows the product to be bundled with service to-be-rendered.

\textsuperscript{7}The model measures levels of service in dollar units.
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expressions whenever needed, I assume \( U(s) = \sqrt{s} \).

A crucial element of the model is what Mathewson and Winter (1998) refer to as a "correlation of product information costs and price information costs". To this end, we postulate an interconnection between a consumer's willingness to pay for service and his travel costs. More specifically, we assume that a consumer of type \( \theta \) located at address \( x \) occurs a disutility cost of \( \theta |d - x| \) when traveling to, and shopping, from the retailer located at location \( d \in \{0, 1\} \). Thus in our model, there is perfect correlation between a consumer's preference for service and his travel cost.

In summary, the model specifies that the utility of a consumer of type \( \{x, \theta\} \) when purchasing from the retailer located at address \( d \) offering the good for sale at a price \( p \) and providing service level \( s \), is given by

\[
u(x, \theta) = R + \theta (\sqrt{s} - |d - x|) - p\]

It follows that, the demand for the product as served by, say retailer 1, is given by the measure of consumers types \( (x, \theta) \in [0, 1] \times \{\theta_L, \theta_H\} \) satisfying two inequalities

\[
\begin{align*}
R + \theta (\sqrt{s_1} - x) - p_1 & \geq 0 \\
R + \theta (\sqrt{s_1} - x) - p_1 & \geq R + \theta (\sqrt{s_2} - (1 - x)) - p_2
\end{align*}
\]

the former being a participation condition, and the latter being a market allocation condition. The conditions defining the demand for the product from retailer 2 are analogous.

Two additional assumption are needed to close the model:

**Assumption 1** The first-best outcome involves a symmetric configuration of retail outlets.

**Assumption 2** In the first-best optimum, low-type consumers are fully served.

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8 The results here can be generalized and shown to hold any distribution of consumers over \( \theta \)-types, and for any increasing and concave function \( U(s) \).

9 An earlier version of this paper included a travel cost parameter \( t \) in the specification. I set \( t = 1 \), but note that the following results can be generalize for any \( t \in (0, \infty) \).

10 This assumption is common in the literature (for example, Iyer (1998)). The justification of this assumption is based on the observation that, a consumers willingness to pay for service and his travel costs originate from the same source, namely the consumer’s income (see, for example the marketing studies by Hill (1985)).

11 The utility specification here differs slightly from that of Winter (1993). To reconcile the differences, let \( r \) be the consumer reservation price, and let \( \frac{1}{2} T \) be amount of time it requires a consumer of type \( \theta \) to shop at a retailer, had no service been provided. Define the function \( T(s) = \frac{1}{2} T - U(s) \). Then, in a Winter(1993) utility specification, we have \( u(x, \theta) = r - \theta[T(s) + |d - x|] - p \), or \( u(x, \theta) = (r - T) + \theta[U(s) - |d - x|] - p \), the latter of which results in the current specification with \( R = r - T \).
A symmetric configuration of retailers is always a local optimum of the first-best problem. However, if the variation in consumer tastes is large enough, the vertically integrated manufacturer may be enticed into segmenting and then price discriminating across consumers by choosing an asymmetric configuration of retailers. Assumption 1 rules this out; and we focus on the case where a symmetric configuration of stores is optimal for the manufacturer. Now, note that it is not possible to have an symmetric equilibrium where both segments are covered.\textsuperscript{12} Assumption 2 states that the segment of consumers that is fully served under vertical integration is the low-type segment. This latter implication is crucial to the model: as shown later, it is competition over low type consumers that creates the need for a price floor\textsuperscript{13}. A necessary condition for Assumptions 1 and 2 to be met is for $0 < \theta_L < \theta_H < 1$; I provide sufficient conditions in the appendix.

![Figure 1: Timing of Events](image)

The timing of events in the model is as follows. At the beginning of the game there is a contracting stage, where the manufacturer chooses the contracts to offer to his retailers. This is followed by a retailer competition game, in which the retailers simultaneously choose the level of their service provisions and their resale prices. Finally, at the end of the game, consumers observe the price-service offerings of the retailers, and decide whether to buy the product, and if so, which retailer to visit.

### 3.2 RPM: Existing Results

The simplified set-up of the model provides closed-form expressions for the demand of product at the two spatially differentiated retail outlets; what follows specifies the demand function at retail outlet 1 - that at retail outlet 2 is analogous. Given the implications of Assumption 2, the participation

\textsuperscript{12}Under vertically integration, an equilibrium in which both high and low type consumers are fully served does not exist. To see this, note that under a configuration where both high and low type consumers are fully served, the upstream firm can increase price or decrease service at both his retailers without affecting demand, and thus increase profit; thus such a configuration cannot be optimal for the manufacturer.

\textsuperscript{13}If the segment of consumers that is fully served is the high types, then the vertical restraint arising from the model will be a price ceiling. See Iyer(1998)
constraint for the high types is binding; hence there is a high type consumer, labeled \( \pi^H \), who is just indifferent between purchasing and not, his location given by

\[
\pi^H = \frac{R - p_1 + \theta_H \sqrt{s_1}}{\theta_H}
\]  

(3)

For low types, the participation constraint is non-binding, as the market is fully covered. Hence, there exists a consumer in the interior of the city, labeled \( \pi^L \), who is the subject of competition between the two retailers. The location of this consumer is given by

\[
\pi^L = \frac{1}{2} + \frac{p_2 - p_1 + \theta_L(\sqrt{s_1} - \sqrt{s_2})}{2\theta_L}
\]  

(4)

Thus, the demand at retail outlet 1

\[
q_1(p_1, p_2, s_1, s_2) = \pi^L + \pi^H = \left(\frac{1}{2} + \frac{p_2 - p_1 + \theta_L(\sqrt{s_1} - \sqrt{s_2})}{2\theta_L}\right) + \left(\frac{R - p_1 + \theta_H \sqrt{s_1}}{\theta_H}\right)
\]  

(5)

The diagram below depicts the demand configuration for each retailer under vertical integration. In this figure, consumers with high willingness-to-pay for service and an inconvenient location do not buy; otherwise, consumers buy from the nearest retailers. Consumers who are just indifferent between buying the product or not are said to be on the product margin (where (1) is satisfied with equality). Consumers who buy the product, but who are just indifferent between the two retailers are said to be on the inter-retailer margin (where (2) is satisfied with equality) and are characterized by inconvenient locations and low willingness to pay for service.

![Diagram of Consumers](image)

**Figure 2: Equilibrium Configuration of Consumers**

Our first task is to establish the levels of price and service that the manufacturer seeks to implement in a decentralized equilibrium, i.e. those that he would have set himself had he vertically integrated
Proposition 1 Under vertical integration the price and service levels the manufacturer would set in a symmetric equilibrium are, respectively

\[ p^* = \frac{2R + \theta_H}{4 - \theta_H} \]  
\[ s^* = \frac{1}{4} \left( \frac{2R + \theta_H}{4 - \theta_H} \right)^2 \]  

Proof. See Appendix.

Intuitively, these solutions indicate that, to maximize total channel profits, the manufacturer focuses on the product margin and wants his retailers to provide a high level of service, thereby attracting consumers with high willingness-to-pay for service into the market. As these consumers are also less sensitive to price, the manufacturer can consequently charge a higher resale price for his product in return.

When the retail network of the manufacturer is decentralized, however, retailers concern themselves not only with the product margin, but the inter-retailer margin as well. Consumers on the inter-retailer margin are low-type, and have less use for service; rather, they are attracted to one retailer over another by lower prices. Consequently, decentralization results in two externalities: a classic vertical externality arising from the double markup of retailer on top of the by the manufacturer, and a horizontal pecuniary-externality arising from the two retailers competing with each other for consumers. Thus, a decentralized retail network leads to an incentive incompatibility between retailers and the manufacturer.

Proposition 2 Given a wholesale price \( w \geq 0 \), in any symmetric decentralized retail equilibrium where low type consumers are fully served, the common price and service levels set by each retailer are given by

\[ p^c(w) = \frac{(2R + \theta_H)\theta_L}{(4 - \frac{3}{2}\theta_H)\theta_L + \theta_H} + \frac{\theta_H + (2 - \frac{3}{2}\theta_H)\theta_L \cdot w}{(4 - \frac{3}{2}\theta_H)\theta_L + \theta_H} \]  
\[ s^c(w) = \frac{9}{16} \left( \frac{(2R + \theta_H)\theta_L}{(4 - \frac{3}{2}\theta_H)\theta_L + \theta_H} - \frac{2\theta_L}{(4 - \frac{3}{2}\theta_H)\theta_L + \theta_H} \right)^2 \]
Proof. See Appendix. ■

The incentive incompatibility between retailer and manufacturer is made clear by comparing the price and service levels under decentralization with those under vertical integration. Recall that the first-best price-service offerings are based on the tastes of the high-type consumers alone. However, when competing with each other for sales, retailers take into consideration low-type consumers as well. Note too that the difference in these expressions stems not only from the introduction of a wholesale price; even when \( w = 0 \), so that the vertical externality is absent, retailers do not set their prices or service provisions to first-best levels.

A simple linear wholesale-pricing contract fails to align the incentives of the retailers with the manufacturer. Intuitively, there are two targets for the manufacturer - the prices and services levels of the retailers - and a single instrument - a linear wholesale price - is insufficient to coordinate the distribution channel. More formally, the source of this incentive incompatibility can be shown by comparing the profit maximization problem of the manufacturer under vertical integration with that of retailers under decentralization. Total channel profits, i.e. those under vertical integration, are given by

\[
\Pi = p_1 q_1(p_1, p_2, s_1, s_2) - s_1 + p_2 q_2(p_1, p_2, s_1, s_2) - s_2
\]

(10)

and the first-best symmetric contract involves sets \( (p^*, s^*) \) to solve

\[
\frac{\partial \Pi}{\partial p_i} = 0
\]

(11)

\[
\frac{\partial \Pi}{\partial s_i} = 0
\]

(12)

On the other hand, the profits of retailer \( i \), given the choices of his competitor, retailer \( j \), are given by

\[
\pi_i = (p_i - w)q_i(p_1, p_2, s_1, s_2) - s_i
\]

(13)

or using \( \Pi \), this can be rewritten as

\[
\pi_i = \Pi - w q_i(p_1, p_2, s_1, s_2) - p_j q_j(p_1, p_2, s_1, s_2) + s_j
\]

(14)

In a decentralized equilibrium, given the choice \( (p_j, s_j) \) of retailer \( j \), retailer \( i \) chooses \( (p_i, s_i) \) to solve...
3.2 RPM: Existing Results

\[ \frac{\partial \pi_i}{\partial p_i} = \frac{\partial \Pi}{\partial p_i} - w \frac{\partial q_i}{\partial p_i} - p_j \frac{\partial q_j}{\partial p_i} = 0 \] (15)

\[ \frac{\partial \pi_i}{\partial s_i} = \frac{\partial \Pi}{\partial s_i} - w \frac{\partial q_i}{\partial s_i} - p_j \frac{\partial q_j}{\partial s_i} = 0 \] (16)

The first differing term in each equation represents the classic vertical externality arising from double marginalization; the retailer stacks his mark-up on top of the manufacturer’s. The second differing term represents the horizontal externality arising from retailer competition for consumers; each retailer takes into consideration only his own profits, and does account the affect his own price and service levels have on the profits of his opposing retailer. The following proposition, due to Winter (1993), formally shows the failure of simple franchise contracts, and the sufficiency of RPM in the current model.

**Proposition 3** In a decentralized retail network: (i) a wholesale price-franchise fee contract fails to coordinate the distribution channel. However, (ii) a contract involving a resale price floor, together with a wholesale price and franchise fee is sufficient to achieve the coordinated outcome.

**Proof.** Part (i): Consider the franchise contract \{F, w\}. By charging a fixed franchise fee equal to \(F = \pi_i\), the manufacturer can transfer all retailer profits upstream without affecting the incentives at the downstream level. What remains to establish is whether a linear wholesale price provides the correct incentives to dealers to undertake the first-best levels of price and service.

From the retailer’s problem in a decentralized supply chain, by imposing symmetry on the associated first order conditions, we can derive the following **Symmetric Best Response Function**\(^{14}\)

\[ b(p, s; \widehat{w}) = \begin{pmatrix} b_p(p, s; \widehat{w}) \\ b_s(p, s; \widehat{w}) \end{pmatrix} = \begin{pmatrix} \frac{1}{2} \left( \frac{(2R+\theta_H)\theta_L}{\theta_H+2\theta_L} + \frac{(p+2\theta_L\sqrt{\theta_H})\theta_H}{\theta_H+2\theta_L} + w \right) \\ \frac{2}{\theta_H}(p - w)^2 \end{pmatrix} \] (17)

A franchise contract is sufficient if there exists a wholesale price \(\widehat{w}\) such that \((p^*, s^*)\) is a fixed point of \(b(\cdot; \widehat{w})\).

Conditional on \(s^*\), the wholesale price which elicits the first-best resale price (i.e. yields \(p^*\) as a fixed point of \(b_p(s^*, \widehat{w})\)) is given by

\(^{14}\)The Symmetric Best Response function is the Best Response function of a retailer from the retailer competition stage, after imposing symmetry.
while that needed to elicit the first-best level of service, conditional on \( p^* \) (i.e. yields \( s^* \) as a fixed point of \( b_s(p^*, s; \hat{w}) \)) is

\[
w^s = \left. \frac{\partial q_j}{\partial q_i} \right|_{p^*} \frac{\partial s}{\partial p} = \frac{1}{3} \frac{2R + \theta_H}{4 - \theta_H}
\]  

But as \( \theta_H > \theta_L \), these two expressions do not coincide. In fact \( w^p > w^s \).

**Part (ii):** By comparing the first-order conditions from retailers' problem in a decentralized equilibrium with those of a vertically integrated manufacturer, we can write the incompatibility between the manufacturer’s and retailer’s incentives when the retailer chooses price and service levels as,

\[
\text{Incompatibility in } p : \quad -w \frac{\partial q_i}{\partial p_i} - p_j \frac{\partial q_j}{\partial p_i} = 0
\]

\[
\text{Incompatibility in } s : \quad -w \frac{\partial q_i}{\partial s_i} - p_i \frac{\partial q_j}{\partial s_i} = 0
\]

By definition, a sufficient contract sets both of these expressions to zero at \((p_1, s_1) = (p_2, s_2) = (p^*, s^*)\).

Suppose the manufacturer set his wholesale price to correct for the externalities in the retailer’s choice of service - choosing \( w^s \) so as to set the second of these equations to zero. Substituting in the appropriate derivative terms into equation (21) yields

\[
w \left( \frac{3}{4\sqrt{s^*}} \right) - p^* \left( \frac{1}{4\sqrt{s^*}} \right) = 0
\]

and we see that the wholesale price that elicits the correct service level is \( w^{RP_M} = \frac{1}{3} p^* \). However, at a wholesale price of \( \frac{1}{3} p^* \), the sign of the combined externalities in the retailers choice of price, equation (20), is negative when \((p_1, s_1) = (p_2, s_2) = (p^*, s^*)\), since we have

\[
-w^{RP_M} \frac{\partial q_i}{\partial p_i} - p^* \frac{\partial q_j}{\partial p_i} = \frac{1}{3} p^* \frac{(\theta_H + 2\theta_L)}{2\theta_H \theta_L} - p^* \left( \frac{1}{2\theta_L} \right)
\]

\[
= \frac{1}{3} p^* \frac{\theta_H - \theta_L}{\theta_H \theta_L} < 0
\]
This implies that a further restraint, namely a price floor at $p = p^*$, is needed to ensure that the retailer sets the correct price. ■

Intuitively, a dealer provides the correct level of service if faced with a large enough retail margin (see (17)). A binding price floor is used to provide this margin because, left unrestrained, retail competition over the marginal low-type consumer drives prices too low to support the efficient level of service.

What is critical is that the mechanism left to the manufacturer to enforce the price floor is to refuse to supply the product to any retailer setting a price below the proscribed minimum price. It is this refusal to supply that lies at the historical root of the legal challenge to contracts involving minimum price floors\textsuperscript{15}.

4 Alternative Solutions to the Problem

As noted above, a manufacturer facing a service problem in the distribution network has the option to use resale price maintenance. Such a contract, if enforced, aligns the incentives of the retailers and those of the manufacturer. The dilemma faced by a manufacturer is that such a contract may face legal challenge. Resale price floors may be legally unenforceable: a court of law may not rule in favor of the manufacturer if a retailer decides to breach the contract, and his price below the proscribed price floor. Moreover, given the optimal strategy for a retailer is to undercut his opponent’s price, should his opponent charge a price of $p^*$, a retailer an every incentive to deviate from the manufacturer’s contract. Thus, given the potential legal challenges associated with RPM, a profit-maximizing manufacturers may be interested in other contracts that make the dealers’ incentives compatible with his own. Defining these other contractual options remain an open question.

I now explore this issue, and in particular, examine whether the set of minimally sufficient contracts also includes contracts that do not rely on vertical restraints to coordinate the distribution channel. What lies at the crux of our analysis so far is that a manufacturer must call on a second instrument, in addition to a wholesale price, to align the incentives of retailers with those of his own. There is no

\textsuperscript{15}For example, in Monsanto Co. v. Spray-Rite Service Corp., 465 U.S. 752 (1984), the Spray-Rite Service Corporation sued the Monsanto Company, after Monsanto declined to renew a herbicide distributorship contract with Spray-Rite on the basis that Spray-Rite did not "exploit fully the potential markets for the Good in the Distributor’s area of primary responsibility". Spray-Rite alleged that its termination violated Section 1 of the Sherman Act. The U.S. Supreme Court agreed, and upheld a Federal District Court’s award of $10.3 million in damages to Spray-Rite (a company whose profits from the resale of Monsanto’s products at the time of the termination were $16,000).
4.1 Schemes Based on Own Targets

A priori reason to expect that only resale price maintenance can to do so. At issues is that, without sufficient incentives, retailers do not provide the "correct" level of point-of-sale service. Intuitively, then, what is needed to overcome the service dilemma is a carefully designed financial incentive scheme.

Bonus schemes are incentive devices as opposed to contractual restrictions. With RPM, incentives are enforced through a stick - the manufacturer’s threat to suspend supply for deviating dealers. Bonus schemes provide incentives or carrots, in the form of financial compensation. While it is obvious that carrots in general provide incentives, what is less obvious is whether there exists incentive mechanisms that provide sufficient incentives. Towards an answer to this question, I first examine financial incentive schemes written on a retailer’s own targets; I then consider sharing schemes.

4.1 Schemes Based on Own Targets

The analysis begins with determining what type of contacts are feasible to a manufacturer, or more precisely what contractual options exist for manufacturer. Clearly, contracting directly on service levels alleviates the coordination problems. Unfortunately, service levels are typically unobservable and unverifiable, and thus such a contract is unenforceable. Likewise, a manufacturer may consider a contract based on profits. But with service levels unobservable, economic costs are a measurement concern: artificial manipulation of costs by a retailer can lead to false profit signals.

If contracts written on service levels or profits are infeasible, this leaves two variables available to the manufacturer to define appropriate incentives: quantities and revenues. The vertical contracting literature appears to have ignored contracts based on these two measures. However, sales quantities are an observable candidate, as retailers must submit their purchase orders to the manufacturer in order to stock and resell the product. Similarly, revenues are a verifiable target: quantities are observable; and if resale prices were unobservable RPM would not have been an option in the first place.

Consider the contract \( \{F, w, I(T)\} \), where the traditional franchise contract is augmented by \( I(T) \), a bonus scheme based on a target \( T \). This contract involves the same number of instruments as a RPM contract. Thus, if \( \{F, w, I(T)\} \) coordinates the distribution channel, it too belongs in the set of

\[ \text{16 Indeed, as Winter (1993) shows, a contract relying on closed territorial distribution, in addition to a wholesale price, is also in the set of minimally sufficient contracts. However, territorial restrictions fall in the field of vertical restraints, and themselves raise anti-trust issues - although such questions are judged on a rule of reason.} \]

\[ \text{17 In fact, even if profits are observable, a bonus scheme based on a retailer’s own profits would not be sufficient. To see this note that, from Proposition (3), we know that there does not exist a franchise contract \( \{F, w\} \) such that, at \( (p_1, s_1) = (p^*, s^*) \), we have } \]

\[ \frac{\partial \pi_i^*(p^*, s^*, w)}{\partial p_i} = \frac{\partial \pi_i^*(p^*, s^*, w)}{\partial s_i} = 0 \]

\[ \text{Now, under an incentives scheme } I(\pi_i^*) \text{ based on a retailer’s own profits, the first order conditions characterizing a retailer’s equilibrium choices can be written as } \]

\[ [1 + I'(\pi_i^*)] \frac{\partial \pi_i^*(p^*, s^*, w)}{\partial p_i} = [1 + I'(\pi_i^*)] \frac{\partial \pi_i^*(p^*, s^*, w)}{\partial s_i} = 0 \]

\[ \text{It follows that there does not exist a contract } \{F, w, I'(\pi_i^*)\} \text{ that can elicit } (p^*, s^*) \text{ as a symmetric retailer equilibrium.} \]
minimally sufficient contracts. Formally, the design problem faced by the manufacturer when offering the contract \( \{ F, w, I(T) \} \) is given by the program

\[
\max_{w, F, I(T), p_1, p_2, s_1, s_2} \quad wq_1(p_1, p_2, s_1, s_2) + F - I(T_1(p_1, p_2, s_1, s_2)) + wq_2(p_1, p_2, s_1, s_2) + F - I(T_2(p_1, p_2, s_1, s_2))
\]

subject to

\[ (IR_1) \quad (p_1 - w)q_1(p_1, p_2, s_1, s_2) - F + I(T_1(p_1, p_2, s_1, s_2)) \geq 0 \tag{27} \]

\[ (IR_2) \quad (p_2 - w)q_2(p_1, p_2, s_1, s_2) - F + I(T_2(p_1, p_2, s_1, s_2)) \geq 0 \tag{28} \]

\[ (IC_1) \quad (p_1, s_1) \in \arg \max_{\hat{p}_1, \hat{s}_1} (\hat{p}_1 - w)q_1(\hat{p}_1, p_2, \hat{s}_1, s_2) - F + I(T_1(\hat{p}_1, p_2, \hat{s}_1, s_2)) \tag{29} \]

\[ (IC_2) \quad (p_2, s_2) \in \arg \max_{\hat{p}_2, \hat{s}_2} (\hat{p}_2 - w)q_1(p_1, \hat{p}_2, p_1, \hat{s}_2) - F + I(T_2(p_1, \hat{p}_2, s_1, \hat{s}_2)) \tag{30} \]

The individual rationality constraints, (27) and (28), require that the contract leave retailers a level of profits no less than their outside competitive option. The incentive compatibility constraints, (29) and (30), require that the retailers self-select the first-best levels of resale price and service in a Nash-Equilibrium of the retail competition stage that follows the contracting stage. The contract \( \{ w, F, I(T) \} \) is alone sufficient if the profits from the above program achieve those from vertical integration. The following proposition shows that such a contract exists.

**Proposition 4** In a decentralized retail network: (i) a contract consisting of a wholesale, franchise fee, and an incentive scheme written on quantity will fail to coordinate the distribution channel. However, (ii) A contract composed of a wholesale, franchise fee, and a bonus incentive scheme written on revenues is sufficient to achieve the first-best equilibrium.

**Proof.** Part (i): Consider the contract \( \{ F, w, I(q) \} \), where \( I(q) \) is an incentive scheme based on a retailer’s sales of \( q \) units. Under such a contract, retailer \( i \)'s problem in the retail competition game,
given his competitor’s choice \((p_j, s_j)\), is

\[
\max_{p_i, s_i} \pi_i = (p_i - w) * q_i(\hat{p}_i, p_j, \hat{s}_i, s_j) - s_i + I(q_i(\hat{p}_i, p_j, \hat{s}_i, s_j))
\] (31)

Use the profit function \(\Pi\) from vertical integration to rewrite this as

\[
\max_{\hat{p}_i, \hat{s}_i} \pi_i = \Pi - w * q_i(\hat{p}_i, p_j, \hat{s}_i, s_j) + I(q_i(\hat{p}_i, p_j, \hat{s}_i, s_j)) - p * q_j(\hat{p}_i, p_j, \hat{s}_i, s_j) - s_j
\] (32)

The associated first order conditions characterizing the equilibrium choice of \((p_i, s_i)\) are

\[
\frac{\partial \pi_i}{\partial p_i} = \frac{\partial \Pi}{\partial p_i} - w \frac{\partial q_i}{\partial p_i} - p_j \frac{\partial q_j}{\partial p_i} + I'(q_i) \frac{\partial q_i}{\partial p_i} = 0
\] (33)

\[
\frac{\partial \pi_i}{\partial s_i} = \frac{\partial \Pi}{\partial s_i} - w \frac{\partial q_i}{\partial s_i} - p_j \frac{\partial q_j}{\partial s_i} + I'(q_i) \frac{\partial q_i}{\partial s_i} = 0
\] (34)

The proof is by contradiction: suppose the quantity bonus scheme is able to implement a symmetric equilibrium at the first-best optimum \((p^*, s^*)\) from vertical integration. At \((p^*, s^*)\), we have \(\partial \Pi / \partial p_i = \partial \Pi / \partial s_i = 0\). Since the proposed contract is assumed to be sufficient, the manufacturer can choose \(w\) and \(I(q)\) to set the last three terms of each first-order conditions to zero at \((p_1, s_1) = (p_2, s_2) = (p^*, s^*)\).

Let the manufacturer set the wholesale price to solve (34), the first order condition for service. This implies that \(w\) must be set to

\[
= I'(q^*) - \frac{\partial q_j}{\partial q_i} \frac{\partial s_i}{\partial s_i} p^*
\] (35)

or, after substituting in the appropriate demand expressions

From the first-order condition for price, equation (33), a bonus contract written on quantity can coordinate the distribution channel if and only if

\[
-\hat{w} \frac{\partial q_i}{\partial s_i} - p_j \frac{\partial q_j}{\partial s_i} + I'(q_i) \frac{\partial q_i}{\partial s_i} = 0
\] (36)

or, substituting in for \(\hat{w}\)

\[
- \left( I'(q^*) - \frac{\partial q_j}{\partial q_i} \frac{\partial s_i}{\partial s_i} p^* \right) \frac{\partial q_i}{\partial s_i} - p_j \frac{\partial q_j}{\partial s_i} + I'(q_i) \frac{\partial q_i}{\partial s_i} = 0
\] (37)

which requires
4.1 Schemes Based on Own Targets

\[ \frac{\partial q_j}{\partial p_i} \] \[ \frac{\partial q_j}{\partial q_i} = \frac{\partial q_j}{\partial s_i} \]

(38)

But, as \( \theta_H > \theta_L \), this last condition yields a contradiction since, as before, in our model we have

\[ \left| \frac{\partial q_j}{\partial p_i} \right| = \frac{\theta_H}{\theta_H + 2\theta_L} > \frac{1}{3} = \left| \frac{\partial q_j}{\partial q_i} \right| \]

(39)

**Part (ii):** Now consider the contract \( \{F, w, I(R)\} \), where \( I(R) \) is an incentive scheme based on a retailer’s revenues of \( R = pq \). Under such a contract, given the competitors choice \((p_j, s_j)\), retailer \( i \)'s problem in the retail competition game may be written as

\[ \max_{\hat{p}_i, \hat{s}_i} \pi_i = (\hat{p}_i - w) * q_i(\hat{p}_i, p_j, \hat{s}_i, s_j) - s_i + I(\hat{p}_i * q_i(\hat{p}_i, p_j, \hat{s}_i, s_j)) \]

(40)

The associated first-order conditions characterizing his equilibrium choice of \((p_i, s_i)\) are

\[ \frac{\partial \pi_i}{\partial p_i} = \frac{\partial \Pi}{\partial p_i} - w \frac{\partial q_i}{\partial p_i} - p_j \frac{\partial q_j}{\partial p_i} + I'(R_i) \frac{\partial R_i}{\partial p_i} = 0 \]

(41)

\[ \frac{\partial \pi_i}{\partial s_i} = \frac{\partial \Pi}{\partial s_i} - w \frac{\partial q_i}{\partial s_i} - p_j \frac{\partial q_j}{\partial s_i} + I'(R_i) \frac{\partial R_i}{\partial s_i} = 0 \]

(42)

Proceed as before: consider, the implementation of the symmetric optimum under integration \((p^*, s^*)\).

Let the manufacturer set the wholesale price to solve (42), the first-order condition for service. Using \( \partial R_i/\partial s_i = p_i \partial q_i/\partial s_i \), this implies that \( w \) be set at

\[ w_R = \left( I'(R^*) - \frac{\partial q_j}{\partial q_i} \right) p^* \]

(43)

Substitute \( w_R \) into the first-order condition for price, equation (41), and use \( \partial R_i/\partial p_i = (q_i + p_i \partial q_i/\partial p_i) \), to define the sufficient bonus contract written on revenues by the simple differential equation

\[ I'(R^*) = \left( \frac{\partial q_j}{\partial q_i} \frac{\partial p_i}{\partial q_i} - \frac{\partial q_j}{\partial q_i} \right) \frac{p^* \partial q_i}{q^* \partial p_i} \]

(44)

Finally, set the franchise fee to \( F^R = (p^* - w) * q^* - s^* + I(R^*) \); then, the manufacturer can extract the rents from the downstream level, at the same time serving as a budget breaker for the incentive scheme, and achieve the same profits that would accrue under vertical integration. □
For the specific functional form assumptions of our model, the sufficient bonus incentive scheme takes the form

\[ I(R^*) = \frac{1}{3} \left( \frac{\theta_H - \theta_L}{\theta_L} \right) R \]  

(45)

and the associated wholesale price

\[ w^R = \frac{1}{3} \left( \frac{\theta_H}{\theta_L} \right) R^* \]  

(46)

### 4.1.1 Discussion

The failure of incentives schemes based on quantity is intimately related to the failure of simple wholesale pricing contracts. Equation (39) from the proof of part \( (i) \) shows that a quantity scheme fails because

\[ \left| \frac{\partial q_j / \partial p_i}{\partial q_i / \partial p_i} \right| > \left| \frac{\partial q_j / \partial s_i}{\partial q_i / \partial s_i} \right| \]  

(47)

or, equivalently\(^{18}\)

\[ \frac{\varepsilon_p}{\varepsilon_M} > \frac{\varepsilon_s}{\varepsilon_M} \]  

(48)

where these terms refer to the retailer and market elasticities of demand with respect to price and service, evaluated at their first-best levels. This latter expression is the exact same necessary and sufficient condition derived by Winter (1993) for a simple spot market contract to fail. An incentive schemes based solely on quantity are subject to the same bias towards price competition over service provision, in the sense that (39) holds, as are contracts based solely on wholesale price. This result is even more general then it appears. Specifically, combine the linear wholesale pricing together with the quantity based incentive scheme to arrive at a contract of the form \( \Omega(q) = wq - I(q) \), i.e. a quantity-based discount wholesale price scheme that explicitly separates the linear part of the contract from the non-linear part. Moreover, Proposition 4\((i)\) implies the following corollary.

**Corollary 1** Quantity forcing is insufficient to coordinate the distribution channel.

\(^{18}\)The condition \( \left| \frac{\partial q_j / \partial p_i}{\partial q_i / \partial p_i} \right| > \left| \frac{\partial q_j / \partial s_i}{\partial q_i / \partial s_i} \right| \) is equivalent to \( \frac{\partial q_j / \partial p_i}{\partial q_i / \partial p_i} < \frac{\partial q_j / \partial s_i}{\partial q_i / \partial s_i} \), as both of these latter expressions are negative. Thus, we have \( \frac{\partial q_j / \partial p_i}{\partial q_i / \partial p_i} > \frac{\partial q_j / \partial s_i}{\partial q_i / \partial s_i} \), which with some algebraic manipulation can be written as \( \frac{\varepsilon_p}{\varepsilon_M} > \frac{\varepsilon_s}{\varepsilon_M} \).
Proof. With quantity forcing, the constraint on retailer \( i \) is \( q_i(p_1, p_2, s_1, s_2) \geq q \), where \( q \) is the quantity floor. Let \( \mu \) denote the Lagrangian multiplier associated with this constraint from retailer \( i \)'s problem under decentralization. Then, the associated first order conditions characterizing his equilibrium choice of \((p_i, s_i)\) are

\[
\begin{align*}
\frac{\partial \pi_i}{\partial p_i} &= \frac{\partial \Pi}{\partial p_i} - w \frac{\partial q_i}{\partial p_i} - p_j \frac{\partial q_j}{\partial p_i} - \mu \frac{\partial q_i}{\partial p_i} = 0 \\
\frac{\partial \pi_i}{\partial s_i} &= \frac{\partial \Pi}{\partial s_i} - w \frac{\partial q_i}{\partial s_i} - p_j \frac{\partial q_j}{\partial s_i} - \mu \frac{\partial q_i}{\partial s_i} = 0
\end{align*}
\] (49) (50)

Follow the same development as the proof of Proposition 4(i) to obtain the result. \( \blacksquare \)

A bonus scheme based on revenues is (i) minimally sufficient to align incentives and (ii) novel to the literature on vertical contractual relations. Equation (44) from the proof of part (ii) makes it clear that this revenue-based bonus scheme is simple, taking a linear form. Moreover, the bonus scheme is easy to implement, as all inputs needed to construct the bonus scheme can be obtained through empirical demand model (see equation (51) below); from a practical viewpoint, this is particularly useful.

The ability for such a bonus contract based on revenues to provide sufficient follows from the rate at which it supplements revenues

\[
I'(R^*) = \left( \frac{\epsilon_p^r}{\epsilon_p^M} - \frac{\epsilon_s^r}{\epsilon_s^M} \right) \frac{\epsilon_p^r}{\epsilon_p^M}
\] (51)

This condition shows that the contract exploits the spread between the ratio of firm to market price elasticities and that of service elasticities (the same spread that causes wholesale pricing contracts to fail) to provide the correct incentive needed to make the manufacturer’s interests compatible with those of the retail sector.

Intuitively, an incentive scheme based on sales quantity fails because it does not alter the source of incentive incompatibility, namely retail competition. Under a scheme based on sales quantities, the incentive for retailers is to remain engaged in competition over the marginal inter-retailer consumer. While one retail outlet may wish to increase its sales (and thus its bonus) by going after high-type consumers - providing them with a higher level of service and charging a higher price in return -
it knows that by doing so, its rival will undercut price in an attempt to steal low-type consumers. With symmetric retailers, each offered the same contract, the logic applies to both. Thus, neither retailer disengages from competition with its rival, but rather attempts to achieve higher bonus levels by discounting price.

On the other hand, revenue based incentives can coordinate the distribution channel, as higher bonuses are attainable not only by increasing sales, but also by increasing price. The incentive to increase price, together with the specific design of the bonus scheme, dampens competition between the retailers to the point where it is in both their interest to provide higher levels of service to attract high-type consumers.

The manufacturer’s role in such a contract is critical. Without someone to act as a Holmstrom (1982) third-party budget breaker for the network of retailers, such a bonus scheme would be infeasible: it requires incremental resources totaling $2(R)$ beyond what the vertical supply chain earns through its operations. Through the use of his franchise fee, the manufacturer serves the purpose of providing budget balancedness in the distribution channel, by requiring each retailer to make an extra payment of $I(R^*)$ up-front; in equilibrium, the two amounts offset.

Proposition 4 characterizes formally establishes that the space of minimally sufficient contracts is not monopolized by contracts which rely solely on vertical restraints – there exists substitutes for resale price maintenance: while resale price maintenance may be sufficient to coordinate a distribution channel, it is not necessary. It also helps us better understand the reasons as to why sophisticated contracts are needed to coordinate the manufacturer’s distribution channel. At first glance, it may appear that the driving force behind the call to vertical restraints is a need to limit horizontal competition amongst downstream retailers. The contract suggested here shows us that this is not the case: the failure of spot contracts is driven by a misalignment of incentives between upstream and downstream firms, particularly over which consumer they should focus their attention on. Vertical restraints are only one way to solve this incentive incompatibility; an equivalent method would be to implement a bonus incentive scheme. Last, it makes clear that the space of solutions to the vertical contracting problem is quite complex: denying incentive schemes based on quantity, but allowing for schemes based on price (resale price maintenance), and on revenue (the product of price and quantity). Additionally, the space of minimally sufficient contracts allows for incentives to come through both sticks (RPM), and carrots (bonus schemes). Moreover, given the limited contracting options of the manufacturer, the analysis suggests that when vertical restraints are infeasible, a bonus scheme based on revenues is
the unique minimally sufficient contract.

Our findings also have significant importance for the marketing literature. For, as resale price maintenance is legally uncertain at least, the managers of an upstream firm may not want to venture into these murky waters. Indeed, what is absent from all models of vertical contractual relations are the implementation costs needed to administer and potentially to provide legal defense for the manufacturer’s contracts. In particular, for price restraints, these costs may be high\(^{19}\). Thus, the managers of profit maximizing upstream firm wishing to avoid any legal issues raised by price restraints, must look at other forms of contracting to coordinate their distribution channel; this paper characterizes a potential contract for this purpose. Additionally, given the nature of the solution space, not permitting solutions based on quantity alone, but allowing for those based on price or on revenue, the managerial implication is that some upstream firms may have to reexamine their current incentive schemes. In particular, quantity based discount schemes may not be providing the level of desired incentives; instead, a move to bonus schemes based on revenues may be called for.

### 5 Revenue Sharing Schemes

As mentioned, a key feature of an incentive scheme based on own revenues is the role of the manufacturer as a third-party budget breaker: by requiring each retailer to make an extra payment up-front through a large franchise fee, the manufacturer can amass enough resources to pay out bonuses after retail competition. However, if retailers are capital constrained at the time of contracting, they will not be able to finance the required franchise fee.\(^{20}\) In this case, the proposed financial incentive scheme based on a retailer’s own revenues will be infeasible. Thus, in the face of retailers who are capital constrained, a manufacturer must restrict his attention to financial incentives schemes which are budget balanced at the downstream level, i.e. sharing schemes.

It is clear that profit sharing scheme amongst the retailers will be able to coordinate the distribution channel, and achieve budget balancedness at the downstream level. In particular, suppose that each retailer is promised one-half of his competitors profits; in return, he must give one-half of his own profits to his competitor. By construction, the sharing scheme is budget balanced. Moreover, with the addition of marginal cost wholesale pricing, the profit sharing scheme is able elicit the first-best levels of

\(^{19}\)See footnote (3).

\(^{20}\)This may be particularly true for the large franchise fee, over and above operating profits, required by the proposed financial incentive scheme.
price and service: the problem of each retailer mirrors that of the vertically integrated manufacturer.\footnote{To see that the profit sharing rule is sufficient, consider the choice problem of a decentralized retailer. With abuse of notation let $\pi^*_i(w)$ denote retailer $i$’s operating profits; under this equal sharing rule, first order conditions characterizing a retailer’s optimal choices are

$$\frac{1}{2} \frac{\partial}{\partial p_i} \pi^*_i(\tilde{p}_1, p_2, \tilde{s}_1, s_2; w) + \frac{1}{2} \frac{\partial}{\partial s_i} \pi^*_i(\tilde{p}_1, p_2, \tilde{s}_1, s_2; w) = 0$$

$$\frac{1}{2} \frac{\partial}{\partial p_i} \pi^*_i(\tilde{p}_1, p_2, \tilde{s}_1, s_2; w) + \frac{1}{2} \frac{\partial}{\partial s_i} \pi^*_i(\tilde{p}_1, p_2, \tilde{s}_1, s_2; w) = 0$$

Now, with $w = 0$ it is plain that the above equations are indeed zero at $(p_1, s_1) = (p_2, s_2) = (p^*, s^*)$.}

While technically able to align the incentives of downstream with upstream, the implementation of a profit sharing scheme requires that the operating profits of each retailer are perfectly observable, both to the manufacturer and to retailers. However, with service levels unobservable, manipulation of costs by a retailer can lead to false profit signals. Thus, a profit sharing scheme may not be feasible for the vertical supply chain.

Of course, the target variables on which the manufacturer to contract on are not limited to profits; as before, retail revenues are perfectly observable to the manufacturer. In this section, I examine the use revenue sharing schemes to coordinate the supply chain.

Consider the contract $(w, F, S(R))$, where $S(\cdot)$ is a revenue sharing rule. Under such a contract, the manufacturer collects a share $S(R_1)$ of revenues from retailer 1 and redistributes it to his competitor, retailer 2; in return, retailer 1 receives a share $S(R_2)$ of retailer 2’s revenues. By construction, the sharing rule achieves budget balancedness at the downstream level: we have

$$Net \ Payment \ to \ Retailer \ 1 + Net \ Payment \ to \ Retailer \ 2 = [S(R_2) - S(R_1)] + [S(R_1) - S(R_2)] = 0$$

However, it is not obvious that a revenue sharing scheme is able to provide sufficient incentives to bring retailer objectives in-line with the manufacturer: while giving a retailer a share of his opponent’s revenues may give him incentive to raise his price and quantity, taking away part of his own revenue has the reverse effect. I now show that there indeed exists a sharing scheme that is sufficient to coordinate the distribution channel.

**Proposition 5** In a decentralized retail network a contract consisting of a wholesale, franchise fee, and revenue sharing scheme is sufficient to achieve the first-best equilibrium, and achieve downstream
Proof. Under the contract \{F, w, S(R)\}, given his competitors choice \((p_j, s_j)\), retailer \(i\)'s problem in the retail competition game may be written as

\[
\max_{p_i, s_i} \pi_i = (\hat{p}_i - w) q_i(\hat{p}_i, p_j, \hat{s}_i, s_j) - s_i - S(\hat{p}_i q_i(\hat{p}_i, p_j, \hat{s}_i, s_j)) + S(p_j q_j(\hat{p}_i, p_j, \hat{s}_i, s_j)) \tag{57}
\]

and the associated first order conditions characterizing his equilibrium choice of \((p_i, s_i)\) are

\[
\frac{\partial \pi_i}{\partial p_i} = \frac{\partial \Pi}{\partial p_i} - w \frac{\partial q_i}{\partial p_i} - p_j \frac{\partial q_j}{\partial p_i} - S'(R_i) \frac{\partial R_i}{\partial p_i} + S'(R_j) \frac{\partial R_j}{\partial p_i} = 0 \tag{58}
\]

\[
\frac{\partial \pi_i}{\partial s_i} = \frac{\partial \Pi}{\partial s_i} - w \frac{\partial q_i}{\partial s_i} - p_j \frac{\partial q_j}{\partial s_i} - S'(R_i) \frac{\partial R_i}{\partial s_i} + S'(R_j) \frac{\partial R_j}{\partial s_i} = 0 \tag{59}
\]

Consider the implementation of the symmetric optimum under integration \((p^*, s^*)\). Note that, at \((p^*, s^*)\) the two retailers make identical revenues, \(R_i = R_j = R^*\). Let the manufacturer set his wholesale price to solve (59), the first order condition for service. Using the fact that \(\partial R_i/\partial s_i = p_i \partial q_i/\partial s_i\), and \(\partial R_j/\partial s_i = p_j \partial q_j/\partial s_i\), this implies that \(w\) be so that

\[
-w \frac{\partial q_i}{\partial s_i} - p^* \frac{\partial q_j}{\partial s_i} - S'(R^*) p^* \frac{\partial q_i}{\partial s_i} + S'(R^*) p^* \frac{\partial q_j}{\partial s_i} = 0 \tag{60}
\]

Hence

\[
w^{\\text{Sharing}} = \left( \frac{\partial q_j/\partial s_i}{\partial q_i/\partial s_i} \right) \left( S'(R^*) - S'(R^*) \right) - \frac{\partial q_j/\partial s_i}{\partial q_i/\partial s_i} \right) p^*
\]

Next, substitute \(w^{\\text{Sharing}}\) into the first order condition (58) for price, and use the fact that \(\partial R_i/\partial p_i = (q_i + p_i \partial q_i/\partial p_i)\) and \(\partial R_j/\partial p_i = p_j \partial q_j/\partial p_i\), to characterize the sufficient revenue sharing scheme through the simple differential equation

\[
-p \left( \frac{\partial q_j/\partial s_i}{\partial q_i/\partial s_i} S'(R^*) - \frac{\partial q_j/\partial s_i}{\partial q_i/\partial s_i} - S'(R^*) \right) \frac{\partial q_i}{\partial p_i} - p^* \frac{\partial q_j}{\partial p_i} - S'(R^*) (q_i + p^* \frac{\partial q_i}{\partial p_i}) + S'(R^*) p^* \frac{\partial q_j}{\partial p_i} = 0 \tag{61}
\]

Thus,
Finally, by charging a fixed franchise fee equal to \( F = \pi_s \), the manufacturer can transfer all rents from the downstream level, at the same time serving as a budget breaker for the incentive scheme, and achieve the profits that he would accrue under vertical integration.

\[ S'(R^*) = \frac{\partial q_i / \partial p_s - \partial q_i / \partial s_i}{\left( \frac{\partial q_i / \partial p_s - \partial q_i / \partial s_i}{\partial q_i / \partial p_s} \right)} \]  

(62)

5.0.2 Discussion

The fact that a retailer receives a share of his competitor’s revenues gives the retailer an incentive to increase his level of price and service. However, taking away part of the retailer’s own revenue has the reverse effect - their is a disincentive to in.

Intuitively, by giving each retailer a share of his opponents revenues, retailers internalize the benefits from raising their price and service levels on the sales revenue of his opponent from - which arise through the horizontal pecuniary externality. Hence, retail’s disengage from price competition, as they put less focusing on the marginal inter-retailer consumer. On the other hand, since a retailer is claimant to less of his own revenues, while still facing the whole cost of service provision, he is less inclined to increase his level of service, and thus increase his price. Thus, the manufacturer must carefully design the revenues sharing scheme to balance disincentives with sufficient incentives.

6 Price Ceilings

In this section, we consider the implication of relaxing Assumption 2 for its alternative. As mentioned before, it is not possible to have an symmetric equilibrium where both segments are covered. As opposed to Assumption 2, we know suppose that the segment of consumers that is fully served under vertical integration is the high-type segment. Thus, for this section, we maintain:22

**Assumption 3** In the first-best optimum, high-type consumers are fully served

\[ \text{Assumption 3} \]

Given the restrictions from Assumption 3, the participation constraint for the low types is binding; hence there is a low type consumer who is just indifferent between purchasing and not, his location given by

\[ \text{22Sufficient conditions provided in the appendix.} \]
\[\pi^L = \frac{R - p_1 + \theta_L \sqrt{s_1}}{\theta_L}\]  

For high types the market is fully covered. Hence, there exists a consumer in the interior of the city, who is the subject of competition between the two retailers. The location of this consumer is given by

\[\pi^H = \frac{1}{2} + \frac{p_2 - p_1 + \theta_H (\sqrt{s_1} - \sqrt{s_2})}{2\theta_H}\]  

Thus, the demand at retail outlet 1 is given by

\[q_1(p_1, p_2, s_1, s_2) = \pi^L + \pi^H = \left(\frac{R - p_1 + \theta_L \sqrt{s_1}}{\theta_L}\right) + \left(\frac{1}{2} + \frac{p_2 - p_1 + \theta_H (\sqrt{s_1} - \sqrt{s_2})}{2\theta_H}\right)\]  

Our first task is to establish the levels of price and service that the manufacturer seeks to implement in a decentralized equilibrium, i.e. those that he would have set himself had he vertically integrated with his retailers.

**Proposition 6** Under vertical integration the price and service levels the manufacturer would set in a symmetric equilibrium are, respectively

\[p^* = \frac{2R + \theta_L}{4 - \theta_L}\]  

\[s^* = \frac{1}{4} \left(\frac{2R + \theta_L}{4 - \theta_L}\right)^2\]  

**Proof.** Similar to Proposition 1. ■

As usual, under vertical integration, the manufacturer focuses on the product margin - which in this case consists of low type consumers. As these consumers are more price sensitive, the manufacturer charges a low price, but offers very little service as a result.

When the retail network of the manufacturer is decentralized, retailers concern themselves with the inter-retailer margin as well. However, in this case, consumers on the inter-retailer margin are those of high-types, who less concerned about price but more interested in sales service. As a result, decentralization results in retailers offering too high level of service and charging too high prices.
Proposition 7  Given a wholesale price $w \geq 0$, in any symmetric decentralized retail equilibrium where low type consumers are fully served, the common price and service levels set by each retailer are given by

\begin{align}
 p^c(w) &= \frac{(2R + \theta_L)\theta_H + \theta_L}{(4 - \frac{3}{2}\theta_L)\theta_H + \theta_L} + \frac{\theta_L + (2 - \frac{3}{2}\theta_L)\theta_H}{w} \\
 s^c(w) &= \frac{9}{16} \left( \frac{(2R + \theta_L)\theta_H}{(4 - \frac{3}{2}\theta_L)\theta_H + \theta_L} - \frac{2\theta_H}{w} \right) \tag{68} \end{align}

Proof. Similar to Proposition 2. ■

As before, simple spot contracts will fail to coordinate the distribution channel - the usual 1 instrument versus 2 externalities × 2 targets story. In this case, retailers are bias towards service competition, and as a result provide too high and charge too high a price, as compared to that which maximizes total supply chain profits. However a price restraint is sufficient - this time, a price ceiling. In this case, a price ceiling mutes the private incentive for retailer’s to provide service, as it effectively limits the size of the retail margin.

Proposition 8  In a decentralized retail network: (i) a wholesale price-franchise fee contract fails to coordinate the distribution channel. However, (ii) a contract involving a resale price floor, together with a wholesale price and franchise fee is sufficient to achieve the coordinated outcome.

Proof. Part (i): Similar to Proposition (3)(i). Here a spot contract fails because retailers are biased towards service in the sense that

\begin{equation}
 \frac{\epsilon^r_M}{\epsilon^r_p} = \frac{\theta_L}{\theta_L + 2\theta_H} < \frac{1}{3} = \frac{\epsilon^r_M}{\epsilon^r_s} \tag{70}
 \end{equation}

Part (ii): Similar to Proposition (3)(ii). Conditional on having elicited the first-best price, the manufacturer can set his wholesale price to $w^{RPM} = \frac{1}{3}p^*$ and elicit the first-best level of service. A price ceiling is needed to elicit the first-best price, since at $w^{RPM} = \frac{1}{3}p^*$ and $(p_1, s_1) = (p_2, s_2) = (p^*, s^*)$ we have

\begin{equation}
 \frac{\partial \pi_i}{\partial p_i} = \frac{1}{3}p^* \frac{\theta_H - \theta_L}{\theta_H \theta_L} > 0 \tag{71}
 \end{equation}

■
Unlike our analysis of the model where retailers are bias towards price competition, the discussion of the model with price-ceiling ends here: price ceilings do not raise anti-trust concerns.\footnote{In Canada, price ceilings have always been legal. In the U.S., price ceilings have been legal since the U.S. supreme court ruling on State Oil Co. v. Khan & Associates, 522 U.S. 3 (1997).} Thus, since a manufacturer who is faced with retailers that are biased towards service competition can freely appeal to price ceilings, and there is no need (beyond theoretical curiosity) for us to examine alternative contracting options.

7 Conclusion

While the existing literature on vertical contractual relations has established that resale price maintenance is sufficient to coordinate the retail network of a manufacturer, this paper asks whether such vertical restraints are necessary. I study the vertical contracting problem between an upstream manufacturer and his downstream retail distribution in a setting where appealing to resale price maintenance is not possible due to legal prohibition, and examine whether other forms of contracting can achieve the outcome of vertical integration.

I show that a bonus scheme based on retail revenues is sufficient to provide enough incentives to decentralized retailers to elicit the correct level of both price and service. Interestingly, an incentive scheme based on retail sales is unable to do so. Intuitively, an incentive scheme based on quantity alone will fail because it does not alter the source of incentive incompatibility, namely retail competition. In addition, when faced with capital constrained franchisees, a revenue sharing contract is able to achieve the outcome of vertical integration while maintaining downstream budget-balancedness. On the other hand, an incentive scheme based on retail revenue is able to coordinate the distribution channel because higher bonus levels are attainable not only by increasing sales, but also by increasing price; higher service levels then follow, as there is sufficient price cost margins to underwrite them.

This paper completes the study of the vertical contracting problem in a Winter (1993) type model. The extant literature has considered which vertical restraints are sufficient to achieve the first-best outcome of vertical integration. Here, I characterize the remainder of the solution space by examining which financial incentive schemes are minimally sufficient.

Of course, this paper does not complete the study vertical restraints. The particular problem modeled here is one between a monopolist manufacturer and a set of independent, oligopolistically competitive retailers who are engaged in both price and non-price competition. What remains for
the literature to examine is the sufficiency of vertical restraints in model with both upstream and downstream oligopoly. To the best of my knowledge, there is no literature on a vertical supply chains in an environment where both non-price retailer decisions and upstream oligopoly are important\textsuperscript{24}. To this end, one possible approach is to take the simplified model I present in Section 3 and extend it to the case where there is duopoly at the upstream level, each manufacturer producing a differentiated variety of the same good. It would be interesting to see whether minimum RPM remains a minimally sufficient contract in a model where upstream firms compete over sales.

\textsuperscript{24}Innes and Hamilton (2009) consider the case where duopoly retailers sell more than one manufactured good. However, in their model, the upstream is characterized by a dominant firm competing against a competitive fringe.
8 Appendix

PROOF OF PROPOSITION 1

The maximization program of a vertically integrated manufacturer is given by

$$\max_{p_1, p_2, s_1, s_2} \Pi_M = p_1 q_1(p_1, p_2, s_1, s_2) - s_1 + p_2 q_2(p_1, p_2, s_1, s_2) - s_2$$

(72)

$$= p_1 \left\{ \frac{1}{2\theta_L} (p_2 - p_1 + \theta_L (1 + \sqrt{s_1} - \sqrt{s_2})) + \frac{1}{\theta_H} (R - p_1 + \theta_H \sqrt{s_1}) \right\} - s_1$$

(73)

$$+ p_2 \left\{ \frac{1}{2\theta_L} (p_1 - p_2 + \theta_L (1 + \sqrt{s_2} - \sqrt{s_1})) + \frac{1}{\theta_H} (R - p_1 + \theta_H \sqrt{s_2}) \right\} - s_2$$

After substituting in the appropriate demand expressions, the first order conditions imply that for $$i = 1, 2$$ and $$j \neq i$$

$$\frac{\partial \Pi_M}{\partial p_i} = \left\{ \frac{p_j - p_i + \theta_L (1 + \sqrt{s_i} - \sqrt{s_j})}{2\theta_L} + \frac{R - p_i + \theta_H \sqrt{s_i}}{\theta_H} \right\} - \left( \frac{\theta_H + 2\theta_L}{2\theta_H \theta_L} \right) p_i + \frac{1}{2\theta_L} p_j = 0$$

(74)

$$\frac{\partial \Pi_M}{\partial s_i} = \frac{3}{4} \frac{p_i}{\sqrt{s_i}} - 1 - \frac{1}{4} \frac{p_j}{\sqrt{s_j}} = 0$$

(75)

or, after collecting terms

$$(2R + \theta_H)\theta_L - 2(\theta_H + 2\theta_L)p_i + 2\theta_H p_j + \theta_H \theta_L (3\sqrt{s_i} - \sqrt{s_j}) = 0$$

(76)

$$\frac{1}{4\sqrt{s_i}} (3p_i - p_j) - 1 = 0$$

(77)

Hence, under a symmetric optimum, where $$p_i = p_j = p^*$$ and $$s_1 = s_2 = s^*$$, we have

$$p^* = \frac{1}{2} \left( R + \frac{1}{2} \theta_H + \sqrt{s^* \theta_H} \right)$$

(78)

$$s^* = \left( \frac{1}{2} p^* \right)^2$$

(79)

Solving this last system of equations yields the result.

LEMMA 1

Assume $$\frac{\theta_H + 2\theta_L - \theta_H \theta_L}{2 - \theta_H + \theta_L} < R < 2 - \theta_H$$. Then, the outcome under vertical integration involves a symmetric price-service offering across retailers. Moreover, under vertical integration low-type consumers are fully served, while a segment of high-type consumers is left uncovered.
**Proof:** The low-type consumers will be the ones that are fully served if these consumers get more utility than do the high-types at every address. In particular, this requires \( R + \theta_L (\sqrt{s^*} - \frac{1}{2}) - p^* > R + \theta_H (\sqrt{s^*} - \frac{1}{2}) - p^* \). But as \( \theta_H > \theta_L \), this can only occur if \( \sqrt{s^*} - \frac{1}{2} < 0 \). Substituting in for \( s^* \) from (7) we see that the restriction on \( R \) is that it is strictly less than \( \bar{R} = 2 - \theta_H \). Now, for the segment of low-type consumers to be fully served, we also need that \( R + \theta_L (\sqrt{s^*} - \frac{1}{2}) - p^* > 0 \). Substituting in for \( s^* \) and \( p^* \), yields the restriction that \( R \) is greater than \( R = \frac{\theta_H + 2\theta_L - \theta_H \theta_L}{2 - \theta_H + \theta_L} \). A graph of \( R \) versus \( R \); establishes that the permissible values of reservation values is non-empty only if \( \theta_H < 1 \).

To establish that the unique outcome under vertical integration involves a symmetric price-service offering across retailers, we begin noting that the best symmetric configuration is always a local optimum (see Winter (1993)). Moreover, given that \( 0 < \theta_L < \theta_H < 1 \), one can show that the Hessian matrix of the profit function is negative definite. Thus, the best symmetric configuration is also a global optimum.

**PROOF OF PROPOSITION 2**

Following the choice of a wholesale price \( w \) by the manufacturer, the problem of retailer \( i \) in the retail competition game, given the price and service level of his competitor - retailer \( j \), is

\[
\max_{p_i, s_i} \pi_i^r = (p_i - w) * q_i(p_1, p_2, s_1, s_2) - s_i
\]

\[
= (p_i - w) \left\{ \frac{1}{2\theta_L} (p_j - p_i + \theta_L (1 + \sqrt{s_i} - \sqrt{s_j})) + \frac{1}{\theta_H} (R - p_i + \theta_H \sqrt{s_j}) \right\} - s_i
\]

(80)

(81)

After substituting in the appropriate demand expressions, the corresponding first order conditions are

\[
\frac{\partial \pi_i^r}{\partial p_i} = \left\{ \frac{p_j - p_i + \theta_L (1 + \sqrt{s_i} - \sqrt{s_j})}{2\theta_L} + \frac{R - p_i + \theta_H \sqrt{s_i}}{\theta_H} \right\} - \frac{(\theta_H + 2\theta_L)}{2\theta_H \theta_L} (p_i - w) = 0
\]

(82)

\[
\frac{\partial \pi_i^r}{\partial s_i} = \frac{3 (p_i - w)}{4 \sqrt{s_i}} - 1 = 0
\]

(83)

or, after collecting terms

\[
(2R + \theta_H)\theta_L - 2(\theta_H + 2\theta_L)p_i + \theta_H p_j + \theta_H \theta_L (3\sqrt{s_i} - \sqrt{s_j}) + (\theta_H + 2\theta_L)w = 0
\]

(84)

\[
\frac{3 (p_i - w)}{4 \sqrt{s_i}} - 1 = 0
\]

(85)
Our focus is on a symmetric equilibrium, where \( p_i = p_j = p^c \) and \( s_1 = s_2 = s^c \). Imposing symmetry on the first order conditions yields

\[
\begin{align*}
    p^c &= \frac{2\theta_H \theta_L \sqrt{s_i} + (2R + \theta_H)\theta_L + (\theta_H + 2\theta_L)w}{(\theta_H + 4\theta_L)} \\
    s^c &= \left(\frac{3}{4} (p^c - w)\right)^2
\end{align*}
\] (86) (87)

Solving this last system of equations gives us the result.

**Lemma 2**

Assume \( R > \max\{2 - \theta_L, \frac{2\theta_H + \theta_H - \theta_H - \theta_L}{\theta_H - \theta_L + 2}\} \). Then, the outcome under vertical integration involves a symmetric price-service offering across retailers. Moreover, under vertical integration low-type consumers are fully served, while a segment of high-type consumers is left uncovered.

**Proof:** The high-type consumers will be the ones that are fully served if these consumers get more utility than do the low-types at every address. In particular, this requires \( R + \theta_L(\sqrt{s^*} - \frac{1}{2}) - p^* < R + \theta_H(\sqrt{s^*} - \frac{1}{2}) - p^* \). But as \( \theta_H > \theta_L \), this can only occur if \( \sqrt{s^*} - \frac{1}{2} > 0 \). Substituting in for \( s^* \) from (67) we see that the restriction on \( R \) is that it is strictly less than \( 2 - \theta_L \). Now, for all high-type consumers to be fully served, we also need that \( R + \theta_H(\sqrt{s^*} - \frac{1}{2}) - p^* > 0 \). Substituting in for \( s^* \) and \( p^* \), yields the restriction that \( R \) is greater than \( \frac{2\theta_H + \theta_H - \theta_H - \theta_L}{\theta_H - \theta_L + 2} \).
9 References


