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Abstract

A manufacturer commonly distributes through a set of retailers who are authorized to sell its product; demand-enhancing services may also be provided by the manufacturer. These services may be granted to all authorized retailers (*uniform* service provision) or to a favored few authorized retailers (*differential* service provision). To determine when a manufacturer does – or does not – bestow equal service levels, we develop a model of one manufacturer selling through two competing retailers. We find manufacturer optimality to entail uniform service at some parametric values, while differential service is optimal at other values. Counterintuitively, with differential service, the recipient of lower service may be better off than it would be with higher service. Equally surprisingly, there are conditions for which the high-service retailer prefers its rival to also receive a high level of service – but only if its rival is sufficiently small. While the three channel members often have different service-provision preferences, there are also parametric values that place them in harmony with either differential or uniform service provision. Retailers sharing the cost of manufacturer-provided service need not lessen firms' preference confliction over the preferred service provision but can improve channel efficiency when the cost-sharing rate is relatively low. We also investigate the effect of retailer-provided services and the impact of service asymmetry level.

Keyword: service provision; channel competition; channel confliction; game theory

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1 Introduction

Manufacturers typically employ multiple retailers to sell their products to consumers. To maintain a consistent product image, many profit-maximizing manufacturers provide uniform service to all their retailers (i.e., *uniform-service provision*), while other profit-maximizers grant retailers different levels of service (i.e., *differential-service provision*). A manufacturer's choice of uniform or differential service is a strategic decision. In the latter case, determining which retailer to give the higher service level is also a strategic issue. Yet the literature has largely focused on price and service determinations under an assumption of uniform service for all retailers. We bring this assumption into question by asking when it is profitable for a manufacturer to provide retailers with differential service levels.

Services that may be granted uniformly or differentially include cooperative advertising; training store personnel; deliveries, returns, maintenance and repairs; product demonstrations; and "*store-in-store*" boutiques. In the extant version of the store-in-store boutique, the manufacturer owns the merchandise, sets retail prices, displays its products in a dedicated space, employs its own salesforce, and pays a fixed fee to the host retailer(s) for the privilege. The retailer's salespeople cannot sell the manufacturer's product. Examples of this approach are Chanel in Bloomingdale's, Neiman Marcus, Nordstrom, and Saks Fifth Avenue stores; and, Sephora in J. C. Penney stores (Jerath and Zhang 2010, 2019).

We investigate *two variants* of in-store service that have not been addressed in the analytical literature, but that exist in some retail stores. In both variants, the retailer owns the merchandise, sets retail prices, and does *not* receive compensation from the manufacturer. Also, in both variants, a manufacturer hires and pays its own employees, trains them to provide in-store product demonstrations, assigns them to stores, expects them to generate sales, and monitors its employees' efforts. Because the manufacturer's employees focus on a single brand, while retail employees are responsible for multiple brands, the former typically have more product-specific knowledge, so they are generally more effective at converting product interest to product purchase. Both variants help retailer and manufacturer achieve their common objective of more sales than they would obtain were the manufacturer's salespeople not in the store.

Our model is a stylized representation of two forms of in-store service that are provided by a manufacturer's (aka a vendor's) employees. We call the first variant an "*employee-in-store*" concept. It is akin to a store-in-store boutique since there is a dedicated space in which the vendor's products are displayed and demonstrated by its salespeople. However, (1) these salespeople are *not* allowed to complete a sale, only the retailer's own employees can accept payment; and, (2) retail employees can promote, demonstrate, and sell the manufacturer's products. The "Samsung Experience Shop" (*SES*) in large Best Buy outlets is an example of this concept (Ziegler 2013). *SES* was initially in smaller Best Buy stores as well, but many of them were closed (Kumar 2016), presumably due to sales being insufficient to justify the expense associated with operating them. Ownership of merchandise, control of prices, and "competition" from retail employees differentiate our "employee-in-store" concept from the "store-in-store" concept. Since larger Best Buy stores benefit from Samsung's product demonstrations, while other Samsung-selling retailers, who are not associated with Best Buy, do not benefit, the employee-in-store variant illustrates *differential-service provision* across stores that ranges from positive to zero.

We call the second variant a "*vendor's representative*" concept. It differs from the first variant in two key ways: (1) there is no space dedicated exclusively to the vendor's products; and, (2) manufacturer's salespeople (called "vendor representatives") can complete a sale – on which they earn a commission that augments their base salary. While the vendor's representatives can only sell their manufacturer's products, the retailer's salespeople can sell the products of any manufacturer. Japanese and Chinese department stores are reported to use vendor's representatives to augment their own selling efforts (Gamble and Huang 2009). The vendor's representative variant may illustrate either *uniform-service provision* (when all stores are treated comparably) or *differential-service provision* (when the manufacturer treats some stores as being worth more effort than other stores).

One may intuitively suspect that differential-service provision always benefits retailers endowed with higher service (*favored retailers*) since additional service enables it to eat into its rival's market share. Simple intuition also intimates that retailers receiving less service (*disfavored retailers*) suffer by being less competitive. In brief, conventional thinking suggests that all retailers would prefer a high level of demand-enhancing service. Therefore, when the manufacturer makes a choice of uniform or differential service, several questions arise:

Q1: Does uniform-service provision always outperform differential-service provision for the manufacturer in a competing retailer channel?

Q2: Does a retailer endowed with a high-service level under differential-service provision always prefer differential-service provision to uniform-service provision?

Q3: Does a retailer who receives a low-service level under differential-service provision always prefer uniform-service provision to differential-service provision?

To answer these research questions, we investigate a stylized model of a manufacturer Stackelberg leader that sells an identical product through two retailers. The manufacturer also determines whether to differentiate service levels across its retailers. If so, it decides which retailer should receive higher service, and which should receive lower service, or even no service. In the game's first stage, the manufacturer makes the service-provision decision; in the second stage it decides on service levels and wholesale prices. In the third stage, retailers determine their respective prices in a Nash equilibrium game. Finally, demand is realized. We solve for the subgame perfect equilibrium by backward induction.

Differential-service provision enables the manufacturer to discriminate between retailers in wholesale pricing while creating greater differentiation between them by granting more service to the larger retailer. We find the manufacturer prefers differential-service provision if and only if the retailers have a sufficiently unequal base level of demand. For the manufacturer, the joint benefits of greater service differentiation and discriminant pricing outweigh the loss caused by higher service costs – but only if retailers are sufficiently asymmetric in base demands. Differential-service provision is apt to outperform uniform-service provision when the per-unit service cost is high since the manufacturer incurs lower *total* service costs than it would with uniform-service provision. If retailers have comparable market sizes, the manufacturer provides uniform service; this leads to equal wholesale prices which intensify horizontal, inter-retailer competition, thus mitigating double marginalization.

The retailers have different preferences over the manufacturer's service provision. Conventional wisdom suggests that the *disfavored* retailer would prefer uniform-service provision due to higher service levels generating a demand-expansion benefit. But this is not the case when the disfavored retailer is sufficiently smaller than its rival; the reason is that uniform service causes harsher inter-retailer competition, thus imposing a higher wholesale price on the smaller retailer. At its core, a sufficiently smaller retailer prefers differential-service provision because it has limited market expansion potential.

Under differential-service provision, the *favored* retailer prefers uniform-service provision – provided its rival is sufficiently smaller. The logic is that while there is more intense competition under uniform-service provision, double marginalization is reduced. This benefit can be so substantial when the rival is small enough that the favored retailer prefers its rival to receive the same level of service.

Over a wide range of parametric values, firms differ on their preferences over manufacturer service provision. We identify three preference zones when store substitutability is moderate. In two of the zones, firms have different service preferences. If one retailer is substantially smaller, the rivals are at odds as to service provision type, while the manufacturer is more apt to adopt differential-service provision the greater the gap in retailer sizes. When retailers are reasonably comparable in their base level of demand, all firms prefer uniform-service provision (a Pareto zone). We find both channel efficiency and consumer surplus to benefit from uniform-service provision. We also find parametric values at which differential-service provision can lead to higher channel efficiency when retailers have a comparable base level of demand.

Retailers sharing the cost of manufacturer-provided service improves channel efficiency when the cost-sharing rate is relatively low; but it need not lessen firms' disagreement over the preferred service provision.

We analyze additional three issues: complementary retailer services, substitutable retailer services, and service asymmetry level. When retailers offer complementary services, the manufacturer has a greater incentive to discriminate between retailers if the per-unit service cost is low. While the manufacturer always welcomes retailers' services that complement its own, it does not always benefit by delegating substitutable service provision to retailers. Similarly, even if retailers can provide their own services, they may benefit by yielding decision-making on substitutable services to the manufacturer. Finally, disagreements over manufacturer's service provision persist in a wide parameter space when service asymmetry varies.

This paper contributes to the literature in three main ways. First, by studying a manufacturer's service-provision strategy in competitive channels at retail, it presents a useful analytical tool for manufacturing managers to decide whether to differentiate retailers on service. Second, it is the first paper to show that a disfavored retailer can benefit from having a lower service level than the favored retailer – although the latter retailer would like both retailers to receive the same level of service. Third, we explicitly show that firms can be in harmony with either uniform- or differential-service provision.

This paper proceeds as follows. We next review the related literature. The baseline model and a preliminary analysis are provided in §3 and §4. We perform the main analysis in §5. We then extend our discussion in §6 and conclude in §7. All proofs are relegated to the Appendix.

2 Literature Review

Our paper is closely related to many studies of channel distribution and management. An early paper by Jeuland and Shugan (1983) considers a one-manufacturer and one-retailer channel structure; it provides channel-coordinating contracts. Ingene and Parry (1995) extends the work of Jeuland and Shugan (1983) by studying two competing, heterogeneous retailers selling a single manufacturer's product; they show that channel coordination is not always in the manufacturer's interest. McGuire and Staelin (1983) analyze the benefits of decentralization by competing oligopolists; they find that double marginalization can reduce price competition. Choi (1991) studies a duopoly model of manufacturers who sell their products through a common retailer; he finds that the form of the demand function determines whether leadership benefits the leader. Cai (2010) investigates the effect of channel structures and channel coordination on the supply chain under different channel structures. Cai et al. (2012) explore the firms' channel strategic choices among four channel structures when the upstream manufacturers' products are complementary to the downstream retailers' services, suggesting revenue sharing is critical in firms' exclusive channel selection. However, these studies focused on designing a contractual mechanism to coordinate the channel; they did not consider the effect of service factors. One may refer to a recent survey conducted by Cai et al. (2019) for more studies regarding multichannel supply chain management with marketing mixes.

Most papers in the service-provision literature have studied the impact of retailer-provided services. Iyer (1998) considers the impact on channel coordination when retailers compete on both price and service. His study shows how a manufacturer should respond to differences in willingness to pay for retail services. Tsay and Agrawal (2000) study a setting in which one manufacturer sells its product through two retailers who compete on price and service. They find that retailers are better off when service plays a role in their competition than they are when competition is only based on price. Coughlan and Soberman (2005) examine manufacturers' decisions regarding whether to sell through single-distribution channels with primary retailers or dual-distribution channels with primary retailers plus their own outlet stores in a framework where only primary retailers provide services. There are also several papers that highlight the manufacturer's role in providing service in the form of advertisements that raise the consumer's product valuation (Lal and Narasimhan 1996, Shaffer and Zettelmeyer 2004, Wu et al. 2009, Liu et al. 2014). A few papers explore whether a manufacturer or a retailer should provide demand-enhancing services, and their impact on channel member profits (Xia and Gilbert 2007, Kolay 2015, Li et al. 2016). One paper proved that when non-price variables are provided by a retailer, a manufacturer, or both, channel coordination requires "appropriate marginalization" (i.e., a markup above marginal cost at one or both channel levels) (Ingene et al. 2012).

These studies consider a channel composed of a single manufacturer and a single retailer. We consider a distribution channel with one manufacturer and two competing retailers and investigate the manufacturer's service provision problem; that is, whether the manufacturer should provide retailers with uniform or differential service. This issue has not been discussed in literature.

Our paper is also related to literature on parallel imports (or gray markets); this research stream investigates unauthorized product flows across markets or channels. The emergence of parallel imports is mainly due to price differences across geographically, politically, and/or economically different countries and markets (Cespedes et al. 1988, Duhan and Sheffet 1988). Since parallel imports compete with products in authorized channels, most research focuses on their negative impact on the profitability of channel members (e.g., Bucklin 1993, Assmus and Wiese 1995, Antia et al. 2004). To deal with the negative effects of parallel imports, many methods have been suggested to address their threats (see Cespedes et al. 1988, Duhan and Sheffet 1988, Cross et al. 1990, Antia et al. 2006). However, some research has suggested that parallel imports may benefit the manufacturer. For example, Ahmadi and Yang (2000) analyze the effects of parallel imports on a manufacturer who sells in two geographically-separated markets; they show that parallel imports may help the manufacturer to extend its product's global reach, and even boost its global profit. Xiao et al. (2011) examine similar issues under different channel structures and show that a manufacturer can benefit from parallel imports by a third party or by an authorized dealer. More recently, Shulman (2014), Shao et al. (2016), Ahmadi et al. (2017) and Altug (2017) study supply chain members' incentives to engage in gray markets, and the impact of gray markets on supply-chain decisions. In all these studies, an unauthorized retailer does not have an official relationship with the manufacturer; however, the manufacturer and its authorized retailers may tolerate or even encourage product diversion to the unauthorized retailer. In our model, all retailers have official contractual relationships with the manufacturer and hence are "authorized" resellers. Rather than assuming uniform service for all retailers, we examine whether a manufacturer should provide differential service across its retailers. Hence, our perspective differs from the extant literature.

Jerath and Zhang (2010, 2019) investigate the "store-in-store" phenomenon with a model of two competing manufacturers, both selling to the same retailer, or to a pair of competing retailers. Key features of their model are that the manufacturers hire their own employees, set their own prices, and pay the retailer(s) a fixed fee, or a share of the selling price, for the privilege of operating an in-store boutique, examples are Chanel and Sephora. Channel operates in-store boutiques in all 42 Neiman-Marcus stores;[1] it sells "fashion eyewear" to authorized retailers like Bloomingdales and Sunglass Hut and "fragrance and beauty" lines in department stores like Belk, Bloomingdales and Dillard's.[2] Sephora, a purveyor of beauty products, sells in Sephora stores and in Sephora boutiques in some 600 J. C. Penney stores.[3]

3 Model

To study the effect of a manufacturer's service provision on channel members, we employ a stylized model of a manufacturer selling an identical product through two retailers. The power structure between channel members is modeled as *manufacturer Stackelberg leader*. As the leader, the manufacturer decides whether to provide uniform or differential service to retailers; and, in either case, how much service each retailer gets. We denote the service level provided to Retailer i as s_i.

We use $D_i, i = 1, 2$, to represent the demand for Retailer i. The initial base demand conditional on zero retail price for Retailer i is given by

$$\alpha_i = A_i(1 + \mathbf{1}(i)s_i), i = 1, 2,$$

where A_i is Retailer i's initial base demand without service and $\mathbf{1}(i) = 1$ or 0 indicates whether Retailer i is or is not endowed with service s_i. To facilitate our discussion, we define

$$a = \frac{A_2}{A_1}$$

as the *base demand ratio* of Retailer 2 (henceforth R2) over Retailer 1 (henceforth R1); a captures retailer asymmetry in term of initial base demand without service. Without loss of generality, we assume R1 has a bigger initial base demand, that is, $a < 1$, thus R1 is larger than R2. For parsimony, we normalize A_1 to 1, although we continue to use the notation whenever need arises.

We define the utility function of a representative consumer as (cf., Cai 2010):

$$U = \sum_{i=1,2} (\alpha_i D_i - D_i^2/2) - \theta D_1 D_2 - \sum_{i=1,2} p_i D_i, \tag{1}$$

where p_i is the Retailer i's retail price and θ $(0 \leq \theta < 1)$ represents retail store substitutability (equivalently inter-retailer competition). By maximizing equation (1), we derive demand for Retailer i as:

$$D_i = \frac{\alpha_i - \theta\alpha_{3-i} - p_i + \theta p_{3-i}}{1 - \theta^2}. \tag{2}$$

(A complete derivation of equation (2) appears in Appendix A.) The key assumption is that firms cannot identify market segments; therefore, they focus on a representative (average) consumer in the market. Intuitively, Retailer i's service boosts its demand, in part by taking market share from the rival retailer.

The manufacturer incurs two types of costs when providing service to Retailer i. First, there is a per-unit service cost, ks_i, that increases with the service level. In terms of a store-in-store boutique, this may be thought of as a salesperson's fixed commission amount per unit sold. Second, there is a set-up cost, $c_i s_i^2$, that is due to construction of the boutique area, training of the salesforce, and supervisors' pay.[4] As a first-order approximation, we model it as convex increasing in the service level. For parsimony, c_i is normalized to 1 without affecting our qualitative insights. An increasing, convex set-up cost also reflects the increasing marginal cost of effort. These assumptions are consistent with the existing literature (Iyer 1998, Khanjari et al. 2014, Li et al. 2012). In our model, set-up cost is determined by the higher level of service. This seems reasonable because once a team is put together for providing high-level service, the team is also able to provide low-level service; the reverse is unapt to be true.

We use π_{R_i} to denote Retailer i's profit and π_M is the manufacturer's profit. The production cost is normalized to zero for parsimony. Thus, retailer and manufacturer profits are given, respectively, by

$$\pi_{R_i} = (p_i - w_i)D_i, i = 1, 2, \tag{3}$$

$$\pi_M = \sum_{i=1}^{2} (w_i - \mathbf{1}(i)ks_i)D_i - Max\{\mathbf{1}(1)s_1^2, \mathbf{1}(2)s_2^2\}. \tag{4}$$

The manufacturer charges the same wholesale price to the retailers if both retailers receive the same level of service, or if neither retailer receives service.

There are three service-provision scenarios in our baseline model. In the threshold scenario there is *no service provision*; we denote this scenario as NN. In the second scenario there is *uniform-service provision*: both retailers receive the same level of service; we denote this case by RR. In the third scenario there is *differential-service provision*: one retailer is endowed with high-level service and the other with low-level service. An extreme version of differential service is *partial-service provision* under which the manufacturer provides service to only one retailer, but nothing to its rival; we denote this as RN or NR (the first letter refers to R1 and the second letter to R2). In the uniform-service provision scenario, both retailers are endowed with an identical level of service: $s_1 = s_2 = s^{RR}$. In the partial-service scenario, the manufacturer provides s^{RN} to one retailer but no service to the other retailer. In the more general scenario of differential-service provision, the manufacturer provides s to one retailer and ρs $(0 \leq \rho < 1)$ to the other retailer. We call ρ the service asymmetry parameter. Partial-service provision is the special case of differential-service provision when $\rho = 0$; we use the symbol Rρ to denote this case – it is the generalized case of RN. As we will elaborate later, the bigger retailer is always endowed with a higher-service level s while the smaller one with the lower-level service ρs.

It may be asked if any of these scenarios violates the Robinson-Patman Act. We will prove that in scenarios NN and RR both retailers pay an equal wholesale price (with RR having a higher wholesale price). As there is no discrimination between retailers, there is no violation of Robinson-Patman with NN or RR. Further, scenario NR is never an optimal outcome in our model. Finally, we do not believe RN (or its generalized version, Rρ) violates Robinson-Patman for two reasons. (1) A "secondary line" violation occurs if "favored customers of a supplier are given a price advantage over competing customers."[5] However, under Rρ, the larger retailer *always* pays a higher wholesale price than the smaller retailer, so while the larger retailer is favored in service, it is burdened with a price disadvantage. (2) Robinson-Patman requires "that a seller treat all competing customers in a proportionately equal manner." While one may quibble about how precisely proportionate an action must be, we note that the FTC does not prosecute cases unless there is "likely injury to competition ... in interstate commerce." Most retail competition occurs within a state; but even when consumers cross a state line to make purchases that could have been made in their home state (as obviously occurs in metropolitan areas that span state lines), we find no evidence of the FTC asserting that competition has been injured by such shopping behavior by consumers. Thus, we believe all facets of our model are compatible with the Robinson-Patman Act as enforced by the Federal Trade Commission.

In practice, manufacturers provide different types of service (e.g., co-op ads, employee training, in-store boutiques, etc.). Under differential-service provision, the manufacturer might provide several services to one retailer but only one type of service (e.g., co-op ads) to the other retailer. Alternatively, service could be distinguished by its level (e.g., "high" or "low"). Such practices appear to be consistent with the Robinson-Patman Act which allows unequal treatment provided it is done proportionally.[6] It seems reasonable to abstract service in discrete forms: one retailer receives s and the other obtains ρs.

The game proceeds as follows. In the first stage, the manufacturer decides whether to provide any retailer with service. In the second stage, the manufacturer determines the service effort level (s and ρs) and the wholesale price(s) – which are unequal unless $\rho = 1$. In the third stage the retailers determine their respective retail prices. Finally, demand is realized, and firms collect their respective revenues. The entire game is characterized by a subgame perfect equilibrium that is solved by backward induction.

4 Preliminary Analysis

This preliminary analysis demonstrates that, compared to no service provision, the manufacturer always provides uniform or differential service to retailers. To show the strength of service provision, we also consider a centralized version of our baseline model in which both retailers are owned by the manufacturer. For ease of exposition, we call the baseline channel structure the *decentralized competing retailer channel* and the centralized version as the *centralized competing retailer channel*.

To focus on the impact of channel asymmetry and service cost, we fix $\theta = 1/2$ in our analysis in the main text. Thus, we model channel competition as being at a moderate level. This assumption enables us to deliver our main qualitative results. We provide additional sensitivity analysis on θ in the appendix.

4.1 Benefits of Service Provision

We compare scenarios where the manufacturer provides retailers with identical or with different service levels against a scenario in which the manufacturer provides no service. We do so for the decentralized and the centralized channel structures mentioned above. The benefits of service provision to the manufacturer is apparent as indicated in the following result.

Lemma 1. *In both the decentralized and centralized competing retailer channels, the manufacturer always chooses uniform- or differential-service provision over no service provision.*

Lemma 1 delivers a one-sided message: the manufacturer benefits from service provision in the two studied channel structures. This result occurs because service raises consumer's valuation and, hence, their demand. Although service incurs additional costs for the manufacturer – which pushes up wholesale price(s) and, consequently, retail price(s) – profit maximization assures that the benefit of more demand overshadows the disadvantages of higher retail prices. In short, providing service to retailers yields the manufacturer more profits than does not providing service.

To avoid conflicting company images in the centralized system, it is meaningful for the manufacturer to provide uniform service to its own retail outlets. The results in Lemma 1 bring us back to our main research question: *In a competing-retailer channel, does uniform-service provision always generate greater manufacturer profit than differential-service provision?* Conventional wisdom seems to support providing uniform service to both retailers, because service exerted results in higher consumer' valuations of the product. Our following analysis will tell otherwise; the manufacturer's preference of uniform- or partial-service provision depends on several factors.

4.2 Partial-Service Provision

Here we analyze partial-service provision, a special case of differential-service provision when $\rho = 0$. There are two sub-scenarios of partial-service provision: (i) providing service to the bigger retailer R1 but no service to the smaller retailer R2, and (ii) providing service to R2 but not to R1. We denote Scenario (i) as RN and Scenario (ii) as NR. Following equations (3) and (4), the profit functions of the retailers and the manufacturer in Scenario RN are respectively given by

$$\pi_{R_i}^{RN} = (p_i^{RN} - w_i^{RN})D_i^{RN}, i = 1, 2, \tag{5}$$

$$\pi_M^{RN} = (w_1^{RN} - ks^{RN})D_1^{RN} - (s^{RN})^2 + w_2^{RN} D_2^{RN}, \tag{6}$$

where the demand D_i^{RN} follows equation (2). The formulas for Scenario NR are similar. In either case, the manufacturer determines service levels and chooses wholesale prices; then retailers decide on their retail prices. The game is solved backward. The immediate question is which retailer should receive service.

Lemma 2. *Under partial-service provision, the manufacturer gives service to the bigger retailer (R1).*

As shown in the proof of Lemma 2, we have $s^{RN} \geq s^{NR}$ and $\sum_{i=1}^{2} D_i^{RN} \geq \sum_{i=1}^{2} D_i^{NR}$ over the entire feasible region. Providing a higher level of service to the larger retailer enables the manufacturer to expand the market more efficiently relative to making the same investment in the smaller retailer. This also creates more differentiation between retailers, letting the manufacturer more fully discriminate between them: R1's wholesale and retail prices go up while those of R2 go down. Overall, the manufacturer's benefit from endorsing the bigger retailer exceeds what could be gained from endorsing the smaller one.

We now explore the impact of the parametric values a (R2's base demand level relative to R1's base level) and k (the per-unit cost of service) on Scenario RN's properties. As shown in Lemma 2's proof, optimal service levels, R1's wholesale price, retail price, demand, and profit all fall with a. This occurs because R2 takes market share from R1, which leads to R1 lowering its price and the manufacturer reducing its wholesale price and service provision to R1. Consequently, R1's profit reduces. In contrast, R2 charges a higher price, sells more, and earns more profits for itself and the manufacturer.

Regarding the impact of unit repair cost (k) in Scenario RN, the optimal level of service, R1's wholesale price, retail price, demand, and profit all fall with k. As unit repair cost rises, it is costlier for the manufacturer to provide high service levels; hence, service reduced. This leads to a lower wholesale price for R1, but at the "expense" of crippling R1's competitive advantage. Thus, R1's demand falls, its price declines, and there are lower profits for R1 and for the manufacturer, while R2 reaps a higher profit.

5 Channel Confliction under Service Provision

Because service provision outperforms no service provision for the manufacturer, for tractability, we concentrate on comparing partial-service provision to uniform-service provision. In the extension, we study the general scenario of differential-service provision by using the parameter ρ at varied interim values to investigate ρ's impact on manufacturer and retailer preferences.

5.1 The Manufacturer's Choice of Service Provision

We first explore whether the manufacturer should adopt uniform-service or partial-service provision. As a first step to understanding the manufacturer's service provision choice, we characterize those optimal values of decision variables by comparing them in Scenarios RN and RR in the following lemma:

Lemma 3. *1. The optimal level of service is higher in RN than in RR (i.e., $s^{RN} > s^{RR}$) when $k > \widetilde{k}$ and the reverse is true otherwise;[7] furthermore, s^{RN} could be greater than $2s^{RR}$ when k is extremely large.*

2. Retailer 1's wholesale and retail prices are greater in RN than their respective counterpart in RR (i.e., $w_1^{RN} > w^{RR}$ and $p_1^{RN} > p_1^{RR}$) unless a is sufficiently large while the reverse is true for Retailer 2 (i.e., $w_2^{RN} < w^{RR}$ and $p_2^{RN} < p_2^{RR}$) in the entire feasible region.

Intuitively, optimal service levels should be higher in RN than in RR because RN aggregates the services that would otherwise be offered to both retailers in RR; but, as Lemma 3 shows this is not always the case. When $k < \widetilde{k}$, the optimal level of service in RR is higher than in RN. A higher service level for both retailers raises consumer's valuations of all products, so total demand rises without incurring intolerable service costs since k is small. However, when $k > \widetilde{k}$, the benefit of providing service to both retailers declines due to high total service costs and worsened double marginalization; thus, the manufacturer offers a high-service level only to R1. This raises wholesale and retail prices for R1, while creating greater differentiation between the channels, thus lowering wholesale and retail prices for R2. When k is extremely large, more channel differentiation and reduced double marginalization at R2 are so desirable that the manufacturer equips R1 at a service level that is even more than twice s^{RR}.

Total demand in RN may rise, compared to RR, due to greater channel differentiation and less double marginalization at R2, but there is worse double marginalization at R1. If $k > \widetilde{k}$ and R1 is sufficiently bigger than R2, then the above trade-off favors RN; otherwise, RR outperforms RN. Comparing the manufacturer's profits in RN with RR, we now present the first main result in Theorem 1:

Theorem 1. *[Value of Partial-Service Provision] In baseline model with decentralized retailers, there exists a threshold base demand ratio value $a = \widetilde{a}_M$, such that the manufacturer prefers partial-service provision if $a < \widetilde{a}_M$ but uniform-service provision otherwise.*

Figure 1 further illustrates Theorem 1. Note that the contour line of $\widetilde{a}_M$ (the profit indifference line between RN and RR such that $\pi_M^{RN} - \pi_M^{RR} = 0$) is unique since we have considered both parameters (i.e., k and a) in the entire feasible region. Figure 1 shows $\widetilde{a}_M$ increases with k; that is, for a given k, it is more likely that the manufacturer chooses RR over RN as a increases. Likewise, for a given a, it is more likely for the manufacturer to choose RN over RR as k increases.[8]

Asymmetry in partial-service provision allows the manufacturer to discriminate between retailers in its wholesale pricing. As explained in Lemma 3, when R1 is sufficiently larger than R2, total demand in RN is more than in RR due to its higher service level. While the manufacturer incurs higher costs for providing service to R1 (which lowers its marginal profit from wholesaling to R2), the benefits surpass the disadvantages if R2 is sufficiently smaller than R1 (i.e., if $a < \widetilde{a}_M$).

From another perspective, for a given a, the manufacturer is more likely to choose RN over RR as k increases. When k is sufficiently large, the benefit of providing service to both retailers reduces due to high total service costs and worse double marginalization at both retailers. Therefore, if the unit service cost is high, the manufacturer would discriminate between retailers by utilizing partial-service provision.

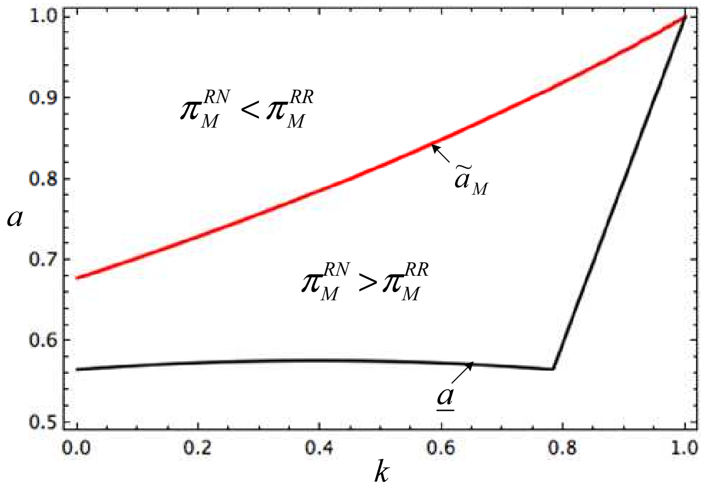

Figure 1: The manufacturer's profit comparison between RN and RR

In deriving the preceding results, the set-up cost coefficient c is normalized to 1 for parsimony. To get a preliminary reading on the impact of c on these results, we fix k at various interim values and compare the manufacturer's profits in RN with RR as functions of a and c. We find similar qualitative results: for any given c, it is more likely for the manufacturer to choose RR over RN as a increases; for a given a, it is more likely for the manufacturer to choose RN over RR as c increases.

We have also compared the manufacturer's profits in RN with RR in the centralized setting where both competing retailers are integrated by the manufacturer. We summarize the results in Corollary 1:

Corollary 1. *[Extension of Theorem 1] When both retailers are integrated by the manufacturer, there exists a threshold value $a = \tilde{a}_M^C$, such that the manufacturer prefers partial-service provision if $a < \tilde{a}_M^C$ but uniform-service provision otherwise.*

Figure 2 further illustrates Corollary 1. The contour line $\tilde{a}_M^C$ is unique over the entire feasible region. Figure 2 shows when k is small, the manufacturer prefers RR; when k is sufficiently large, the manufacturer is more likely to chooses RN.

By contrast, the manufacturer's preference zone for RN in the centralized setting is much smaller than that in the decentralized setting and is only a small portion of the overall feasible region. In this sense, the RN scenario is less likely to happen in reality. Indeed, in the centralized system, to avoid conflicting company images, the manufacturer often provides uniform service to all its own retail outlets.

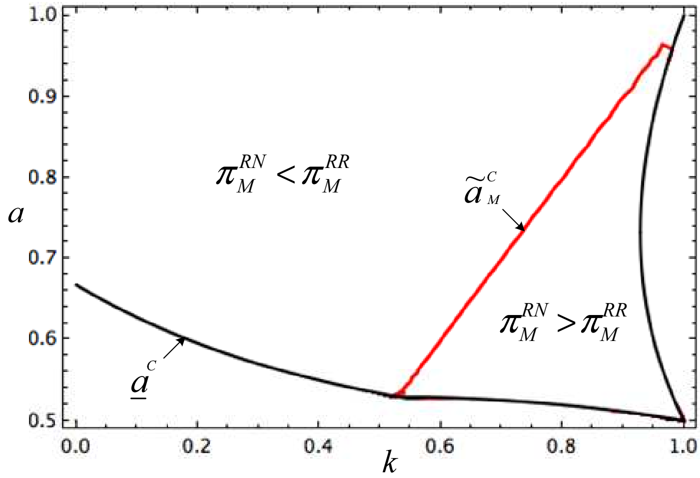

Figure 2: The manufacturer's profit comparison between RN and RR in the centralized system

5.2 Retailers' Responses and Firms' Confliction

We now investigate the retailers' responses with respect to the manufacturer's service provision decision. The benefit of receiving service may seem to inevitably benefit the favored retailer under partial-service provision, just as it would seem to disadvantage the disfavored retailer. Partial-service provision hones the favored retailer's competitive edge but weakens the disfavored one, so it might be natural to expect that the disfavored retailer under partial-service provision prefers to get the same level of service, and the favored retailer under partial-service provision always prefers to be favored. Would this conventional wisdom sustain in the entire feasible domain? Our next main findings suggest otherwise.

Theorem 2. *There exists a unique threshold value $\widetilde{a}_{R_2}$, where $\widetilde{a}_{R_2}$ lies above $\widetilde{a}_M$ (see Figure 3), when comparing the retailers' profits in Scenarios RN and RR, such that*

1. *[Value of Being Disfavored] The disfavored retailer (i.e., R2) in Scenario RN benefits from being given no service (i.e., $\pi_{R_2}^{RN} > \pi_{R_2}^{RR}$) as long as $a < \widetilde{a}_{R_2}$.*
2. *[Devaluation of the Rival Being Disfavored] The favored retailer (i.e., R1) in RN hurts from the rival retailer (i.e., R2) being disfavored (i.e., $\pi_{R_1}^{RN} < \pi_{R_1}^{RR}$).*

R2 benefits from going without service in Scenario RN when its market size is sufficiently smaller than R1. This is counter to conventional wisdom which suggests that being endowed with service always boosts consumers' product valuations. To see this, note that shifting from Scenario RN to Scenario RR causes R2's wholesale price to rise due to higher service costs for the manufacturer while R1's wholesale price declines due to reduced service in RR compared with RN. These two effects drive R1 to set a lower price, which takes demand from R2. The corresponding disadvantages can be absorbed by enlarged demand because of R2's ability to expand the market with embedded service when R2 is sufficiently large; however, the disadvantages overweigh the demand benefit when R2's market size is too small (i.e., $a < \widetilde{a}_{R_2}$). Hence, a sufficiently smaller retailer prefers being disfavored (Scenario RN).

R1 can benefit from the manufacturer providing identical service to both retailers (Scenario RR) rather than only to R1 (Scenario RN). This is at odds with conventional wisdom which suggests that providing equal service to both retailers intensifies inter-retailer competition. While R1 must reduce its price to counter a more powerful R2 in Scenario RR, the lower price in Scenario RR significantly lessens double marginalization by R1 in Scenario RN and can even enlarge R1's demand despite R2's being empowered with service. The advantage to R1 becomes more apparent as a reduces, because a higher wholesale price to R2 in Scenario RR owing to embedded service helps blunt R2's competitive strength. Therefore, the favored retailer prefers its rival to receive the same privilege too.

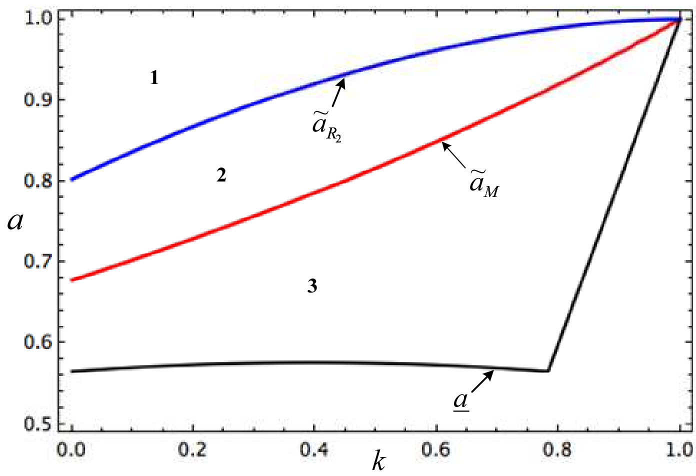

Figure 3: Firms' preferences over service provision (The preference zones are described in Table 1)

Zone	M prefers	R1 prefers	R2 prefers
1	RR	RR	RR
2	RR	RR	RN
3	RN	RR	RN

Table 1: The firms' preferences over service provision (the zones are illustrated in Figure 3)

We summarize the service provision preferences of all firms, the manufacturer and both retailers, in Figure 3 and Table 1. As indicated in Figure 3 and Table 1, partial-service provision (RN) is more likely to be objected to by the favored retailer than to be welcomed by the disfavored retailer. As discussed previously, both retailers' double marginalization, demand expansion, wholesale costs, and inter-retailer competition are affected by the manufacturer's service provision decision. Giving R2 the same level of service as R1 (from RN to RR) intensifies inter-retailer competition but reduces double marginalization and the wholesale price for R1, while shifting from RR to RN creates more differentiation between the retailers and also reduces double marginalization and the wholesale price for R2.

Conflict obviously arises among the firms. Because each firm has different trade-offs, their preferences vary as the initial base demand ratio (a) and the unit repair cost (k) change. From the manufacturer's perspective, the demand lost at one retailer could be gained at the other. Thus, over most of the feasible domain, the manufacturer's preference does not overlap with both retailers.

When R1 and R2 have similar initial market size, all firms have a common preference in RR (a *Pareto zone*, Zone 1 in Figure 3). Thus, firms can be in harmony provided the retailers are of roughly equal size. However, since Zone 1 is much smaller than the sum of the other areas, there is inter-firm conflict over much of parameter space. Indeed, as a decreases (Zone 2), harmony is disturbed: R2 prefers RN here, not RR. However, if a is really small (Zone 3), the manufacturer aligns with R2 by shifting to an RN policy.

Overall, Zone 1's area shrinks as k grows. A higher k raises the wholesale price, so it lowers R2's profit under RR. Thus, R2 is more likely to prefer RN as k increases. Similarly, by comparing the retailers' profits in RN versus RR at different values for the set-up cost coefficient c, the above results hold qualitatively.

5.3 Channel Efficiency and Consumer Surplus

This subsection studies the impact of the manufacturer's service provision strategy on channel efficiency and consumer surplus. *Channel efficiency* can be measured by the sum of all firms' profits in the channel system. *Consumer surplus* is measured by the utility of the representative consumer as in equation (1). We first compare total channel profits between RN and RR in the decentralized system.

Corollary 2. *Total channel profit is lower in RN than RR in the decentralized system.*

Provided the market expansion effect is higher in uniform service provision, Corollary 2 is intuitive because both retailers are provided with service; thus, the overall channel benefits from mitigated double marginalization and from more intense inter-retailer competition. A service provision strategy with both retailers endowed with identical service also appeals to more consumers.

Channel efficiency can also be measured by the efficiency ratio $\frac{\pi_D}{\pi_C}$ where π_D is the sum of all firms' profits in the decentralized system and π_C is the total profit of the centralized system. We use ER^{RN} and

ER^{RR} to denote the efficiency ratios for RN and RR, respectively.

We now compare efficiency ratios in Scenario RN with Scenario RR. The comparison is based on a numerical study that uses 0.2, 0.4, 0.6 and 0.8 for the per-unit cost k, and employs 0.6, 0.7, 0.8, 0.9 and 1.0 for parameter a. These values cover a wide range of the parameter space; hence, they are a representative subset. As before, the set-up cost coefficient c and channel substitutability parameter θ are $c = 1$ and $\theta = 1/2$, respectively. We solve each scenario for 4×5 parameter combinations that correspond to different channel environments. Table 2 illustrates the efficiency ratios for Scenarios RN and RR, and the manufacturer's choice in the decentralized system.

k	a	ER^{RN}	ER^{RR}	M prefers	k	a	ER^{RN}	ER^{RR}	M prefers
0.2	0.6	0.7981	0.8587	RN	0.6	0.6	0.8390	0.8874	RN
	0.7	0.8253	0.8595	RN		0.7	0.8592	0.8867	RN
	0.8	0.8477	0.8578	RR		0.8	0.8738	0.8848	RN
	0.9	0.8643	0.8543	RR		0.9	0.8828	0.8827	RR
	1.0	0.8749	0.8490	RR		1.0	0.8866	0.8805	RR
0.4	0.6	0.8237	0.8760	RN	0.8	0.6	0.8471	0.8942	RN
	0.7	0.8468	0.8763	RN		0.7	0.8656	0.8924	RN
	0.8	0.8645	0.8746	RR		0.8	0.8786	0.8900	RN
	0.9	0.8764	0.8721	RR		0.9	0.8859	0.8881	RN
	1.0	0.8828	0.8687	RR		1.0	0.8884	0.8869	RR

Table 2: Efficiency Ratios, where $c = 1$ and $\theta = 1/2$

Table 2 shows that channel efficiency, measured by the efficiency ratio, is lower in RN than RR (i.e., $ER^{RN} < ER^{RR}$) when a is relatively small but the reverse is true when a is large. The service provided to both retailers under RR raises consumer's valuations of all products. When a is large, the manufacturer offers higher service levels, which raises wholesale prices and worsens double marginalization at both retailers. In RN, service is only offered at R1, so they create greater differentiation between the retailers, while limiting overall market expansion. The benefits of increased differentiation, together with mitigated double marginalization, lead to higher channel efficiency in RN when a is large.

From Table 2 we see that the manufacturer's interest does not necessarily align with overall channel benefits since the manufacturer aims to maximize its own profit. When a is relatively small, channel efficiency is higher in RR than in RN, but the manufacturer prefers RN. When a is large enough, channel efficiency is higher in RN than in RR, but the manufacturer prefers RR. This suggests that some mechanisms such as cost sharing may be used to improve channel efficiency if service costs can be properly shared among firms. We will examine the value of cost sharing in the next subsection.

Now we compare consumer surplus in Scenario RN with Scenario RR. We find consumer surplus to be lower in RN than RR.

Corollary 3. *Consumer surplus is lower in RN than RR in the decentralized system.*

Providing service increases the representative consumer's product evaluation (raising purchases), but it also increases the product's price (lowering sales). Uniform-service provision (i.e., RR) generates a higher consumer surplus than does partial-service provision (i.e., RN). This is because RR has a more balanced service provision (both retailers' customers benefit) while there is more intense inter-retailer competition. We note that double marginalization persists in both RN and RR. Overall, comparing the preferences of firms and consumers, we find agreement only if uniform-service provision is adopted. In other words, the social welfare (consumer surplus plus all firms' profits) is higher in RR than RN.

5.4 Value of Cost Sharing

As Table 2 depicted, the manufacturer may choose the service provision scenario that hurts channel efficiency. This subsection is devoted to explore the impact of cost sharing on the firms' preferences and channel efficiency.

Cost sharing has been touted as a channel coordinating mechanism (Berger 1972, Jorgensen et al. 2000, Liu et al. 2014), because it can reduce cost burden for one party while incentivizing the service provider to enhance its effort. In our model, service-cost sharing reduces the manufacturer's cost; this yields more service which boosts demand. However, it remains unclear whether cost sharing helps resolve conflict over manufacturer's service provision.

To investigate the value of cost sharing, we assume that a retailer endowed with service shares a fixed portion of the total cost incurred by the service. To focus purely on the impact of any given cost-sharing rate on firms' preferences, we assume that the cost sharing rate η is exogenous. In Scenario CSRR (i.e., Scenario RR with cost sharing), the retailers' and manufacturer's profit functions can be written as:

$$\pi_{R_i}^{CSRR} = (p_i^{CSRR} - w^{CSRR} - \eta k s^{CSRR}) D_i^{CSRR} - \frac{1}{2}\eta (s^{CSRR})^2, \; i = 1, 2, \tag{7}$$

$$\pi_M^{CSRR} = \sum_{i=1}^{2} (w^{CSRR} - (1-\eta) k s^{CSRR}) D_i^{CSRR} - (1-\eta)(s^{CSRR})^2. \tag{8}$$

In CSRR, the manufacturer provides the same service level and charges the same wholesale price to both retailers per the Robinson-Patman Act. In Scenario CSRN (i.e., Scenario RN with cost sharing), R2's profit function remains the same as in equation (3), while R1's and the manufacturer's profit functions are written as:

$$\pi_{R_1}^{CSRN} = (p_1^{CSRN} - w_1^{CSRN} - \eta k s^{CSRN})D_1^{CSRN} - \eta(s^{CSRN})^2, \tag{9}$$

$$\pi_{M}^{CSRN} = (w_1^{CSRN} - (1-\eta) k s^{CSRN})D_1^{CSRN} + w_2^{CSRN} D_2^{CSRN} - (1-\eta)(s^{CSRN})^2. \tag{10}$$

The game proceeds in the same manner as in our baseline model. To focus on our main insights, we restrict our analytical results to $k = 0.4$, which means the per-unit service cost is at a moderate level. We have also tested different values of k and find that our qualitative results are robust.

To demonstrate firms' preferences over service provision under cost sharing, we compare their profits under cost sharing to those without cost sharing. The result is summarized as follows.

Theorem 3. *1. Under RR, the manufacturer prefers cost sharing. The smaller retailer prefers no cost sharing. The bigger retailer prefers cost sharing if and only if cost sharing rate* $\eta < \widetilde{\eta}_{R_1}$, *where* $\widetilde{\eta}_{R_1} = \frac{58265383 - 79511674a + 13244741a^2 + 5876340a^3 - 581675a^4 - 109250a^5 - 15625a^6}{150(394231 - 490688a + 135882a^2 + 16640a^3 - 4225a^4)}$.

2. Under RN, the manufacturer prefers cost sharing. But, neither retailer prefers cost sharing.

Theorem 3 indicates that the manufacturer always prefers cost sharing. This is unsurprising since cost sharing lowers the manufacturer's service-provision cost, encouraging higher service levels – which expands the market as well as allowing the manufacturer to capitalize on higher wholesale prices.

The retailers' reactions differ between uniform- and differential-service provision. Under uniform-service provision, the smaller retailer (R2) prefers no cost sharing so as to avoid excessive inter-retailer competition. The bigger retailer (R1) can benefit from cost sharing by taking market share away from R2. This occurs if and only if the cost sharing rate is not too high (i.e., $\eta < \widetilde{\eta}_{R_1}$); otherwise, the bigger retailer would suffer from squeezed profit margin (due to sharing cost with the manufacturer) and reduced market share (due to excessive inter-retailer competition).

Under differential-service provision, neither retailer prefers cost sharing. Obviously, cost sharing burdens the bigger retailer – who cannot gain enough from market share because the smaller retailer sets a low enough retail price to minimize the loss in market share.

Overall, we find cost sharing does not soften firms' conflict over service provision. Instead, as shown in Figure 4 and Table 3, only in Zone 3 do all firms prefer uniform-service provision. But this zone gradually diminishes as cost sharing rate grows. The higher the cost-sharing rate, the larger the area in which the manufacturer and retailers disagree on the desirability of cost sharing.

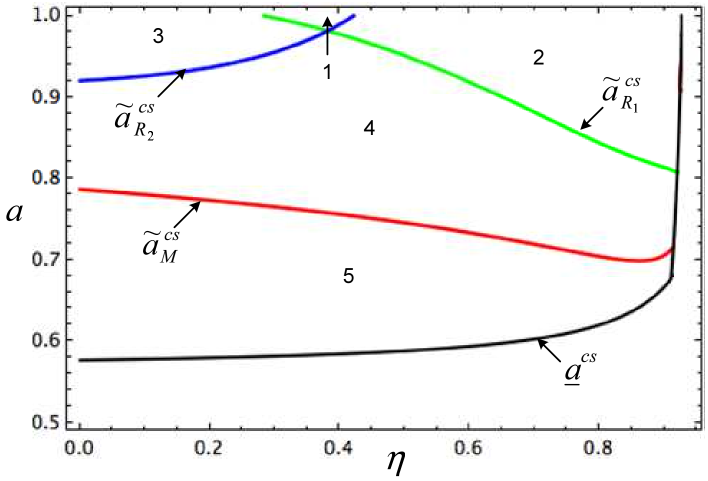

Figure 4: Firm preferences with cost sharing

Zone	M prefers	R1 prefers	R2 prefers
1	RR	RN	RR
2	RR	RN	RN
3	RR	RR	RR
4	RR	RR	RN
5	RN	RR	RN

Table 3: Firm preferences with cost sharing

Cost sharing improves channel efficiency at some parameter values, although the firms' preference conflict persists. To illustrate such improvement, we calculate and compare efficiency ratios under scenarios with and without cost sharing. We choose 0.2, 0.4 and 0.6 for the cost-sharing rate η; these values cover low, medium and high cost-sharing rates. As before, we choose 0.2, 0.4, 0.6 and 0.8 for the per-unit cost k. These values cover a wide range of parameter space, so they are a representative subset. The set-up cost coefficient c and substitutability parameter θ are again fixed at 1 and $\frac{1}{2}$, respectively.

We use ER^{CSRN} and ER^{CSRR} to denote the efficiency ratios for RN and RR under cost sharing. For brevity, in Table 4 we report the signs of $ER^{CSRN} - ER^{RN}$ and $ER^{CSRR} - ER^{RR}$ given two representative values, 0.7 and 0.9, for the base demand ratio a.

From Table 4, we see that cost sharing improves channel efficiency when η is relatively low. But

		$a = 0.7$		$a = 0.9$	
η	k	$ER^{CSRN} - ER^{RN}$	$ER^{CSRR} - ER^{RR}$	$ER^{CSRN} - ER^{RN}$	$ER^{CSRR} - ER^{RR}$
0.2	0.2	+	+	+	+
	0.4	+	+	+	+
	0.6	+	+	+	+
	0.8	+	+	+	+
0.4	0.2	+	+	+	−
	0.4	+	+	+	+
	0.6	+	+	+	+
	0.8	+	+	+	+
0.6	0.2	−	−	−	−
	0.4	−	−	−	−
	0.6	−	−	−	−
	0.8	−	−	−	−

Table 4: Efficiency Ratios (with and without Cost Sharing), where $c = 1$ and $\theta = 1/2$

when η becomes large, cost sharing hurts channel efficiency because more cost sharing stimulates more service from the manufacturer, which places more cost burden on the retailers and, thus, worsens double marginalization. This observation suggests that although all firms could be better off with an appropriate cost-sharing rate combined with profit redistribution, the retailers should not offer to share too much of the service costs.

6 Extensions and Robustness

As Theorems 1 and 2 demonstrate, the manufacturer and retailers have different preferences over partial- and uniform-service provision, so inter-firm conflict arises whether there is service provision discrimination or not. This section further discusses the impact of retailer-provided service on the manufacturer's service provision decisions and the retailers' responses. Moreover, we examine the robustness of our main results by considering a wide range of values for parameter ρ. The impact of store substitutability θ is provided in the Appendix.

6.1 Impact of Retailer-Provided Services

This subsection examines the prospect of some (or all) retailers providing their own services even when they are endowed with manufacturer service (as is the case with Best Buy). However, other retailers might alter their marketing efforts when they receive manufacturer service. To examine how retailer-provided services affect firms' service-provision preferences, we study two cases: (1) retailer-provided services complement manufacturer-provided service; (2) retailer-provided services perfectly substitute for manufacturer-provided service.

6.1.1 Complementary Retailer Services

Here we study retailers providing services that complement manufacturer-provided service. Extending from the baseline model, we assume Retailer i exerts service level e_i and correspondingly incurs a per-unit service cost k_ie_i and a set-up cost $c_ie_i^2$. For tractability, we assume $k_i = k$ and $c_i = c = 1$. In this situation the initial base demand conditional on zero retail price for Retailer i is given by:

$$\alpha_i = A_i(1 + \mathbf{1}(i)s_i + e_i).$$

The new demand function follows equation (2). Therefore, in Scenario RR with complementary retailer services, the retailers' and manufacturer's profit functions can be rewritten, respectively, as follows.

$$\pi_{R_i}^{RR-E} = (p_i - w_i - ke_i)D_i - e_i^2,\ i = 1, 2, \tag{11}$$

$$\pi_M^{RR-E} = \sum_{i=1}^{2}(w_i - ks_i)D_i - Max\{s_1^2, s_2^2\}. \tag{12}$$

Since the manufacturer provides equal level of service (i.e., $s_1 = s_2$) in RR, it charges a uniform wholesale price to both retailers (i.e., $w_1 = w_2$). In Scenario RN with complementary retailer services, Retailers' profit functions remain in the same format as above except that the manufacturer charges two different wholesale prices, while the manufacturer's profit function can be written as

$$\pi_M^{RN-E} = (w_1 - ks)D_1 + w_2D_2 - s^2. \tag{13}$$

The game setting is akin to the baseline model. The manufacturer determines the wholesale price and its service level first, then the retailers simultaneously determine their retail prices and service levels.

Before discussing the manufacturer's choice between RN and RR when both retailers provide complementary services, we first examine whether the manufacturer would prefer no service provision (NN) over

RN or RR. In Scenario NN the equilibrium outcome is for both retailers to provide services – as indicated in Lemma 4. The scenarios RN and RR here are defined similarly to the baseline model except that both retailers provide complementary services. We compare Scenario NN to Scenarios RN and RR, respectively.

Lemma 4.

1. *When the manufacturer does not provide service, both retailers provide services in equilibrium (provided they are able to do so).*

2. *When both retailers provide complementary services, the manufacturer also provides service, either in an RN or an RR scenario.*

As in the baseline model, the benefit of service provision to the manufacturer is again apparent in the case where both retailers provide complementary services.

We now determine if the manufacturer also provides service, perhaps by discriminating between retailers, when there are complementary retailer services. Comparing manufacturer and retailer profits between RN and RR with complementary retailer services, we obtain similar results as in Lemma 3 and Theorem 1. However, as illustrated in Figure 5, there are some nuances. First, the bottom and right boundary shrinks inward. This is mainly because added retailer services intensify inter-retailer competition; hence, a much weaker R2 is more likely to be pushed out of the market. Second, when k is low, $\widetilde{a}_{R2}$ goes down slightly, so R2 is more apt to receive manufacturer service when k is low. Zone 1, where all firms prefer RR, expands slightly, so retailer services lower conflict over service provision.

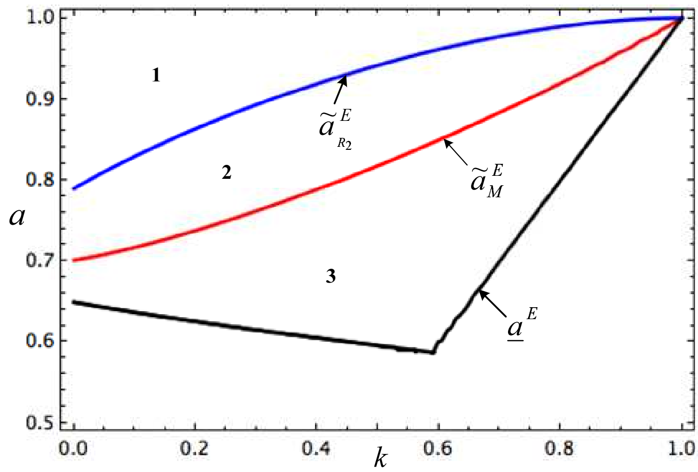

Figure 5: The firms' preferences with complementary retailer services

Zone	M prefers	R1 prefers	R2 prefers
1	RR	RR	RR
2	RR	RR	RN
3	RN	RR	RN

Table 5: The firms' preferences with complementary retailer services

We also compare scenarios with and without complementary retailer services for both the RN and RR Scenarios. We find that scenarios with complementary retailer services outperform having only manufacturer service – both for the manufacturer and for the overall channel; the reason is that added retailer services raise consumers' product valuations. For brevity and due to limited space, we do not report further details here.

6.1.2 Substitutable Retailer Services

Now we investigate the case of retailers providing services that substitute manufacturer efforts. We do so for the extreme case of retailer-provided services perfectly substituting for those provided by the manufacturer. Accordingly, we consider two alternatives: either the manufacturer or the retailers provide the services. This setup enables us to highlight differential economic effects that may occur depending on who takes on the more significant role in service provision.

For simplicity, we assume equal per-unit cost k and equal set-up cost c across channel members. As indicated in Lemma 4, if the manufacturer delegates services to retailers, both retailers providing services is the equilibrium outcome. With service level e_i exerted by Retailer i, the initial base demand conditional on zero retail price for Retailer i is given by

$$\alpha_i = A_i(1 + e_i).$$

The retailers' and manufacturer's profit functions can be rewritten, respectively, as follows.

$$\pi_{R_i}^{NN-E} = (p_i - w_i - ke_i)D_i - e_i^2,\ i = 1, 2, \tag{14}$$

$$\pi_M^{NN-E} = \sum_{i=1}^{2} w_i D_i. \tag{15}$$

Superscript *NN-E* means the manufacturer provides no service, but retailers do. Like Scenario *NN* in the baseline model, the manufacturer again charges the same wholesale price to both retailers (i.e., $w_1 = w_2$).

Compared with no service provision, the manufacturer is better off when services are provided – no matter who performs the services. We formalize the above results in the following lemma.

Lemma 5. *In a decentralized, competing retailer channels, the manufacturer is better off when either the manufacturer or the retailers provide the services than when no service is provided.*

Lemma 5 again confirms that the manufacturer benefits from service provision, no matter who provides the services. This is because service raises product valuations, hence demand and manufacturer profits.

Given that retailers could provide the same services as those of manufacturer at the same cost, does the manufacturer always prefer to delegate the services to the retailers? It seems the manufacturer should favor this delegation due to the cost savings arising from shifting service responsibilities from itself to the retailers. However, our next study shows that it is not always true. Comparing manufacturer and retailer profits when the manufacturer alone provides service to the case where both retailers provide services, we obtain the following result:

Theorem 4. *It is not always beneficial for the manufacturer to delegate service provision to the retailers; and it is not always profitable for the retailers to exercise their ability to choose their own service levels.*

Theorem 4 tells us that even when the manufacturer could endogenize the choice of who provides the service, it should not simply look at cost savings arising from shifting service responsibility from itself to the retailers. The underlying rationale is as follows. As we previously discussed, having the control over service provision, the manufacturer could exercise service differentiation and choose service levels that are optimal for itself. This leverage weakens when service provision is delegated to the retailers although the manufacturer benefits from shifting the service cost to the retailers. Similarly, even when the retailers are able to provide their own services, they may benefit from yielding the service-provision decision to the manufacturer. The reason is because providing services by the retailers leads to fiercer horizontal competition considering that they further compete on services in addition to prices. The net effect therefore depends on the trade-off between channel differentiation, horizontal competition, and cost saving.

6.2 Impact of Service Asymmetry Level

In the preceding analyses, we assumed service asymmetry level $\rho = 0$, which means the disfavored retailer receives no service. By comparing two polar opposite scenarios (i.e., RN and RR in the baseline model), we highlight differential economic effects that may occur when the manufacturer takes an asymmetric service provision strategy. But in reality, manufacturers may provide at least a minimal service level to an authorized retailer, for example, a limited warranty. In this subsection, due to tractability, we numerically run ρ at various interim values and demonstrate that similar firm confliction over service provision persists over a wide range of ρ.

Considering the decentralized competing retailer channels, we have two sub-scenarios of the more general scenario of differential-service provision: (i) providing high-level service to R1 and low-level service to R2 (we call it *Scenario Rρ*), (ii) providing low-level service to R1 and high-level service to R2 (we denote it *Scenario ρR*). In *Scenario Rρ*, profit functions of the retailers and the manufacturer are given by:

$$\pi_{R_i}^{R\rho} = (p_i - w_i)D_i, i = 1, 2, \tag{16}$$

$$\pi_M^{R\rho} = \sum_{i=1}^{2}(w_i - ks_i)D_i - (s^{R\rho})^2, \tag{17}$$

where $s_1 = s^{R\rho}$, $s_2 = \rho s^{R\rho}$ $(0 < \rho < 1)$, the demand D_i follows equation (2). The formulas for *Scenario ρR* are similar. In either case, the manufacturer determines the level of service and chooses the wholesale prices; then retailers determine their retail prices. Solving the game, we obtain the manufacturer's profits in Scenarios Rρ and ρR as follows.

$$\pi_M^{R\rho} = \frac{7 - \rho^2 k^2 - 2a[2 - \rho^2 k + \rho(1-k)k] + a^2[6 - \rho^2 + 2\rho(1-k) + 2k - k^2]}{38 - 7\rho^2 a^2 + 2(7 - 2\rho)k - (7 - 4\rho + 7\rho^2)k^2 + 2\rho a[2 + (7\rho - 2)k]},$$

$$\pi_M^{\rho R} = \frac{7 + a^2[6 + 2\rho(1-k) - \rho^2(1-k)^2] - k^2 - 2a(2 - k + \rho k - \rho k^2)}{45 - 7a^2 + 2a[2\rho(1-k) + 7k] - 7\rho^2(1-k)^2 - 4\rho(1-k)k - 7k^2}.$$

In view of the analytical difficulty, we compare the manufacturer's profits $\pi_M^{R\rho}$ and $\pi_M^{\rho R}$ numerically. The comparisons are based on hundreds of parameter combinations spanning the parameter space (i.e., $0 \leq a \leq 1$, $0 \leq k \leq 1$, $0 < \rho < 1$) but here we only report one of those results as presented in Table 6. Table 6 indicates that manufacturer's profits increases with ρ, but the difference between $\pi_M^{R\rho}$ and $\pi_M^{\rho R}$ decreases with ρ. Nevertheless, the numerous comparisons consistently reveal that under differential-service provision, the manufacturer gives high-level service to the bigger retailer. The underlying logic is similar to Lemma 2. A higher level of service for R1 enables the manufacturer to expand the market more efficiently. Further, asymmetry in differential service creates greater differentiation between the retailers. For the manufacturer, the benefit of giving high-level service to the bigger retailer outperforms the gain of doing so to the smaller one.

To illustrate the impact of ρ on firms' preferences over differential- and uniform-service provision, we again restrict our analytical results to $k = 0.4$. We then examine how threshold values $\widetilde{a}_M$ and $\widetilde{a}_{R_2}$ in Theorems 1 and 2 vary with ρ. The result is illustrated in Figure 6.

k	a	ρ	$\pi_M^{R\rho}$	$\pi_M^{\rho R}$	k	a	ρ	$\pi_M^{R\rho}$	$\pi_M^{\rho R}$
	0.6	0.1	0.1647	0.1585		0.8	0.1	0.1900	0.1856
	0.6	0.3	0.1650	0.1593		0.8	0.3	0.1910	0.1869
0.4	0.6	0.5	0.1654	0.1606	0.4	0.8	0.5	0.1922	0.1888
	0.6	0.7	0.1657	0.1624		0.8	0.7	0.1934	0.1911
	0.6	0.9	0.1660	0.1648		0.8	0.9	0.1948	0.1939
	0.7	0.1	0.1758	0.1703		0.9	0.1	0.2074	0.2047
	0.7	0.3	0.1764	0.1713		0.9	0.3	0.2089	0.2064
0.4	0.7	0.5	0.1771	0.1728	0.4	0.9	0.5	0.2107	0.2086
	0.7	0.7	0.1778	0.1748		0.9	0.7	0.2128	0.2113
	0.7	0.9	0.1785	0.1774		0.9	0.9	0.2150	0.2145

Table 6: Sample manufacturer profits in differential-service provision, where $c = 1$ and $\theta = 1/2$

Firms' preferences in each zone are exactly the same as described in Table 1. In other words, the firm's preference conflict over service provision consistently holds for the whole range of ρ. Nevertheless, both $\widetilde{a}_M$ and $\widetilde{a}_{R2}$ increase as ρ becomes larger. The manufacturer's threshold value $\widetilde{a}_M$ rises more rapidly when ρ approaches 1. This is because service exerted on both retailers becomes less asymmetric as ρ increases. Any fractional value for ρ allows the manufacturer to discriminate between retailers in service provision and wholesale pricing. These forces weaken as ρ increases. When an identical level of service is offered to both retailers (i.e., $\rho = 1$), the manufacturer enjoys no extra leverage compared to the case where differential service is performed.

Although firm conflict over service provision holds for a wide range of ρ-values, we now check if an intermediate value of ρ would improve the channel efficiency. We again calculate and compare efficiency ratios among differential-, partial- and uniform-service provision. For illustrative purpose, we choose 0.5 for ρ as a representative value. And, as earlier, we choose 0.2, 0.4, 0.6 and 0.8 for the per-unit cost k, and choose 0.6, 0.7, 0.8, 0.9 and 1.0 for parameter a. The set-up cost coefficient c and channel substitutability parameter θ are fixed at 1 and $\frac{1}{2}$. Denote by $ER^{R\rho}$ the efficiency ratio for differential-service provision when $\rho = 0.5$. Again, for brevity, we report in Table 7 the signs of $ER^{R\rho} - ER^{RN}$ and $ER^{R\rho} - ER^{RR}$. Scenarios RN and RR are special cases of differential-service provision when $\rho = 0$ as previously defined.

As Table 7 indicates, when k is not very high, channel efficiency is lower in Scenario $R\rho$ than Scenario RR (i.e., $ER^{R\rho} < ER^{RR}$) but higher than in Scenario RN (i.e., $ER^{R\rho} > ER^{RN}$) when a is relatively small; the reverse is true when a is substantially large. Put another way, the relationship $ER^{RN} < ER^{R\rho} < ER^{RR}$

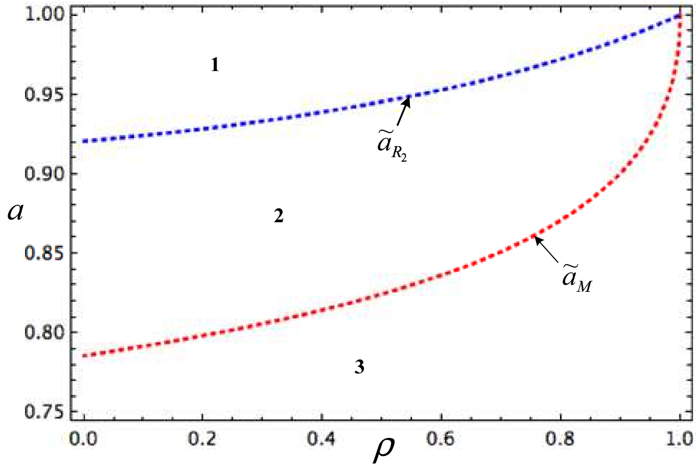

Figure 6: The impact of ρ on firms' indifference lines between RN and RR

holds when both a and k are not very high. When k is high, RN becomes the most efficient service provision strategy while RR becomes the worst. The underlying logic is like what we explained in Subsection 5.3, so we do not reiterate here for brevity. In summary, whether the general case of differential-service provision is more efficient than the special cases of RN and RR in term of the efficiency ratio depends on the parametric combinations under study. The main qualitative results in Lemma 2, Theorems 1 and 2 continue to hold in a wide range of ρ values.

7 Conclusion

We have investigated firms' reactions to a manufacturer's service provision decision. We show that it is not always beneficial for the manufacturer to provide both retailers with uniform service unless they have a comparable base level of demand. We also demonstrate that firms may disagree on their preferences for service. Perhaps surprisingly, it is not necessarily disadvantageous for a retailer to be restricted to a lower service level.

Channel efficiency and consumer surplus can both benefit from uniform-service provision since it yields a greater market expansion effect; further, more intense inter-retailer competition results from a more balanced service-provision management. When service is only offered to the larger retailer, there is greater differentiation between retailers; this limits overall market expansion capability. We also observe that when retailers have comparable base demands, asymmetric service provision can lead to higher channel efficiency due to increased differentiation and mitigated double marginalization. Moreover, retailer cost sharing of manufacturer-provided service does not necessarily help with firms' disagreements over service provision;

k	a	$ER^{R\rho}-ER^{RN}$	$ER^{R\rho}-ER^{RR}$	k	a	$ER^{R\rho}-ER^{RN}$	$ER^{R\rho}-ER^{RR}$
	0.6	+	−		0.6	+	−
	0.7	+	−		0.7	+	−
0.2	0.8	+	−	0.6	0.8	−	−
	0.9	−	+		0.9	−	−
	1.0	−	+		1.0	−	+
	0.6	+	−		0.6	−	−
	0.7	+	−		0.7	−	−
0.4	0.8	−	−	0.8	0.8	−	−
	0.9	−	+		0.9	−	−
	1.0	−	+		1.0	−	+

Table 7: Efficiency Ratios, where $c = 1$ and $\theta = 1/2$

however, cost sharing does improve channel efficiency when the cost-sharing rate is not too high.

Our extended analysis indicates that if retailers provide complementary services, the manufacturer has more of an incentive to discriminate between retailers when the per-unit service cost is low. Although the manufacturer always welcomes retailers' services that complement its own, it is not always beneficial for the manufacturer to delegate service provision to the retailers. Similarly, even when the retailers could provide their own services, they sometimes benefit from yielding the decision on service provision to the manufacturer. Finally, firm confliction over a manufacturer's service provision persists in a wide parameter space when service asymmetry varies.

There are limitations to our research; these represent potential extensions. First, due to enormous computational complexity, we have limited our discussion to a single manufacturer selling through two retailers. As it is plausible to expect multiple manufacturers to compete in a service war, a corresponding study would be in order. Second, the cost-sharing rate in our model is exogenously given due to tractability. While this assumption is sufficient to derive qualitative results, this rate could be examined endogenously in future studies. Third, as shown in Appendix C, a coordination mechanism of cost-sharing combined with profit redistribution can outperform a pure cost-sharing mechanism. Therefore, it warrants future exploration for a better channel coordination mechanism in a new study. Fourth, we concentrate on the manufacturer's strategic service-provision decision. The impact of retailer-provided services was discussed, but in a simplified way. A more comprehensive study of this topic is certainly our future research priority.

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Notes

[1]See https://www.neimanmarcus.com/c/designers-chanel-fashion-cat55920934; accessed 9-15-18.

[2]See https://www.chanel.com/us/; accessed 9-17-18.

[3]See https://ir.jcpenne.com/sec-filings/annual-reports#document-6099-0001166126-18-000014; accessed 9-14-18.

[4]As the number of salespeople increases, there is a discontinuous increase in the number of required supervisors.

[5]All quotes in this paragraph are from FTC: Federal Trade Commission. (n.d.). "Price Discrimination: Robinson-Patman Violations." https://www.ftc.gov/tips-advice/competition-guidance/guide-antitrust-laws/price-discrimination-robinson-patman; accessed 10/6/18.

[6]Sections 2(d) and (e) [of the Robinson-Patman Act] require sellers to provide allowances and services promoting resale on a *proportionally equivalent basis* to all competing customers. Only allowances/services intended to promote resale are relevant; promotions in connection with the original sale rather than the buyer's resale are irrelevant for purposes of Sections 2(d) and (e) (e.g., delivery services, returning unsold inventory, technical support, etc.). https://www.americanbar.org/groups/young_lawyers/publications/the_101_201_practice_series/robinson_patman_act.html; accessed 9-23-18.

[7]The cutoff level $\widetilde{k}$ uniquely solves $\frac{(7-2a)(1-k)}{45-7(1-k)^2} = \frac{(1+a)(1+a-2k)}{18-(1+a-2k)^2}$. Please see Proof of Lemma 3 for more detail.

[8]Note that $\underline{a} = \frac{4k^2-23+\sqrt{529+104k-168k^2-32k^3+16k^4}}{4k}$ is the lower bound of a in the decentralized system.

References

Ahmadi, R., F. Iravani, H. Mamani. 2017. Supply chain coordination in the presence of gray markets and strategic consumers. *Production and Operations Management*, 26 (2), 252-272.

Ahmadi, R. H., B. R. Yang. 2000. Parallel imports: Challenges from unauthorized distribution channels. *Marketing Science*, 19 (3), 279-294.

Altug, M. S. 2017. The dynamics of domestic gray markets and its impact on supply chains. *Production and Operations Management*, 26 (3), 525-541.

Antia, K., M. Bergen, S. Dutta. 2004. Competing with gray markets. *MIT Sloan Management Review*, 46 (1), 63-69.

Antia, K., M. Bergen, S. Dutta, R. J. Fisher. 2006. How does enforcement deter gray market incidence? *Journal of Marketing*, 70 (1), 92-106.

Assmus, G., C. Wiese. 1995. How to address the gray market threat using price coordination? *MIT Sloan Management Review*, 36 (3), 31-41.

Berger, P. D. 1972. Vertical cooperative advertising structures. *Journal of Marketing Research*, 9 (3), 309-312.

Blair, R., F. Lafontaine. 2015. Formula pricing and profit sharing in inter-firm contracts. *Managerial and Decision Economics*, 36 (1), 33-43.

Bucklin, L. P. 1993. Modeling the international gray market for public policy decisions. *International Journal of Research in Marketing*, 10 (4), 387-405.

Cai, G. 2010. Channel selection and coordination in dual-channel supply chains. *Journal of Retailing*, 86 (1), 22-36.

Cai, G., Y. Dai, and W. Zhang. 2019. Multichannel Supply Chain Management with Marketing Mixes: A Survey. H*andbook of Research on Distribution Channels*, Edited by Charles A. Ingene, James R. Brown and Rajiv P. Dant, Northampton, MA: Edward Elgar Publishing. Pages 165-199.

Cai, G., Y. Dai, S. Zhou. 2012. Exclusive channels and revenue sharing in a complementary goods market. *Marketing Science*, 31 (1), 172-187.

Cespedes, F. V., E. R. Corey, V. K. Rangan. 1988. Gray markets: Causes and cures. *Harvard Business Review*, 66 (4), 75-83.

Choi, S. C. 1991. Price competition in a channel structure with a common retailer. *Marketing Science*, 10 (4), 271-296.

Coughlan, A. T., D. A. Soberman. 2005. Strategic segmentation using outlet malls. *International Journal of Research in Marketing*, 22 (1), 61-86.

Cross, J., J. Stephans, R. E. Benjamin. 1990. Gray markets: A legal review and public policy perspective. *Journal of Public Policy and Marketing*, 9 (2), 183-194.

Duhan, D., M. Sheffet. 1988. Gray markets and the legal status of parallel imports. *Journal of Marketing*, 52 (3), 75-83.

Gamble, J., Q. Huang. 2009. One store, two employment systems: core, periphery and flexibility in China's retail sector. *British Journal of Industrial Relations*, 47 (1), 1-26.

Ingene, C. A., M. E. Parry. 1995. Channel coordination when retailers compete. *Marketing Science*, 14 (4), 360-377.

Ingene, C. A., M. E. Parry. 2007. Bilateral monopoly, identical distributors, and game-theoretic analyses of distribution channels. *Journal of the Academy of Marketing Science*, 35 (4), 586-602.

Ingene, C. A., S. Taboubi, G. Zaccour (2012). Game-theoretic coordination mechanisms in distribution channels: Integration and extensions for models without competition. *Journal of Retailing*, 88 (4), 476-496.

Iyer, G. 1998. Coordinating channels under price and nonprice competition. *Marketing Science*, 17 (4), 338-355.

Jerath, K., Z. J. Zhang. 2010. Store within a store. *Journal of Marketing Research*, 47 (4), 748-763.

Jerath, K., Z. J. Zhang. 2019. Platform retailing: From online stores within a store to online marketplaces. In C. A. Ingene, J. R. Brown and R. Dant, editors, *Handbook of Distribution Channels Research*. London: Edward Elgar Publishing, 2019.

Jeuland, A. P., S. M. Shugan. 1983. Managing channel profits. *Marketing Science*. 2 (3), 239-272.

Jorgensen, S., G. Zaccour, S. P. Sigue. 2000. Dynamic cooperative advertising in a channel. *Journal of Retailing*, 76 (1), 71-92.

Khanjari, N. E., S. Iravani, H. Shin. 2014. The impact of the manufacturer-hired sales agent on a supply chain with information asymmetry. *Manufacturing & Service Operations Management*, 16 (1), 76-88.

Kolay, S. 2015. Manufacturer-provided services vs. retailer-provided services: Effect on product quality, channel profits and consumer welfare. *International Journal of Research in Marketing*, 32 (2), 124-154.

Kumar, K. 2016. Some of best buys samsung mini-shops are closing, others expanding. *Star Tribune*, August 2; http://www.startribune.com/some-of-best-buy-s-samsung-mini-shops-are-closing-others-expanding/388998631/; accessed October 21, 2018.

Lal, R., C. Narasimhan. 1996. The inverse relationship between manufacturer and retailer margins: A theory. *Marketing Science*, 15 (2), 132-151.

Li, K., S. Mallik, D. Chhajed. 2012. Design of extended warranties in supply chains under additive demand. *Production and Operations Management*, 21 (4), 730-746.

Li, X., Y. Li, X. Cai, J. Shan. 2016. Service channel choice for supply chain: Who is better off by undertaking the service? *Production and Operations Management*, 25 (3), 516-534.

Liu, B., G. Cai, A. Tsay. 2014. Advertising in asymmetric competing supply chains. *Production and Operations Management*, 23 (11), 1845-1858.

McGuire, T. W., R. Staelin. 1983. An industry equilibrium analysis of downstream vertical integration. *Marketing Science*, 2 (2), 161-191.

Park, S.-J., R. Staelin. 2019. Interpretation of product differentiation in linear demand functions. In C. A. Ingene, J. R. Brown and R. Dant, editors, *Handbook of Distribution Channels Research*. London: Edward Elgar Publishing, 2019.

Shaffer, G., F. Zettelmeyer. 2004. Advertising in a distribution channel. *Marketing Science*, 23 (4), 619-628.

Shao, J., H. Krishnan, S. T. McCormick. 2016. Gray markets and supply chain incentives. *Production and Operations Management*, 25 (11), 1807-1819.

Shulman, J. D. 2014. Product diversion to a direct competitor. *Marketing Science*, 33 (3), 422-436.

Tsay, A., N. Agrawal. 2000. Channel dynamics under price and service competition. *Manufacturing & Service Operations Management*, 2 (4), 372-391.

Wu, C., Y. Chen, C. Wang. 2009. Is persuasive advertising always combative in a distribution channel? *Marketing Science*, 28 (6), 1157-1163.

Xia, Y. and S. M. Gilbert. 2007. Strategic interactions between channel structure and demand enhancing services. *European Journal of Operational Research*, 181 (1), 252-265.

Xiao, Y., U. Palekar, Y. Liu. 2011. Shades of gray-the impact of gray markets on authorized distribution channels. *Quantitative Marketing and Economics*, 9 (2), 155-178.

Ziegler, C. 2013. 1,400 samsung experience shops in best buy locations spell more bad news for htc. *The Verge*, April 24; https://www.theverge.com/2013/4/4/4180554/1400-samsung-experience-shops-in-best-buy-locations; accessed October 21, 2018.