Quant Mark Econ
DOI 10.1007/s11129-010-9090-z

Ownership coordination in a channel: Incentives, returns, and negotiations

Eyal Biyalogorsky · Oded Koenigsberg

Received: 11 May 2008 / Accepted: 10 August 2010

Abstract In many industries firms have to make quantity decisions before knowing the exact state of demand. In such cases, channel members have to decide which firm will own the units until demand uncertainty is resolved. The decision about who should retain ownership depends on the balance of benefit and risk to each member. Ownership, after all, is costly. Whichever member owns the units accepts the risk of loss if more units are produced than can be sold. But ownership also grants firms the flexibility to respond to demand once it becomes known by adjusting price. In this study, we analyze ownership decisions in distribution channels and how those decisions are affected by demand uncertainty. We model demand based on micro-modeling of consumer utility functions and capture demand uncertainty related to market size and price sensitivity. This study shows that as long as the degree of uncertainty about market size is intermediate, the retailer and the manufacturer both benefit when the manufacturer maintains ownership of the units. But when there is substantial uncertainty about market size, the retailer and the channel are better off if the retailer takes ownership but the manufacturer still prefers to maintain ownership. Thus, there is potential for channel conflict regarding ownership under high levels of uncertainty. We show that, using product returns, the manufacturer can achieve the same outcome under retailer ownership as under manufacturer ownership. This provides an additional new rationale for the prevalence of product returns. The first-best outcome (from the perspective of total channel profit), however, is under retailer ownership without product returns when uncertainty is high (i.e., product returns reduce the total channel profit). Negotiations between the manufacturer and the retailer can lead to the first-best outcome but only under quite restrictive constraints that include direct side payments by the retailer to the manufacturer and the retailer

E. Biyalogorsky
Arison School of Business, IDC, Herzliya, Israel 46150
e-mail: ebialogorsky@idc.ac.il

O. Koenigsberg (✉)
Columbia Business School, Columbia University, New York, NY 10027, USA
e-mail: ok2018@columbia.edu

Published online: 14 September 2010

being pessimistic about its outside option (when an agreement cannot be reached) during the negotiation.

Keywords Channels · Demand uncertainty · Lead time · Pricing · Product returns · Negotiations

JEL Classification C78 · D23 · D24 · L11 · L22 · M31

1 Introduction

One of the important tasks facing firms in setting up distribution channels is organizing different flows through the channel to ensure the best possible performance. Coughlan et al. (2006) identified eight generic activities that must be considered: physical possession, ownership, promotion, negotiation, financing, risk, ordering, and payment. In this paper we investigate how the ownership flow in a channel should be organized. Ownership is the power to exercise control over an asset (Grossman and Hart 1986). In a distribution channel, one of the ownership decisions is which member should own (control) the inventory carried by the channel—the manufacturer or the retailer—and under what conditions.[1]

Ownership matters in a channel when demand is uncertain. The firm that owns the units in the channel can adjust its actions in response to new information regarding actual demand by consumers. For example, if a manufacturer retains ownership of the units in the channel and finds that demand for the product is higher than expected, it can increase the wholesale price in response. Conversely, a channel member that does not own the units has limited ability to respond to new information. If the manufacturer transfers ownership of the units to the retailer before learning that demand is higher than expected, the manufacturer loses the ability to increase its wholesale price in response. Thus, ownership conveys the ability to respond to changes in the market (Grossman and Hart 1986).

Ownership, however, is risky and hence costly since the owner is liable for any unsold units if demand turns out to be low. This risk can prompt each channel member to prefer not to own the units (Cachon 2004; Netessine and Rudi 2004). Thus, it is not clear *a priori* what sort of ownership arrangement is in the best interest of the retailer, the manufacturer, and the channel under a particular set of conditions. In practice, we observe firms and industries adopt different stances regarding ownership in the channel. L.L. Bean, a direct catalog retailer, takes ownership of its merchandise fairly early and makes final, firm commitments to its vendors 12 weeks before a catalog reaches consumers. These commitments create inflexibility that costs the retailer $20 million annually due to stockouts or liquidations (Schleifer 1993). In channels that use consignment arrangements, on the other hand, ownership of the units always remains with the manufacturer (Dong et al. 2007; Rubinstein and Wolinsky 1987). Ownership arrangements also change over time in response to changes in conditions. Johnson

[1] Another aspect of ownership in a channel is vertical integration—whether channel members should be independent entities. This issue has received extensive attention in the literature (see, for example, McGuire and Staelin (1983) and Desai et al. (2004)) and is not dealt with in this paper.

(2001) described a trend in the toy industry to shift ownership of units from retailers to manufacturers. Recently, retailers such as J.C. Penney, Sacks, and Macy's changed their strategies such that manufacturers end up carrying more of the inventory in the channel (The Economist 2010).

What should be the ownership structure in a channel? And how is it affected by the demand conditions? In this paper we examine these questions by looking at a channel facing demand uncertainty and determine which member in the channel—the manufacturer or the retailer—should retain ownership of the units. We develop a model in which a manufacturer sells its product to a retailer that then sells the units to consumers. The cost of physically handling the units is the same regardless of the ownership structure and thus immaterial to the ownership decision. Channel members are initially uncertain about the potential demand in the market and the units must be produced before this uncertainty is resolved. However, retail prices—and, under manufacturer ownership, wholesale prices—can be changed in response to any new information about demand. This separation of production and price-setting decisions creates the basic trade-off of inventory ownership: the ability to respond to demand conditions versus the risk of being stuck with unsold units.

The results show that the manufacturer always prefers to own the units in the channel. The retailer, on the other hand, wants to own the units only when uncertainty regarding market size is high; otherwise, it prefers that the manufacturer own the units. This misalignment of incentives when demand uncertainty is high creates a coordination problem for the channel and can lead to channel conflict. We show that the manufacturer can resolve this coordination problem using product returns. By letting the retailer own the units and offering the retailer a suitable product return program, the manufacturer can achieve the same expected profits as if it owned the units in the channel. This point to an additional role and rationale for the use of product returns.

When demand uncertainty is high, total channel profits are greater under retailer ownership without product returns compared to manufacturer ownership or retailer ownership with product returns. Therefore, the efficient ownership structure under high uncertainty conditions is retailer ownership without product returns. To investigate when channel members may reach the efficient ownership structure, we consider potential outcomes of bargaining between the retailer and the manufacturer. We show that bargaining can lead to the efficient outcome of retailer ownership without product returns if (1) the players' beliefs regarding the outside option (the option available if negotiations fail) are pessimistic and (2) direct side payments from the retailer to the manufacturer are possible.

The remainder of this paper is organized as follows. In the next section we describe the previous literature and in section 3 we lay out the model and our assumptions and present our basic analysis. We introduce and discuss our results in section 4, discuss how to resolve the ownership conflict in section 5 and conclude in section 6.

2 Related literature

The decision regarding ownership flow in a channel comes down to the benefits and costs associated with postponing the transfer of ownership from the manufacturer to the retailer until after demand uncertainty is resolved. Intuitively, the ability to postpone decisions until after demand is known should be valuable. Ferguson (2003) looked at how a retailer postponing the ordering decision (without changing the retail price, which was exogenous) affects the manufacturer's production decision. Cachon (2004) showed that offering advance-purchase discounts and allowing the retailer to place some orders before and some orders after demand is known can help to coordinate the channel when demand is uncertain. Netessine and Rudi (2004, 2006) investigated how demand uncertainty affects the use of drop shipping, in which the manufacturer/wholesaler owns and stocks the inventory and ships units directly to customers at the retailer's direction. Lee et al. (1997) showed that when there are single manufacturer, multiple retailers and asymmetric information, the better-informed retailer should own the units. A common theme in these papers is that prices are exogenous and only the production decision is considered. In contrast, our focus is on the effect that the ability to respond to new information by changing the price *ex post* (while production decisions must be taken *ex ante*) has on channel members.

Investigating the effect of the ability to respond to new information by changing the price is important in light of a number of papers that point out that the added flexibility from postponement may not always be beneficial. Iyer and Padmanabhan (2000) asked when a manufacturer should offer flexible terms of trade to a retailer that faces demand uncertainty and showed that there are times when a manufacturer will offer rigid rather than flexible terms. Similarly, Iyer and Bergen (1997) found that manufacturers may not be better off under quick-response channel arrangements and that rigid rather than flexible terms may improve quick-response arrangements. In a setting of a single manufacturer and multiple competing retailers, Iyer et al. (2007) investigated how improved information affects the manufacturer's preference regarding where to keep the inventory. They found that, with more reliable information, the manufacturer prefers to hold the inventory only if the retail market is very competitive.[2]

The work most closely related to the current study is a paper by Taylor (2006). Taylor studied a setting that is similar to the one in our model. Among the questions he posed was when a manufacturer should sell to a retailer—whether early or late in the selling season. He showed that the manufacturer always (weakly) prefers to sell late rather than early. One can interpret the sale-timing decision in Taylor as a decision about when to transfer ownership of the units in the channel from the manufacturer to the retailer. Thus, Taylor's result is equivalent to result 1 in section 4, which describes manufacturer preferences regarding ownership of units in the channel. We differ from Taylor in viewing the ownership decision as a strategic choice for the channel rather than only for the manufacturer. Thus, we consider issues affecting incentives for the retailer while Taylor's model included a constraint that the retailer had to be no worse off under manufacturer ownership than under retailer ownership. Our results show that the retailer and manufacturer may not agree about who should own the units. Thus, instead of assuming that the manufacturer makes this decision, we consider how product returns and bargaining may affect how channel members may reach an accommodation regarding the ownership

[2] This may be partly due to an increase in manufacturer power as the retail market becomes more competitive. Iyer and Villas-Boas (2003) showed in a channel-bargaining model that only a powerful manufacturer will voluntarily offer a return policy.

structure. These results explain when and why we see ownership rights given to retailers.

Research has shown that the use of product returns can help coordinate the channel in the face of uncertainty (Marvel and Peck 1995; Pasternack 1985). Product returns provide insurance for the retailer against getting stuck with unsold units. Padmanabhan and Png (1997) showed that a return policy reduces the dispersion in retail prices between the high and low demand states. Our model shows that return policies can help channel coordination, not just in terms of price and inventory but also regarding the ownership decision.

3 Model

We consider a bilateral channel in which a risk-neutral manufacturer sells its product to a risk-neutral retailer that then sells it to consumers. In the beginning, the manufacturer and the retailer each have some symmetrical and exogenous uncertainty about demand.[3] Then, at a later point, they learn true demand for the product in the market. Production decisions must be made before the firms learn the true demand state but pricing decisions can be made after.

This setting is typical of industries such as fashion and toys that must commit to a production quantity very early in the planning cycle. In the fashion industry, for example, lead time between the start of production and availability of those units for sale can be as long as 12 months (Fisher and Raman 1996). In these industries, production decisions are typically made under conditions of more severe uncertainty than are pricing decisions and changing the initial production plan at a later point in time is very costly when possible at all (see, for example, Caruana and Einav (2005), Fisher and Raman (1996), Johnson (2001), and Schleifer (1993)).

Given these conditions, it is natural to ask which channel members have incentives to own the units produced until the pricing decision must be made. If the manufacturer retains ownership, it can adjust the wholesale price in response to reduced demand uncertainty but also risks being stuck with units that cannot be sold or can be sold only at a deeply discounted price. The retailer can always adjust the retail price as it learns more about demand. If the retailer takes ownership of the units, the wholesale price charged by the manufacturer is fixed and the retailer reaps most of the windfall if demand turns out be high but suffers being stuck with unwanted units if demand turns out to be low.

The sequence of events in the model is as follows. Under the retailer ownership scenario, the retailer assumes ownership of the units before the uncertainty is resolved (Fig. 1a). The manufacturer sets a linear per-unit wholesale price[4] and the retailer decides how many units to order. These decisions are made while channel

[3] An analysis of the asymmetric information case is available from the authors. We briefly summarize the conclusions in the discussion section.

[4] We consider in this analysis only linear per-unit wholesale arrangements. This is a reasonable starting point in view of the wide use of such arrangements in practice (Lariviere and Porteus 2001) and because it is the optimal outcome expected of bargaining in channels under uncertainty (Iyer and Villas-Boas 2003). In addition, understanding firms' incentives under linear contracts is a necessary first step in determining whether more complex arrangements such as side payments and nonlinear prices are called for.

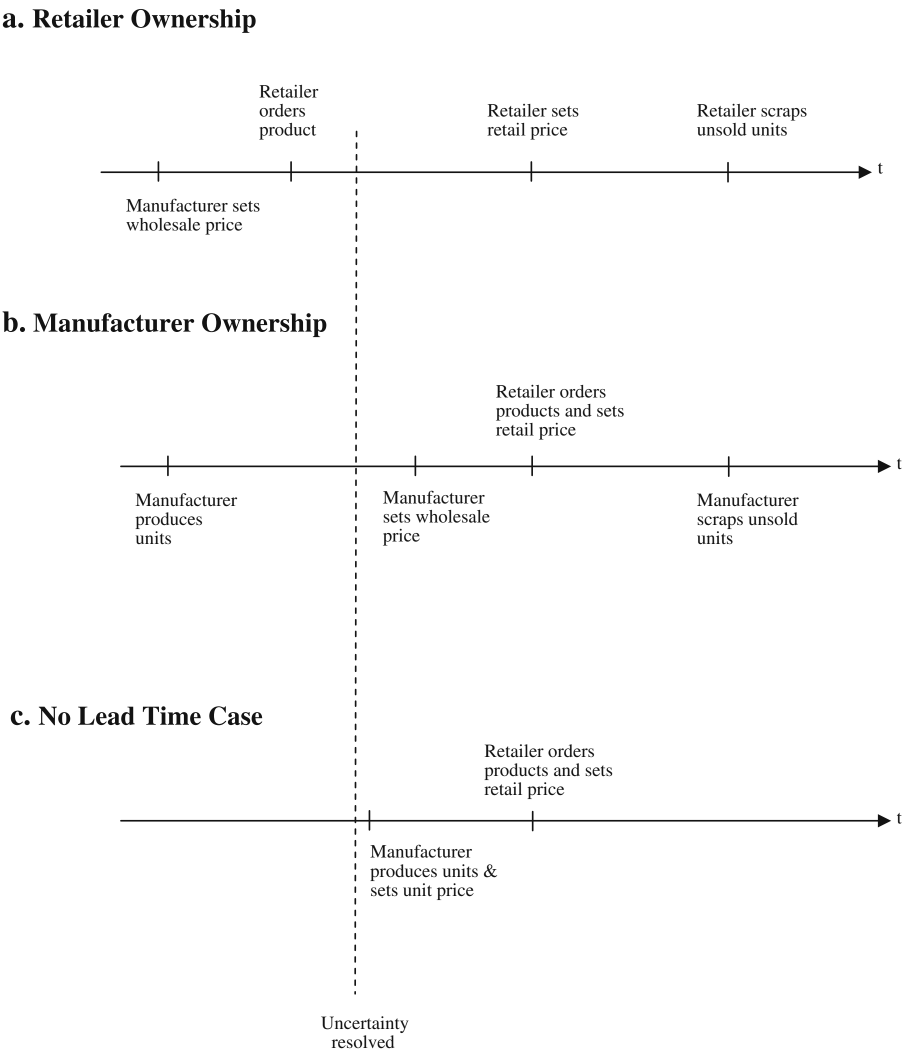

Fig. 1 **a** Retailer ownership. **b** Manufacturer ownership. **c** No lead time case

members remain uncertain of the demand conditions. The units are produced and delivered to the retailer. After the firms learn the true demand conditions, the retailer sets the retail price. Any unsold units are scrapped. Under this scenario, the retailer bears the cost of unsold inventory.

Under the manufacturer ownership scenario, the manufacturer retains ownership of the units until the uncertainty is resolved (see Fig. 1b) and the retailer places its order with the manufacturer only after learning what the true demand in the market is. The manufacturer decides how many units to produce based on its estimate of how many units the retailer will order. After the firms learn the true demand condition, the manufacturer sets the wholesale price and the retailer places orders with the manufacturer and sets the retail price. The manufacturer ships the requested units to the retailer and scraps any leftover units. Under this scenario, the manufacturer bears the cost of unsold inventory.

As a reference, we also depict in Fig. 1 (see Fig. 1c) the sequence of events when there is no lead time in the channel. In that case, production takes place after the demand uncertainty has been resolved and both wholesale and retail prices are set after demand is known. Note that ownership in this case does not matter because all decisions are made after the uncertainty is resolved.

3.1 Demand uncertainty

We model demand and uncertainty in the following manner: Let ϕ be consumers' valuation of the service provided by the product. We assume that ϕ is distributed uniformly in the interval $\left[0, \frac{1}{\beta}\right]$]; that there are α consumers in the market, each with valuations which are independently drawn from the distribution of ϕ; and that each consumer uses at most one unit.[5] From these assumptions, the quantity demanded as a function of price, p, is

$$q = \alpha \Pr[\phi \geq p] = \alpha[1 - \Pr[\phi \leq p]] = \alpha\left(1 - \frac{p}{1/\beta}\right) = \alpha(1 - \beta p).$$

Thus, the market demand function q is given by

$$q = \alpha(1 - \beta p)$$

where α represents market size and β represents consumer price sensitivity.

There are two possible sources of uncertainty: (1) the firm may be uncertain about the exact number of consumers in the market, α; and/or (2) the firm may be uncertain about consumers' valuation of the product, which in this case means uncertainty regarding the upper bound of the valuation distribution. Uncertainty regarding consumer valuation is reflected as uncertainty regarding the price sensitivity in the market, β.

We assume that the manufacturer and the retailer are uncertain about the true market size, which can be large (α_h) with probability θ or small (α_l) with probability ($1-\theta$) where $\alpha_h > \alpha_l$. Note that, as the difference between the high demand state and low demand state increases, the standard deviation, which is a measure of uncertainty, increases. We also looked at the effect of having uncertainty regarding price sensitivity (and on both market size and price sensitivity). Since we find that ownership decisions are not affected by uncertainty about price sensitivity, we do not present those results here.[6]

Note that, in contrast to the usual linear demand function formulation, in our demand formulation we keep α as a multiplicative term outside the parentheses. This is done to avoid confounding the effects of potential market size (number of consumers) and price sensitivity. It is common to write the preceding demand function in reduced form as $q = \alpha - \beta' p$ with $\beta' = \alpha\beta$ and to model uncertainty as an

[5] These assumptions lead to a linear demand-function formulation. We also conducted an analysis using an exponential demand formulation. All of the results of the linear case hold for the exponential case as well. Details are available from the authors upon request.

[6] Details of the price-sensitivity analysis are available from the authors.

additive linear error term on α while keeping β' fixed. Such an approach confounds uncertainty regarding the number of consumers and their valuations of the product because keeping β' fixed requires that β must change in negative correlation to α. This confounding causes problems in interpretation of the mathematical results. To avoid this, we use the demand formulation with α as a multiplicative term.

3.2 Costs

Regarding costs, we assume that there is a constant marginal cost of production, c, per unit; the retailer's marginal cost is zero; the holding cost is zero;[7] and the unsold units are scrapped with no cost or value to either the manufacturer or the retailer.

4 Ownership incentives

In this section we look at the incentives of the manufacturer and the retailer to maintain ownership over the units in the channel. We analyze the two scenarios of manufacturer and retailer ownership as a game between a manufacturer and a retailer in which the manufacturer acts as the Stackelberg leader and the retailer as the follower. The analysis is straightforward; the details are omitted here and can be found in the appendix. The equilibrium outcomes of the analysis are given in Table 1.

Retaining ownership of the units in a channel until uncertainty is resolved exposes a firm to the risk of not being able to sell all the units. If the optimal sale quantity turns out to be smaller than the number of available units by Δ, then the firm wastes money ($c\Delta$ for a manufacturer that retains ownership and $w\Delta$ for a retailer that retains ownership). On the other hand, owning the units provides a firm with another degree of freedom in responding to eventual demand conditions. For example, a manufacturer that owns the units can adjust the wholesale price according to revealed demand. If, on the other hand, ownership is first transferred to the retailer, the manufacturer must fix the wholesale price before demand is revealed and cannot adjust it later. The added flexibility is useful if the firm finds it profitable not to sell all the available units when demand is low. The firm can then restrict the quantity sold by setting a higher price. For example, the manufacturer can set a higher wholesale price that results in the retailer ordering (and selling) fewer than the number of units available in inventory.

The analysis results (see Table 1) show that for the manufacturer the benefit of ownership is always at least as great as the cost of ownership. Thus, letting $k = 1 - \frac{\beta c}{\theta}$:

Result 1 (manufacturer incentives) The manufacturer always (weakly) prefers owning the units. The manufacturer strictly prefers to own the units when the difference in market size is sufficiently large $\left(\frac{\alpha_l}{\alpha_h} < k\right)$ and is indifferent when the difference in market size is small $\left(k < \frac{\alpha_l}{\alpha_h}\right)$.

[7] All of the results directly extend to the case of a positive symmetric holding cost, $h > 0$. Details are available from the authors upon request.

Table 1 Equilibrium outcomes

	Retailer ownership $\alpha_l < \frac{\alpha_h}{2}\left(1-\frac{\beta c}{\theta}\right)$	Manufacturer ownership $\alpha_l < \alpha_h\left(1-\frac{\beta c}{\theta}\right)$	Indifference $\alpha_l > \alpha_h\left(1-\frac{\beta c}{\theta}\right)$	No lead time	Integrated
Price (large market size)	$\frac{1}{4}\left[\frac{3}{\beta}+\frac{c}{\theta}\right]$	$\frac{1}{4}\left[\frac{3}{\beta}+\frac{c}{\theta}\right]$	$\frac{1}{2\beta}\left[2-\frac{\alpha_l(1-c\beta)}{2[\alpha_h(1-\theta)+\alpha_l\theta]}\right]$	$\frac{3+c\beta}{4\beta}$	$\frac{\beta c+\theta}{2\beta\theta}$
Price (small market size)	$\frac{1}{2\beta}$	$\frac{3}{4\beta}$	$\frac{1}{2\beta}\left[2-\frac{\alpha_h(1-c\beta_h)}{2[\alpha_h(1-\theta)+\alpha_l\theta]}\right]$	$\frac{3+c\beta}{4\beta}$	$\frac{1}{2\beta}$
Wholesale price (large market size)	$\frac{\beta c+\theta}{2\beta}$	$\frac{1}{2}\left[\frac{1}{\beta}+\frac{c}{\theta}\right]$	$\frac{1}{\beta}\left[1-\frac{\alpha_l(1-c\beta)}{2[\alpha_h(1-\theta)+\alpha_l\theta]}\right]$	$\frac{1+c\beta}{2\beta}$	
Wholesale price (small market size)	$\frac{\beta c+\theta}{2\beta}$	$\frac{1}{2\beta}$	$\frac{1}{\beta}\left[1-\frac{\alpha_h(1-c\beta)}{2[\alpha_h(1-\theta)+\alpha_l\theta]}\right]$	$\frac{1+c\beta}{2\beta}$	
Sales (large market size)	$\frac{\alpha_h}{4}\left[1-\frac{\beta c}{\theta}\right]$	$\frac{\alpha_h}{4}\left[1-\frac{\beta c}{\theta}\right]$	$\frac{\alpha_h\alpha_l(1-c\beta)}{4[\alpha_h(1-\theta)+\alpha_l\theta]}$	$\frac{\alpha_h(1-c\beta)}{4}$	$\frac{\alpha_h}{2}\left[1-\frac{\beta c}{\theta}\right]$
Sales (small market size)	$\frac{\alpha_l}{2}$	$\frac{\alpha_l}{4}$	$\frac{\alpha_h\alpha_l(1-c\beta)}{4[\alpha_h(1-\theta)+\alpha_l\theta]}$	$\frac{\alpha_l(1-c\beta)}{4}$	$\frac{\alpha_l}{2}$
Production (ordering) quantity	$\frac{\alpha_h}{4}\left[1-\frac{\beta c}{\theta}\right]$	$\frac{\alpha_h}{4}\left[1-\frac{\beta c}{\theta}\right]$	$\frac{\alpha_h\alpha_l(1-c\beta)}{4[\alpha_h(1-\theta)+\alpha_l\theta]}$	$\frac{1}{4}(1-c\beta)\alpha_i$	$\frac{\alpha_h}{2}\left[1-\frac{\beta c}{\theta}\right]$
Retailer profit	Π_{R1}	Π_{R2}	$\frac{\alpha_h\alpha_l(1-c\beta)^2}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$	$\frac{(1-c\beta)^2\alpha_i}{16\beta}$	$\frac{\alpha_l(1-\theta)\theta+\alpha_h+(\theta-\beta c)^2}{4\beta\theta}$
Manufacturer profit	$\frac{\alpha_h(\beta c-\theta)^2}{8\theta\beta}$	Π_{M2}	$\frac{\alpha_h\alpha_l(1-c\beta)^2}{8\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$	$\frac{(1-c\beta)^2\alpha_i}{16\beta}$	
Consumer surplus	CS_1	CS_2	$\frac{\alpha_h\alpha_l(1-c\beta)^2}{32\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$	$\frac{(1-c\beta)^2\alpha_i}{32\beta}$	

Where, $\Pi_{R1}=\frac{4\theta\alpha_l(1-\theta)+\alpha_h(\beta c-\theta)^2}{16\theta\beta}$, $CS_1=\frac{4\theta\alpha_l(1-\theta)+\alpha_h(\beta c-\theta)^2}{32\theta\beta}$, $\Pi_{R2}=\frac{\theta\alpha_l(1-\theta)+\alpha_h(\beta c-\theta)^2}{16\theta\beta}$, $\Pi_{M2}=\frac{\theta\alpha_l(1-\theta)+\alpha_h(\beta c-\theta)^2}{8\theta\beta}$, $CS_2=\frac{\theta\alpha_l(1-\theta)+\alpha_h(\beta c-\theta)^2}{32\theta\beta}$

The only way in which the manufacturer can respond to the actual demand conditions is by retaining ownership of the units in the channel and changing the wholesale price in response to new information about demand. The benefits of doing this are especially large when the potential difference in market size is large. At the same time, the manufacturer can restrict the potential cost of ownership by restricting *a priori* the production quantity. As a result, the cost of ownership for the manufacturer is never greater than the benefit of ownership.[8]

Result 2 (retailer incentives) The retailer prefers to own the units when there is a large difference in market size $\left(\frac{\alpha_l}{\alpha_h} < \frac{k}{2}\right)$, prefers manufacturer ownership when there is an intermediate difference in market size $\left(\frac{k}{2} < \frac{\alpha_l}{\alpha_h} < k\right)$, and is indifferent when the difference in market size is small $\left(k < \frac{\alpha_l}{\alpha_h}\right)$.

The retailer, as opposed to the manufacturer, can always adjust its price to changes in demand regardless of ownership. The benefit of ownership to the retailer stems from the lower wholesale price the manufacturer has to offer to convince the retailer to carry sufficient inventory in the face of uncertainty. This benefit increases with the level of uncertainty about demand. The potential cost of ownership for the same level of inventory is greater for the retailer because the wholesale price is greater than the production cost. Therefore, for the retailer the benefit of ownership outweighs its cost only under a relatively large difference in market size. At a lower level of difference in market size, the cost outweighs the benefit and the retailer prefers that the manufacturer own the units. At even lower levels of market size difference, the entire inventory will be sold regardless of demand conditions and it does not matter who owns the units.

Result 3 (total channel profit) Total channel profit is greater under retailer ownership when the difference in market size is large $\left(\frac{\alpha_l}{\alpha_h} < \frac{k}{2}\right)$ and under manufacturer ownership when the difference in market size is intermediate $\left(\frac{k}{2} < \frac{\alpha_l}{\alpha_h} < k\right)$. Channel profits are the same regardless of ownership when the difference in market size is small $\left(k < \frac{\alpha_l}{\alpha_h}\right)$.

The results point to several important implications. First, it does matter who owns the units in a channel. Specifically, it matters when the potential difference in market size is large enough (see Table 2). For intermediate differences in market size, the manufacturer should retain ownership of the units. Since this arrangement also benefits the retailer, it is reasonable to expect that the manufacturer and retailer can reach an arrangement that keeps ownership with the manufacturer. When there is a large difference in market size, the retailer would like to have ownership of the units. However, in this case the manufacturer's interest differs from the retailer's interest in that the manufacturer also prefers to retain ownership. Since in this case total channel profits are greater under retailer ownership (see result 3), there are potential arrangements under which both benefit when the retailer assumes ownership. This may explain cases in which we observe retailer ownership in practice. Of course, the

[8] When the difference in market size is small and the production quantity is optimal, all of the units are sold regardless of the actual demand condition and it does not matter who owns the units.

Table 2 Ownership structure preferences

	$\frac{\alpha_l}{\alpha_h} < \frac{k}{2}$	$\frac{k}{2} < \frac{\alpha_l}{\alpha_h} < k$	$k < \frac{\alpha_l}{\alpha_h}$
Manufacturer's preference	Manufacturer ownership	Manufacturer ownership	Indifferent
Retailer's preference	Retailer ownership	Manufacturer ownership	Indifferent
Total channel profit is greater under	Retailer ownership	Manufacturer ownership	Indifferent

fact that an agreement is possible does not mean that the parties will reach one so there is the potential for channel conflict under these conditions.

To illustrate the importance of these results, consider one possible set of parameters: β=0.04, θ=0.5, and c=4. In this case, if expected market size in the low demand state is 68% or less than that of the high demand state, it matters who owns the units in the channel. If the low-demand market size is even smaller (34% or less of the high-demand market size), the manufacturer and the retailer will have opposing interests regarding ownership of the units. The profit implications are substantial. For example, if α_h=200 and α_l=60, the manufacturer's profits are 64% higher under manufacturer ownership than under retailer ownership, but the retailer's profits are 148% higher under retailer ownership than under manufacturer ownership.

It matters who owns the units in the channel only if the firm that owns the units finds it optimal to restrict sales in a low-demand case to less than the available inventory.[9] The more the sale quantity in the low demand state is restricted, the more important the ownership issue becomes. The critical threshold $k = 1 - \frac{\beta c}{\theta}$, which determines when ownership matters and when the manufacturer and retailer both want to own the units, is the ratio of the actual production quantity to the number of units the manufacturer would like to sell *ex post* when market size turns out to be large. Thus *(1–k)* can be thought of as a measure of the reduction in quantity produced because of demand uncertainty on the part of channel members. The greater the reduction in production, the fewer units the channel carries and, therefore, the benefit of ownership is reduced and ownership matters only at larger potential differences in market size. Not surprisingly, demand uncertainty leads to lower production as the production cost (c) and consumer price sensitivity levels (β) rise. Thus, k increases with θ and decreases with c and β.

The incentive misalignment between the retailer and the manufacturer regarding ownership when the difference in market size is large enough shows that the ownership decision presents a coordination problem for the channel and can potentially lead to conflicts in the channel. A natural question is what types of arrangements can help channel members avoid this conflict. We turn our attention to this question in the next section.

5 Resolving the ownership conflict

We consider two mechanisms that can help resolve the ownership conflict. First, we investigate whether the manufacturer offering a product return arrangement

[9] Notice that the production quantity is the same regardless of whether the manufacturer or the retailer owns the units. Therefore, it does not affect the question of ownership.

can coordinate the channel. We show that by offering product returns the manufacturer can achieve the same profit under retailer ownership as can be achieved under manufacturer ownership. This means that the manufacturer no longer cares who owns the units; the conflict disappears and the retailer will own the units.

While product returns solve the potential channel conflict, total channel profits with returns are less than those without. In section 5.2 we study whether negotiations between the manufacturer and the retailer can resolve the ownership conflict and help achieve the efficient outcome. We show that negotiations can lead to retailer ownership and to an efficient outcome if side payments from the retailer to the manufacturer are feasible. However, even with side payments allowed, it is not always the case that negotiations will resolve the ownership conflict and lead to the efficient outcome. Thus, we must conclude that, in many cases, achieving the efficient outcome will not be easy and may not be feasible.

5.1 Product returns

The loss from carrying unsold units is greater for the retailer than for the manufacturer (since wholesale price is greater than the production cost). Facing the same level of uncertainty, the retailer is more reluctant to carry the same level of inventory. To convince the retailer to carry more inventory, the manufacturer has to lower its wholesale price significantly. This is why the manufacturer's profit is less under retailer ownership than under manufacturer ownership.

A common method manufacturers use to protect retailers from uncertain demand is to offer product returns. With product returns the retailer can return unsold units to the manufacturer and receive a (partial) refund for the units. Product returns partially insure the retailer against the risk of getting stuck with unsold units, thereby reducing the uncertainty the retailer faces. This allows the manufacturer to increase (or, more precisely, not decrease as much) its wholesale price, improving the manufacturer's profits under retailer ownership, potentially to the point that the manufacturer's incentives change and it would prefer retailer ownership.

Let r be the return refund offered by the manufacturer ($r \leq w$). The manufacturer makes decisions on wholesale price, w, and return, r, simultaneously. Recall that it is optimal to sell all of the units in the high demand state so the return refund does not affect the retail price in the high demand state. In the low demand state, the retailer's profit is $\pi_{rl} = p_l q_l + r(Q - q_l)$ where Q is the order quantity and q_l is the quantity sold in the low demand state. The profit can be rewritten as $q_l(p_l - r) + Qr$. Note that the last term is already fixed at this point (Q units have already been ordered) from the retailer's pricing perspective. Thus the refund is exactly like another variable cost and the optimal retail price in the low demand state increases with the refund amount, $p_l^* = \frac{1+\beta r}{2\beta}$.

The retailer orders the amount, Q, which maximizes its expected profit over both demand states given w and r. The manufacturer sets w and r to maximize the following expected profit: $\pi_m = (w - c)Q - (1 - \theta)r(Q - q_l)$. The solution for this optimization problem yields $w^*_{ret} = \frac{1+\beta c}{2\beta}$, $r^*_{ret} = \frac{1}{2\beta}$ and $Q^*_{ret} = \frac{a_h(\theta - \beta c)}{4\beta}$. Comparing the results under retailer ownership with product returns to the results under manufacturer ownership, we find that:

Result 4 The manufacturer's and the retailer's expected profits under retailer ownership with product returns are equal to those under manufacturer ownership.

Using product returns, the manufacturer can earn the same expected profit as if it had ownership, making the manufacturer indifferent to who owns the units. This provides one way to resolve the ownership conflict. The manufacturer is willing to let the retailer own the units because the product return program allows it to earn the same level of profit.

A product return arrangement enables the manufacturer to earn more because it reduces the retailer's risk and allows the manufacturer to charge a higher wholesale price (compare w^*_{ret} to the optimal wholesale price under retailer ownership in Table 1). The sale quantity in the high demand state (and the production quantity) is the same regardless of the return program so the higher wholesale price leads to greater profits if demand is high. On the other hand, if demand is low, the return program hurts the manufacturer's profit. But the combined effect is still positive for the manufacturer. In essence, by offering product returns, the manufacturer transfers some of the risk from the retailer to itself. This translates into a larger variance between the profits of the high and low demand states. The compensation for the increased risk is the greater expected profit for the manufacturer.

Allowing product returns (refunds) increases retail price in the low demand state and reduces sales. The optimal size of the refund is such that the quantity sold in the low demand state is the same under product returns as under manufacturer ownership. Thus, both product returns and manufacturer ownership lead to the same number of units sold, which means that consumer surplus and total channel profit are the same as well. Recall that the total channel profit under manufacturer ownership is less than under retailer ownership without returns when the difference in market size is large (result 3). Thus, although returns can resolve the ownership conflict, they do not lead to the efficient outcome.

5.2 Negotiations

The efficiency criterion suggests that there is a potential outcome when the difference in market size is large under which both the retailer and the manufacturer will be no worse off under retailer ownership than under manufacturer ownership. In other words, there are potential gains from "trade" so negotiation between the manufacturer and the retailer can lead to the first-best outcome of retailer ownership when the difference in market size is large. In this section we investigate whether negotiation can indeed lead to the first-best outcome, how likely that is, and what conditions are necessary to achieve that outcome.

Channel members can negotiate a number of different aspects of their relationship, including the wholesale price and the quantity ordered under each ownership structure. They also can negotiate directly over the ownership structure (this requires direct side payments between channel members).

We show that although negotiating over the terms of the exchange (price and quantity) affects the outcome substantially generally it is not sufficient to resolve the potential conflict over ownership and generate the first-best outcome. In fact, it may introduce new sources of friction over ownership. Negotiation directly over ownership, on the other hand, can, under certain conditions, resolve the ownership conflict and lead to the first-best outcome.

5.2.1 Negotiating over price and quantity

We consider the same model as presented in section 3 except that now the wholesale price and the retailer's order quantity are determined through negotiations. Essentially, we can think of the model in this section as a two-stage game. In the first stage, there is a coordination game in which the manufacturer and the retailer state their ownership preferences. Given an agreed-upon ownership structure, the manufacturer and the retailer move on to negotiate the price and order quantity. If there is no agreement, the manufacturer and the retailer end up with a conflict. Note that in stating their preferences in the first stage the manufacturer and the retailer take into account the expected outcomes of the 2nd stage negotiations.

Negotiations in the second stage can potentially lead to Pareto improvements in expected profits and therefore to changes in the incentive structure in the first stage (the coordination stage). In section 4 we learned that under the Stackelberg set-up a conflict (no coordination) occurs when the difference in market size is large enough. Negotiations on the wholesale price and order quantity do not directly attempt to resolve this conflict but changing the incentive structure in the first stage may (a) reduce the amount of conflict and (b) lead to the first-best outcome of retailer ownership when the difference in market size is large.

To look at those issues, we employ the general Nash bargaining (GNB) solution concept. The GNB solution is a cooperative game approach to bargaining that states that bargaining outcomes are the decisions that maximize the following function of the joint profit of the bargaining parties: $[\pi_m(w,q)-o_m]^\tau[\pi_r(w,q)-o_r]^{1-\tau}$ where π_i ($i \in \{r,m\}$) is the profit of each party, o_i is the outside option of each party (i.e., the profit if they walk away from the negotiation without reaching an agreement), and τ is a parameter bounded between zero and one. Basically, the GNB solution maximizes the weighted product of the parties' profits and τ determines the weight for each party's profit. τ is usually interpreted as a measure of the relative power of each party in the negotiation. Inclusion of the outside option guarantees that the solution is Pareto-improving in the sense that each party receives at least what it could get if it walked out on the negotiation.

In the second stage we have to analyze negotiation over (w, q) under the two ownership structures—retailer and manufacturer. Here we describe the analysis of negotiation under retailer ownership.[10] We define $\prod_i \triangleq \pi_i - o_i$, derive the GNB function with respect to the decision variables (w, q), and obtain the following two first-order conditions: $\tau\Pi_r = (1-\tau)\Pi_m$, and $\tau\Pi_r(w-c)+$

[10] Details of the derivation of negotiation under manufacturer ownership are available in the appendix. Note that for the manufacturer ownership case we get two sets of first-order conditions: one for the high demand state and one for the low demand state. This is because negotiations in this case take place after demand is known.

$(1-\tau)\Pi_m\left[\frac{(\alpha_h-2q)\theta}{\beta\alpha_h}-w\right]=0$. The solutions of this set of first-order conditions are the candidate solutions of the GNB maximization problem.

One challenge is to specify the outside options for the manufacturer and the retailer. A number of intuitive alternatives exist: Given that we saw in 5.1 that the manufacturer can basically impose manufacturer ownership, one natural alternative is to take the profit levels under the take-it or leave-it manufacturer ownership as the relevant outside options. Another is to use the corresponding take-it or leave-it levels under each of the ownership structures from section 4. A third one might be to use the maximum value a player can expect across the ownership structures in section 4.

Bargaining theory is silent about how to choose the outside option. Nor do the marketing or IO literature offer any guidance. Fortunately, it turns out that the conclusion we reach is the same regardless of the outside option chosen.[11] Anticipating the results in section 5.2.2, however, we note that the choice of the outside option has a critical effect on the conclusions. Next to illustrate the approach we present the analysis and the solution for the case when the outside options for the manufacturer and the retailer are zero.[12] Note that there are four cases to analyze; a) retailer assumes ownership and does not sell all units if demand turns low, b) retailer assumes ownership and sells all units if demand turns low, c) manufacturer assumes ownership and does not sell all units if demand turns low and d) manufacturer assumes ownership and sells all units if demand turns low. For case (a), the retailer and manufacturer profit functions are: $\prod_r=\frac{\alpha_l(1-\theta)}{4\beta}+\frac{(\alpha_h-Q)Q\theta}{\alpha_h\beta}-wQ$, and $\prod_m=Q(w-c)$ respectively. The GNB maximizes the joint profit $[Q(w-c)]^{\tau}\left[\frac{\alpha_l(1-\theta)}{4\beta}+\frac{(\alpha_h-Q)Q\theta}{\alpha_h\beta}-wQ\right]^{1-\tau}$. The first order conditions with respect to the order quantity Q and the wholesale price w are $\alpha_h(\tau[a_l(1-\theta)+4Q\theta]-4\beta Q[w-c(1-\tau)])-4Q^2\theta\tau=0$ and $\alpha_h(4Q(\beta w-\theta)-\alpha_l(1-\theta)\tau)+4Q^2\theta(2-\tau)=0$ respectively, which yield the following solution: $Q=\frac{\alpha_h(\theta-\beta c)}{2\theta}$ and $w=\frac{\alpha_l(1-\theta)\theta\tau+\alpha_h(\theta-\beta c)((2-\tau)\beta c+\theta\tau)}{2\alpha_h\beta(\theta-\beta c)}$. Note, that this solution is feasible only when the inventory is positive thus the following condition, $\alpha_l<\frac{\alpha_h(\theta-\beta c)}{\theta}$ should be satisfied. Solutions for the other cases are derived in the same way and the resulting profit functions for all the cases are given in Table 3.

Comparing the firms' profits under either retailer or manufacturer ownership, we can see that in many instances negotiations do not resolve the ownership conflict. For example, for low values of α_l, the manufacturer always prefers that the retailer own the units, while a retailer with low bargaining power (high τ) prefers that the manufacturer own the units. Thus, there is conflict when τ is high. Note, that in this case each of the players prefers not to own the units, which is a type of conflict that we did not observe in the model without negotiations. We find similar results when we analyze other possible choices of the outside options. Thus, we can state the following result:

Result 5 In general, negotiations over the wholesale price and the order quantity do not align the incentives of the manufacturer and retailer and do not resolve the potential conflict between them.

[11] The solution details differ, sometimes substantially. But the conclusion regarding resolution of the conflict is the same.

[12] Details of the solution for other outside option choices are available from the authors.

Table 3 Expected profits with negotiations on (w, q) (outside options equal zero)

	Retailer ownership		Manufacturer ownership	
	$\alpha_l < \frac{\alpha_h(\theta-\beta c)}{\theta}$	$\alpha_l \geq \frac{\alpha_h(\theta-\beta c)}{\theta}$	$\alpha_l < \frac{\alpha_h(\theta-\beta c)}{\theta\tau}$	$\alpha_l \geq \frac{\alpha_h(\theta-\beta c)}{\theta\tau}$
Manufacturer profit	$\frac{(\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2)\tau}{4\beta\theta}$	$\frac{\alpha_h\alpha_l(1-\beta c)^2\tau}{4\beta(\alpha_h(1-\theta)+\alpha_l\theta)}$	$\frac{\alpha_l(1-\theta)\theta\tau^2+\alpha_h(\theta\tau-\beta c)^2}{4\beta\theta\tau}$	$\frac{\alpha_h\alpha_l(\tau-\beta c)^2}{4\beta(\alpha_h(1-\theta)+\alpha_l\theta)\tau}$
Retailer profit	$\frac{(\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2)(1-\tau)}{4\beta\theta}$	$\frac{\alpha_h\alpha_l(1-\beta c)^2(1-\tau)}{4\beta(\alpha_h(1-\theta)+\alpha_l\theta)}$	$\frac{(\alpha_l(1-\theta)\theta\tau^2+\alpha_h\theta\tau^2-\alpha_h\beta^2c^2)(1-\tau)}{4\beta\theta\tau^2}$	$\frac{\alpha_h\alpha_l(\tau^2-\beta^2c^2)(1-\tau)}{4\beta(\alpha_h(1-\theta)+\alpha_l\theta)\tau^2}$

Negotiating over wholesale price and order quantity can lead to improved profits for the manufacturer and the retailer and sometimes can help to resolve some of the potential conflict over ownership. Many times, however, the improvements are not sufficient to align the ownership incentives of channel members and avoid the conflict. In fact, as we wrote earlier, it turns out that the negotiated outcomes introduce new sources of conflict over ownership (for example, with negotiation, conflict arises when both sides prefer not to retain ownership). So negotiating over wholesale price and order quantity is no panacea to the ownership conflict.

To gain some insight into the kind of effects negotiations have on the ownership incentive in Fig. 2 we show the manufacturer's and retailer's ownership preferences as a function of k and τ (for a specific set of parameters and under the assumption that the outside options are the maximum a player can expect over the ownership structures in section 4). The preferences shown in Fig. 2 are typical of the outcomes of negotiations for a wide range of parameters and outside options specifications.

Conflict arises under the take-it-or-leave-it situation if k is smaller than *0.4* (for this particular set of parameters). Comparing the ownership preferences under negotiation as depicted in Fig. 2 to preferences under the take-it-or-leave-it situation, we see that negotiating radically impacts those preferences. The manufacturer in the current situation prefers retailer ownership except when k is low and τ is high, compared to always (weakly) preferring manufacturer ownership without negotia-

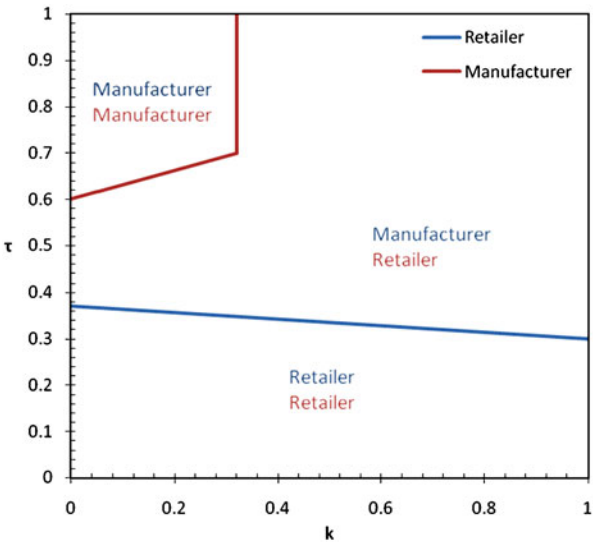

Fig. 2 Ownership preferences with negotiations over wholesale price and order quantity (β=1, c=0.1, θ=0.5)

tions. The retailer prefers to have ownership if τ is low (below about 0.35) even if k is high, compared to only when k is low without negotiations. These changes sometimes succeed in preventing ownership conflict as now there is no conflict when k is low and τ is either high or low. But in other cases the conflict remains, as when k is low and τ is intermediate. In addition, now there is conflict when k and τ are not too low. Note also that the nature of the conflict changes. Without negotiations, conflict arises when both sides want to retain ownership. With negotiations, conflict arises when both sides prefer not to retain ownership. Negotiation changes the ownership incentives but that does not prevent conflict and may in some cases increase its likelihood.

One reason for the failure of negotiation to prevent conflict is that negotiation improves the expected profit under both ownership structures. To align the ownership incentives and reach the first-best outcome, the profit improvement has to be greater under retailer ownership than under manufacturer ownership. There is no reason to expect this to be the case. In fact, it can be argued that there is more room for negotiation to improve profits under the less efficient manufacturer ownership structure.

A second reason is that negotiation tends to reduce the benefits of ownership, leading to conditions in which channel members prefer not to have ownership (as observed in Fig. 2). Because a negotiated outcome is a cooperative one, then except when the power of one party is very low, each party expects its interests to be taken into account (and the more power a party has, the more so) regardless of the prevailing ownership structure. This makes the benefit of ownership much less important and emphasizes the cost of ownership, causing each party to actually prefer the other party to have ownership.

5.2.2 Negotiations over ownership

We now consider a model in which the manufacturer and the retailer negotiate directly over ownership of the units in the channel. In this case, the manufacturer and retailer first decide on the ownership structure and then, given the agreed-upon structure, determine the wholesale price and order quantity. Determination of price and quantity in the second stage can be done using the Stackelberg model from sections 3 and 4 or the negotiation model from section 5.2.1.

Ownership in the model is a discrete variable. Therefore, to make negotiation over ownership meaningful, we have to allow for transfer payments, t, from one party to the other. The negotiation outcome is $\{i,t_i\}$: the ownership locus, $i \in \{r,m\}$, and the associated transfer payment, t_i. In the negotiation, the manufacturer and the retailer take into account their expected profits from the second-stage price and order quantity decisions given the ownership decision. The first stage GNB objective function is $Max_{i,t}(\pi_{mi} + t_i - o_m)^{\tau}(\pi_{ri} - t_i - o_r)^{1-\tau}$ where π_{ji} is expected second-stage profits for the manufacturer (m) and the retailer (r) given the ownership outcome (i) and o_j the respective outside options. Note that π_{ji} is not a function of the transfer payments, t_i. The transfer payments do not improve the joint (channel) profit but only redistribute it. This redistribution can potentially lead to more efficient ownership structure and thereby lead to higher channel profits. For example, it is easy to verify that when the players believe that the outside options are zero, they will always reach an agreement with the most efficient ownership structure. This, however, is not the case when the players' outside options are higher. Consider the case in which the parties are optimistic (the outside options are very attractive). The most (realistic) optimistic outcome is when o_j is the maximum possible profit across all ownership structures: $o_j = \underset{i}{Max}\, \pi_{ji}$. It follows that $\forall i\; \pi_{mi} + \pi_{ri} < o_m + o_r$. Therefore, if the parties are optimistic, there is no possible transfer payment, t_i, that will make the retailer and the manufacturer better off and the negotiation will fail. Thus, for negotiations to succeed and lead to the first-best ownership structure, the parties have to be somewhat pessimistic about their outside options if the negotiation fails.

Result 6 Negotiations over ownership will lead to the first-best outcome if and only if the manufacturer and retailer are sufficiently pessimistic about their outside prospects if negotiations fail.

We are particularly interested in the possibility of retailer ownership (which yields the highest channel profits) when the difference in potential market size is large. One can assume that the firms' beliefs about the outside options take into account different alternatives. Thus, the firms may assign different probabilities for the different scenarios. For examples, they can consider the outside options that are shown in Section 4 and the outside option of zero. Under these conditions, negotiation fails if the retailer strongly believes that it's outside option correspond to the retailer's ownership outcomes of section 4 because there is no possible side payment that will make the manufacturer better-off without making the retailer worse-off. Thus,

Corollary 1: *Negotiations over ownership will lead to the first-best outcome of retailer ownership (when k is low) if and only if the retailer is sufficiently pessimistic about its outside prospect if negotiations fail.*

6 Conclusion

One of the decisions faced in organizing a channel of distribution is assignment of ownership of the inventory of units in the channel. Previous research on this question has concentrated on cost and efficiency considerations related to the physical location of the inventory in the channel. We instead focus on decision rights that ownership provides and suggest that the assignment of these decision rights is another important aspect that firms should consider when determining ownership. The decision rights conferred by ownership can benefit a firm because they provide flexibility in how the firm can respond to changes in market conditions. We show that this flexibility is indeed valuable and may lead firms to seek ownership when the benefits of such flexibility exceed the potential cost of ownership.

We consider the situation of a monopolistic channel consisting of a manufacturer and a retailer that are uncertain *a priori* about demand conditions in the market. We find that the incentives for ownership for the manufacturer and the retailer are such that both prefer to own the units in the channel when there is a large degree of uncertainty regarding market size (the potential difference in market size is large). This can potentially lead to conflict in the channel over ownership.

While we do not purport that our findings completely explain firms' decisions in practice as many other factors are involved, the results do point out the importance of strategic considerations such as the flexibility afforded by ownership. They provide another important explanation for why we observe different arrangements regarding ownership of units in channels and under what conditions those arrangements should be used. They also point to the importance of understanding the nature of demand uncertainty facing the firm and how that is likely to affect the firm's decisions. The choice of whether to own the units depends only on uncertainty regarding market size and not on uncertainty regarding price sensitivity, which affects only the price and not the sale quantity.

The strategic considerations highlighted in the paper can shed light on firms' distribution channel decisions. A *New York Times* article from May 15, 2009, described how Gazprom's long-term contracts for gas with Central Asian countries are saddling it with excess supply just as gas prices are plunging. Anyone reading that article would perceive the signing of those long-term contracts as a mistake. Natural gas markets have experienced a high degree of volatility over the last few years. Our model suggests that it is precisely in this kind of circumstances that it is important for retailers and distributors, with Gazprom acting as a distributor in this particular case, to have ownership over the supply in the channel. Thus, even though the outcome may have been negative, the decision to enter into the long-term contracts was, setting other issues aside, likely the right call.

An important issue that emerges from the results of the basic model is the potential for disagreements over ownership in the channel. We find that one way in which channel conflict regarding ownership can be avoided is for the manufacturer to offer a product return program to the retailer. The return program affects the retailer's decisions to the benefit of the manufacturer to such an extent that the manufacturer no longer cares who owns the units. Thus, conflict is avoided.

This interesting result suggests that a return program may also function as one of the control mechanisms that a manufacturer employs to affect channel structure and organization. Usually, return programs are thought of as a form of insurance for the retailer that enables the manufacturer to convince the retailer to carry more inventory. Interestingly, in this paper the retailer carries the same amount of inventory regardless of the return program. What the return program enables the manufacturer to do is to charge more for the same units. It seems to provide "insurance" more for the manufacturer than the retailer.

Return programs, however, do not lead to the most efficient outcome, which, when uncertainty is high, is the retailer taking ownership without a product return program. One way to achieve the first-best outcome is through direct negotiation of ownership between the manufacturer and the retailer. If side payments from the retailer to the manufacturer are feasible and if the retailer's beliefs about the outcome in case of negotiation failure are pessimistic enough, then negotiations will lead to the first-best outcome.

Negotiations then can lead to the first-best ownership structure. How likely is it that this will be achieved? That is a more difficult question. The answer ultimately depends on how likely the retailer is to be pessimistic about the outcome if negotiations fail. We can state with certainty that negotiation can lead to the first-best outcome but it is not clear how often we should expect to see that outcome in actual situations.

In this paper the focus is on how the firms can achieve an efficient ownership structure. Clearly the most efficient outcome is the one achieved by an integrated channel (see Table 1). From Table 1 we can see that regardless of the ownership structure, the production quantity under the (first-best) integrated solution is double that as under the non-integrated solutions. Hence to achieve the integrated profits it is not enough to coordinate the ownership in the channel. The firms also have to resolve the double marginalization problem. A familiar approach to achieve an integrated outcome in a non-integrated channel is using non-linear pricing (e.g., quantity discount, two-part tariff). Such an approach works under manufacturer ownership, but does not under retailer ownership because when the retailer owns the units, the manufacturer has to set the price schedule before the demand conditions are revealed. Whereas, when the manufacturer owns the units, both the manufacturer and the retailer set the prices (wholesale and retail) after the demand conditions were revealed. Thus, achieving full channel coordination also depends on the ownership structure, which can be an additional explanation for the paucity of non-linear pricing in practice.

The basic tension in our model is between the benefit that ownership confers through greater flexibility in decision-making and the potential cost of ownership in the form of overstocks and inventory risks. Thus, our model is suited for situations in which direct variable costs are substantial, making the potential cost of ownership large. This is true for products such as cars, durable consumer goods, clothes, and toys. On the other hand, the model does not effectively capture situations in which direct variable costs are relatively small or even nonexistent, as is the case for wholly digital products. In those situations, the cost of overstock is very low and, therefore, issues associated with making the production decision before demand is known are not as important.

We assume in the model that there is only one production run that takes place before the firms learn about demand. This corresponds well to situations in which replenishment orders cannot be fulfilled during the selling season (see, for example, Fisher et al. (1994) and Moon (2002)) but it is clearly a simplification of situations in which firms can place replenishment orders. The ability to have an additional production run in response to actual demand may affect ownership choices and other decisions, such as the initial quantity ordered by the retailer. Multiple production runs also may lead to situations in which the manufacturer and the retailer simultaneously own some of the units. For example, the manufacturer may, in such situations, try to limit the number of units the retailer can order before the uncertainty is resolved. In this paper, we conceptualize ownership of the units in the channel as a simple either/or construct.

In the model the manufacturer and retailer have the same information about demand. In many cases one party may possess better information. In such asymmetric information cases, besides the strategic considerations that affect ownership, one must also consider the effect that less accurate information may have on the decisions taken in the channel. Our analysis shows that as long as the information of the retailer is not significantly better than the manufacturer's the strategic considerations described in this paper dominate. If the retailer has much better information, however, both the retailer and manufacturer prefer the retailer to own the units since it can make better informed decisions.[13]

Our model uses the common assumption that firms are risk-neutral (or at least that they should be risk-neutral). It is interesting to consider how different risk attitudes might affect the results. *Ex ante*, for the manufacturer (retailer), the difference in profit between the two demand states varies more when the manufacturer (retailer) owns the units. Thus, risk-aversion tends to reduce the expected benefit of ownership. As a consequence, one would not expect there to be a region of indifference regarding ownership if firms are risk-averse. Instead, in that case, both firms would prefer not to own the units (the cooperative nature of negotiation also leads to a similar effect). In addition, greater benefit from ownership for the firm will be required for the firm to prefer to own the units. Thus the regions in which the manufacturer and retailer both want to own the units will be at higher levels of uncertainty in the risk-averse case than in the risk-neutral case (the critical threshold k will be lower).[14] Another effect is that risk averse manufacturers find return programs less appealing thus limiting the use they can make of them to coordinate the channel. A full analysis of the effect of risk attitude is beyond the scope of the paper; nonetheless, it appears that risk-aversion, while weakening the results somewhat, does not affect the overall structure of the findings.

These issues require additional follow-up research. This paper provides the beginnings of an understanding of the implications of ownership for the channel and of the effects of the presence of lead time and demand uncertainty on decision-making by channel members.

Appendix

Market size is high (α_h) with probability θ or low (α_l) with probability ($1-\theta$). There are two cases. We start with the case where the manufacturer owns the units and continue with the case where the retailer owns the units.

Manufacturer owns the units

In this section, we analyze the case where the manufacturer makes the production decision before, and the wholesale pricing decision after, uncertainties are revolved. Note that when demand is high the firm sells all units. This is because at the time of the pricing decision, the production costs are sunk. Therefore, it is always optimal for the manufacturer to sell all units. Obviously, the optimal production quantity will never be higher than the number of units sold in the high demand state. This is not the case in the low demand case, where the manufacturer can choose not to sell all units.

[13] Details of the analysis are available from the authors.
[14] The effects for a risk-seeking firm are the opposite of those for the risk-averse firm.

Subcase A (inventory constraint is not binding) To find the subgame perfect equilibrium, we solve this game backward, starting with the retailer's pricing decision (in this stage, demand is already revealed).

The retailer's profit function is $\pi_R = (p - w)q$, where q is given by the demand function $q = \alpha(1 - \beta p)$. Solving the retailer's first-order condition, we find the optimal retail price, $p_i = \frac{1+\beta w_i}{2\beta}$, where $i=(h, l)$. Note that the optimal selling quantity is $Q_i = \frac{\alpha_i(1-\beta w_i)}{2}$.

Next, we find the manufacturer wholesale price (demand is already revealed). It is obvious that, if market size is high, the manufacturer sets the wholesale price such that it can sell all units, Q, $w_h = \frac{\alpha_h - 2Q}{\beta\alpha_h}$. In this case, the manufacturer's profits are $\pi_M^h = Q\frac{\alpha_h - 2Q}{\beta\alpha_h}$. If market size is low, the manufacturer profit function is $\pi_M^l = w_l Q_l$.

Solving the manufacturer's first-order condition given the assumption that the inventory constraint is not binding, we find that the optimal wholesale price (for low market size) is $w_l = \frac{1}{2\beta}$. The manufacturer's profits when market size is low are $\pi_M^l = \frac{\alpha_l}{8\beta}$.

Finally, we find the manufacturer production level. The production decision is made before demand is revealed. Thus, the manufacturer's expected profits in this stage are $E[\prod_M] = \theta\pi_M^h + (1-\theta)\pi_M^l - cQ$. Solving the first-order condition, we find that $Q = \frac{\alpha_h(\theta - c\beta)}{4\theta}$. Note, we find that $q_1 = \frac{\alpha_l}{4}$. It is easy to verify that, when market size is low, the manufacturer does not sell $\frac{1}{4}\left[\alpha_h\left[1 - \frac{\beta c}{\theta}\right] - \alpha_l\right]$ units. Therefore, the manufacturer follows Subcase A (inventory constraint is not binding) when $\alpha_l \leq \alpha_h\left[1 - \frac{\beta c}{\theta}\right]$ and Subcase B (inventory constraint is binding) when $\alpha_l > \alpha_h\left[1 - \frac{\beta c}{\theta}\right]$.

Subcase B (inventory constraint is binding) To find the subgame perfect equilibrium, we solve this game backward, starting with the retailer's pricing decision (in this stage, demand is already known). The analysis of the retailer's decisions is the same as in Subcase A. Therefore, we start with the analysis of the manufacturer's wholesale decision.

In this subcase, the inventory constraint is binding in all demand states. Therefore, the wholesale price is $w_i = \frac{\alpha_i - 2Q}{\beta\alpha_i}$ $i = (h, l)$ and the manufacturer revenues are $\pi_M^i = Q\frac{\alpha_i - 2Q}{\beta\alpha_i}$.

Finally, we find the manufacturer production level. The production decision is made before demand is realized. Thus, the manufacturer's expected profits in this stage are $E[\prod_M] = \theta\pi_M^h + (1-\theta)\pi_M^l - cQ$. Solving the first-order condition, we find that $Q = \frac{\alpha_h\alpha_l(1-c\beta)}{4[\theta\alpha_l + \alpha_h(1-\theta)]}$.

Retailer Owns the Units

In this section, we analyze the case where the retailer makes the ordering decision before, and the retail pricing decision after, uncertainties are revolved. Note that when demand is high the retailer sells all units. This is because at the time of the pricing decision, the wholesale costs are sunk. Therefore, it is always optimal for the retailer to sell all units. Obviously, the optimal ordering quantity will never be higher than the number of units sold in the high demand state. This is not the case in the low demand state, where the retailer can choose not to sell all units.

Subcase A (inventory constraint is not binding) To find the subgame perfect equilibrium, we solve this game backward, starting with the retailer's pricing decision (in this stage, demand is already revealed).

The retailer's profit function in this stage is π_R=$pq,$ where q is given by the demand function $q = \alpha(1 - \beta p)$. Solving the retailer's first-order condition, we find the optimal retail price is $p_l = \frac{1}{2\beta}$, when market size is low and $p_h = \frac{\alpha_h - Q}{\alpha_h \beta}$, when market size is high. The corresponding profits are $\pi_R^l = \frac{\alpha_l}{4\beta}$ and $\pi_R^h = \frac{Q(\alpha_h - Q)}{\alpha_h \beta}$.

Next, we analyze the retailer ordering decision, which is made before demand is revealed. Thus, the retailer has to maximize the following expected profit function: $E[\prod_R] = \theta\pi_R^h + (1-\theta)\pi_R^l - wQ$. The first-order condition yields $Q = \frac{\alpha_h(\theta - w\beta)}{2\theta}$.

Finally, we analyze the manufacturer wholesale-pricing decision. The manufacturer makes its decision when demand is still unknown. Therefore, the manufacturer maximizes the following profit function: $\prod_M = (w-c)Q$. This optimization problem yields $w = \frac{c\beta + \theta}{2\beta}$ Note, we find that $q_1 = \frac{\alpha_l}{2}$. It is easy to verify that, when market size is low, the retailer does not sell $\frac{1}{4}\left[\alpha_h\left[1 - \frac{\beta c}{\theta}\right] - 2\alpha_l\right]$ units. therefore, the retailer follows Subcase A (inventory constraint is not binding) when $\alpha_l \leq \frac{\alpha_h}{2}\left[1 - \frac{\beta c}{\theta}\right]$ and Subcase B (inventory constraint in binding) when $\alpha_l > \frac{\alpha_h}{2}\left[1 - \frac{\beta c}{\theta}\right]$.

Subcase B (inventory constraint is binding) To find the subgame perfect equilibrium, we solve this game backward, starting with the retailer's pricing decision (in this stage, demand is already known).

In this case, the inventory constraint is binding in both demand states. Thus, the optimal retail price is $p_i = \frac{\alpha_i - Q}{\alpha_i \beta}$ $i = (h,\ l)$ and the retailer revenues are $\pi_R^i = Q\frac{\alpha_i - Q}{\alpha_i \beta}$.

Next, we analyze the retailer's ordering decision, which is made before demand is revealed. Thus, the retailer has to maximize the following expected profit function: $E[\prod_R] = \theta\pi_R^h + (1-\theta)\pi_R^l - wQ$. The first-order condition yields $Q = \frac{\alpha_h \alpha_l(1 - w\beta)}{2[\theta\alpha_l + \alpha_h(1-\theta)]}$.
Finally, we analyze the manufacturer's wholesale pricing decision. The manufacturer maximizes the following profit function: $\prod_M = (w-c)Q$. This optimization problem yields $w = \frac{c\beta + 1}{2\beta}$.

No lead-time

In this section, we analyze the case where there is no lead-time in the channel. In this case, production takes place after demand uncertainty is resolved, and both wholesale and retail prices are set after demand is known. Note that since in this case all decisions are made after uncertainty is resolved, ownership does not matter as the firms order the exact quantity that they plan to sell.

To find the subgame perfect equilibrium, we solve this game backward, starting with the retailer's pricing decision (in this stage, demand is already known). At this stage the retailer has to maximize the following profit function: $\prod_R = \alpha_i(1 - \beta\, p_i)(p_i - w_i)$, with respect to the retail price p_i. The solution for the first order condition yields $p_i = \frac{1 + \beta w_i}{2\beta}$. This reflects sales of $Q_i = \alpha_i\left[1 - \frac{1 + \beta w_i}{2}\right]$ which is exactly the quantity that the retailer orders from the manufacturer. Next, we analyze the manufacturer wholesale price decisions. At this stage the manufacturer has to maximize the following profit function: $\prod_M = (w_i - c)Q_i = (w_i - c)\alpha_i\left[1 - \frac{1 + \beta w_i}{2}\right]$ with respect to the wholesale price w_i. The first order condition yields $w_i = \frac{1+\beta c}{2\beta}$. Thus, the optimal retail price is $p_i = \frac{3+\beta c}{4\beta}$ and the optimal selling/ordering quantity is $Q_i = \alpha_i \frac{1-\beta c}{4}$.

Coordinated channel

In this section, we analyze the coordinated case where a single decision maker (firm) makes both production and selling decisions. The firm makes the production decision before, and the retail pricing decision after, uncertainties are revolved. Note that when demand is high the firm sells all units. This is because at the time of the pricing decision, the production costs are sunk. Therefore, it is always optimal for the firm to sell all units. Obviously, the optimal production quantity will never be higher than the number of units sold in the high demand state. This is not the case in the low demand state, where the firm can choose not to sell all units.

Subcase A (inventory constraint is not binding) To find the subgame perfect equilibrium, we solve this game backward, starting with the firm's pricing decision (in this stage, demand is already revealed).

The firm's profit function in this stage is $\pi_I = pq$, where q is given by the demand function $q = \alpha(1 - \beta p)$. Solving the firm's first-order condition, we find the optimal retail price $p_l = \frac{1}{2\beta}$, when market size is low and $p_h = \frac{\alpha_h - Q}{\alpha_h \beta}$, when market size is high. The corresponding profits are $\pi_I^l = \frac{\alpha_l}{4\beta}$ and $\pi_I^h = \frac{Q(\alpha - Q)}{\alpha_h \beta}$.

Next, we analyze the firm's production decision, which is made before demand is revealed. Thus, the firm has to maximize the following expected profit function: $E[\prod_I] = \theta\pi_I^h + (1-\theta)\pi_I^l - cQ$. The first-order conditions yields $Q = \frac{\alpha_h(\theta - c\beta)}{2\theta}$. Note, we find that $q_1 = \frac{\alpha_l}{2}$. It is easy to verify that, when market size is low, the retailer does not sell $\frac{1}{2}\left[\alpha_h\left[1 - \frac{\beta c}{\theta}\right] - \alpha_l\right]$ units. therefore, the firm follows Subcase A (inventory constraint is not binding) when $\alpha_l \leq \alpha_h\left[1 - \frac{\beta c}{\theta}\right]$ and Subcase B (inventory constraint is binding) when $\alpha_l > \alpha_h\left[1 - \frac{\beta c}{\alpha}\right]$.

Subcase B (inventory constraint is binding) To find the subgame perfect equilibrium, we solve this game backward, starting with the firm's pricing decision (in this stage, demand is already known).

In this case, the inventory constraint is binding in both demand states. Thus, the optimal retail price is $p_i = \frac{\alpha_i - Q}{\alpha_i \beta}$ $i = (h, l)$ and the firm revenues are $\pi_I^i = Q\frac{\alpha_i - Q}{\alpha_i \beta}$.

Next, we analyze the firm's production decision, which is made before demand is revealed. Thus, the firm has to maximize the following expected profit function: $E\left[\prod_R\right] = \theta\pi_R^h + (1-\theta)\pi_R^l - cQ$. The first-order condition yields $Q = \frac{\alpha_h \alpha_l (1 - c\beta)}{2[\theta\alpha_l + \alpha_h(1-\theta)]}$.

Proof of Result 1

When $\frac{\alpha_l}{\alpha h} < \frac{k}{2}$: From 8.1. subcase A (manufacturer owns the units), the manufacturer's expected profits are given by $E[\prod_M] = \frac{\alpha_l(1-\theta)\theta + \alpha_h(\theta - \beta c)^2}{8\theta\beta}$, and from 8.2. subcase A (retailer owns the units), the manufacturer's profits are given by $\prod_M = \frac{\alpha_h(\theta - \beta c)^2}{8\beta\theta}$.

When we compare the manufacturer's profits, we get $E[\prod_M] - \prod_M = \frac{\alpha_l(1-\theta)}{8\beta} > 0$. Thus, the manufacturer is better off when it owns the units.

When $\frac{k}{2} < \frac{\alpha_l}{\alpha_h} < k$: From 8.1 subcase A (manufacturer owns the units), the manufacturer's expected profits are given by $E[\prod_M] = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{8\beta\theta}$, and from 8.2 subcase B (retailer owns the units), the manufacturer's profits are given by $\prod_M = \frac{\alpha_l\alpha_h(1-\beta c)^2}{8\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$. When we compare the manufacturer's profits, we get $E[\prod_M] - \prod_M = \frac{(1-\theta)[\alpha_h\beta c-\theta(\alpha_h-\alpha_l)]^2}{8\theta[\alpha_h(1-\theta)+\alpha_l\theta]\beta} > 0$. Therefore, the manufacturer is better off when the manufacturer owns the units.

When $k < \frac{\alpha_l}{\alpha_h}$: From 8.1 subcase B (manufacturer owns the units), the manufacturer's expected profits are given by $E[\prod_M] = \frac{\alpha_l\alpha_h(1-\beta c)^2}{8\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$, and from 8.2 subcase B (retailer owns the units), the manufacturer's profits are given by $\prod_M = \frac{\alpha_l\alpha_h(1-\beta c)^2}{8\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$. It is obvious that the expected profits of the manufacturer are equal in both cases.

Proof of Result 2

When $\frac{\alpha_l}{\alpha_h} < \frac{k}{2}$: From 8.1. subcase A (manufacturer owns the units), the retailer's profits are given by $\pi_R = \frac{4\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$, and from 8.2. subcase A (retailer owns the units), the retailer's expected profits are given by $E[\pi_R] = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$.

When we compare the retailer's profits, we get $E[\pi_R] - \pi_R = \frac{3\alpha_l(1-\theta)}{16\beta} > 0$. Thus, the retailer is better off when it owns the units.

When $\frac{k}{2} < \frac{\alpha_l}{\alpha_h} < k$: From 8.1. subcase A (manufacturer owns the units), the retailer's profits are given by $\pi_R = \frac{4\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$, and from 8.2. subcase B (retailer owns the units), the retailer's expected profits are given by $E[\pi_R] = \frac{\alpha_l\alpha_h(1-\beta c)^2}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$.

When we compare the retailer's profits, we get $\pi_R - E[\pi_R] = \frac{(1-\theta)[\alpha_h\beta c-\theta(\alpha_h-\alpha_l)]^2}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]} > 0$. Therefore, the retailer is better off when the manufacturer owns the units.

When $k < \frac{\alpha_l}{\alpha_h}$: From 8.1. subcase B (manufacturer owns the units), the retailer's profits are given by $\pi_R = \frac{\alpha_l\alpha_h(1-\beta c)^2}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$, and from 8.2 subcase B (retailer owns the units), the retailer's expected profits are given by $E[\pi_R] = \frac{\alpha_l\alpha_h(1-\beta c)^2}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]} = \pi_R$. It is obvious that the expected profits of the retailer are equal in both cases.

Proof of Result 3

When $\frac{\alpha_l}{\alpha_h} < \frac{k}{2}$: Total channel profits when the manufacturer owns the units are $\prod_{M1} = \frac{3[\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2]}{16\beta\theta}$. Total channel profits when the retailer owns the units are $\pi_{R1} = \frac{4\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$. When we compare the two profits, we get $\pi_{R1} - \prod_{M1} = \frac{\alpha_l(1-\theta)\theta}{16\beta} > 0$ Thus, the channel is better off when the retailer owns the units.

When $\frac{k}{2} < \frac{\alpha_l}{\alpha_h} < k$: As we have shown in 1A and 1B, both the retailer and the manufacturer are better off when the manufacturer owns the units and $\frac{k}{2} < \frac{\alpha_l}{\alpha_h} < k$; thus, obviously, total channel profits when $\frac{k}{2} < \frac{\alpha_l}{\alpha_h} < k$ are higher when the manufacturer owns the units.

When $k < \frac{\alpha_l}{\alpha_h}$: As we have shown in 1A and 1B, both the retailer and the manufacturer are indifferent regarding who should own the units when $k < \frac{\alpha_l}{\alpha_h}$; thus ,obviously, total channel profits when $k < \frac{\alpha_l}{\alpha_h}$ are the same under these two scenarios.

Proof of Result 4

Retailer can Return Units to the Manufacturer In this section, we analyze the case where the retailer makes the ordering decision before, and the retail pricing decision after, uncertainties are revolved. Note that when demand is high the retailer sells all units. However, when demand turns out to be low demand state, where the retailer can choose not to sell all units and can return the unsold units to the manufacturer for a refund of r per unit.

Inventory constraint is not binding To find the subgame perfect equilibrium, we solve this game backward, starting with the retailer's pricing decision (in this stage, demand is already revealed).

The retailer's profit function in this stage is $\pi_R = pq + r(Q - q)$, where q is given by the demand function $q = \alpha(1 - \beta p)$. Using the retailer's first-order condition, we find the optimal retail price is $p_l = \frac{1+\beta r}{2\beta}$, when market size is low and $p_h = \frac{\alpha_h - Q}{\alpha_h \beta}$, when market size is high. The corresponding profits are $\pi_R^l = \frac{\alpha_l(1-\beta r)^2 + 4\beta r Q}{4\beta}$ and $\pi_R^h = \frac{Q(\alpha_h - Q)}{\alpha_h \beta}$.

Next, we analyze the retailer ordering decision, which is made before demand is revealed. Thus, the retailer has to maximize the following expected profit function: $E[\prod_R] = \theta\pi_R^h + (1-\theta)\pi_R^l - wQ$. The first-order condition yields $Q = \frac{\alpha_h[\beta[r(1-\theta) - w] + \theta]}{2\theta}$.

Finally, we analyze the manufacturer wholesale-pricing and retail-pricing decisions. The manufacturer makes its decision when demand is still unknown. Therefore, the manufacturer maximizes the following profit function: $\prod_M = (w - c)Q - r(q - q_1)(1 - \theta)$. This optimization problem yields $w = \frac{1+c\beta}{2\beta}$ and $r = \frac{1}{2\beta}$. Note, we find that $\mathrm{q}_1 = \frac{\alpha_l}{4}$. It is easy to verify that, when market size is low, the retailer returns (unsold units) $\frac{1}{4}\left[\alpha_h\left[1 - \frac{\beta c}{\theta}\right] - \alpha_l\right]$ units. Therefore, the retailer follows Subcase A (inventory constraint is not binding) when $\alpha_l \le \alpha_h\left[1 - \frac{\beta c}{\theta}\right]$ and Subcase B (inventory constraint is binding) when $\alpha_l > \alpha_h\left[1 - \frac{\beta c}{\theta}\right]$. When they apply products' return the manufacturer's and the retailer's profits are $\prod_M = \frac{\alpha_h(\theta-\beta c)^2 - \alpha_l\theta(1-\theta)}{8\beta\theta}$ and $\prod_M = \frac{\alpha_h(\theta-\beta c)^2 - \alpha_l\theta(1-\theta)}{16\beta\theta}$ respectively which are identical to the manufacturer's and the retailer's profits under manufacturer's ownership without product returns.

Proof of Result 5

The manufacturer and the retailer negotiate over wholesale price and order quantity In this section, we analyze the case where the wholesale price and retailer's order quantity are determined through negotiation between the manufacturer and the retailer.

The outside option, o_i ($i{=}r$ for the retailer or $i{=}m$ for the manufacturer) is the maximum value a player can get from all other ownership structures. In order to find the subgame perfect equilibrium of this game we start with solving the second stage. In this stage we have to consider seven different options:

Option 1: For values of $\frac{\alpha_l}{\alpha_h} \le \frac{\theta-\beta c}{2\theta}$, the retailer owns units and does not sell all units when market size is small. The maximum outside options for the retailer and the manufacturer are $o_r = \frac{4\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$, and $o_m = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{8\beta\theta}$ respectively.

Option 2: For values of $\frac{\theta-\beta c}{2\theta} \le \frac{\alpha_l}{\alpha_h} \le \frac{\theta-\beta c}{\theta}$, the retailer owns units and does not sell all units when market size is small. The maximum outside options for the retailer and the manufacturer are $o_r = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$, and $o_m = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{8\beta\theta}$ respectively.

Option 3: For values of $\frac{\theta-\beta c}{2\theta} \le \frac{\alpha_l}{\alpha_h} \le \frac{\theta-\beta c}{\theta}$ the retailer owns units and sells all units when market size is small (and large). The maximum outside options for the retailer and the manufacturer are $o_r = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$, and $o_m = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{8\beta\theta}$ respectively.

Option 4: For values of $\frac{\theta-\beta c}{\theta} \le \frac{\alpha_l}{\alpha_h}$, the retailer owns units and sells all units when market size is small (and large). The maximum outside options for the retailer and the manufacturer are $o_r = \frac{\alpha_l\alpha_h(1-\beta c)^2}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$, and $o_m = \frac{\alpha_l\alpha_h(1-\beta c)^2}{8\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$ respectively.

Option 5: For values of $\frac{\alpha_l}{\alpha_h} \le \frac{\theta-\beta c}{2\theta}$, the manufacturer owns units and does not sell all units when market size is small (and large). The maximum outside options for the retailer and the manufacturer are $o_r = \frac{4\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$, and $o_m = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{8\beta\theta}$ respectively.

Option 6: For values of $\frac{\theta-\beta c}{2\theta} \le \frac{\alpha_l}{\alpha_h} \le \frac{\theta-\beta c}{\theta}$, the manufacturer owns units and does not sell all units when market size is small (and large). The maximum outside options for the retailer and the manufacturer are $o_r = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$, and $o_m = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{8\beta\theta}$ respectively.

Option 8: For values of $\frac{\theta-\beta c}{\theta} \le \frac{\alpha_l}{\alpha_h}$, the manufacturer owns units and sells all units when market size is small (and large). The maximum outside options for the retailer and the manufacturer are $o_r = \frac{\alpha_l\alpha_h(1-\beta c)^2}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$, and $o_m = \frac{\alpha_l\alpha_h(1-\beta c)^2}{8\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$ respectively.

Analysis of Option 1 In order to find the subgame perfect equilibrium we solve the game backward starting in stage 2—the retailer selling decision (after uncertainty has resolved).

If market size turns high (with probability θ) the demand function is $q_h = \alpha_h(1-\beta p_h)$ and the profits are $\pi_{rh}=p_h Q$ (where $Q=q_h$, is the ordering quantity). The retailer optimal policy is to sell all units and thus the optimal retail price is $p_h = (\alpha_h - Q)/(\alpha_h\beta)$.

If market size turns low (with probability (1-θ)) the demand function is $q_l = a_l(1-\beta p_l)$.

Thus the inverse demand function is $p_l = (\alpha_l - q_l)/(\alpha_l\beta)$ the profits are $\pi_{rl} = p_l q_l = q_l(\alpha_l - q_l)/(\alpha_l\beta)$. The retailer optimal policy is to sell (q_l) units and scrap the unsold units (Q- q_l). We first order condition of the profits function with respect to the selling quantity (q_l) yields; $q_l=\alpha_l/2$.

Next we solve stage 1 (before uncertainty is resolved). In this stage the manufacturer and the retailer bargain the ordering (Q) and wholesale price (w) decisions. In this case the retailer outside option is $o_r = \frac{4\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{16\beta\theta}$, and the manufacturer outside option is $o_m = \frac{\alpha_l(1-\theta)\theta+\alpha_h(\theta-\beta c)^2}{8\beta\theta}$. We follow the General-Nash-Bargaining concept and maximizing the joint profits of the parties $Z_1 =$

$[\prod_m(w,q)-o_m]^{\tau}*[\prod_r(w,q)-o_r]^{1-\tau}$ where $\prod_r = -wQ+\theta\pi_{rh}+(1-\theta)\pi_{rl}$, and $\prod_m=(w-c)Q$. The first order condition of Z_1 with respect to w and Q yields the following set of two equations: $\frac{\partial Z_1}{\partial Q} = \tau\left[\frac{[\prod_m(w,q)-o_m]}{[\prod_r(w,q)-o_r]}\right]^{\tau-1}(w-c)+\left[\frac{[\prod_m(w,q)-o_m]}{[\prod_r(w,q)-o_r]}\right]^{\tau}(1-\tau)\left[\frac{(\alpha_h-2Q)\theta}{2\alpha_h\beta}-w\right]=0$, and $\frac{\partial Z_1}{\partial w}=\tau\left[\frac{[\prod_m(w,q)-o_m]}{[\prod_r(w,q)-o_r]}\right]^{\tau-1}Q+\left[\frac{[\prod_m(w,q)-o_m]}{[\prod_r(w,q)-o_r]}\right]^{\tau}(1-\tau)Q=0$. Solving these two equations yields: 1. $Q=0$, 2. $\tau[\prod_r(w,q)-o_r]+(1-\tau)[\prod_m(w,q)-o_m]=0$ and 3. $\tau[\prod_r(w,q)-o_r](w-c)+(1-\tau)[\prod_m(w,q)-o_m]\left(\frac{(\alpha_h-2Q)\theta}{2\alpha_h\beta}-w\right)=0$ Solving #2 and #3 simultaneously yields two sets of equations:

a) $$w_1=\frac{2\alpha_l(1-\theta)\theta(1-\tau)+\alpha_h(\theta-\beta c)[\beta c(6-\tau)+\theta(2+\tau)]}{8\alpha_h\beta(\theta-\beta c)},\ Q=\frac{\alpha_h(\theta-\beta c)}{2\theta},\text{ and}$$

$$\prod_{1r}^{\alpha}=\frac{\alpha_h(\theta-\beta c)^2(2-\tau)+2\alpha_l(1-\theta)\theta(1+\tau)}{16\beta\theta},\text{ and}$$

$$\prod_{1m}^{\alpha}=\frac{\alpha_h(\theta-\beta c)^2(2+\tau)+2\alpha_l(1-\theta)\theta(1-\tau)}{16\beta\theta}\text{ and}$$

b) $$w_1=\frac{2(\alpha_h)^2\theta(\theta-\beta c)^2(\theta+2\beta c)+\alpha_l(1-\theta)\theta Y+\alpha_h[2\alpha_l(1-\theta)\theta^2(\theta+\beta c)+(\theta+\beta c)^2Y]}{[2\alpha_h\beta\theta[2\alpha_l(1-\theta)\theta+3\alpha_h(\theta-\beta c)^2]]}$$

$$Q=\frac{2\alpha_h\theta(\theta-\beta c)+Y}{4\theta^2},\text{ and }\prod_r^b=\frac{\alpha_h(\theta-\beta c)^2(2-\tau)+4\alpha_l(1-\theta)\theta}{16\beta\theta},\text{ and}$$

$$\prod_{1m}^{b}=\frac{\alpha_h(\theta-\beta c)^2+\alpha_l(1-\theta)\theta}{8\beta\theta}\text{ where }Y=\sqrt{\alpha_h\theta^2[2\alpha_l\theta(1-\theta)+\alpha_h(\theta-\beta c)^2]}$$

Comparing the two options we can find that $\prod_{1r}^a-\prod_{1r}^b=\frac{\left[\alpha_h(\theta-\beta c)^2-2\alpha_l(1-\theta)\theta\right](1-\tau)}{16\beta\theta}$, and $\prod_{1m}^a-\prod_{1m}^b=\frac{\left[\alpha_h(\theta-\beta c)^2-2\alpha_l(1-\theta)\theta\right]\tau}{16\beta\theta}$. Thus $\prod_{1r}^a>\prod_{1r}^b$ and $\prod_{1m}^a>\prod_{1m}^b$ if $\frac{\alpha_l}{\alpha_h}\le\frac{(\theta-\beta c)^2}{2(1-\theta)\theta}$. Note that that Option 1 is considered under values of $\frac{\alpha_l}{\alpha_h}\le\frac{\theta-\beta c}{2\theta}$ and that $\frac{\alpha_l}{\alpha_h}\le\frac{(\theta-\beta c)^2}{2(1-\theta)\theta}=\frac{(\theta-\beta c)}{2\theta}\frac{(\theta-\beta c)}{(1-\theta)}$. Also note that $\frac{(\theta-\beta c)}{(1-\theta)}$ implies $c<\frac{2\theta-1}{\beta}=\frac{\theta}{\beta}-\frac{1-\theta}{\beta}<\frac{\theta}{\beta}$ and thus for values of $\frac{\alpha_l}{\alpha_h}\le\frac{(\theta-\beta c)^2}{2(1-\theta)\theta}=\frac{(\theta-\beta c)}{2\theta}\frac{(\theta-\beta c)}{(1-\theta)}\le\frac{(\theta-\beta c)}{2\theta}\to\prod_{1r}=\prod_{1r}^a=\frac{\alpha_h(\theta-\beta c)^2(2-\tau)+2\alpha_l(1-\theta)\theta(1+\tau)}{16\beta\theta}$, and $\prod_{1m}=\prod_{1m}^a=\frac{\alpha_h(\theta-\beta c)^2(2+\tau)+2\alpha_l(1-\theta)\theta(1+\tau)}{16\beta\theta}$ are optimal.

The profits of the other cases are given below[15] $\prod_{2r}=\frac{\alpha_h[\theta-\beta c]^2+\alpha_l(1-\theta)\theta(2-\tau)}{16\beta\theta}$, and $\prod_{2m}=\frac{[\alpha_h(\theta-\beta c)^2+\alpha_l(1-\theta)\theta](2+\tau)}{16\beta\theta}$, $\prod_{3r}=\frac{1}{16\beta\theta[\alpha_h(1-\theta)+\alpha_l\theta]}$

$$\left[\begin{array}{l}\alpha_l^2(1-\theta)\theta^2(2-3\tau)+\alpha_h^2(1-\theta)(2-3\tau)(\theta-\beta c)^2+\\ \alpha_h\alpha_l\theta[-2+(\theta^2-\theta)(4-6\tau)-(\beta c)^2(2-\tau)+\tau+\beta c[4-4\tau-\theta(2-3\tau)]]\end{array}\right]\text{ and}$$

$$\prod_{3m}=\frac{1}{16\beta\theta[\alpha_h(1-\theta)+\alpha_l\theta]}\left[\begin{array}{l}\alpha_l^2(1-\theta)\theta^2(2-3\tau)+\alpha_h^2(1-\theta)(2-3\tau)(\theta-\beta c)^2+\\ \alpha_h\alpha_l\theta[-2+(\theta^2-\theta)(4-6\tau)-(\beta c)^2(2-\tau)+\tau+\beta c[-4\tau-\theta(2-3\tau)]]\end{array}\right]$$

[15] The detailed solutions of options 2–6 can be retrieved from the authors by request.

$\prod_{4r} = \frac{\alpha_h\alpha_l(1-\beta c)^2(2-\tau)}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$ and $\prod_{4m} = \frac{\alpha_h\alpha_l(1-\beta c)^2(2-\tau)}{16\beta[\alpha_h(1-\theta)+\alpha_l\theta]}$,

$\prod_{5r} = \frac{2\alpha_l\theta\tau^2(1-\theta)(1-\tau)+\alpha_h[(\theta\tau)^2(2-\tau)+2\beta c\theta\tau^2(2-3\tau)-(\beta c)^2[4-4\tau+\tau^2(2-3\tau)]]}{16\beta\theta\tau^2}$ and

$\prod_{5m} = \frac{2\alpha_l\theta\tau(1-\theta)(1-\tau)+\alpha_h[\theta^2\tau(2+\tau)-6\beta c\theta\tau(2-\tau)+(\beta c)^2(4+2\tau-3\tau^2)]}{16\beta\theta\tau^2}$ and

$\prod_{6r} = \frac{\alpha_l\theta\tau^2(1-\theta)(2-\tau)+\alpha_h[(\theta\tau)^2(2-\tau)+2\beta c\theta\tau^2(2-3\tau)-(\beta c)^2[4-4\tau+\tau^2(2-3\tau)]}{16\beta\theta\tau^2}$

$\prod_{6m} = \frac{\alpha_l\theta\tau(1-\theta)(2+\tau)+\alpha_h[\theta^2\tau(2+\tau)-6\beta c\theta\tau(2-\tau)+(\beta c)^2(4+2\tau-3\tau^2)]}{16\beta\theta\tau}$,

$\prod_{7m} = \frac{\alpha_h\alpha_l[-6\beta c\tau(\tau-2)-\tau(2+\tau)(\beta c)^2[4+\tau[-4+\tau(2-3\tau)]]]}{-16\beta\tau[\alpha_h(1-\theta)+\alpha_l\theta]}$,

$\prod_{7r} = \frac{\alpha_h\alpha_l[-\tau^2(\tau-2)-2\beta c\tau^2(-2+3\tau)+(\beta c)^2[4+\tau[-4+\tau(2-3\tau)]]]}{-16\beta\tau^2[\alpha_h(1-\theta)+\alpha_l\theta]}$.

To prove result 5 we compare the profits under retailer ownership to manufacturer ownership and demonstrate that in many cases retailer profits are larger under a different ownership arrangement than manufacturer ownership.

For example, comparing the retailer profits under options 1 and 5 we get $\prod_{1r} - \prod_{5r} = (1-\tau)\left[\begin{array}{l}(\alpha_l)^2(\theta-1)(\theta\tau)^2+(\alpha_h)^2(\theta-1)(\theta-\beta c)^2\tau^2+\\ \alpha_l\alpha_h\theta[2\beta c\theta\tau^2+2(1-\theta)\theta\tau^2-(\beta c)^2(1+\tau^2)]\end{array}\right]/[-4\beta\theta\tau^2[\alpha_h(1-\theta)+\alpha_l\theta]]$.

Comparing the manufacturer profits under options 1 and 5 we get $\prod_{1m} - \prod_{5m} = \left[\begin{array}{l}(\alpha_l)^2(\theta-1)(\theta\tau)^2+(\alpha_h)^2(\theta-1)(\theta-\beta c)^2\tau^2+\\ \alpha_l\alpha_h\theta[2\beta c\tau(\theta\tau-1)+2(1-\theta)\theta\tau^2-(\beta c)^2(\tau^2-1)]\end{array}\right]/[-4\beta\theta\tau[\alpha_h(1-\theta)+\alpha_l\theta]]$.

It can be shown that wide range of parameters $\prod_{1r} - \prod_{5r} \leq 0$ while $\prod_{1r} - \prod_{5r} \geq 0$.

References

Cachon, G. (2004). The allocation of inventory risk in a supply chain: push, pull, and advance-purchase discount contracts. *Management Science, 50*(2), 222–238.

Caruana, G., & Einav, L. (2005). Quantity competition with production commitment: Theory and evidence from the auto industry. working paper, Stanford University.

Coughlan, A. T., Anderson, E., Stern, L. W., & El-Ansary, A. I. (2006). *Marketing channels* (7th ed.). Upper Saddle River: Prentice Hall.

Desai, P., Koenigsberg, O., & Purohit, D. (2004). Strategic decentralization and channel coordination. *Quantitative Marketing and Economics, 2*(1), 5–22.

Dong, Y., Shankar, V., & Dresner, M. (2007). Efficient replenishment in the distribution channel. *Journal of Retailing, 83*(3), 253–278.

Ferguson, E. M. (2003). Commitment time issues in a serial supply chain with forecast updating. *Naval Research Logistics, 50*, 917–936.

Fisher, M. L., & Raman, A. (1996). Reducing the cost of demand uncertainty through accurate response to early sales. *Operations Research, 44*(1), 87–99.

Fisher, M. L., Hammond, J. H., Obermeyer, W. R., Raman, A. (1994). Making supply meet demand in an uncertain world. *Harvard Business Review*, May–June, 83–93.

Grossman, S. G., & Hart, O. D. (1986). The costs and benefits of ownership: a theory of vertical and lateral integration. *Journal of Political Economy, 94*(4), 691–719.

Iyer, A. V., & Bergen, M. E. (1997). Quick response in manufacturer-retailer channels. *Management Science, 43*(4), 559–570.

Iyer, G., & Padmanabhan, V. (2000). Product lifecycle, demand uncertainty, and channel contracting. Working paper. University of California, Berkeley.

Iyer, G., & Villas-Boas, M. J. (2003). A bargaining theory of distribution channels. *Journal of Marketing Research, 40*, 80–100.

Iyer, G., Narasimhan, C., & Niraj, R. (2007). Information and inventory in a distribution channel. *Management Science, 53*(10), 1551–1561.
Johnson, M. E. (2001). Learning from toys: lessons in managing supply chain risk from the toy industry. *California Management Review, 43*(3), 106–124.
Lariviere, M. A., & Porteus, E. (2001). Selling to the newsvendor: an analysis of price-only contracts. *Manufacturing Service Operations Management, 3*, 293–305.
Lee, H. L., Padmanabhan V., & Whang, S. (1997). Information distortion in a supply chain: the bullwhip effect. *Management Science, 43*, 546–558.
Marvel, P. H., & Peck, J. (1995). Demand uncertainty and returns policies. *International Economic Review, 36*, 691–714.
McGuire, T., & Staelin, R. (1983). An industry equilibrium analysis of downstream vertical integration. *Marketing Science, 2*(2), 161–191.
Moon, Y. (2002). *Electronic arts introduces the sims online*. Harvard Business School Case 9-503-008.
Netessine, S., & Rudi, N. (2004). Supply chain structures on the internet and the role of marketing-operations interaction. In D. Simchi-Levi, S. D. Wu, & M. Shen (Eds.), *Supply Chain Analysis in an E-business Era*. Kluwer.
Netessine, S., & Rudi, N. (2006). Supply chain choice on the internet. *Management Science, 52*(6), 844–864.
New York Times (2009). *Falling gas prices deny Russia a lever of power*. May 15, by Andrew E. Kramer.
Padmanabhan, V., & Png, I. P. L. (1997). Manufacturer's return policies and retail competition. *Marketing Science, 16*(1), 81–94.
Pasternack, B. (1985). Optimal pricing and return policies for perishable commodities. *Marketing Science, 4*(2), 166–176.
Rubinstein, A., & Wolinsky, A. (1987). Middlemen. *The Quarterly Journal of Economics, 102*(3), 581–593.
Schleifer, A. Jr. (1993). *L.L. Bean, Inc*. Harvard Business School Case 9-893-003.
Taylor, A. T. (2006). Sale timing in a supply chain: when to sell to the retailer. *Manufacturing and Service Operations Management, 8*(1), 23–42.
The Economist (2010) *The retailers' dilemma*. May 29, 63-64.