KONKURRANSE· TILSYNET
Norwegian Competition Authority

Rapport 12/2018

When Should Retailers Use a Category Captain

Tommy Staahl Gabrielsen, Bjørn Olav Johansen og Greg Shaffer

Prosjektet har mottatt midler fra det alminnelige prisreguleringsfondet.

When Should Retailers Use a Category Captain*

Tommy Staahl Gabrielsen† Bjørn Olav Johansen‡

University of Bergen *University of Bergen*

Greg Shaffer§

University of Rochester

November 2018

Abstract

We consider a market where upstream manufacturers have private information about their products' demand potential, and where they face a retailer with limited shelf space in a category. The retailer can either pick which product to choose himself, or he can allow the manufactuerers to bid for the right to be the category captain. The category captain will give the retailer advice on which product to include in the category. If a captain is chosen, he can be incentivized to be more or less biased by a contract which gives the captain a smaller or larger share of the retail profit of the category. We show that the retailer can always improve on his profit by allowing suppliers to bid for captaincy, and the larger manufacturer will

*We thank the "alminnelige prisreguleringsfondet" through the Norwegian Competition Authority for financial support for this research.

†University of Bergen, Department of Economics, tommy.gabrielsen@uib.no.

‡University of Bergen, Department of Economics, bjorn.johansen@uib.no.

§Simon School RC 270100, University of Rochester, Rochester, NY 14627; shaffer@simon.rochester.edu.

always be chosen as the captain. We also show that even if the captain can be fully incentivized to give the retailer unbiased advice, the retailer may prefer not to do so. Instead, the retailer while seeking to maximize his profit may want to give the captain a contract that makes the captain biased in favour of recommending its own product in the category. Our results have wide implications for retail managers and policy.

1 Introduction

A product category is a group of products that consumers regard as similar or substitutable. Examples of grocery categories are tinned fish, washing detergent and oral care products. Retailers manage product categories as separate business units, a process often denoted as category management. Among other things, category management consist of choosing which products should be given shelf space in a given category, how much self space each product should have, and the relative prices of the products that are chosen.

Traditionally, retailers have performed category management themselves, but it has become more and more common for retailers to appoint a specific supplier to run the category on behalf of the retailer. These suppliers are denoted Category Captains (CC). For instance, Kurtulus and Toktay (2011) report that Carrefour uses Colgate as a captain in the oral care category, and that Walmart uses category captains in some of their product categories. In the UK, the Groceries Code Adjudicator (2016) reports that the leading grocery retailer Tesco has used category captains in many categories. The Federal Trade Commission in its investigation into slotting allowances (FTC 2003) also reports that retailers use captains. Here is how FTC describes the practice:

"Five of the seven retailers noted they sometimes use vendors' category captains. A category captain typically is a leading supplier's employee, who is responsible for recommending to the retailer an optimal product mix and promotional plans for a particular product category. A key component of category captaincy is collaboration between the retailer and supplier and the sharing of category specific information, data, expertise, and analysis."

The role of the category captain may vary substantially, but in general the captain is expected to have regular contact with the retailer, give the retailer advice on category management and also to invest time and effort into the development of the category. Most often (but not always) the category captain will be the leading brand manufacturer in a category. The captain and the retailer also engage in information-sharing of sales data to make the management of the category efficient.

The category captains are not only expected to invest in the development of the category, but they sometimes also pay substantial amounts of money to be a captain. In the UK for instance, the Groceries Code Adjudicator (2016) found in her 2015-16 investigation into Tesco plc that some suppliers paid "large sums of money in exchange for category captaincy or participation in a price review". The payments often amounted to millions of British pounds.

In the extensive UK investigation of the grocery sector in 2000 and 2008 (Competition Commission, 2000, 2008) the Competition Commission also investigated category management. The 2000-report identified concerns about the fact that in some category management arrangements decisions on the allocation of shelf space were made by the supplier designated as category captain rather than by the retailer. The main concern in the 2008-report was the danger of collusion. In the latter report the Competition Commission saw both pros and cons with the practice. They stated that the use of category captains could introduce efficiencies because suppliers may have better knowledge of consumer demand, and that they therefore may be better positioned to provide advice on the products in a category most likely to appeal to different types of consumers. On the other hand, they wrote that "extensive use of category management might also bring about an environment which could facilitate collusion between retailers, between suppliers, and collusion involving both retailers and suppliers". However, in the 2008 investigation, the Competition Commission concluded that there were no evidence of collusive effects.

In the adjudicator's report from 2016 (Section 48), the finding of substantial payments to be category captains for Tesco, raise new concerns. First, the adjudicator is concerned that the involvement of payments to be a captain represents an evolvement since the 2000- and 2008-reports, and she suggests that CC-arrangements involving large payments, might be a circumvention of the prohibition in article 12 of the amended UK Groceries Supply Code of Practice (GSCOP) which was an outcome of the 2008 investigation. Article 12 of the GSCOP basically prohibits suppliers making payments to secure better positioning of their goods. Second, the adjudicator reports that "some suppliers were of the view that category captains were required to remain neutral in their analysis of the market. However many also viewed category captaincy as a competitive advantage because of the increased knowledge of the category and the influence over Tesco decision making that it was perceived the position brought". According to the report, suppliers also stated that they paid for category captaincy "because of the commercial and strategic benefits of the position, to ensure that decisions about the category were customer focused or because of a fear that their products would be detrimentally affected if a competitor were advising Tesco". The essence of this argument is that suppliers may be better informed, and exploiting this informational benefit by using a captain is beneficial both for the retailer and the consumers. The potential downside of category captaincy is that the captain may be biased. He may be tempted to favour his own product even though he knows that a competitor has a better one, and this may - if the retailer follows his advice - lead to exclusion of a better product, and by that harming both competitors and consumers.

Exploring this trade-off between informational advantages and inefficient exclusion stemming from the use of category captains is the focus of this paper. We will consider a model where we assume that the suppliers have private information about their products' demand potential. To take advantage of this information asymmetry, the retailer may want to appoint one of the supplier as a category captain. We allow the suppliers to compete for category captaincy by offering payments to the retailer, and we allow the retailer to offer performance-based compensation schemes to the captain. The sole role of the captain in our model is to advice the retailer on which products to include in a category based on his private information and the wholesale terms offered by all other suppliers. The retailer will consider the advice, but is free to take any other decision. With this model we can study the following type of questions:

First, should the retailer use a category captain at all, or should he perform the category management himself? Second, if the retailer decides to use a captain, which producer should he pick to be the captain? Third, how should the retailer incentivize the captain? In our model, the retailer may incentivize the captain by offering him a smaller or larger share of the retail profit of the relevant category in exchange for the payment made to be a captain. Intuitively, if the captain is offered a high share of the retail profit in the category, the incentives of the captain and the retailer are aligned in the sense that the captain will more often give advice that is in the interest of the retailer. On the other hand, if the captain is not fully incentivized to act in the interest of the retailer, he might sometimes give bad advice in the sense that the retailer would be better off not following the captain's advice.

In our model, we assume that the retailer is facing a number of potential suppliers in a category, and that he at most can stock one of the products. The question for the retailer is which product should he accept in the category. First, we study a situation where the producers are symmetric in the sense that the demand potential for all products are drawn from the same distribution, and they all have the same expected demand potential in the eyes of the retailer and the rival suppliers. If the retailer decides not to appoint a captain, producers will compete by offering their wholesale prices. With symmetric suppliers, competition will drive wholesale prices down to producer marginal costs, and the retailer will pick one of the products at random and appropriate the entire profits. The downside of doing his own category management, is that the retailer may choose the wrong product, in the sense that there will exist a better product that have higher profitability, but is excluded.

We then show that in this situation the retailer can improve on his profit by appointing a CC. We first assume that the captain is fully incentivized, i.e. that captain receives the full retail profit in exchange for the fee he pays to be a captain. If so, the retailer will always give the retailer a "good" advice, i.e., if his own's product demand potential is less than the expected profit from his rival(s), he will recommend one of the rival products. With more than two suppliers, the suppliers will try to outbid one another to be the captain, and the retailer will appropriate all the expected total surplus. However, when there are only two symmetric suppliers, the competition to be the captain will end. In this case each supplier now prefers *not* to be the captain, but is still beneficial for the retailer to have a captain. The retailer will therefore earn less than when there are more than two manufacturers, but he will still earn more than without using a captain.

The intuition is as follows. The basic benefit of having an unbiased captain is that the chances of stocking the best product increases. When there are only two suppliers, the outsider which is not the captain will compete less fiercely, and he will do that by increasing his wholesale price as compared to the case when no one is captain. The reason is that with an unbiased captain there is still a chance that he will be picked (and this will happen if the chosen captain's product turns out to be "bad"). With more than two suppliers this changes, and the reason is that with many outsiders they will compete among themselves to be chosen by the unbiased captain. Hence, wholesale prices of the outsiders will be equal to marginal costs in this case. This is why expected profit from using a captain will be higher for the retailer when there are more than one outsider.

From this, one should intuitively think that the retailer would always incentivize the captain fully to give good advice. Surprisingly, this intuition may turn out to be wrong. In fact, in our model, the retailer may want to deliberately incentivize its captain to give bad advice (be biased), and in our model he does that by giving the captain less than 100 % of the retail profit. This means that the captain will be induced to recommend his own product more often, i.e. even though he expects that his rival has a better product. The intuition for this result is the following. Suppose there are only two potential suppliers. We then know that the outsider will face an unbiased captain by a relatively high wholesale price. If the captain instead is biased in favour of his own product, the outsider will respond to this by lowering his wholesale price. The reason is that it is harder to be picked as an outsider when the captain is biased. Hence, a biased captain works as a mechanism for rent-shifting. Think of a producer that knows that his product has a high demand potential. If the retailer appoints a biased competitor as a captain it will be difficult for this producer to be picked, and he will have to offer a low wholesale price to increase his chances. A low probability of being picked and a low price if you picked both diminish the expected profit from being an outsider. This obviously increases this producer's willingness to pay to be the captain. An alternative way of seeing this is that a producer with a high demand potential will be willing to pay a lot to avoid that a biased producer with a lower expected demand potential becomes the captain. In our model, this effect turns out to be so strong that the retailer prefers to have a biased captain.

Finally, we also investigate the same set of issues where the manufacturers may be asymmetric in the sense that their demand potentials are drawn from different (but partly overlapping distributions). From this we find that the largest manufacturer will always be chosen as the captain, and that all other results goes through as before.

The rest of this paper is organized as follows. In Section 2 we review the relevant literature on category management and captaincy. In Section 3 we describe our model and Section 4 analyzes the case where the manufacturer are symmetric. Section 5 contains an extension where we look at the case where the manufacturers may be asymmetric, and Section 6 concludes.

2 The literature

Both in the US (in 2003) and in the UK (in 2000 and 2008) there has been concerns about category management in the grocery industry, and investigations into the issue have been made in both countries. The FTC (2003) report and the Competition Commission (2008) report concede that "category management can produce significant efficiencies that will benefit retailers, manufacturers and consumers." The FTC-report summarizes two main competitive concerns (see also Desrochers et al., 2003; Klein and Wright, 2010; Leary 2003; Steiner 2001). The first concern is that the category captaincy relationship might facilitate collusion between either manufacturers, retailers, or both. A similar concern is also expressed by the Competition Commission (2008): "For example, a supplier providing the same category management advice to a number of retailers may dampen competition between those retailers. Alternatively, category management could give rise to collusion by facilitating an indirect exchange of information between competing retailers through suppliers. Similarly, category management may provide increased opportunities to exchange information between suppliers, whether directly or indirectly via retailers."

A second concern is that the captain may use its position to effectively exclude or significantly disadvantage competitors, and thereby exposing consumers to the risk of decreased product variety and/or increased prices. Most antitrust challenges to category captaincy contracts have been restricted to the exclusionary theory (Wright, 2009).

While the empirical literature on category management and captaincy is quite extensive[1], the formal theoretical literature that analyzes category captaincy specifically is

[1] For empirical papers, policy papers and surveys, see e.g. Balto (2002); Carameli et al (2004); Freedman et al. (1997); Gooner et al. (2011); Steiner (2001); Bandyopadhyay et al. (2009); Desrochers et al. (2003); Klein and Wright (2004); Kurtulus and Toktay (2005); Morgan et al. (2007).

rather limited. To our knowledge, there are as little as five papers on the topic (Niraj and Narasimhan, 2003; Wang et al., 2003; Nijs et al., 2014; Subramanian et al., 2010; Kurtulus and Toktay, 2011).

Niraj and Narasimhan (2003) develop a model with two manufacturers who sell their differentiated products to a retailer facing uncertain demand. The manufacturers and the retailer each observe a demand signal before entering into a wholesale price contract. Category captaincy is defined as an exclusive information sharing alliance that one manufacturer and the retailer enter into before the wholesale price game. The focus in the paper is how sharing of demand information in an CC-arrangements may improve pricing and increase profit in the vertical relationship.

Nijs et al., 2014 is an empirical paper that also investigates delegation of the pricing to a category captain. The focus in this paper is the role of informational firewalls. Similar to Niraj and Narasimhan (2003), Wang et al. (2003) also model captaincy as an alliance between the retailer and the category captain, and the role of he captain is focused on pricing. They show that the alliance profit always increases under captaincy, whereas we find that including the opportunity cost of shelf space reverses this result under some conditions.

Subramanian et al., 2010 analyze a setting where two manufacturers sell to a single retailer, and the retailer may engage one or both manufacturers to provide retail service. Even in the absence of competition for category captaincy, they find that the category captain may still provide a service that enhances demand for all brands in the category. Moreover, even when the category captain's service depletes demand for the rival's brand, the rival manufacturer and the retailer may still benefit. When there is competition for category captaincy, they show that not only does the category captain provide a higher level of service, but also the service is less biased towards its own brand. The retailer may prefer the category captain arrangement over engaging both manufacturers jointly to provide service. They conclude that there is limited evidence of harm to rival manufacturers, even if the captain is biased.

These papers differ from ours in that they all focus on the delegation of either pricing decisions or service provision to the category captain. Instead, our paper focus specifically on the selection of products into a category given that self space is limited. Limited shelf space is a feature that is well documented in the grocery sector (Dreze et al., 1994) and also in many other retail markets. With limited shelf space it becomes crucial for the retailer to choose the right products to include in a category.

In this sense Kurtulus and Toktay (2011) is more related to our approach as they also focus on the case of limited shelf space. They consider a model where two competing manufacturers sell their differentiated products through a single retailer who determines the shelf space allocated to the category. However, also in this paper the scope of category management is pricing and how this affect the allocation of limited shelf space. They contrast two different approaches; retailer category management (RCM), where the retailer determines product prices, and category captainship (CC), where a manufacturer in the category determines them. They find that the retailer can use the form of category management and the category shelf space to control the intensity of competition between manufacturers to his benefit. Moreover, the emergence of CC depends on the degree of product differentiation, the opportunity cost of shelf space, and the profit sharing arrangement in the alliance. The latter feature of profit sharing is similar to our approach.

In our view, one of the key features of the grocery market and many other retail markets is limited shelf space. If so, it becomes crucial for retailers to select the best products in any given category. At the same time manufacturers often have private information about the profitability of their products, which makes an argument for using captains. In sum, as far as we are aware of, our paper is the first to analyze how category captains will perform in a setting where they give advice on category composition and where suppliers have private information and shelf space are limited, all key features of the grocery industry and other retail markets.

There is also a more remotely related literature on information sharing in vertical relations (Zhang, 2002; Cachon and Fisher, 2000: Creane, 2007, 2008)[2], but this literature does not consider explicitly the effect of category captains.

3 The model

We consider a setting in which a set of $n \geq 2$ manufacturers, $N = \{1, ..., n\}$, face a single retailer. We will use $N \backslash \{i\}$ to denote the set of all manufacturers except for manufacturer i. The retailer has limited shelf space and can accept at most one of the manufacturers' products in their store. Assuming that the manufacturers have private information about the demands for their products (i.e., how well their products would sell if carried by the retailer), the question we address in the following is whether, when, and under what conditions will it be profitable for the retailer to appoint a category captain to help them decide which product to stock?

We assume for simplicity that all consumers who are interested in product $i \in N$ have

[2] See also Dukes et al., 2011; Gal-Or et al., 2008; Guo, 2009; Guo and Iyer, 2010; He et al, 2008; Li, 2002; Li and Zhang, 2008; Mittendorf et al., 2013.

a maximum willingness to pay of v per unit of the good, and that each good is produced at constant marginal cost c per unit, $0 \leq c < v$. Demand for product i is denoted q_i. We assume that the manufacturers' demand are drawn from potentially different supports, specifically $q_i \sim U\left[\underline{q}_i, \overline{q}_i\right]$, where $0 \leq \underline{q}_i \leq \overline{q}_i$. We further assume that only manufacturer i gets to know the actual value of q_i before profits are realized. The rival manufacturer and the retailer only know the distribution of q_i.

We assume that each manufacturer $i \in N$ may offer the retailer a fixed payment f_i in order to be appointed as category captain ('captain' henceforth). We will sometimes refer to manufacturers who are not the captain as 'outsiders'. If a captain is appointed by the retailer, we will assume that the captain is awarded an incentive contract, which gives the captain (on each unit sold) a share $\alpha \in [0, 1]$ of the retailer's downstream markup $(p_i - w_i)$ (assuming manufacturer i's product is selected). We may think of this contract as a reduced form way of capturing the fact that, over time, the retailer may be able to incentivize the captain to offer honest advice at least part of the time.

If $\alpha = 1$, then the captain's incentives are perfectly aligned with the incentives of the vertically integrated firm consisting of the captain and the retailer – i.e., the captain k's expected flow profit is equal to $(p_k - c)\, q_k$ if their own product is chosen, and $(p_i - w_i)\, E[q_i]$ if the retailer picks outsider i's product instead, $k \neq i \in N$. If $\alpha = 0$, then the captain only cares about their upstream markup $(w_k - c)$ – i.e., the captain earns the flow profit $(w_k - c)\, q_k$ if his own product is selected and zero if an outsider's product is chosen. If $\alpha \in]0, 1[$ the captain will put some weight both on his own upstream margin and on the retailer's downstream margin when maximizing profits.

We will consider the following game: At the first stage the retailer decides whether he want to use a category captain and, if so, how strong incentives α he would like to offer to the captain.[3] At stage two, first each manufacturer $i \in N$ makes an offer $f_i \geq 0$ (a fixed payment) to the retailer in order to become the captain. The retailer may then either appoint one of the manufacturers as captain, or reject all offers and choose to continue to operate without a captain. At stage three, first each manufacturer learns its own demand, q_i, and then offers a per-unit wholesale price, w_i, to the retailer. If the retailer did not appoint a captain at stage two, the game then proceeds directly to stage five. If the retailer did appoint a captain at stage two, at stage four the captain is informed about the wholesale prices that have been offered $(w_1, ..., w_n)$. The captain, k, may then revise his own wholesale price, w_k, before making a recommendation to the retailer about which product to stock. We assume that the retailer always believes that the captain wants the

[3]We are not able to obtain tractable solutions for all values of α, thus we will restort to numerical analysis for parts of our analysis.

retailer to follow the recommendation. Finally, at stage five the retailer decides which product to stock (and thus whether to follow the captain's recommendation or not), and then sales and profits are realized.

We will denote by π_r the retailer's (base) profit, excluded the potential fixed fee paid to the retailer at stage 2, and π_i the gross profit of manufacturer $i \in N$ (gross of the potential fixed fee paid to the retailer at stage 2). We will use $\bar{\pi}_r$ and $\bar{\pi}_i$ to denote the expected profits of the retailer and manufacturer i respectively (again fixed fees are excluded).

4 Symmetric manufacturers

We will start with the case where the manufacturers are symmetric, in the sense that their demands are all drawn from the same support $\left[\underline{q}, \overline{q}\right]$. As our first benchmark, we will also consider the case where the retailer decides not to use a captain at stage 1. After having observed all the wholesale prices offered at stage 2, the retailer accepts the offer of one of the manufacturers at stage 4. Given that manufacturer i's profit is increasing in the wholesale price w_i, irrespective of their demand q_i, the wholesale price carries no information about the manufacturer's type. Hence, the retailer should simply pick the manufacturer who offers the lowest per unit price. In equilibrium therefore at least two manufacturers will be offering their goods 'at cost', i.e., we have $w_i^* = c$ for at least two of the manufacturers, $i \in \{1, ..., n\}$. The retailer picks at random one of the manufacturers who offer their goods at cost. The retailer's expected profit without a captain is therefore simply $\bar{\pi}_r^{NC} = (v - c)\left(\underline{q} + \overline{q}\right)/2 > 0$ (the superscript NC here means 'no captain'). We may summarize these results in the following proposition.

Proposition 1: *(No captain). In equilibrium with $n \geq 2$ symmetric manufacturers, equilibrium wholesale prices are equal to c (for at least two manufacturers) and the retailer's expected profit is equal to $\bar{\pi}_r^{NC} = (v - c)\frac{\underline{q}+\overline{q}}{2}$. The manufacturers earn zero profits.*

The intuition for Proposition 1 is straightforward: given that the retailer has no information about the products offered (and the manufacturers all draw their demands from the same support $\left[\underline{q}, \overline{q}\right]$, the retailer's best strategy is always to pick the product that has the lowest wholesale price. This also implies that the retailer's expected sales will be equal to $\left(\underline{q} + \overline{q}\right)/2$ in this case, which, in the symmetric case, is the expected demand for each of the products in the category.

4.1 Case 1: $\alpha = 1$

Consider instead the case in which the retailer at stage 1 appoints manufacturer $k \in N$ as captain (we will use k to denote the captain throughout). Suppose also initially that the retailer has set $\alpha = 1$. This implies that the captain has an incentive to recommend his own product only if he knows that it will perform better than the other products on average, all else being equal.

If there are $n > 2$ manufacturers, then we know again that $w_i^* = c$ for all $i \in N \backslash \{k\}$ in the subgame in which manufacturer k is the captain. The reason is that, if the retailer does not sell the captain's product, then he will simply offer to sell the product that has the lowest wholesale price.[4] (Because $\alpha = 1$, it does not really matter what the captain's wholesale price w_k^* is.) We can therefore state the following lemma.

Lemma 1. *(A captain is appointed and $\alpha = 1$) In equilibrium with $n > 2$ symmetric manufacturers, we have that $w_i^* = c$ for all outsiders $i \in N \backslash \{k\}$.*

We may thus distinguish between two cases in this subgame:

1. If $q_k \geq \frac{\underline{q}+\overline{q}}{2}$, which happens with 50% chance, the captain will recommend their own product. The conditional expectation for q_k in this case is

$$E\left[q_k | q_k > \tfrac{\underline{q}+\overline{q}}{2}\right] = \frac{\underline{q} + 3\overline{q}}{4}$$

2. If $q_k < \frac{\underline{q}+\overline{q}}{2}$, which also happens with 50% chance, the captain recommends one of the rival's products with an expected demand of $E[q_i] = \frac{\underline{q}+\overline{q}}{2}$, $i \in N \backslash \{k\}$.

Hence, the captain's expected profit in this subgame (gross of the fixed payment f_k to become captain) is simply

$$\bar{\pi}_k^* = (v - c)\left(3\underline{q} + 5\overline{q}\right)\frac{1}{8}, \tag{1}$$

and because each manufacturer who is not the captain earns zero profits in equilibrium, at stage 1 every manufacturer $j \in N$ optimally offers the retailer a fixed fee f_j^* to become captain, where

$$f_i^* = (v - c)\left(3\underline{q} + 5\overline{q}\right)\frac{1}{8}$$

[4] To be precise, we are invoking a tie-breaking rule here. As the retailer is really indifferent between all products, given that the captain, on each unit sold, is extracting 100% of the downstream mark-up.

Suppose instead that there are only two manufacturers.[5] Because $\alpha = 1$, the optimal wholesale price for the captain at stage 4 again does not matter. On the other hand, because there is only one outsider, we now know that $w_i^* > c$ for this manufacturer. To see this, notice again that we can distinguish between two cases:

1. If the captain's demand satisfies

$$q_k \geq \theta(w_i) \equiv \frac{\left(\underline{q} + \overline{q}\right)(v - w_i)}{2(v - c)},$$

which happens with probability $\frac{\overline{q}-\theta(w_i)}{\overline{q}-\underline{q}} \in [0,1]$ (assuming $c \leq w_i \leq c + (v-c)\frac{\overline{q}-\underline{q}}{\overline{q}+\underline{q}}$), the captain will recommend his own product. The conditional expectation for q_k in this case is

$$E[q_k | q_k > \theta(w_i)] = \frac{\theta(w_i) + \overline{q}}{2} > \frac{\underline{q} + \overline{q}}{2}$$

2. If $q_k < \theta(w_i)$, on the other hand, the captain will recommend the rival's product, which has an expected demand equal to $\frac{\underline{q}+\overline{q}}{2}$.

Hence, the captain's (ex ante) expected profit in this subgame (gross of the fixed fee f_k) is

$$\begin{aligned}
\overline{\pi}_k(w_i) &= \frac{\overline{q} - \theta(w_i)}{\overline{q} - \underline{q}} \left(\frac{\theta(w_i) + \overline{q}}{2}\right)(v - c) \\
&\quad + \frac{\theta(w_i) - \underline{q}}{\overline{q} - \underline{q}} \left(\frac{\underline{q} + \overline{q}}{2}\right)(v - w_i),
\end{aligned}$$

while (ex ante) expected profit of the outsider is

$$\overline{\pi}_i(w_i) = \frac{\theta(w_i) - \underline{q}}{\overline{q} - \underline{q}} \left(\frac{\underline{q} + \overline{q}}{2}\right)(w_i - c)$$

The outsider's stage 3 expected profit in this case is maximized for the wholesale price

$$w_i = w_i^* = c + \frac{v - c}{2}\frac{\overline{q} - \underline{q}}{\overline{q} + \underline{q}} > c$$

We may state the following lemma.

[5] One interpretation of this scenario is that manufacturers are asymmetric, and that the retailer has enough information to narrow down his choice to just two of them.

Lemma 2. *(A captain is appointed and $\alpha = 1$) In equilibrium with $n = 2$ symmetric manufacturers, we have that $w_i^* > c$ for the outsider. (Because $\alpha = 1$, the captain's price is of no consequence to the outcome.)*

Substituting $w_i = w_i^*$ into the captain's profit function, we find that the captain's expected equilibrium (gross) profit in this subgame is equal to

$$\bar{\pi}_k^* = \bar{\pi}_k (w_i^*) = (v - c) \left(15\underline{q} + 17\overline{q}\right) \frac{1}{32} \tag{2}$$

The outsider's profit, on the other hand, is equal to

$$\bar{\pi}_i^* = (v - c) \left(\overline{q} - \underline{q}\right) \frac{1}{16}$$

It is straightforward to check that $\bar{\pi}_r^{NC} < \bar{\pi}_k^*|_{n=2} < \bar{\pi}_k^*|_{n>2}$. (This follows from the fact that the outsider's price is $w_i^* > c$ when $n = 2$, whereas the outsiders' prices are equal to c when $n > 2$.) We can therefore conclude that, in the case of $\alpha = 1$, the retailer and the captain will always jointly benefit from the arrangement, compared to the benchmark case without a captain. However, in order to become captain, the manufacturer has to pay the retailer a fee $f_k \geq \bar{\pi}_r^{NC}$. Otherwise the retailer would be better off without a captain. This means that the captain will earn the net profit $\bar{\pi}_k^* - f_k^* = (v - c) \left(\overline{q} - \underline{q}\right) /32$ in the symmetric case with two manufacturers and $\alpha = 1$, which is only half of what the outsider is earning in this case.

In the case without a captain, both manufacturers earn zero profit in equilibrium. Hence, someone will be captain in equilibrium (as it increases the overall profits), but there will be no competition between the manufacturers to become the captain (as each would like the rival to be captain). There are therefore two asymmetric equilibria: in each equilibrium one manufacturer, k, offers the retailer a fee $f_k^* = \bar{\pi}_r^{NC}$ at stage 1, while the rival manufacturer offers a fee $f_i < \bar{\pi}_r^{NC}$, $k \neq i \in \{1, 2\}$.[6] We can summarize the case $\alpha = 1$ in the following proposition.

Proposition 2. *(A captain is appointed and $\alpha = 1$) The captain acts in the joint interest of the retailer and the captain, and the joint profit of the captain and the retailer is higher than in the benchmark case without a captain. Moreover:*

- *with $n > 2$ symmetric manufacturers, there will be competition to become captain.*

[6] We invoke a tie-breaking rule here, which says that as long as the retailer is indifferent between using a captain and not, they will appoint a captain.

All manufacturers earn zero expected profit, and the retailer appropriates the total expected surplus, $\bar{\pi}_r^* + f_k^* = (v-c)\left(3\underline{q} + 5\overline{q}\right)/8 > \bar{\pi}_r^{NC}$.

- *with* $n = 2$ *symmetric manufacturers, there will be no competition to become captain. The outsider earns the expected profit* $\bar{\pi}_i^* = (v-c)\left(\overline{q} - \underline{q}\right)/16$, *while the captain earns the expected (net) profit* $\bar{\pi}_k^* - f_k^* = (v-c)\left(\overline{q} - \underline{q}\right)/32$. *The retailer therefore does not appropriate the total expected surplus, and earns an expected profit of* $\bar{\pi}_r^* + f_k^* = \bar{\pi}_r^{NC}$. *The overall surplus is reduced compared to the case with* $n > 2$ *manufacturers.*

We may note that, with only two manufacturers, appointing a captain makes the outsider compete less fiercely for the shelf space. Thus, the outsider will increase their wholesale price compared to in the benchmark case without a captain. The reason is that, when a captain gives the retailer advice about which product to sell, there is a positive chance that the outsider will be picked, even with a wholesale price $w_i > c$ (as long as w_i is not too high). In the case without a captain, the outsider has zero chance of being picked with a wholesale price $w_i > c$.

4.2 Case 2: $\alpha < 1$

Suppose instead that the retailer's contract with the captain, k, has $0 \leq \alpha < 1$. This implies that the captain will be (more or less) biased when giving their recommendation to the retailer. However, we know from above that when $n > 2$, competition between the outsiders will ensure that $w_i = c$ for all $i \in N\backslash\{k\}$ and the retailer will appropriate all expected surplus as the manufacturers compete to be appointed captain. Hence, $\alpha < 1$ is clearly not optimal for the retailer in this case. We therefore focus on the more interesting case with two manufacturers in the following.

As we showed above, with $\alpha = 1$ the joint expected profit of the captain and the retailer is above the benchmark level $\bar{\pi}_r^{NC}$. Moreover, the captain always has an incentive to recommend truthfully, i.e. recommend the product with the highest expected demand. However, this also means that the outsider would raise their wholesale price compared to the case without a captain, and this hurts the joint profit of the captain and the retailer, all else being equal. Intuitively, setting $\alpha < 1$ could therefore potentially benefit the captain and the retailer. The reason is that with $\alpha < 1$, and assuming $w_k > c$, the captain will now be induced to recommend their own product more often. To counter this incentive, the outsider will have to reduce their wholesale price, which will benefit the captain and the retailer. However, there is a trade-off, as $\alpha < 1$ means that the captain is biased when giving their recommendation, and sometimes will give the retailer bad advice (as seen from the retailer's perspective). To see this, note that with $\alpha < 1$, the condition that the captain, k, would like to recommend their own product (and have the retailer follow the recommendation) is

$$\alpha(v - w_k) q_k + (w_k - c) q_k \geq \alpha(v - w_i) \frac{\underline{q} + \overline{q}}{2}.$$

We may note that the captain's profit when product k is sold, is strictly increasing in the captain's wholesale price w_k (given that $\alpha < 1$). Rearranging this condition gives

$$q_k \geq \theta(w_i, w_k) \equiv \frac{\alpha\left(\underline{q} + \overline{q}\right)(v - w_i)}{2(w_k - c + \alpha(v - w_k))},$$

where $0 < \theta(w_i, w_k) < \overline{q}$ (as long as $c \leq w_i < v$ and $c \leq w_k < v$), and $\frac{\partial\theta(w_i,w_k)}{\partial w_i} < 0$ and $\frac{\partial\theta(w_i,w_k)}{\partial w_k} < 0$. Let $\hat{\theta}(w_i, w_k) = \max\left\{\theta(w_i, w_k), \underline{q}\right\}$. We can see that $\hat{\theta}(w_i, w_k) < \frac{v-w_i}{v-c}\frac{\underline{q}+\overline{q}}{2}$ as long as $w_k > c$ and $\alpha < 1$, and thus the captain now recommends their own product more often than when $\alpha = 1$. Specifically, for given wholesale prices, the ex ante probability that the captain would like their own product to be sold, is $\frac{\overline{q}-\hat{\theta}(w_i,w_k)}{\overline{q}-\underline{q}}$, and the probability that the captain would like the outsider's product to be sold is $\frac{\hat{\theta}(w_i,w_k)-\underline{q}}{\overline{q}-\underline{q}}$.

Given that the captain recommends their own product (and given that the retailer believes that the captain would like the retailer to follow the recommendation), the retailer expects the demand of the captain's product to be equal to

$$E\left[q_k | q_k > \hat{\theta}\right] = \frac{\hat{\theta}(w_i, w_k) + \overline{q}}{2}$$

We will now consider whether the retailer should follow the advice of the captain or not. Let $\bar{\pi}_r^{ik}$ denote the retailer's expected profit when the captain gives the advice to sell product k, but the retailer decides to sell the outsider's product instead; let $\bar{\pi}_r^{kk}$ be the expected profit when the retailer follows the captain's advice to sell product k; and finally, let $\bar{\pi}_r^{ii}$ denote the retailer's expected profit when following the captain's advice to sell the outsider's product (fixed fees excluded). The retailer's expected profit when following the captain's advice to sell product k is

$$\bar{\pi}_r^{kk}(w_k, w_i) = (1 - \alpha)(v - w_k) \frac{\hat{\theta}(w_i, w_k) + \overline{q}}{2}$$

where $\frac{d\bar{\pi}_r^{kk}(w_k,w_i)}{dw_k} < 0$ and $\frac{\partial\bar{\pi}_r^{kk}(w_k,w_i)}{\partial w_i} < 0$. The retailer's expected profit when not following the advice to sell product k, on the other hand, is identical to the expected profit when following the advice to sell product i, which is simply

$$\bar{\pi}_r^{ik}(w_i) = \bar{\pi}_r^{ii}(w_i) = (1-\alpha)(v-w_i)\frac{\underline{q}+\overline{q}}{2}$$

Note that the case in which the captain recommends the outsider's product but the retailer picks the captain's product, is irrelevant; given the retailer's belief that the captain would like the retailer to follow their advice, the retailer should never consider going against the captain's advice to sell the rival's product. On the other hand, the retailer should not necessarily follow the advice to sell the captain's own product. The retailer should follow the recommendation to sell the captain's product only as long as

$$\begin{aligned} \bar{\pi}_r^{kk}(w_k,w_i) &\geq \bar{\pi}_r^{ii}(w_i) \\ &\Updownarrow \\ (v-w_k)\frac{\hat{\theta}(w_i,w_k)+\overline{q}}{2} &\geq (v-w_i)\frac{\underline{q}+\overline{q}}{2} \end{aligned}$$

Note that as $\bar{\pi}_r^{kk}(w_k,w_i)$ is continuous and decreasing in w_k, with $\bar{\pi}_r^{kk}(c,w_i) > \bar{\pi}_r^{ii}(w_i)$ and $\bar{\pi}_r^{kk}(v,w_i) < \bar{\pi}_r^{ii}(w_i)$ as long as $c < w_i < v$; this follows from the fact that $\hat{\theta}(w_i,w_k)$ is decreasing in w_k as long as $\theta > \underline{q}$. Thus, a critical value $\hat{w}(w_i)$ exists, $c < \hat{w}(w_i) < v$, such that the retailer will follow the captain's recommendation only if the captain's price satisfies $w_k \leq \hat{w}(w_i)$. Because the captain's profit is everywhere increasing in w_k, in equilibrium the captain will offer the price $w_k = \hat{w}(w_i)$ at stage 4. As an example, when $\underline{q} = 0$ we find that

$$\begin{aligned} \hat{w}(w_i) = & \frac{2c+(2-\alpha)w_i-3\alpha v}{4(1-\alpha)} \\ & +\frac{\sqrt{(3\alpha v-2c-(2-\alpha)w_i)^2+8(1-\alpha)(v\alpha(v+w_i)-2cw_i)}}{4(1-\alpha)} \end{aligned}$$

which is everywhere increasing in $w_i \geq c$, and which becomes equal to

$$\hat{w}(c) = \frac{(4-\alpha)c-3v\alpha+(v-c)\sqrt{(8+\alpha)\alpha}}{4(1-\alpha)} > c$$

when $w_i = c$.

We can conclude that the captain always charges a price $w_k^* = \hat{w}(w_i) > c$ in equilibrium at stage 4 (given that also $w_i \geq c$). Moreover, the captain's price is increasing in the price of the outsider. We may therefore write the (ex ante) expected joint profit of the captain and the retailer, as a function of the outsider's price w_i, as follows

$$\begin{aligned}\bar{\Pi}_{r+k}(w_i) &= (v-c)\left(\frac{\overline{q}-\hat{\theta}^*(w_i)}{\overline{q}-\underline{q}}\right)\frac{\hat{\theta}^*(w_i)+\overline{q}}{2} \\ &\quad+(v-w_i)\left(\frac{\hat{\theta}^*(w_i)-\underline{q}}{\overline{q}-\underline{q}}\right)\frac{\underline{q}+\overline{q}}{2}\end{aligned}$$

where $\hat{\theta}^*(w_i) = \hat{\theta}(w_i, \hat{w}(w_i))$ is decreasing in w_i. $\bar{\Pi}_{r+k}(w_i)$ is everywhere decreasing in w_i. At stage 3, the expected profit of the outsider, as a function of their wholesale price w_i, is therefore[7]

$$\pi_i(w_i) = (w_i - c)\underbrace{\frac{\hat{\theta}^*(w_i)-\underline{q}}{\overline{q}-\underline{q}}}_{P(w_i)} q_i$$

We may notice that the price elasticity of the outsider's expected demand at stage 3 (which takes into account the captain's price response $\hat{w}(w_i)$ at stage 4), is higher when $\alpha < 1$ compared to when $\alpha = 0$. To see this, notice that we can write the elasticity for the outsider as

$$\varepsilon_D^i \equiv -\frac{w_i}{P(w_i)q_i}\frac{dP(w_i)q_i}{dw_i} = -\frac{w_i}{P(w_i)}\frac{1}{\overline{q}-\underline{q}}\left(\frac{\partial\hat{\theta}}{\partial w_k}\frac{d\hat{w}}{dw_i}+\frac{\partial\hat{\theta}}{\partial w_i}\right).$$

ε_D^i is the sum of two parts, $-\frac{\partial\hat{\theta}}{\partial w_i}\frac{w_i}{P(w_i)}\frac{1}{\overline{q}-\underline{q}}$ and $-\frac{\partial\hat{\theta}}{\partial w_k}\frac{d\hat{w}}{dw_i}\frac{w_i}{P(w_i)}\frac{1}{\overline{q}-\underline{q}}$. The first part is never increasing in α, and is strictly decreasing in α when $\underline{q} > 0$,

$$\frac{\partial}{\partial\alpha}\left[-\frac{\partial\hat{\theta}}{\partial w_i}\frac{w_i}{P(w_i)}\frac{1}{\overline{q}-\underline{q}}\right] = -\frac{2\underline{q}\left(\underline{q}+\bar{q}\right)(\hat{w}-c)w_i}{\left[\alpha\left(\bar{q}-\underline{q}\right)(v-w_i)-2\underline{q}(\hat{w}-c)+2\alpha\underline{q}(\hat{w}-w_i)\right]^2} \leq 0.$$

The second part, $-\frac{\partial\hat{\theta}}{\partial w_k}\frac{d\hat{w}}{dw_i}\frac{w_i}{P(w_i)}\frac{1}{\overline{q}-\underline{q}}$, is positive when $\alpha < 1$, and equal to zero when $\alpha = 1$. The latter follows from the fact that $\partial\hat{\theta}/\partial w_k = 0$ (as well as $d\hat{w}/dw_i = 0$) when $\alpha = 1$. Thus, the outsider optimally offers a lower wholesale price w_i when $\alpha < 1$ compared to when $\alpha = 1$. This is intuitive: a lower α means that $\hat{\theta}^*$ becomes lower, which means that the captain now is more likely to recommend their own product at the price $\hat{w}(w_i)$

[7] We obtain the outsider's ex ante expected profit by replacing q_i with $E[q_i] = \left(\overline{q}+\underline{q}\right)/2$.

(which the retailer will accept). All else being equal, this reduces the outsider's expected demand at stage 3. In addition, the own-price effect on the outsider's demand strengthens, as $\hat{w}(w_i)$ is increasing in w_i, which adds to the effect on $\hat{\theta}^*$: $\frac{d\theta^*}{dw_i} = \frac{\partial\hat{\theta}}{\partial w_k}\frac{d\hat{w}}{dw_i} + \frac{\partial\hat{\theta}}{\partial w_i} < 0$. A lower α thus increases ε_D^i, and in turn this will induce the outsider to offer a lower price w_i. We may state the following lemma.

Lemma 3. *(A captain is appointed and $\alpha < 1$) In equilibrium with $n = 2$ symmetric manufacturers, the outsider's wholesale price w_i^* satisfies $c \leq w_i^* < w_i^*|_{\alpha=1}$, and the captain's wholesale price satisfies $w_k^* = \hat{w}(w_i^*) > c$.*

This countervailing effect on w_i^* of setting a low α, as detailed by Lemma 3, may imply that $\alpha < 1$ is jointly profitable for the retailer and the captain, even though it means that the captain sometimes will give bad advice to the retailer.

Proposition 3. *(A captain is appointed and $\alpha < 1$) In equilibrium with $n = 2$ symmetric manufacturers, the captain is biased and recommends his own product more often compared to the case $\alpha = 1$. The joint profit of the retailer and the captain is still sometimes higher when $\alpha < 1$ (compared to when $\alpha = 1$), because of the countervailing effect that a lower α has on the outsider's wholesale price w_i^*.*

Proof. We may give a proof by example. Consider the case $v = 1$, $c = 0$ and $\underline{q} = 0$. The joint profit of the captain and the retailer when $\alpha = 1$ is then equal to $\frac{17}{32}\overline{q} \approx 0.531\overline{q}$ (Proposition 2). If $\alpha = 1/2$, according to Lemma 3 the captain's optimal price when recommending their own product at stage 4 is equal to

$$\hat{w}(w_i) = \frac{1}{4}\left(3w_i + 2\sqrt{-\frac{5}{2}w_i + \frac{9}{4}w_i^2 + \frac{17}{4}} - 3\right),$$

while the outsider's optimal wholesale price at stage 3 is the price w_i that maximizes

$$\pi_i(w_i) = w_i\frac{\alpha(1-w_i)}{2(\hat{w}(w_i) + \alpha(1-\hat{w}(w_i)))}q_i,$$

which is the price $w_i^* \approx 0.445$, if $\alpha = 1/2$. Inserting w_i^* and $w_k^* = \hat{w}(w_i^*)$ into the join profit function of the retailer and the captain, we obtain $\bar{\Pi}_{r+k} \approx 0.534\overline{q}$, which is strictly higher than their profit when $\alpha = 1$. *Q.E.D.*

In the case with $\alpha < 1$, there is still some price competition between the outsider and the captain, as they fight to gain the retailer's favor at stages 3 and 4. This is not like the case when $\alpha = 1$, in which there is effectively no price competition between the manufacturers at stage 3 and 4. This is the reason why the joint profit of the captain and the retailer is sometimes higher when $\alpha < 1$.

How much profit the retailer earns in equilibrium, depends on whether or not the manufacturers are competing to become captain at stage 2. Suppose the captain pays the retailer the minimum fee, $\underline{f}$, which we define as the fee that is just high enough for the retailer to earn the expected profit $\bar{\pi}_r^{NC}$. If in this case we still have $\bar{\pi}_k^* - \underline{f} < \bar{\pi}_i^*$, then there is effectively no competition to become captain at stage 2. The outsider then earns an expected profit that is higher than the captain's expected profit – and thus each manufacturer would like there to be a captain, but they would each like the rival to be the captain. The retailer then earns an expected profit equal to $\bar{\pi}_r^{NC}$ (like in the case $\alpha = 1$, cf. Proposition 2).

However, if $\bar{\pi}_k^* - \underline{f} > \bar{\pi}_i^*$, then the manufacturers will compete to become captain at stage 2. In this case, in equilibrium each manufacturers will offer a fee such that $\bar{\pi}_k^* - f_k^* = \bar{\pi}_i^*$, such that the captain and the outsider both earn the same expected profits in equilibrium. The retailer's equilibrium expected profit is now equal to $\bar{\pi}_r^* + \bar{\pi}_k^* - \bar{\pi}_i^*$, which is a function of α.

Note that, when $\alpha < 1$ we cannot easily evaluate the resulting equilibrium profit expressions for all possible parameter values. Hence, we are unable to verify (for all possible parameter values) whether or not the manufacturers compete to become captain when $\alpha < 1$. However, we can use a numerical example to provide some insight into what happens in this case. Suppose therefore that $v = 1$, $c = 0$, $\underline{q} = 0$ and $\overline{q} = 1$. In this case it is easy to verify that the outsider's profit is higher, $\bar{\pi}_i^* > \bar{\pi}_k^* - \underline{f}$, only if α is high enough, specifically only as long as $\alpha \gtrapprox 0.37$. Therefore, for $\alpha < 0.37$ there will be competition between the manufacturers to become captain.

Lemma 4. *(Numerical example) In equilibrium with $n = 2$ symmetric manufacturers, given that the captain k pays the retailer the minimum fee to become captain, $f_k = \underline{f} = \bar{\pi}_r^{NC} - \bar{\pi}_r^*$, the outsider's (ex ante) expected profit is higher than the captain's expected profit only if α is high enough. Specifically, we have $\bar{\pi}_i^* \geq \bar{\pi}_k^* + \bar{\pi}_r^* - \bar{\pi}_r^{NC}$ as long as $\alpha \gtrapprox 0.37$ and $\bar{\pi}_i^* < \bar{\pi}_k^* + \bar{\pi}_r^* - \bar{\pi}_r^{NC}$ otherwise. In equilibrium, the retailer therefore earns the profit $\bar{\pi}_r^{NC}$ when $\alpha \gtrapprox 0.37$, and the profit $\bar{\pi}_r^* + \bar{\pi}_k^* - \bar{\pi}_i^*$ when $\alpha < 0.37$.*

Because the manufacturers are competing to become captain when $\alpha < 0.37$, the retailer's profit is also higher in this case. Moreover, because $\bar{\pi}_i^*$ is increasing in α, the value of α that maximizes the retailer's profit, $\bar{\pi}_r^* + \bar{\pi}_k^* - \bar{\pi}_i^*$, is lower than the value of α that maximizes the joint profit of retailer and the captain, $\bar{\pi}_r^* + \bar{\pi}_k^*$. In equilibrium, therefore, the retailer will opt for a relatively low value of α (less than 0.37) at stage 1 of the game.

Proposition 4. *In equilibrium with $n = 2$ symmetric manufacturers, the retailer may prefer to set a relatively low value for α at stage 1 and to appoint a captain at stage 2. Whenever this happens, the retailer earns the expected profit $\bar{\pi}_r^* + \bar{\pi}_k^* - \bar{\pi}_i^* > \bar{\pi}_r^{NC}$.*

Proposition 4 illustrates that there are situations in which the retailer prefers to have a very biased captain, and in which the manufacturers compete fiercely to become captain (offering the retailer large fees).

5 Asymmetric manufacturers

Often retailers will pick manufacturers of leading brands to be their category captains. So far we have not been able to say anything about the retailer's incentive to appoint a leading manufacturer as its captain, as we have assumed that all manufacturers are ex ante symmetric. Assume therefore that, in the duopoly case, the manufacturers' demands are drawn from different supports. Specifically, assume that manufacturer 1's demand is uniformly distributed with density β^{-1} on $[1-\beta, 1]$, while manufacturer 2's demand is uniformly distributed (with density β^{-1}) on $[0, \beta]$, where we assume that $1/2 < \beta < 1$ (i.e., we assume the manufacturers' supports are overlapping).[8] We will also assume that $v = 1$ and $c = 0$, like we did in the example above.

Suppose initially that no captain is appointed. In this case the retailer picks a product on the basis of its wholesale price and expected demand only. Given that manufacturer 1 offers the highest expected quantity, $E[q_1] = (2-\beta)/2$, and 2 offers the lowest expected quantity, $E[q_2] = \beta/2$, the retailer will accept manufacturer 1's product as long as

$$(1-w_1)\frac{2-\beta}{2} \geq (1-w_2)\frac{\beta}{2}$$
$$\Updownarrow$$
$$w_1 \leq \frac{2(1-\beta)+\beta w_2}{2-\beta}$$

Thus, for any price $w_2 \geq 0$, manufacturer 1 is able to offer a price w_1 that is strictly positive (while still achieving distribution). The best that manufacturer 2 can do, is

[8] Note that these assumptions imply that the demand variance is the same for the two manufacturers, i.e. $Var(q_1) = Var(q_2) = \beta^2/12$.

therefore to offer the price $w_2^* = 0$. Manufacturer 1's best response (assuming the retailer adopts a tie-breaking rule in favor of manufacturer 1), is then the price

$$w_1^* = 2\left(\frac{1-\beta}{2-\beta}\right) > 0$$

In equilibrium, the retailer thus always sells the dominant manufacturer's product. Moreover, in equilibrium, manufacturer 1's expected profit is positive and equal to $\bar{\pi}_1^* = 1-\beta$, while the retailer's expected profit is $\bar{\pi}_r^* = \beta/2$, and manufacturer 2's expected profit is zero.

Proposition 5. *(No captain). In equilibrium with $n = 2$ asymmetric manufacturers, the wholesale prices are equal to $w_1^* = 2\left(\frac{1-\beta}{2-\beta}\right)$ and $w_2^* = 0$. The retailer will accept manufacturer 1's product, and the expected profits of the retailer and manufacturer 1 are $\bar{\pi}_r^* = \beta/2$ and $\bar{\pi}_1^* = 1-\beta$, while manufacturer 2's profit is zero.*

Next, consider the case in which a captain, k, is appointed with $\alpha < 1$. Similar to the case with symmetric manufacturers, the captain would like to recommend his own product (and have the retailer follow the recommendation) as long as his demand is above some threshold value,

$$q_k \geq \theta_k(w_i, w_k) \equiv \frac{\alpha E[q_i](1-w_i)}{w_k + \alpha(1-w_k)},$$

where $0 < \theta_k(w_i, w_k) < \bar{q}_k$ (as long as $0 \leq w_i < 1$ and $0 \leq w_k < 1$), and where $\frac{\partial\theta_k(w_i,w_k)}{\partial w_i} < 0$ and $\frac{\partial\theta_k(w_i,w_k)}{\partial w_k} < 0$, similar to the symmetric case. However, because the manufacturers' expected demands now differ, the threshold values θ_1 and θ_2 will also differ. Let $\hat{\theta}_k(w_i, w_k) = \max\left\{\theta_k(w_i, w_k), \underline{q}_k\right\}$. For given wholesale prices (w_i, w_k), the ex ante probability that the captain would like to recommend their own product is then equal to $\frac{\bar{q}_k - \hat{\theta}_k(w_i,w_k)}{\bar{q}_k - \underline{q}_k}$, while the probability that the captain would like to recommend the outsider's product is $\frac{\hat{\theta}_k(w_i,w_k) - \underline{q}_k}{\bar{q} - \underline{q}_k}$.

Similar to the case with symmetric manufacturers, the retailer will only accept the captain's advice to sell the captain's product, as long as

$$(1-w_k)\frac{\underline{q}_k + \hat{\theta}_k(w_i, w_k)}{2} \geq (1-w_i)E[q_i],$$

which again implies a threshold value for w_k, $\bar{w}_k(w_i)$, such that the retailer will accept the advice only as long as $w_k \leq \bar{w}_k(w_i)$. Because of the asymmetry between the manufacturers, however, the manufacturers threshold prices are typically different, i.e. we have that $\bar{w}_2(w) < \bar{w}_1(w)$ because $E[q_2] < E[q_1]$. Similar to the symmetric case, the captain's profit is always increasing in the price w_k, whenever the captain's own product is sold. Thus, the price $w_k = \bar{w}_k(w_i)$ is always optimal.

Note that, for positive but sufficiently low values of α, we may have $\theta_1(0, \bar{w}_1(0)) < 1 - \beta$, and thus $\hat{\theta}_1(0, w_1) = 1 - \beta$ for all $w_1 > \underline{w} > \bar{w}_1(0)$. In this case, the dominant manufacturer would always like to recommend their own product when he is captain. This situation is therefore equivalent to the situation without a captain, in which manufacturer 1 (the captain) offers the price $w_1^* = 2\left(\frac{1-\beta}{2-\beta}\right)$, while manufacturer 2 (the outsider) offers the price $w_2^* = 0$. However, having manufacturer 1 as captain may still be more profitable for the retailer (compared to not having a captain), as long as the manufacturers are actually competing to become captain.

Unfortunately, in the asymmetric case we are unable to obtain analytical solutions and to evaluate firms' profits as functions of α. We therefor have to rely on numerical evaluations. For example, by setting $\beta = 0.95$ we are able to verify (through numerical evaluation over a large number of α values, $\alpha \in (0, 1)$) that 1) the manufacturers will compete to become captain as long as α is below a certain threshold, 2) the retailer thus prefers to set a relatively low value for α (same as in the symmetric case), and 3) the dominant manufacturer will be the captain in equilibrium. Similar results can be obtained for different values of β. In fact, it seems like the retailer's optimal α value becomes even smaller as the asymmetry between the manufacturers grows (as β becomes smaller).

The intuition for these results is that the retailer is using the category captainship as a rent-shifting device. The dominant manufacturer always wins the bid to become captain, simply because he has more to lose from the rival being captain. Setting a low α, and letting the manufacturers compete to become captain, thus allows the retailer to extract more profits from the dominant manufacturer, which becomes more important as the asymmetry between the manufacturers grows bigger. Moreover, the efficiency cost of setting a low α becomes small as the asymmetry grows, because ex ante there is then a smaller chance that the retailer will pick the wrong product, all else being equal.

6 Conclusion

An inherent feature of most retail markets, and the grocery market in particular, is that shelf space is scarce. There are far more products offered by manufacturers than can be given shelf space in any particular store. Hence, choosing the best products in any given category is crucial for retailers. Moreover, suppliers often have private information about the demand potential for their products, information that retailers do not have. In these situations it may make sense for retailers to take advantage of this information by letting suppliers bid for the right to be a category captain who wil give advice to the retailers on which products to include in a given category. We have also provided evidence that manufacturers in fact do bid for captaincy, and may pay large sums of money for such a position.

The downside of appointing a captain is that the captain may be biased in favor of its own product, and both retailers and competitors fear that this may lead to inefficient stocking decisions. When better products are excluded from the market consumers are also hurt. This exclusionary theory of category captaincy is the one we most often hear about in antitrust cases involving category management.

The trade-off between exploiting the information advantages of a captain and the fear of inefficient exclusion of better products is the key focus in this paper. We have anlyzed a market where upstream manufacturers have private information about their products' demand potential, and where they face a retailer with limited shelf space in a category. The retailer can either pick which product to choose himself, or he can allow the manufactuerers to bid for the right to be the category captain. The category captain will give the retailer advice on which product to include in the category. If a captain is chosen, he can be incentivized to be more or less biased by a contract which gives the captain a smaller or larger share of the retail profit of the category.

We have shown that the retailer can always improve on his profit by allowing suppliers to bid for captaincy, and the larger manufacturer will always be chosen as the captain. We also show that even if the captain can be fully incentivized to give the retailer unbiased advice, the retailer may prefer not to do so. Instead, the retailer while seeking to maximize his profit may sometimes give the captain a contract that makes the captain biased in favour of recommending its own product in the category.

Our results have wide implications both for retail managers and policy. For managers our results provide specific guidance on when and how to use category captains, and how to incentivize them. For policymakers our research show that category captains in some circumstances may lead to inefficient exclusion of better products, and when this is likely to happen.

References

[1] Balto, D. (2002), Recent Legal and Regulatory Developments in Slotting Allowances and Category Management, Journal of Public Policy & Marketing, 21: 289-294.

[2] Bandyopadhyay, S., Rominger, A., and S. Basaviah (2009), Developing a Framework to Improve Retail Category Management Through Category Captain Arrangements, Journal of Retailing, 16: 315-219.

[3] Cachon, G. and M. Fisher (2000), Supply Chain Inventory Management and the Value of Shared Information, Management Science, 46: 1032-1048.

[4] Carameli, L. (2004), The Anti-Competitive Effects and Antitrust Implications of Category Management and Category Captains of Consumer Products, Chicago-Kent Law Review, 79: 1313-1356.

[5] Creane, A. (2007), Productivity Information in Vertical Sharing Arrangements, International Journal of Industrial Organization, 25: 821-841.

[6] Creane, A. (2008), Input Suppliers, Differential Pricing, and Information-Sharing Agreements, Journal of Economics & Management Strategy, 17: 865-893.

[7] Desrochers, D., G. Gundlach, and A. Foer (2003), Analysis of Antitrust Challenges to Category Captain Arrangements, Journal of Public Policy & Marketing, 22: 201-215.

[8] Dreze, X, Hoch, S., and M. Purk (1994), Shelf Management and Space Elasticity, Journal of Retailing, 70: 301-326.

[9] Dukes, A., Gal-Or, E., and T. Geylani (2011), Who Benefits from Bilateral Information Exchange in a Retail Channel, Economics Letters, 112: 210-212.

[10] Freedman, P., Reyner, M. and T. Tochtermann (1997), European Category Management: Look Before You Leap, McKinsey Quarerly, 156-164.

[11] Gal-Or, E., Geylani, T., and A. Dukes (2008), Information Sharing in a Channel with Partially Informed Retailers, Marketing Science, 27: 642-658.

[12] Gooner, R., Morgan, N., and W. Perreault (2011), Is Retail Category Management Worth the Effort (and Does a Category Captain Help or Hinder), Journal of Marketing, 75: 18-33.

[13] Guo, L. (2009), The Benefits of Downstream Information Acquisition, Marketing Science, 28: 457-471.

[14] Guo, L. and G. Iyer (2010), Information Acquisition and Sharing in a Vertical Relationship, Marketing Science, 29: 483-506.

[15] He, C., Marklund, J., and T. Vossen (2008), Vertical Information Sharing in a Volatile Market, Marketing Science, 27: 513-530.

[16] Klein, B. and J.Wright (2004), The Antitrust Law and Economics of CategoryManagement, American Law & Econnomics of Category Management, paper 55.

[17] Kurtulus, M. and L. Toktay (2005), Category Captainship: Who Wins, Who Loses?, International Commerce Review: ECR Journal, 5: 58-65.

[18] Kurtulus, M. and L. Toktay (2011), Category Captainship vs. Retailer Category Management Under Limited Retail Shelf Space, Production Operations Management, 20: 47-56.

[19] Leary, T. (2004), A Second Look at Category Management, address to the American Antitrust Institute.

[20] Li, L. (2002), Information Sharing in a Supply Chain with Horizontal Competition, Management Science, 48: 1196-1212.

[21] Li, L. and H. Zhang (2008), Confidenitialty and Information Sharing in Supply Chain Coordination, Management Science, 54: 1467-1481.

[22] Lindblom, A. and R. Olkkonen (2008), An Analysis of Suppliers' Role in Category Management Collaboration, Journal of Retailing and Consumer Services, 15: 1-8.

[23] Lindblom, A. Olkkonen, R., Ollila, P., and S. Hyvonen (2008), Suppliers' Roles in Category Management: A Study of Supplier-Retailer Relationships in Finland and Sweden, Industrial Marketing Management, 38: 1006-1013.

[24] Mittendorf, B, Shin, J. and D. Yoon (2013), Manufacturer Marketing Initiatives and Retailer Information Sharing, Quantitative Marketing and Economics, 11: 263-287.

[25] Morgan, N., Kaleka, A., and R. Gooner, (2007), Focal Supplier Opportunism in Supermarket Retailer Category Management, Journal of Operations Management, 25: 512-527.

[26] Nijs, V., Misra, K., and K. Hansen (2014), Outsourcing Retail Pricing to a Category Captain: The Role of Information Firewalls, Marketing Science, 33: 66-81.

[27] Niraj, R. and C. Narasimhan (2004), Vertical Information Sharing in Distribution Channels, mimeo.

[28] Steiner, R. (2001), Category Management: A Pervasive, New Vertical/Horizontal Format, Antitrust, Spring, 15: 77-81.

[29] Subramanian, U., Raju, J., Dhar, S., and Y. Wang (2010), Competitive Consequences of Using a Category Captain, Management Science, 56: 1739-1765.

[30] Wright, J. (2009), An Antitrust Analysis of Category Management, Supreme Court Economic Review, 17: 311-337.

[31] Zhang, H. (2002), Vertical Information Exchange in a Supply Chain with Duopoly Retailers, Production and Operations Management, 11: 531-546.