Effects of category management on producer-retailer relationships

Vincent Hovelaque [1] Louis-Georges Soler [2] Abdelhakim Hammoudi [2]

[1] UMR SMART INRA – AGROCAMPUS OUEST
65 rue de Saint Brieuc, CS 84215, 35042 Rennes cedex, France
hovelaque@agrocampus-ouest.fr

[2] UR ALISS INRA
65 bd de Brandebourg, 94205 Ivry sur Seine cedex, France
soler@ivry.inra.fr; hammoudi@ivry.inra.fr

Paper prepared for presentation at the 113th EAAE Seminar "A resilient European food industry and food chain in a challenging world", Chania, Crete, Greece, date as in: September 3 - 6, 2009

Effects of category management on producer-retailer relationships

Vincent Hovelaque [1] Louis-Georges Soler [2] Abdelhakim Hammoudi [2]

[1] UMR SMART INRA – AGROCAMPUS OUEST
65 rue de Saint Brieuc, CS 84215, 35042 Rennes cedex, France
hovelaque@agrocampus-ouest.fr

[2] UR ALISS INRA
65 bd de Brandebourg, 94205 Ivry sur Seine cedex, France
soler@ivry.inra.fr; hammoudi@ivry.inra.fr

Abstract: The relationships between retailers and producers are considered for understanding the determinants of quality, variety and prices. In the food sector, some issues have been extensively studied: impacts of private labels, supply contracts, price transmission. Despite an increasing role, the implementation of "Category management" (CM) has been less studied. CM belongs to a set of methods based on the concepts of Efficient Consumer Response and Supply Chain Management which have been widely implemented by large retailers and thus have changed the relationships among actors in the food chain. As a part of this evolution, Category Captain's concept (CC) involves a commitment between a retailer and one of the suppliers who receives decision-making power over the product category. Usually, the major of the food suppliers plays the CC's role in partnership with the retailers. In practices, CC raises many questions. What effects on the sales and prices? Is it beneficial for all the stakeholders, including the consumers? What are their consequences on the non captain suppliers? We propose a vertical relationship model considering that the retailer is the chain's leader (Stackelberg game). We compare a non-cooperative game (no CC) to a cooperative game (one supplier as CC). We analyse under which conditions CC improves the profit of each stakeholder, as well as the consumers' surplus. We show that the cooperative game is always a "win, win, win" game for stakeholders (but not necessary for consumers) if the two suppliers offer similar products. If products are different, we define the parameters relationships under which CC is beneficial for stakeholders and consumers.

Keywords Category captain, shelf space allocation, game theory, Stackelberg equilibrium.

1. Introduction

The relationships between retailers and producers are important to consider for understanding the determinants of quality, variety and prices. In the food sector, some issues have been extensively studied: impacts of private labels on the retailer/supplier competition; effects of various supply contracts on the profit sharing between stakeholders in chains; price transmission from upstream to downstream levels... Despite an increasing role in the producer-retailer relationships, the implementation of "Category management" (CM) has been less studied. "CM" belongs to a set of methods based on the concepts of Efficient Consumer Response and Supply Chain Management which have been widely implemented by large retailers and thus have changed the relationships among actors in the food chain. Linked tools bring improvements in supplier-retailer relationship, such as inventory drops, customer welfare increase, costs decrease...

As a part of this evolution, supermarkets have successfully engendered a competition among suppliers for "Category Captaincies". Category Captain's concept involves a commitment between a retailer and one of the suppliers who receives decision-making power over the product category. Usually, the major of the food suppliers plays the role of 'Category Captain' (CC) in partnership with the retailers, further weakening the position of secondary brand suppliers (Duffy & Fearne, 2007). The CC, in collaboration with the retailer, decides the share of the shelf-space allocated to the various products within the category, the prices and promotional actions, and where each brand must be located on the shelves. Such a method is based on the assumption that the suppliers have a better knowledge than the retailers about the consumers' preferences and are able to better organize the shelf-space in order to maximize the sales (Steiner, 2001).

CM practices raise many questions. What effects do they have on the sales and prices? Are they beneficial for all the stakeholders, including the consumers? Particularly, what are their consequences on the non captain suppliers? Some recent papers have proposed interesting models to answer these questions. For instance, some papers determine the optimal shelf space allocation (Bai & Kendall, 2008) and optimal prices (Rosenthal, 2008). Other ones propose a game-theoretic approach in a supplier and retailer brands' competing (Martin *et al*, 2005; Amrouche & Zaccour, 2009). However, in many of these papers, the analysis is based on the assumption that's the suppliers have the bargaining power in the chain.

As such an assumption is not always true in the food sector, we propose an analytical framework considering that the retailer is the chain's leader. In the first section of the paper, we describe some examples of CM methods implemented in the food sector. In the second section, we propose a vertical relationship model in which a retailer and two suppliers are involved. Each of the two suppliers offers a national brand product of the same category, but one of them plays the CC role. Considering that the retailer is the leader (Stackelberg game), we compare a non-cooperative game (no category captain) to a cooperative game (one supplier is a category captain).

In scenario 1, the retailer seeks to allocate her shelf space and to determine her prices so as to maximize her profit. The suppliers then react by choosing their developed unit wholesale prices. In scenario 2, a cooperative game is between one supplier and the retailer. They seek conjointly to allocate the shelf space and to determine the prices so as to maximize their joint profit. A Nash negotiation allows determining the wholesale price of the category captain. The non captain supplier reacts by determining her wholesale price. We then analyse under which conditions the cooperative game improves the profit of each stakeholder, as well as the consumers' surplus. We show that the cooperative game is always a "win, win, win" game for the suppliers and the retailer (but not necessary for consumers) if the two suppliers offer similar products (that is with the same crossed price elasticity). If products are different, we define the parameters relationships under which the category captain improves suppliers-retailer profits and consumers' surplus.

The economic environment in which retailers and suppliers operate has changed considerably in recent years. In consideration on innovation and change, food firms must respond to numerous disruptions, both internal and / or external. The increase of references, severe fluctuations in demand and the power of large retailers (in terms of packaging, delivery schedules, deadlines consumption ,...) impose on industry to question their relationships with suppliers and retailers, and consequently their logistical and organizational principles of production. Moreover, food chains are highly subject to the requirements of quality, safety and health.

The complexity of relationships with large retailers is reinforced by the specific nature of the food industry in the management of logistics flows (Treillon & Lecomte, 1996). Since the initial development of hypermarkets and supermarkets, difficulties in the supplier-retailer relationship has been established. In the 70's, new power relations have moved from producers to distributors, who wanted to keep low prices, encouraging volumes versus margins. During the 80's, the development of private labels has imposed new conditions in the relations. Starting 90's, the retailers concentration (mergers) has accelerated. Today in France, six distributors share about 80% of the food market, with an increase of hard discount channels.
In this new competitive environment, industrial policy could not only focus on lower costs but also on value-added rise. Food industry and distributors have thus become aware of the need to closely coordinate their activities to improve the consumer satisfaction. The realization of this collaboration then expressed through new concepts such as the ECR (*Efficient Consumer Response*) and SCM (*Supply Chain Management*). These concepts have lead to a large number of organisational structures and operational tools. The category management concept appears as the management of a set of distinct products that consumers consider complementary or substitutable in order to meet their needs (Steiner, 2001). In addition to the CM concept, Category Captain has emerged as the supplier who will be responsible for managing distributor shelves. He proposes new shelves allocation, selling prices, promotional plans.

The paper deals with this category captain concept and its effects on inventory policy and prices definition. With a mathematical approach, we compare two scenarii of prices and shelf space allocations with and without a category captain.

2. The model

Consider first all parameters and variables:

d_i	demand function for product i
p_i	retailer's price of product i
w_i	supplier's price of product i
c_i	supplier's production cost of product i
a	constant scale of market
b_i	price elasticity of product i
θ	crossed price elasticity
e	shelf space elasticity
s	shelf space share

We consider a classical model involving a retailer R and two suppliers S_i (i=1, 2) that offer a national brand product of the same category. We assume that the total capacity of the shelf space equals 1. Then, *s* denotes the share of shelf-space dedicated to product 1, and then (1-*s*) the share dedicated of product 2.

Following Amrouche and Zaccour (2007), we assume that the demand of each product increases with the shelf space. Then, demands take the following form:

$$q_1 = aes - b_1 p_1 + \theta(p_2 - p_1)$$
$$q_2 = ae(1-s) - b_2 p_2 + \theta(p_1 - p_2)$$

We assume that the retailer and two suppliers act regarding to their own profit, that is :

$$\Pi_R = (p_1 - w_1)q_1 + (p_2 - w_2)q_2$$
$$\Pi_i = w_i q_i$$

To illustrate our purpose, we compare one non-cooperative game (no category captain) to a cooperative game (S1 is the category captain).

In scenario 1, the game is played with the retailer as leader and the suppliers as follower. The retailer seeks to determine prices pi to maximize her profit with a given shelf space s (exogenous). The suppliers then react by choosing there unit wholesale prices w_i. In that case, wholesale prices w_i are exogenous.

In scenario 2, a cooperative game is developed between the supplier S_1 (category captain) and the retailer. They seek conjointly to determine prices p_i and shelf space *s* to maximize their joint profit. A Nash negotiation allows determining the wholesale price w_1. Supplier 2 (follower) then reacts by defining her wholesale price w_2. To take into account a negotiation power of S2, the shelf space share is computed such that her profit evolution is α ($\alpha > 0$).

To complete our notation, we add an index "ni" (situation 1) or "i" (situation 2) to each parameter that can change between the two models. The two procedures are then defined as follows:

Scenario 1 Non-cooperative game (no captain)

Exogenous parameters: w_{1ni}, w_{2ni}, a, e, b_1, b_2, θ, s_{ni}
The retailer optimizes her profit:

$$\underset{p_{1ni}, p_{2ni}}{Max}\ \Pi_R \Rightarrow p^*_{1ni}, p^*_{2ni} \text{ and then } q^*_{1ni}, q^*_{2ni}$$

Thus: $\Pi^*_{Rni}(p^*_{1ni}, p^*_{2ni})$, $\Pi_{1ni}(p^*_{1ni}, p^*_{2ni})$, $\Pi_{2ni}(p^*_{1ni}, p^*_{2ni})$

Scenario2 Cooperative game (S1 is captain)

Exogenous parameters: w_{1ni}, w_{2ni}, a, e, b_1, b_2, θ, s_{ni}

R and S_1 optimizes their joint profit $\underset{p_1,p_2}{Max}(\Pi_R + \Pi_{S_1})$

The wholesale price w_1 is determinated by a Nash negotiation:

$$Max\left\{(\Pi^*_{Ri}(w_1) - \Pi^*_{Rni}(k_1)) \times (\Pi_{1i}(w_1) - \Pi_{1ni}(k_1))\right\}$$

s_i such that $\Pi_{2i} - \alpha.\Pi_{2ni} = 0$

Thus: $\Pi^*_{Ri}(p^*_{1i}, p^*_{2i})$, $\Pi^*_{1i}(p^*_{1i}, p^*_{2i})$, $\Pi_{2i}(p^*_{1i}, p^*_{2i})$

All optimizations verify the classical first and second order conditions.
In the non-cooperative game, one obtains:

$$p^*_{1ni} = \frac{1}{2}\left(\frac{ae(\theta + s_{ni}b_2)}{\theta b_2 + b_1(\theta + b_2)} + k_1\right) \qquad q^*_{1ni} = \frac{1}{2}\left(aes_{ni} - k_1(\theta + b_1) + \theta k_2\right)$$

$$p^*_{2ni} = \frac{1}{2}\left(\frac{ae(\theta - (-1 + s_{ni})b_1)}{\theta b_2 + b_1(\theta + b_2)} + k_2\right) \qquad q^*_{2ni} = \frac{1}{2}\left(-ae(-1 + s_{ni}) + \theta k_1 - k_2(\theta + b_2)\right)$$

In the cooperative game, one obtains:

$$p^*_{1i} = \frac{1}{2}\left(\frac{ae\theta + b_2(ae(1 + (s_{ni} - 1)\alpha) - \alpha\theta k_1 + (\alpha - 1)(\theta + b_2)k_2}{\theta b_2 + b_1(\theta + b_2)}\right)$$

$$p^*_{2i} = \frac{1}{2}\left(\frac{ae\theta + \theta b_2 k_2 + b_1(-ae(s_{ni} - 1)\alpha + \alpha\theta k_1 - (\alpha - 2)(\theta + b_2)k_2}{\theta b_2 + b_1(\theta + b_2)}\right)$$

$$q^*_{1i} = \frac{1}{2}\left(ae(1 + (s_{ni} - 1)\alpha) - \alpha\theta k_1 + (\alpha\theta + (\alpha - 1)b_2)k_2\right)$$

$$q^*_{2i} = \frac{1}{2}\alpha\left(-ae(-1 + s_{ni}) + \theta k_1 - k_2(\theta + b_2)\right)$$

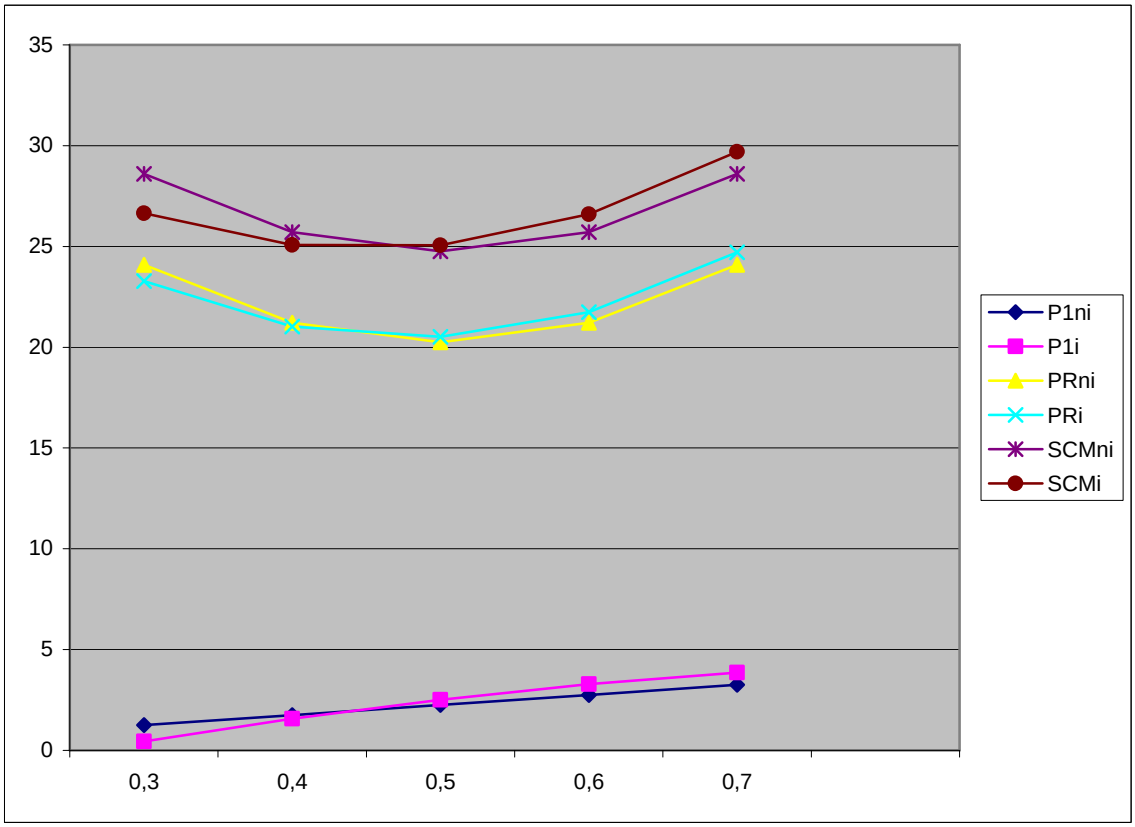
$$s_i = \frac{ae(1 + (s_{ni} - 1)\alpha) - \alpha\theta k_1 + (\alpha - 1)(\theta + b_2)k_2}{ae}$$

3. Analysis of results

In this part, we analyse the conditions which allows the cooperation (that is the profit of R and S1 increase) with $a = 10; b_1 = 0.5; b_2 = 0.5; \theta = 0.01; e = 1; \alpha = 0.9$.

Initial shelf space threshold

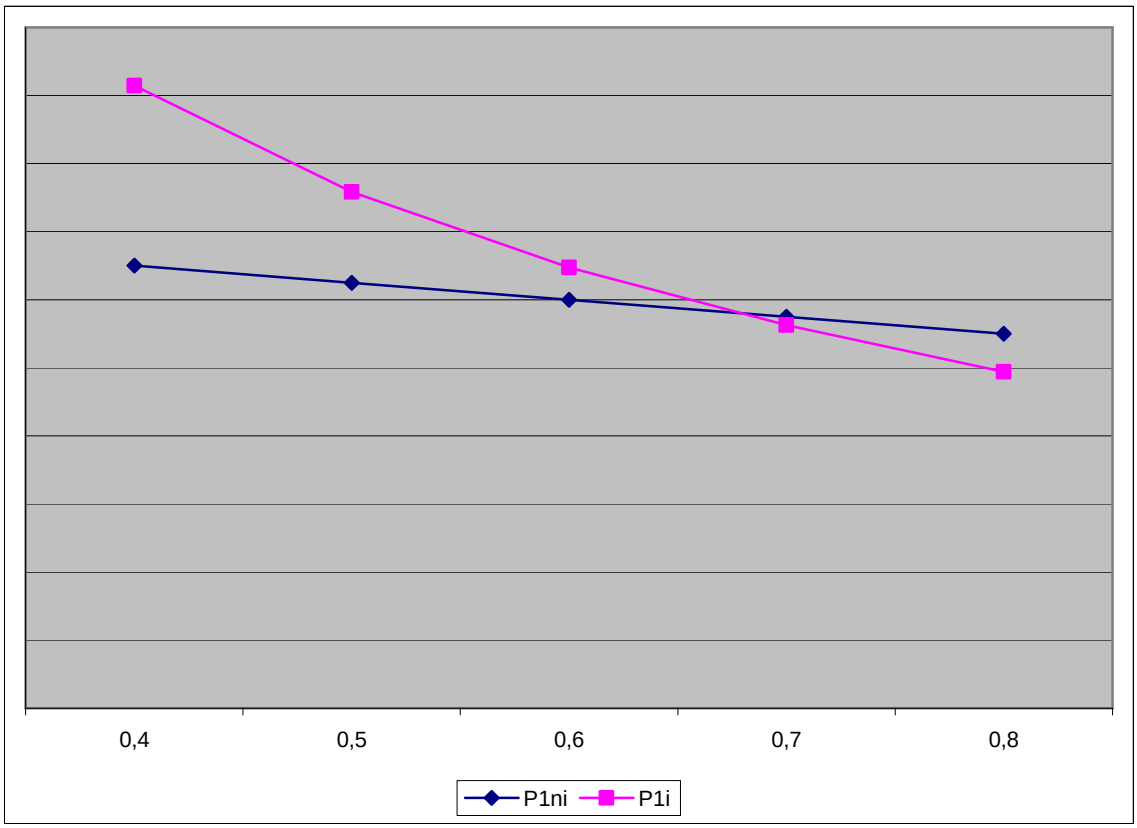
With $w_{1ni} = w_{2ni} = 1$, we obtain a minimal value s_{ni} that allows cooperation ($\Pi 1i > \Pi 1ni$)

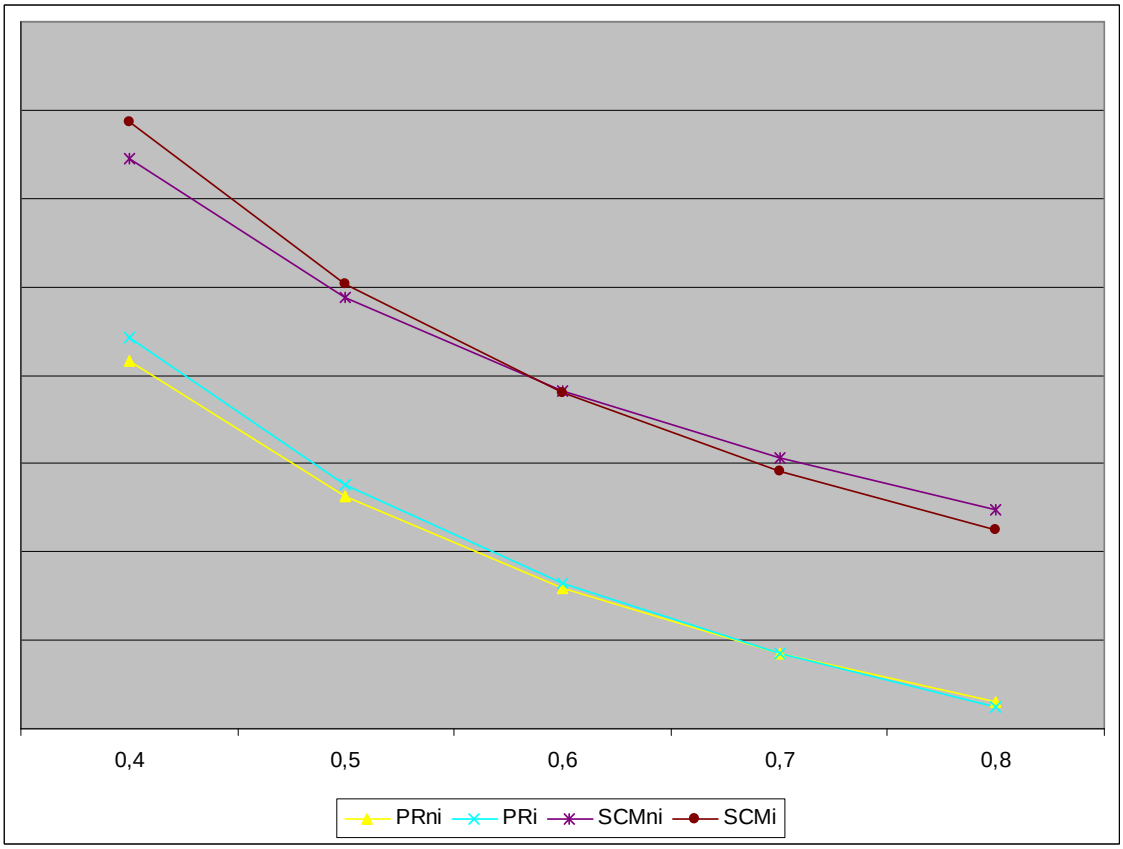


If we compare the profits obtained by retailer R and Supplier S1 before and after the implementation of the Category Captain organization, it appears that the retailer and the CC refuse the cooperation if the shelf space of S1 is too low in the initial situation. This threshold decreases with α (that is the negotiation power of the competitor S2 decreases).

Price elasticity threshold

With $s_{ni} = 0.5$, we obtain a maximal value β_i that allows cooperation ($\Pi 1i > \Pi 1ni$)





Once again, the behaviors of the retailer and the category captain depend on the price elasticity level of the products. Nevertheless, the total market (q_1+q_2) increases with the CC organization.

4. Concluding remarks

The category Captain organization is becoming a current practice in supply chain management which modifies the relationships between producers and retailers. In this paper, we proposed a first version of a model designed to assess the impacts of such an organization. Despite some limitations we will have to reduce in a future work, it allows to identify some conditions under which one supplier decides or not to accept the role of category captain. If we impose some condition on the competitor (with α), it appears that some parameter condition will influence the cooperation decisions of the retailer and the supplier designed as category captain.

References

Amrouche N., Zaccour G. (2007). Shelf-space allocation of national and private brands. European Journal of Operational Research, Volume 180, p. 648-663.

Bai R., Kendall G. (2008). A Model for Fresh Produce Shelf-Space Allocation and Inventory Management with Freshness-Condition-Dependent Demand. INFORMS Journal on Computing, vol 20, p. 78-85.

Duffy R., Fearne A. (2007). Partnerships and Alliances in UK Supermarket Supply Networks. in Food Supply Chain Management, eds Michael A. Bourlakis, Paul W. H. Weightmanp. Blackwell Publishing Ltd. p. 136-152.

Martin-Herran G., Taboubi S., Zaccour G. (2005). A time-consistent open-loop Stackelberg equilibrium of shelf-space allocation. Automatica, Vol 41, p. 971-982.

Steiner R.L. (2001). Category Management: A Pervasive, New Vertical/Horizontal Format. Antitrust, Spring, pp. 77-81.

Treillon R., Lecomte C. (1996). Gestion industrielle et entreprises alimentaires, Editions Lavoisier.