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Brief paper

Coordinating static and dynamic supply chains with advertising through two-part tariffs☆

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ABSTRACT

Zaccour (2008) analyses a marketing channel where firms invest in advertising to increase brand equity, showing that an exogenous two-part tariff cannot replicate the vertically integrated performance. I revisit the model proving that a multiplicity of efficient franchising contracts exists. I characterise an optimal two-part tariff specified as a linear function of the upstream firm's advertising effort, performing this task both in the static and in the dynamic games. An analogous result emerges both in the static game, writing the fixed component of the two-part tariff as a non-linear function of the manufacturer's advertising effort, and in the dynamic game, using a contract which is linear in the brand equity.

1. Introduction

The analysis of marketing channel behaviour is a core issue which has remained at the top of the research agenda in this field since the identification of the double marginalisation problem by Spengler (1950), showing that the strategic interaction along the channel affects individual as well as collective profits. Later on, the discussion has expanded to include market failure considerations connected to transaction cost economics and contractual incompleteness (Klein, Crawford, & Alchian, 1978; Williamson, 1971) and the hold-up problem affecting firms' investment incentives (Grout, 1984). The identification of coordination devices to correct the distortions generated by double marginalisation has been intensively investigated, generating solutions based on pull promotions (Gerstner & Hess, 1995), quantity discounts based on two-part tariffs (Ingene & Parry, 1995; Jeuland & Shugan, 1983; McGuire & Staelin, 1983) and cooperative advertising campaigns (Bergen and John, 1997). An updated account of the debate is in Ingene, Taboubi, and Zaccour (2012). Perhaps the most important aspect of this debate is how to specify the franchising contract so as to replicate the performance of a vertically integrated firm. While this is easily done if the only variable involved is price (or quantity), it becomes somewhat more intriguing if investments enter the picture, even more so if the model is dynamic. Indeed, it all boils down to specifying the equilibrium contract, including all the relevant features of the vertical relation along the supply chain. Can one write an efficient set of contracts safeguarding the firms' strategic incentives all along the channel? Or, is it possible to write a contract preventing the well known hold-up problem usually affecting vertical relations?

This paper nests into this research line, being connected to Zaccour (2008), where it is argued that a two-part tariff (TPT) allowing the channel to attain the efficient solution as an equilibrium of a decentralised game does not exist. This is claimed in a model in which two vertically related firms invest in an advertising campaign aimed at increasing goodwill, and both the static and dynamic versions of the problem are investigated. Using the same setup, I prove the existence of a multiplicity of optimal TPTs driving the channel to the efficient outcome. It is fair to add a few words in order to clarify at the outset the nature of the route I am about to take. In what follows, the fixed part of the tariff remains exogenous insofar as it does not affect the optimal choices of the downstream firm, while solving the problem of the upstream one. What differs from Zaccour's (2008) approach is that in the solutions investigated in the present paper the 'fixed' component of the tariff is a function of either the state variable or one of the manufacturer's controls, as this limited degree of endogenisation is in fact the *conditio sine qua non* to restore the manufacturer's investment incentive.

The research question, i.e., how to write the franchising contract so as to induce the marketing channel to replicate the performance of the integrated monopolist, may receive an answer along several different but ultimately equivalent lines. First, I propose a tariff

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whose fixed component is a linear function of the upstream firm's advertising effort.[2] If such a tariff is used in the franchising contract, the upstream firm can drive the supply chain to replicate the profits as well as the price and advertising strategies of a vertically integrated monopolist (and can appropriate the entire channel profits). I also show that the same result is obtained if the upstream firm commits to its own optimal share of the advertising campaign, provided that this effort be specified in terms of the demand and intertemporal parameters of the model. Additionally, the efficient outcome can also be achieved by specifying the fixed fee appearing in the TPT as a non-linear function of the manufacturer's investment, in two different but ultimately equivalent ways (in the static model). Finally, in the dynamic model the efficient outcome can be attained by defining the fixed fee as a linear function of the brand equity.

The remainder of the paper is organised as follows. Section 1 contains a sketch of the optimal TPT when only market variables are involved. The static model is investigated in Section 2, while the dynamic game (including the commitment case) in Section 3. Alternative solutions of the static and dynamic models are given in Section 4. Section 5 concludes.

2. The simplest two-part tariff model

Here I summarise the efficient use of TPTs as illustrated in Jeuland and Shugan (1983, 1988a,b) and Moorthy (1987). Consider a vertical relation between a manufacturer, M, and a retailer, R. The manufacturer operates at constant returns to scale with unit production cost $c > 0$, and no investment is carried out by either firm. Market demand is $Q = \beta - \alpha p$, and the unit price paid by the retailer is w. In such a case, the vertically integrated firm would attain monopoly profit $\pi_m = (\beta - \alpha c)^2 / (4\alpha)$, and the channel can replicate it by adopting a TPT $w = c + k/Q$: each unit is sold by the manufacturer at the marginal cost c but the retailer pays a fixed fee k as well, so that the TPT is in fact $cQ + k$, with k being the fixed component. If the latter is indeed set at the monopoly profit level, the retailer obtains $\pi_R = (\beta - \alpha c)^2 / (4\alpha) - k = 0$ and the manufacturer obtains $\pi_M = k = (\beta - \alpha c)^2 / (4\alpha)$. Hence, channel profits are the same as under vertical integration. This conclusion has been incorporated into the literature on vertical relations and supply chain coordination (Cachon, 2003; Ingene & Parry, 2004).

3. The static problem

The model is the same as in Zaccour (2008, p. 1234). Two firms belonging to a marketing channel may invest in advertising to increase goodwill; market demand is $Q = \beta + a_M + a_R - \alpha p$ where Q is the output level, p is the market price and α_M and α_R are the advertising efforts of the manufacturer and the retailer, respectively. Advertising involves a quadratic cost $C_i = a_i^2/2, i = M, R$, with the resulting profit functions being:

$$\pi_M = (w - c)\, Q - a_M^2/2; \qquad \pi_R = (p - w)\, Q - a_R^2/2, \tag{1}$$

while the vertically integrated firm's profit function is $\pi_{VI} = (p - c)\, Q - (a_M^2 + a_R^2)/2$. $c \in (0, \beta)$ is the constant marginal production cost, and w is the unit price at which the manufacturer sells the product to the retailer. Demand parameters α and β are both positive, with $\alpha > 1$ and $\beta > \alpha c$. Consider first the vertically integrated solution. The optimal triple is

$$p^* = \frac{\beta + c\,(\alpha - 2)}{2\,(\alpha - 1)}; \qquad a_M^* = a_R^* = \frac{\beta - \alpha c}{2\,(\alpha - 1)}, \tag{2}$$

which are admissible if parameters $\{\alpha, \beta, c\}$ satisfy the aforementioned conditions (cf. Zaccour, 2008, p. 1235). Equilibrium output and profits are $Q^* = \alpha\,(\beta - \alpha c) / [2\,(\alpha - 1)]$ and $\pi_{VI}^* = (\beta - \alpha c)^2 / [4\,(\alpha - 1)]$. What if the vertically separated firms try to replicate the performance of the vertically integrated one by resorting to a TPT defined as above, i.e., with an *exogenously given* fixed fee k? Doing so, the manufacturer's advertising incentive disappears altogether, a clearcut example of the hold-up problem. To see this, one proceeds by backward induction, maximising the retailer's profits π_R w.r.t. p and a_R, to obtain (superscript T stands for *two-part tariff*):

$$p^T = \frac{\beta + c\,(\alpha - 1) + a_M}{2\alpha - 1}; \qquad a_R^T = \frac{\beta - \alpha c + a_M}{2\alpha - 1} \tag{3}$$

that can be plugged into π_M together with $w = c$ to verify that $\pi_M = k - a_M^2/2$, so that the upstream firm's optimal advertising is nil. I am about to illustrate that there is more to it, as there exists a way of specifying the fixed component of the TPT allowing the channel to replicate the profits, output and advertising investment of the vertically integrated firm. To see this, write $k = x + y a_M$, that is, specify the fixed fee as a function of the manufacturer's advertising effort. In such a way, the fee remains 'fixed' in that it is not a function of output, but allows one to rewrite the upstream firm's profit function as $\pi_M = x + y a_M - a_M^2/2$, whereby $a_M^T = y$, requiring $y > 0$. If so, then the total channel advertising effort amounts to $a_M^T + a_R^T = [\alpha\,(2y - c) + \beta] / (2\alpha - 1)$ with $a_M^T + a_R^T = a_M^* + a_R^*$ at $y = (\beta - c\alpha) / [2\,(\alpha - 1)] = a_M^* = a_R^*$. This proves the following lemma.

Lemma 1. *If $y = (\beta - c\alpha) / [2\,(\alpha - 1)]$, the total advertising investment and its components along the channel replicate the behaviour of the vertically integrated firm.*

There remains to assess the profit performance and the distribution of such profits in correspondence of this particular specification of the TPT. Overall profits are $\pi_M^T + \pi_R^T = \pi_{VI}^* = (\beta - \alpha c)^2 / [4\,(\alpha - 1)]$ while the retailer's profits are

$$\pi_R^T = \frac{(\beta - \alpha c)^2\,(2\alpha - 3) - 8x\,(\alpha - 1)^2}{8\,(\alpha - 1)^2}. \tag{4}$$

Hence, setting $x = (\beta - \alpha c)^2\,(2\alpha - 3) / [8\,(\alpha - 1)^2]$, the manufacturer can appropriate the entire channel profits in correspondence of the efficient solution attained under vertical integration. This amounts to the following proposition.

Proposition 2. *At $y = (\beta - c\alpha) / [2\,(\alpha - 1)]$ and $x = (\beta - \alpha c)^2\,(2\alpha - 3) / [8\,(\alpha - 1)^2]$, the channel's performance is the same as the vertically integrated monopolist's, and $\pi_M^T = \pi_{VI}^*$.*

An ancillary but relevant remark is mentioned in the following corollary.

Corollary 3. *There exist infinitely many optimal contracts allowing the supply chain to perform efficiently, summarised by any pair $y = (\beta - c\alpha) / [2\,(\alpha - 1)]$ and $x \in \left\{x | \pi_R^T \geq 0\right\}$.*

The choice of the specific contract driving to zero the retailer's profits is the most advantageous for the manufacturer, which might instead leave the retailer with some positive (but arbitrarily small) profit ε by setting $\widehat{x} = x - \varepsilon$.

[2] Contracts of this kind are used by multiutility firms in Italy, which also pay considerable attention to informing consumers about such agreements to eliminate distortions along the channel, in order to enhance the credibility of the firms themselves. I warmly thank several managers of Hera Spa for enlightening me in this respect, without involving them in the responsibility of the contents of the paper.