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How Does Price-Sales Correlation Affect Vertical Restraints?

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Abstract

Based on the relation between prices and sales, this study investigates how manufactures coordinate advertising and resale price maintenance. A real options analysis shows that market power theory and product information theory can lead to divergent results. Advertising is likely to influence resale price maintenance through the market power effect and the product information effect. When the market power effect is dominant, advertising will discourage manufacturers from imposing resale price maintenance; the opposite is true when the product information effect is dominant. Whether advertising induces the adoption of resale price maintenance depends on how advertising impacts the relation between prices and demand quantities. This study provides implications for marketing managers and antitrust policy makers. Marketing managers can coordinate their strategies of advertising and resale price maintenance based on real options models in this study. For the antitrust policy makers, the real options model indicates the *per se* rule against resale price maintenance should be reconsidered.

Keywords: Advertising, Resale price maintenance, Real Options Analysis

JEL classification: M37; L42; G13

1. Introduction

Advertising provides information and establishes brand loyalty among consumers of advertised products. Resale price maintenance (RPM) specifies the final price that retailers charge consumers, serves to coordinate channel interests. Both of them are marketing practices that are used frequently. However, the topic of the relationship between advertising and RPM has rarely been studied. Exploring the theoretic basis of relationship between advertising and RPM provides implications for channel coordination, price rigidity and antitrust policymaking. In this article, we connect advertising and RPM by using the real options approach, to examine the effects of advertising on RPM.

Imposing minimum RPM is similar to getting a put option that reduces the downside risk of retail price. Advertising's effect on the correlation between retail prices and quantities will affect the option's value, further, influence manufacturers' incentives to impose RPM. In the theoretical literature, there are two dominant views of the role of advertising, which we will refer to as the "market power" and the "information" effects. Which effect is dominant could determine whether advertising encourages manufacturers to use RPM. The market power view of advertising is that it creates or augments the perceived degree of differentiation among brands. This will increase brand "loyalty" which, in turn, will reduce demand elasticity. The lower demand elasticity represents that the association between prices and sales is less negatively related and more positively related. Manufacturers are encouraged to use RPM because a price reduction does not generate sale quantities effectively. In contrast, the information view of advertising is that it provides information about the existence of a brand or about its quality. This leads to increased consumer awareness of attributes of available brands, reduced search costs and expanded consideration sets, which, in turn, results in more elastic demand. The higher demand elasticity represents that the sales quantities are more negatively related to prices. The incentives of manufacturers to use RPM are reduced because a price reduction can generate sale quantities effectively.

2. Literature review

2.1Advertising and Price Sensitivity

Models of advertising and their effects on price are based on two broad economic theories. One predicts that advertising reduces price elasticity and stabilizes price competition because firms use advertising to create brand loyalty and make consumers less sensitive to prices (Bain, 1956; Comanor and Wilson, 1974). This theory is supported by empirical research (Lambin, 1976; Popkowski-Leszczyc and Rao, 1989; Boulding et al., 1994). In contrast, the other theory regards advertising as a source of information about choices, thus increasing price elasticity by allowing consumers to comparison shop (Stigler, 1961; Nelson, 1974; Albion, 1983; Steiner, 1993). This theory is also confirmed by many empirical studies (Eskin and Baron, 1977; Wittink, 1977; Moriarty, 1983; Sethuraman and Tellis, 2002). Vanhonacker (1989) found a nonlinear relationship between price elasticity and advertising. By estimating an econometric model, he found that advertising first decreases price elasticity, and then increases it as advertising rises to a very high level. The nonlinear effect of information diffusion on price elasticity is also discussed in other studies (Simon, 1989; Parker, 1992; Parker and Neelamegham, 1997) which show price elasticity first declines and then ultimately increases over the life cycle of products.

2.2. Economics of RPM

The standard explanation for RPM is that manufacturers use it to protect downstream profits,

and induce dealers to provide services, quality certification, investment in relationship, stocks of inventory (Telser, 1960; Marvel and McCafferty, 1984; Klein and Murphy, 1988; Deneckere et al., 1997). Orbach (2008) indicates that the main purpose RPM in many cases is to preserve brand image. He provides many legal cases in which manufacturers argue that variations in retail prices hurt sales. These arguments examine RPM from a positive perspective and assume that a protected retail margin may increase product visibility and stimulate interbrand competition. However, critics were skeptical of the evidence supporting the service argument because RPM is used for a much wider variety of products than that service argument suggests (Mathewson, F. and Winter, 1998). There are opponents argue that RPM prevents consumers who do not value retailers' services from purchasing products at lower prices (Comanor, 1985). There is no assurance that the retailers protected by RPM would provide services to consumers. They may prefer to provide less service while keeping the high margin (Goyder, 1998). Conspiracy theory argues that RPM can be initiated by retailers to enforce a retail cartel, guaranteeing a high margin and preventing themselves from entering into competition (Bowman, 1955). Moreover, RPM might be used as a tool to facilitate collusion among manufacturers. RPM could eliminate manufacturers' incentives to reduce wholesale prices secretly, because such price cutting results in greater profits for retailers and lower profits for the manufacturers (Scherer and Ross, 1990).

3. Real Options Model

The real options approach is a useful methodology for the analysis of various investment projects under uncertainty. Black and Scholes (1973) and Merton (1973) showed how to value a financial option whose payoff is contingent on the value of the underlying asset. Brennan and Schwartz (1985) and McDonald and Siegel (1985) were the first to actually apply these insights to investment valuation, which is now known as 'real options' analysis. Dixit and Pindyck (1994) and Trigeorgis (1996) systematically introduced the importance of uncertainty to investment decisions. Some studies incorporate the real option approach into the research of marketing practices (Timothy and Patterson, 2004; Chen and Chen, 2007).

Adoption of RPM is analogous to getting a put option that reduces the downside risk of retail price, thus leading to stable factory price. The value of RPM is the same as that of the put option, which is the conditional expectation of price below minimum resale price. The correlation between the price and sales could affect options value. We assume that both retail price P and sale quantities Q follow geometric Brownian motions of the form

$$dP = (\mu_P - \delta_P)Pdt + \sigma_P PdW_P \tag{1}$$

$$dQ = (\mu_Q - \delta_Q)Qdt + \sigma_Q QdW_Q \tag{2}$$

where dW_P, dW_Q are the increments of Wiener processes with coefficient of correlation ρ, μ denotes the risk-adjust return, δ denotes the rate-of-return shortfall, σ denotes the variance parameter, assume $-1 \le \rho \le 1$, μ, δ, $\sigma > 0$, and the subscripts P and Q correspond to retail price and demand quantity processes, respectively. We also assume for convenience that the uncertainty over future value of P and Q is spanned by the capital market. Assuming complete market, the value of any contingent claim is given by the expectation respect to an equivalent martingale measure. Under the equivalent martingale measure, the price processes will be as above, but with the drift μ_P and μ_Q replaced by risk-free interest rate.

We emphasize that we let the correlation ρ be the function of advertising A:

$$\rho = \kappa A^{\phi} \tag{3}$$

where $\phi > 0$, and κ may be positive or negative. If $\kappa > 0$, it means that advertising makes the sale quantities are more positive related to prices; on the other hand, $\kappa < 0$ means that advertising makes sales quantities are more negatively related to prices.

The reason that we assume the retail price fluctuates stochastically is, without RPM, the retail price is set by retailers autonomously. If P fluctuates, the manufacturer's revenue fluctuates as well and generates operating risk. In practice, retailers often charge a certain percentage of retail price, so we let the one-unit revenue of manufacturers be πP, and that of retailers be $(1-\pi)P$, with $0<\pi<1$. If a manufacturer sets the minimum resale price at $\underline{P}$, its revenue per unit will be $\pi\underline{P}$. Suppose that the value of minimum RPM per unit sold is equivalent to a put option $H(\pi P)$, because minimum RPM and put option both serve the same function: eliminating downside risk of P. The value of $H(\pi P)$ can be derived by solving the differential equation:

$$\frac{1}{2}H''(\pi P)\sigma_P^2\pi^2 P^2 + (r-\delta_P)H'(\pi P_0)\pi P - rH(\pi P) = 0 \tag{4}$$

where $r > 0$ denotes the risk-free rate. In addition, $H(\pi P)$ must satisfy the following boundary conditions[1]:

$$H(\pi P) = (\pi\underline{P} - \pi P) \tag{5}$$

$$H'(\pi P) = -1 \tag{6}$$

The solution takes the form:

$$H(\pi P) = G(\pi P)^{\beta_1} \tag{7}$$

with

$$G = -(\pi\overline{P})^{1-\beta_1}\beta_1^{-\beta_1}(\beta_1 - 1)^{\beta_1 - 1} \tag{8}$$

$$\beta_1 = \frac{1}{2} - \frac{(r-\delta_P)}{\sigma_P^2} - \sqrt{\left[\frac{(r-\delta_P)}{\sigma_P^2} - \frac{1}{2}\right]^2 + \frac{2r}{\sigma_P^2}} \tag{9}$$

The value of minimum RPM in this period is $R = H(\pi P)Q$, and the expected present value of minimum RPM is $R/\delta_R = H(\pi P)Q/\delta_R$, where δ_R denotes the rate-of-return shortfall of R.

Imposing RPM requires costs including constructing a monitoring mechanism, and any other investments that convince retailers that the payoff is worth the investment. Although previous models assume the cost of RPM is zero, RPM is undeniably a costly process in reality. To impose and maintain RPM, manufacturers need to spend enormous amount on constructing a monitoring system to control the behavior of downstream members. We denote the cost of RPM by I in the rest of this article.

[1]Please see Dixit and Pindyck (1994) and Chen and Chen (2007).

Before imposing minimum RPM, manufacturers have the flexibility to wait. This flexibility to wait is similar to a wait option, which is denoted by $F(R)$, that gives manufacturers the right, but not the obligation, to choose when to pay an exercise price I and in return receive R/δ_R. $F(R)$ is valuable to manufacturers, unless the R rises above a critical threshold equal to $F(R)$ and I, at which point the manufacturer will not impose RPM. This is because once manufacturers undertake RPM, they give up not only I but also $F(R)$. We can determine a unique threshold R^* such that it is optimal to undertake RPM. $R > R^*$ implies that $R/\delta_R \geq F(R) + I$, the manufacturers will then impose RPM. If $R < R^*$, manufacturers will keep $F(R)$ and have no incentive to impose RPM. It is noteworthy that a higher R^* means less incentive for manufacturers to impose RPM.

According to standard arguments, the value of $F(R)$ is described by the differential equation:

$$\frac{1}{2}F''(R)R^2(\sigma_H^2 + \sigma_Q^2 + 2\kappa A^{\phi}\sigma_Q\sigma_H) + (r - \delta_R)F'(R)R - rF = 0 \quad (10)$$

To solve the threshold, $F(R)$ must satisfy the following boundary conditions:

$$F(R) = R/\delta_R - I \quad (11)$$

$$F'(R) = 1/\delta_R \quad (12)$$

The solution takes the form:

$$F(R) = KR^{\beta_2} \quad (13)$$

By substituting (13) into (11) and (12) and rearranging, the solution of RPM threshold is

$$R^* = I\delta_R \frac{\beta_2}{\beta_2 - 1} \quad (14)$$

where

$$\sigma_H = \beta_1\sigma_p \quad (15)$$

$$\delta_R = \delta_Q - r - \kappa A^{\phi}\sigma_H\sigma_Q \quad (16)$$

$$\beta_2 = \frac{1}{2} - \frac{r-\delta_R}{\sigma_H^2+\sigma_Q^2+2\kappa A^{\phi}\sigma_H\sigma_Q} + \sqrt{\left[\frac{r-\delta_R}{\sigma_H^2+\sigma_Q^2+2\kappa A^{\phi}\sigma_H\sigma_Q} - \frac{1}{2}\right]^2 + \frac{2r}{\sigma_H^2+\sigma_Q^2+2\kappa A^{\phi}\sigma_H\sigma_Q}} \quad (17)$$

From (14), a higher R^* means that the manufacturers have less incentive to impose RPM. In what follows, if the change of one parameter leads to a higher R^*, it indicates that this change will discourage manufacturers from imposing RPM. On the contrary, if the change of one parameter leads to a lower R^*, this change will encourage manufacturers to impose RPM. Figure 1 shows how advertising affects RPM. If advertising can increase correlation between prices and sales ($\kappa > 0$), advertising encourages manufacturers to use RPM, because the value of options (value of RPM) becomes higher if a price reduction results in a sales reduction. In contrast, if advertising can decrease correlation between prices and sales ($\kappa < 0$), advertising discourages manufacturers to use RPM because the demand for minimum price declines if price discounts become more effective in attracting sales.

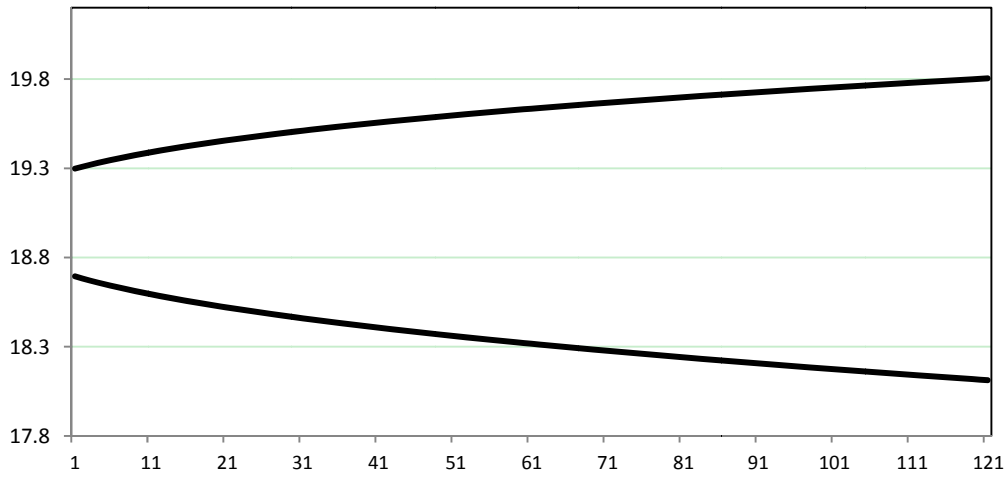

Figure 1. Effects of advertising on RPM

(Parameter value: $\phi = 0.4$, $r = 0.02$, $\pi = 0.8$, $\kappa = 0.4$, $\delta_P = 0.02$, $\delta_Q = 0.08$, $I = 200$)

Figure 2 shows that higher σ_P (more intrabrand price competition) encourages manufacturers to adopt RPM (threshold R^* is decreasing). The economical intuition is that imposing RPM is analogous to acquiring a put option that is designed to eliminate price downside risk. As intrabrand price competition intensifies, RPM becomes more valuable and more attractive to manufacturers. In addition, Figure 2 also shows that the incentive to use RPM become higher as advertising increases correlation between prices and sales. For example, the incentive to use RPM when $\kappa = 0.1$ is higher than when $\kappa = -0.1$ (threshold R^* when $\kappa = 0.1$ is lower when $\kappa = -0.1$).

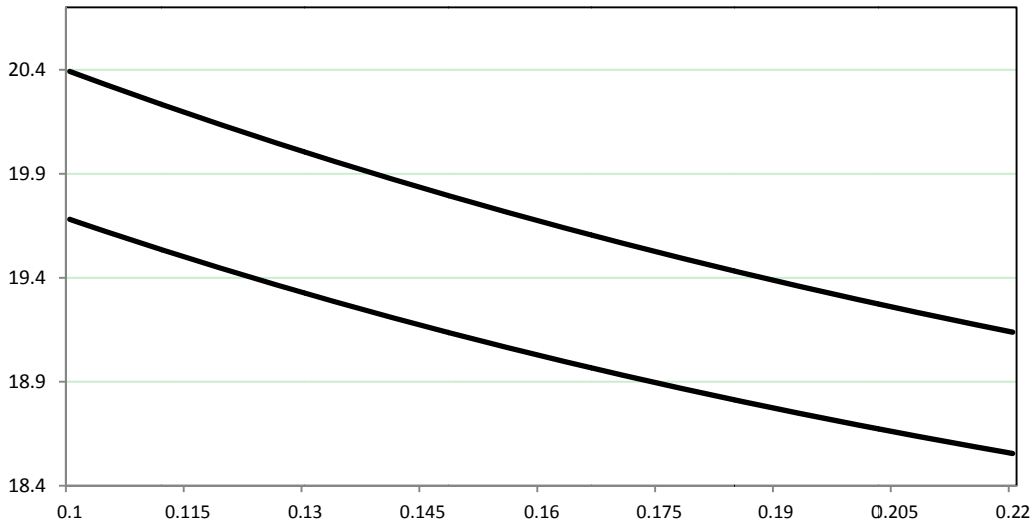

Figure 2. Effect of price competition and correlation on RPM

(Parameter value: $\phi = 0.4$, $r = 0.02$, $\pi = 0.8$, $\delta_P = 0.02$, $\delta_Q = 0.08$, $I = 200$)

4. Conclusions

For a manufacturer, imposing minimum RPM is analogous to purchasing a put option to reduce the downside risk of retail price. This study proposes that the main motivation behind RPM is to control the price downside risk, serving as a tool to alleviate the negative externality between manufacturers and retailers. The real options model allows us to examine the relationships between RPM and advertising. As the "market power" effect is dominant, advertising build brand loyalty and decreases price sensitivity. The lower price sensitivity represents that the correlation between price and sales is toward positive, and encourages manufacturers to use RPM. As the "information" effect is dominant, advertising expands consideration sets and increases price sensitivity. The higher price sensitivity represents that the correlation between price and sales is toward negative, and discourages manufacturers to use RPM. This study indicates that the marketing mangers should consider whether RPM should be used when they expand advertising expenditures. If advertising makes sales quantities more positively related to prices, marketing managers should use RPM otherwise advertising might be ineffective. Intrabrand price competition could make the sales generated by advertising less than expected. For antitrust policy makers, this study shows that applying the *per se* rule against RPM on all products might not be reasonable. Because if sale quantities are positively related to prices, RPM is necessary for manufacturers even the markets are very competitive.

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