The Influence of Efficient Consumer Response on Retailers Competition

Kyungdo Park
(College of Business Administration, Ewha Womans University)

Abstract: We examined the implications of a new grocery industry strategy, ECR, on retail competition and channel management in the context of a simple game theoretic model. Our main finding can be summarized in two results. First, we find that when two retailers are competing with each other, the introduction of ECR by both retailers is a Nash equilibrium. Thus, ECR, which is currently at an introductory stage, will be a prevalent strategy in the grocery industry. Second, we find that by introducing ECR, not only retailers but also manufacturers will get the benefit from ECR. This result justifies co-operation between manufacturers and retailers in the introduction of ECR.

Key words: Efficient Consumer Response. Retail competition

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I. Introduction

Recently, Efficient Consumer Response (ECR) has attracted a great deal of attention among practitioners in the grocery industry. ECR is a new strategy for the supermarket industry to meet ever-increasing competition, especially when other types of stores like wholesale clubs and mass merchants have started to compete with traditional grocery retailers. The main purpose of ECR is to reduce the operating cost of grocery stores by both retailers and manufacturers working together. One important element in the implementation of ECR is sharing the information between manufacturers and retailers using information technology. Implementation of ECR means drastic change for retailers and manufacturers and the relationship between them. It is generally believed that ECR will make the overall channel system more efficient and make grocery retailers more competitive by decreasing costs and increasing the retail margin.

Unfortunately, this belief about ECR has not yet been investigated by marketing researchers. We believe that industry-wide empirical research into the effects of ECR is not yet practicable because ECR is still at an introductory stage. However, in this paper, we try to explain the influence of ECR on channel systems by way of a game theoretic model.

The purpose of this research is to take a first step toward understanding the influence of ECR on retail competition and channel systems. More specifically, we try to answer the following questions: 1) How will retail competition change if some or all retailers introduce ECR? 2) Why should manufacturers cooperate with retailers in adopting ECR?'We believe that our research will help to achieve a better understanding of ECR, and help practitioners in the grocery industry, as well as marketing researchers, to gain some insight into the impact of ECR.

The industry structure we will focus on in this research is composed of one manufacturer and two competing retailers in a given market area. We treat the retailers' decision of whether or not to

introduce ECR endogenously, so that each retailer can decide whether to adopt ECR or not. Under this market structure, we will investigate three market scenarios: 1) when both retailers do not introduce ECR, 2) when one adopts ECR and the other does not, 3) when both adopt ECR.

We show that both retailers adopting ECR isa Nash equilibrium market condition. We also show that when ECR is introduced, retailers can lower retail prices due to the benefit from ECR. These lower prices stimulate greater demand and the retailer's profit will increase as a result of the adoption of ECR. The manufacturer can claim a share in the increase in the retailer's profit that results from ECR by increasing wholesale prices. Furthermore, the manufacturer will also benefit from expanded industry demand. Therefore, the manufacturer's profit will also increase if the retailer introduces ECR. As both manufacturers and retailers can share the benefit from ECR, they have an incentive to co-operate in the introduction of ECR and improve its performance.

This paper is organized as follows. In the following section, we investigate our three scenarios and derive the equilibrium prices and quantities under each scenario. In this section, we also pay attention to how the prices and quantities change under each scenario. In section 3, we derive a Nash eqilibrium market scenario and look at the comparative static to show how the benefit from ECR will influence theprices and quantities under a Nash eqilibrium market condition. In section 4, we summarize and conclude.

Ⅱ. Model

Let us first discuss what ECR is. In the late 1980s wholesale clubs and mass merchants emerged as a new threat to the supermarket industry because of their price advantage over traditional grocery retailers due to operating efficiency, economies of scale, etc. (Margolies 1995). In 1992, the grocery industry, alarmed by these new competitors, formed a task force and developed a recommendation to make supermarkets more competitive. The result of this effort was

called ECR. ECR is a grocery-industry strategy in which distributors and suppliers work closely together to bring better value to the grocery consumer (Kurt Salmon Associates, Inc). ECR focuses on the efficiency of the total grocery supply system, resulting in quicker deliveries, faster inventory turnaround, fewer stock-outs, fewer markdowns and lower inventory investment. The task force team for ECR suggested four strategies for the successful implementation of ECR: Efficient Store Assortment, Efficient Replenishment, Efficient Promotion, and Efficient Product Introduction.

ECR is still at an introductory stage but is a burning issue among grocery industry practitioners. They wonder whether or not they should adopt it and are not sure what change will take place if in fact they do adopt thisstrategy. Will it be beneficial enough to cover the investment? Do they have to introduce it before their competitors or wait until the competitors introduce it? Unfortunately, such burning questions are as yet unanswered by marketing research. The difficulties of ECR research are twofold: First, it is still in an initial stage and a new concept even among marketing researchers. Second, ECR is not just a kind of logistic system but it contains marketing, organizational and manufacturing issues that make itis difficult to deal with comprehensively.

In the pages that follow, we develop a simple model which relies on game theory to see how a grocery industry channel system will change because of this new strategy. As in many previous studies, the market underconsideration has a two-level channel structure, i.e., the manufacturer and the retailer levels. More specifically, the market structure we investigate consists of one manufacturer and two retailers, both of which receive one product from a common manufacturer.

We rule out the possibility of two-part tariffs that allow one party to capture all the profits of the other channel member. In the grocery industry on which we focus, assuming two-part tariffs is unrealistic.

As in most previous research (for example McGuire and Staelin 1983), we assume that the power balance between a manufacturer and retailers is skewed in favor of the manufacturer. This assumption is

particularly realistic in this research as big manufacturers like Proctor & Gamble have taken the initiative in introducing the ECR strategy to some of their retail partners. As a result, retailers initially introduce ECR with big manufacturers and subsequently extend it to other manufacturers.

In the Manufacturer- Stackelberg game, the manufacturer chooses the wholesale price using the response function of the two retailers, and the retailers determine the retail prices so as to maximize their profit given the wholesale price. Some previous research has used margin as a decision variable, for example Jeuland and Shugan(1983). We choose retail and wholesale prices as decision variables. However, the choice of decision variable would not change the implications of the result.

All the agents in the market behave as if they have perfect knowledge of the demand and the cost structures within the industry. This is a conventional assumption and even realistic in this research between the manufacturer and the retailer using ECR. Once the ECR relationship is established between the manufacturer and the retailer,they will share their own private information with each other to enhance the productivity of the overall channel system. On the other hand, as information sharing between manufacturers and retailers is one of the key elements of ECR, when ECR retailers compete with non-ECR retailers, non-ECR retailers could face a disadvantage. Further, our assumption that even non-ECR retailers also have perfect knowledge could distort the results. This is a one weakness in our model and further research is needed in this area.

For simplicity, we do not consider the marginal cost of production for the mauufacturer or the selling cost of retailers. This is typical in analytical modeling. Also, for the same reason, we use the most simple demand functions - symmetric linear demand functions - for both retailers. The demand function of a manufacturer is thus the sum of the two retailers' demand functions.

With the above described assumptions, we will analyze three scenarios: First, neither of the retailers introduces ECR and they each

compete with the other. Second, one retailer adopts the ECR strategy and the other does not. Third, both retailers adopt ECR. The first scenario is used as a benchmark to compare the results of the second and the third scenarios.

2.1. First Model: When both retailers do not introduce ECR

In the first model, neither retailer adopts the ECR strategy. Each retailer faces a downward sloping linear demand function written as:

$$Q_i=\alpha-\beta P_i+\gamma P_j \quad i,j=1,2, \quad j\neq i, \tag{1}$$

where Q_i is the quantity sold by the retailer i given his or her own price P_i and the price P_j of the other retailer. We assume that $\beta>\gamma>0$, $\alpha>0$ so as to ensure that make his or her own price elasticity of demand always exceeds his or her cross price elasticity of demand. The difference between β and γ represents the degree of substitutability, so that if $\beta-\gamma$ is smaller, the two products become more substitutable; therefore, price competition between the two retailers becomes more severe (Choi 1991).

Let W be the wholesale price of the manufacturer. Then the profit function of the manufacturer can be written as:

$$\Pi_M=W(Q_i+Q_j) \tag{2}$$

Therefore the demand function that the manufacturer faces is the sum of the demands of both retailers. The manufacturer should charge the same wholesale price to both of the retailers. Each retailer's profit function is:

$$\Pi_{Ri}^{N}=(P_i-W)Q_i, \quad i=1,2. \tag{3}$$

Each agent in the model has one decision variable: the manufacturer chooses the wholesale price W, which it charges to retailers, while each retailer decides its retail price P_i of the product.

The sequence of decisions is as follows: First, the manufacturer chooses its wholesale price considering the reaction functions of the two retailers to maximize their own profit. Then each retailer maximizesits profit by deciding its retail price given the wholesale price. The retailers' reaction functions, given the wholesale price W, can be derived from the first order conditions of each retailer's profit function given as

$$\frac{\partial \prod}{\partial P_1} = \alpha - 2\beta P_1 + \gamma P_2 + \beta W = 0, \quad (4)$$

for retailer 1 and

$$\frac{\partial \prod}{\partial P_2} = \alpha - 2\beta P_2 + \gamma P_1 + \beta W = 0, \quad (5)$$

for retailer 2. From (4) and (5), the reaction functions of the retailers can be derived as

$$P_1 = P_2 = \frac{\alpha + \beta W}{2\beta - \gamma}, \quad (6)$$

both of which represent the retail prices as functions of the wholesale price, W.

The manufacturer's wholesale price is derived by the following first order condition of the manufacturer's profit maximization problem:

$$\frac{\partial}{\partial W} \prod_M (P_1(W)), P_2(W, (W)) = 0. \quad (7)$$

We can obtain the equilibrium wholesale price from (7) and the retail price of each retailer from equation (6). The result of our first model is as follows.

The equilibrium wholesale price is

$$W^N = \frac{\alpha}{2(\beta - \gamma)}, \quad (8)$$

and the equilibrium retail price is

$$P_1^N = P_2^N = \frac{\alpha(3\beta - 2\gamma)}{2(2\beta - \gamma)(\beta - \gamma)}, \quad (9)$$

where the superscript N denotes that the ECR strategy has not been adopted by either retailer. The appendix summarizes the results, including other relevant quantities which are derived in a straightforward manner.

2.2 Second Model: When one retailer introduces ECR and the other retailer does not

The second model represents the situation where one retailer, say retailer 1, adopts the ECR strategy and the other retailer, say retailer 2, has not yet introduced the ECR strategy. We think this market situation (in which some retailers adopt ECR and the rest do not) describes the most prevalent situation in the current grocery industry. To reflect the benefit from the ECR strategy, we introduce an additional parameter δ in the profit function of the retailer who adopts the ECR strategy. The benefit of the ECR strategy, δ, mainly comes from cost savings as the channel system becomes more efficient. For example, reduced inventory holding costs, shorter lead time and lower administrative costs may result. However, the parameter δ includes other benefits resulting from ECR, such as benefits from developing better promotion, decreasing the chance of stock-out, well-executed category management, and efficient use of shelf space. Therefore, our model emphasizes that ECR is not just a money-saving logistics system, but an overall strategy for supermarket management.

By introducing the benefit parameter, δ, the profit function of the retailer which adopts the ECR strategy, retailer 1, becomes

$$\Pi_{MRi}^M = (P_i - W + \delta)Q_i,$$

Where δ is assumed to be greater than zero. However, the profit function of the retailer which has not yet introduced ECR, retailer 2,

remains the same as in section 2.2, written as:

$$\prod_{NRi}^{M}=(P_j-W)Q_j.$$

The demand functions of the retailers, regardless of whether they adopt ECR or not, are the same as in section 2-1. The profit function for the manufacturer also remains same as that in section 2.1.

By following a similar procedure, which is described in detail in section 2.1, we can obtain the following equilibrium wholesale and retail prices derived as:

$$W^N=\frac{\alpha}{2(\beta-\gamma)}+\frac{\delta}{4}, \tag{11}$$

$$P_{Ei}^N=\frac{\alpha(3\beta-2\gamma)}{2(2\beta-\gamma)(\beta-\gamma)}-\frac{\alpha(6\beta-\gamma)\delta}{4(2\beta-\gamma)(2\beta+\gamma)} \tag{12}$$

$$P_{Nj}^M=\frac{\alpha(3\beta-2\gamma)}{2(2\beta-\gamma)(\beta-\gamma)}+\frac{\beta(2\beta-3\gamma)\delta}{4(2\beta-\gamma)(2\beta+\gamma)},$$

where the superscript M makes it clear that one retailer is an ECR retailer E and N the other is not. The subscripts and show whether or not the retailer adopts ECR. The appendix summarizes the results, including other related quantities, which are easily derived.

By comparing the results of 2.2 with those of 2.1 in the Appendix, we can see the influence sof ECR on the channel system when the ECR retailer competes with the non-ECR retailer. First of all, we find that the ECR retailer's retail price goes down ($P_{Ei}^M-P_i^N<0$). However, due to price reduction, the ECR retailer can increase its market demand($Q_{Ei}^M-Q_i^N>0$). Because of this demand increase, the ECR retailer can increase his or her profit even though his or her retail price goes down($\prod_{Ei}^M-\prod_i^N<0$). Once a retailers adopts ECR, the manufacturer increases the wholesale price so as to share with retailers the increased profits which result from the adoption of ECR(W^M-W^N). Also, industry demand increases after one retailer adopts ECR.

Therefore, the manufacturer can increase profits through higher wholesale prices as well as increased industry demand. The above results show that both retailers and manufacturers have strong incentives to institute ECR, and a strategicalliance between retailers and manufacturers can be formed based on these profit incentives. In other words, adopting ECR is beneficial to both manufacturers and retailers insofar as both of them can increase their profits.

Whereas, the ECR retailer and the manufacturer enjoy the benefit of ECR, the non-ECR retailer faces a higher wholesale price. The higher wholesale price forces the retailer to increase its retail price. Correspondingly, increased retail price results in a fall in demand and, in the end, lower profits.

2.3 Third Model: When both retailers introduce ECR

Lastly, our third model examines the market structure in which two retailers, both adopting ECR, compete in a given market area. Therefore, both retailers can acquire the benefit of ECR and their profit functions become

$$\Pi_{Ri}^{M}=(P_i-W+\delta)Q_i$$

where $i=1,2$. The demand functions and the manufacturer's profit function remain unchanged from those of the previous models. By following the standard procedure of the Manufacturer-Stackelberg game (which is described in detail in section 2.1), we can get the wholesale and retail prices. The wholesale price is

$$W^{E}=\frac{\alpha+\beta\delta-\gamma\delta}{2(\beta-\gamma)},$$

and the retail prices when both retailers adopt ECR become

$$P_i^{E}=\frac{\alpha(3\beta-2\gamma)}{2(2\beta-\gamma)(\beta-\gamma)}-\frac{\beta\delta}{2(2\beta-\gamma)},$$

where the superscript E denotes that both retailers adopt ECR and the

subscript I means retailer 1 or retailer 2. Other relevant quantities are also given in the appendix.

Let us compare the results of this section withthe results of our benchmark model in section 2.1. The appendix summarizes the results. We can see that by introducing ECR, both retailers decrease their retail prices and the market demand for each retailer increases due to the lower retail price. Retailers'profits increase because of the increased demand. On the other hand, the manufacturer can increase the wholesale price to extract additional profit by introducing ECR and also enjoy the increased industry demand. Therefore, the profit of a manufacturer also increases after retailers introduce ECR.

One interesting result becomes apparent when we compare the results of this section with those of section 2.2 (when one retailer adopts ECR and the other doesn't). As a result of both retailers adopting ECR, we can see that the wholesale price goes up from the case in which only one retailer adopts ECR ($W^E - W^M > 0$). This happens because the additional profit obtained as a result of adopting ECR has been increased after both retailers adopt ECR. However, in the case of the retail price change, the difference in the retail price between our third model and the retail price of the ECR retailer in our second model, depends on the size of the parameters β and γ($P_i^E - P_{Ei}^M = \frac{\beta(2\beta-3\gamma)\delta}{4(2\beta-\gamma)(2\beta+\gamma)}$). Therefore, if $\beta > \frac{3}{2}\gamma$, then $P_i^E - P_{Ei}^M > 0$ and if $\gamma < \beta < \frac{3}{2}\gamma$, then $P_i^E - P_{Ei}^M < 0$. Let us recall that if $\beta - \gamma$ is smaller, the two products become more substitutable, therefore, price competition between the two retailers becomes more severe. That is, if competition between the two retailers is more severe, then P_i^E is lower than P_{Ei}^M, but if competition between the two retailers is less severe, then P_i^E is higher than P_{Ei}^M. Stated differently, if the competition is less severe, the ECR retailer can increase his or her retail price when the other non-ECR retailer decides to introduce ECR.

Ⅲ. Eauilibrium Analysis

In this section of the paper, we highlight the equilibrium results and investigate their implications. In the previous section, we examined three different scenarios: 1) Two non-ECR retailers compete with each other, 2) One ECR retailer competes with the other non ECR retailer, 3) Two ECR retailers compete with each other. If we treat the decision of adopting ECR endogenously, we can find a Nash equilibrium market condition. First, let us consider the first scenario: two non-ECR retailers compete with each other. In this case, either retailer can increase its profit by introducing the ECR strategy. If one of the retailers introduces ECR(which is our second scenario), the other non-ECR retailer can also increase his or her profit by adopting ECR. Therefore, the second scenario is also unstable. Finally, if both retailers introduce ECR, this condition becomes a Nash equilibrium. Our reasoning above can be summarized in the following proposition:

PROPOSITION 1: *When two retailers compete in a given market, the introduction of ECR by both retailers is a Nash equilibrium.*

Therefore, our research shows that ECR, which is still at an introductory stage, will be a prevailing strategy in the grocery industry.

The benefit from ECR increases as the level of the ECR implementation progresses. At the initial stage of ECR implementation, the benefit from ECR comes mainly from a decrease in store management costs such as ordering costs and inventory holding costs. As the ECR implementation progresses and the retailer adopts a higher level of ECR implementation, the benefit from ECR will increase. Therefore, it is meaningful to see comparative static at the Nash equilibrium condition of two ECR retailers competing with each other. The result of the comparative static is stated in the following proposition:

PROPOSITION 2: *When two ECR retailers compete with each*

other, as the benefit of ECR increase,

1) *The retail price will go down,*
2) *The wholesale price will go up,*
3) *The market demand will increase, and*
4) *The profits of both retailers and the manufacturer will increase.*

PROOF: From the result of section 2.3, we derive and $\frac{\partial P_i^E}{\partial \delta} < 0$, $\frac{\partial W^E}{\partial \delta} > 0$, $\frac{\partial Q_{Ri}^E}{\partial \delta} > 0$, $\frac{\partial \Pi_{Ri}^E}{\partial \delta} > 0$, and $\frac{\partial \Pi_M^E}{\partial \delta} > 0$.

As the benefit from ECR increases, retailers can lower their retail price. The lower retail price stimulates greater demand. As a result of increased demand, the retailer's profit will increase. On the other hand, the manufacturer can enjoy the increased benefit of ECR by increasing the wholesale price and from demand increase.

Ⅳ. Conclusion

We examined the implications of a new grocery industry strategy, ECR, on the retail competition and cannel management in the context of a simple game theoretic model. Our main finding can be summarized in two results. First, we find that when two retailers are competing with each other, the introduction of ECR by both retailers is a Nash equilibrium. Thus, ECR, which is currently at an introductory stage, is likely to become a prevalent strategy in the grocery industry. Second, we find that by introducing ECR, not only the retailers but also the manufacturers will benefit from ECR. This result justifies cooperation between manufacturers and retailers in the introduction of ECR.

It is generally believed that ECR can lower the costs of the manufacturer as well as those of retailers. The model we have proposed does not attempt to reflect the reduction in the manufacturer's costs. We do not believe additional insights can be

obtained by doing so. In this research, we rely on non-cooperative game theory. However, bearing in mind that cooperation between manufacturers and retailers plays an important role in the implementation of ECR, we believe that to solve this problem using cooperative game theory may prove to be a fruitful area for future research, which should also pay greater attention to the informational aspect of ECR.

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Appendix

1. First Model: When both retailers do not introduce ECR

$$W^N = \frac{\alpha}{2(\beta-\gamma)}$$

$$P_i^N = \frac{\alpha(3\beta-2\gamma)}{2(2\beta-\gamma)(\beta-\gamma)}$$

$$Q_{Ri}^N = \frac{\alpha\beta}{2(2\beta-\gamma)}$$

$$Q_M^N = \frac{\alpha\beta}{(2\beta-\gamma)}$$

$$\Pi_{Ri}^N = \frac{\alpha^2\beta}{4(2\beta-\gamma)^2}$$

$$\Pi_M^N = \frac{\alpha^2\beta(3\beta-2\gamma)}{2(2\beta-\gamma)^2(\beta-\gamma)}$$

2. Second Model: When one retailer introduces ECR and the other retailer does not

$$W^M = \frac{\alpha}{2(\beta-\gamma)} + \frac{\delta}{4}$$

$$P_{ERi}^M = \frac{\alpha(3\beta-2\gamma)}{2(2\beta-\gamma)(\beta-\gamma)} + \frac{\beta(6\beta-\gamma)\delta}{4(2\beta-\gamma)(2\beta+\gamma)}$$

$$P_{NRi}^M = \frac{\alpha(3\beta-2\gamma)}{2(2\beta-\gamma)(\beta-\gamma)} + \frac{\beta(2\beta-3\gamma)\delta}{4(2\beta-\gamma)(2\beta+\gamma)}$$

$$Q_{ERi}^M = \frac{\alpha\beta}{2(2\beta-\gamma)} + \frac{\beta(6\beta^2+\beta\gamma-6\gamma^2)}{4(2\beta-\gamma)(2\beta+\gamma)}\delta$$

$$Q_{NRi}^M = \frac{\alpha\beta}{2(2\beta-\gamma)} + \frac{\beta(2\beta^2+3\beta\gamma-\gamma^2)}{4(2\beta-\gamma)(2\beta+\gamma)}\delta$$

$$\Pi_{ERi}^M = \frac{1}{16(4\beta^2-\gamma)}\{2\alpha(2\beta+\gamma)+(6\beta^2+\beta\gamma-6\gamma^2)\delta\}$$
$$\{2\alpha(2\beta+\gamma)+\beta(6\beta^2+\beta\gamma-3\gamma^2)\delta\}$$

$$\Pi_{NRi}^{M}=\frac{\beta}{16(4\beta^2-\gamma^2)^2}\{2\alpha(2\beta+\gamma)+(6\beta^2+\beta\gamma-3\gamma^2)\delta\}^2$$

$$\Pi_{N}^{M}=\frac{\beta\{2\alpha+(\beta-\gamma)\delta\}^2}{8(\beta-\gamma)(2\beta-\gamma)}$$

3. Third Model: When both retailers introduce ECR

$$W^N=\frac{\alpha+\beta\delta-\gamma\delta}{2(\beta-\gamma)}$$

$$P_i^E=\frac{\alpha(3\beta-2\gamma)}{2(2\beta-\gamma)(\beta-\gamma)}-\frac{\beta\delta}{2(2\beta-\gamma)}$$

$$Q_{Ri}^E=\frac{\alpha\beta+\beta(\beta-\gamma)\delta}{2(2\beta-\gamma)}$$

$$Q_M^E=\frac{\alpha\beta+\beta(\beta-\gamma)\delta}{2(\beta-\gamma)}$$

$$\Pi_{Ri}^E=\frac{\beta\{\alpha+(\beta-\gamma)\delta\}^2}{4(2\beta-\gamma)^2}$$

$$\Pi_M^E=\frac{\beta\{\alpha+(\beta-\gamma)\delta\}^2}{2(\beta-\gamma)(2\beta-\gamma)}$$