Substitutes or Compliments Pricing Effect Modeling for Shipment Timing Decision-Making Support System

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Abstract. The purpose of the study is to develop comprehensive modeling alternatives for substitutes or compliments pricing effect and to compare the explanation power among alternatives. The first model is to explore the price level effect between substitutes or compliments. The second model is to investigate the price gap model between substitutes or compliments. The third model is to find the price gap model between substitutes or compliments with proportional price response. The fourth model is to explore the price gap model between substitutes or compliments with non-proportional price response. Final model is developed to produce the price gap and price level model with non-proportional price response. The researchers applied to the wholesale price data with four graded Fuji apple announced by SAMPC in Korea. The result showed that the modeling of the price gap between excellent grade and three lower grade apples with proportional response showed the highest adjusted R2 among five models.

Keywords: Substitutes Pricing Effect, Compliments Pricing Effect, Shipment Timing Decision-making Support System

1 Introduction

Farmers and wholesalers’ shipment decision-making from the warehouse to market is based on the price level in wholesale market. The price level at wholesale market for stored apple at a given period depends on the various variables such as the price level at the previous period, the total shipment volume at the previous period, the price level of substitute or product line, the price expectation effect, the holiday effect, the day-of-the-week effect and so on. Therefore, Shipment Timing Decision-Making Support System should faithfully incorporate the various variables [1]. However, among the variables, the price level of substitutes or compliments has been explored rare relative to the other variables in academic field. Especially, in agricultural industry, the empirical studies to explore the substitutes or compliments pricing effect found rare in academic field [2] [3].
The purpose of the study aims to develop comprehensive modeling for substitutes or compliments pricing effect and compare the explanation power among alternative modeling. The highest explanation power model for substitutes or compliments pricing will be included into STSS for stored apple.

2 Modeling

2.1 Data sets

The wholesale prices of apples used in this study were daily announcement sales and price data presented by the Seoul Agricultural & Marine Products Corporation (SAMPC) on on-line in Korea. Because prices of apples were depending on the type, grades, and package units of apple, Fuji 15kg apple with four grades were selected to be the subjects in the study. We regard the four grade apple as the substitutes or compliments. The data was collected from October 6 in 2012 to February 28 in 2013. The number of auction at a given period is 121 observations for four graded apple.

2.2 Modeling

Because price is subjectively recognized by buyer and seller, the substitutes or compliments pricing modeling should focus on the psychological aspect of pricing [4].

First, the researchers assume that the price level of the other grade apple at the previous period t-1 would directly affect the price level of the excellent grade apple at the period t.

\[ p_t = a + c_1 p_{t-1} \]  \hspace{1cm} (2-1)

where \( p_t \) = wholesale price at period t for excellent grade,  
\( p_{t-1} \) = average wholesale price at period t-1 for high, middle, and low grade or high grade  
and \( a \) and \( c_1 \) = parameters to be estimated

The reason of developing formula 2-1 is to explore the price level effect. The retail and wholesale price have the unpredictable fluctuation at daily, weekly, and monthly. Furthermore, each year has its own fluctuation pattern. In this regard, farmers and wholesalers always experienced subjective evaluation for the price level for everyday. For example, at the beginning of the season and the end of the season, the same price level gives the different psychological impact on wholesalers’ cognition for the price level. So, their shipment volume will vary depending on the price level and the season [4]. In this regard, the price level of the object will be affected by substitutes or compliments.

Second, the difference in price level between excellent grade and other grade at the previous period t-1 would affect the price level of the excellent grade apple at the
period t. The formula 2-2 is to ignore the price level effect. Regardless the price level, we assume that the price gap between the product and its substitutes or compliments will affect the price level of excellent grade. We got

\[ pt = at - c1 \ (pt-1 - p't-1) \]  

(2-2)

where, \( pt-1 \) = wholesale price at period t-1 for excellent grade.

The reason of developing formula 2-2 is to explore the price gap effect. Using the price gap modeling we can investigate several rival explanations for price gap effect on the dependent price level. If buyers choose more expensive apple, when the price gap is wider than ever, we can explain the phenomenon as price-quality effect. In this situation, buyers prefer the more expensive apple, because buyers have doubts to the cheap priced apple’s quality. The sign of the coefficient for formula 2-2 with this explanation will be appeared positive, vice versa.

Third, the ratio of the difference in price level between excellent grade and other grade at the previous period t-1 would affect the price level of the excellent grade apple at the period t. The formula 2-3 assumes that the reference price is the average price of three apple grades to evaluate the price level of excellent grade apple. We manipulated

\[ pt= at – c1 \ (pt-1 – p’t-1) / p’t-1) \]  

(2-3)

The rational of developing formula 2-3 is to explore the price gap effect and price level effect simultaneously. According to the reference price level, the price gap between the excellent grade and other grade apple will be recognized differently at individual and segment level.

Fourth, in many cases, it seems that small price changes cause under-proportional responses and big price changes produce over-proportional responses. For example, price reduction of less than 10% has no significant effect no sales, while the sales increase strongly when price reductions are more than 15% [5]. The hypothesis of non-proportional response to price changes is similar to Gutenberg hypothesis for price differentials between competitive products [6]. Relatively, farmers who stored apple would not response to small wholes price in comparison to big price gaps. Formally Gutenberg asserted that a sinus-hyperbolic function can generate the shape of the curve and non-proportional response to price gap. If we choose the relative price gap as the independent variable, we manipulated the price gap as the absolute gap or relative gap as follows.

\[ pt= at – c1 \ sinh (c2 (pt-1 – p’t-1)) \]  

(2-4)

\[ pt= at – c1 \ sinh (c2 (pt-1 – p’t-1) / p’t-1) \]  

(2-5)

Formula 2-4 and formula 2-5 can explore the price gap effect, price level effect, and price gap effect between objects with non-proportional price response simultaneously. On the other hand, formula 2-2 and 2-3 can be characterized as proportional price response model.
3 Results and Discussion

To apply the five rival explanation modeling to observations, the researchers conduct regression analysis. The results showed that five models showed the significant F-value. So, the researchers regard the five modeling as comprehensive model for substitutes or compliments effect. So, researchers can compare the explanation power among them, through which researchers can find more comprehensive model to include the STSS.

Table 1. Results of regression analysis from five models with average price for three apple grades

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>coefficinet ( t )</th>
<th>Standardized coefficients</th>
<th>( t )</th>
<th>( p )-value</th>
<th>F</th>
<th>Adjusted R(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p't-1 )</td>
<td>0.580</td>
<td>0.246</td>
<td>2.740</td>
<td>0.007</td>
<td>7.51</td>
<td>0.052</td>
</tr>
<tr>
<td>( pt-1 – p't-1 )</td>
<td>0.456</td>
<td>0.411</td>
<td>4.873</td>
<td>0.000</td>
<td>23.74</td>
<td>0.162</td>
</tr>
<tr>
<td>( (pt-1 – p't-1) / p't-1) )</td>
<td>13994.3</td>
<td>0.334</td>
<td>3.834</td>
<td>0.000</td>
<td>14.697</td>
<td>0.104</td>
</tr>
<tr>
<td>( \text{sinh} (c2 (pt-1 – p't-1)) )</td>
<td>536.89</td>
<td>0.340</td>
<td>3.917</td>
<td>0.000</td>
<td>15.341</td>
<td>0.108</td>
</tr>
<tr>
<td>( \text{sinh} (c2 (pt-1 – p't-1)) / p't-1) )</td>
<td>11242.05</td>
<td>0.324</td>
<td>3.710</td>
<td>0.000</td>
<td>13.76</td>
<td>0.098</td>
</tr>
</tbody>
</table>

Second, the direction of sign of coefficients is positive for five models. Formula 2-1 shows that the higher average price for three apple grade yields the higher price level for excellent price. The positive sign of the coefficients means that the relationship of the excellent grade and other grade is substitutes at the sample. The result of formula 2-2 to 2-5 appears that the price gap between the grades is increasing the price level of the excellent grade apple. This result implies that when the demand for the excellent grade apple is constant and the price level of lower grade apple is constant, if wholesalers want to increase the profit, they should set the excellent grade apple higher than before.

Third, the proportional response to gap in price level between excellent grade and average three grades at the previous period \( t-1 \) showed the higher effect on the price level of the excellent grade apple at the period \( t \) than in case of non-proportional response modeling. Adjusted R\(^2\) of proportional modeling is 0.162. The non-proportional modeling’s adjusted R\(^2\) is 0.108. That is, the proportional response modeling produces more explanation power than non-proportional modeling. The researchers assumed that because the price data was collected daily base market,
price level for excellent grade apple did not easily response to the width of price gaps between price level at period t and period t-1.

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