

Production Volume Effect on Daily Wholesale Price of Stored Apple for Shipment Timing Decision-Making Support System

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Abstract. The purpose of this study is to develop a forecasting model of daily wholesale price with macro and micro variables for a shipment timing support system for stored apples based on the transaction quantity and the wholesale price information announced by Seoul Agricultural & Marine Products Corporation's online system. This study identified two operational definitions for production volume and applied two variables to dynamic price forecasting modeling for stored apple at daily base, empirically. Researchers could conclude that the apple production volume at a given year affected the daily price level significantly.

Keywords: Apple's Product Volume Effect, Daily Apple Price, Shipment Timing Decision-making Support System

1 Introduction

The Shipment Timing Decision-making Support System (STSS) for stored apple is to help the farmers and wholesalers to decide when the stored apples should be shipped from the warehouse to market [5]. Variables used in the STSS were micro variables. Variables such as the total shipment quantity of apples at the previous day and apple's wholesale price at previous day had a decisive impact on the price of apples on the day under consideration at the micro perspectives.

However, if total supply increases when demand is constant, price decreases and if total supply decreases when demand is constant, price increases, as per traditional economic theory. Total quantity of apples traded on the Seoul Agricultural & Marine Products market and the average wholesale price of apples from 2009 to 2013 reports that the average wholesale price of apples increase in the years when the annual

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shipment quantity of apples decreases. However, we cannot conclude that two variables have the significant relationship statistically.

Nevertheless, if interpreted from macro perspectives, the report indicates that the wholesale price decreased when an increase in supply was expected owing to a good harvest in the relevant year, vice versa. In particular, wholesale prices increased significantly in 2012 when the quantity of annual accumulated shipments was small. Thus, a possibility that the total production of apples in a year was the variable that affected daily wholesale price of apples cannot be ruled out.

The study of production volume effect at a given year on wholesale price level from macro perspectives in practice, especially in agricultural industry, has been relatively rare. The researchers aimed to try to fill this gap by developing an integrated forecasting model of daily wholesale price with macro and micro variables for a shipment timing support system for stored apples.

2 Data and Modeling

2.1 Data

The dataset of this study is the same one used in the study on the construction of the STSS. Using the same dataset allows comparison of the differences between the existing study and this study. The wholesale prices of apples used in this study were from the daily announcement sales data released via on-line by the Seoul Agricultural & Marine Products Corporation. As prices of apples are different from varieties, grades, and package units, excellent grade Fuji apple of 15kg package was selected to be the subjects in this study [5]. The data was collected between October 14 in 2009 and May 24 in 2014. The number of auction observed was 1,224.

2.2 Modeling

In case of micro variable, the researchers used the same independent variables Kwak et al. used at aggregate level for excellent grade Fuji apple [6]. We expect that the results from this study can be compared with the results from the Kwak et al.'s results. In this study, independent variables included total apples' shipment quantity at the previous time $t(Q_{t-1})$, the wholesale price of excellent grade of Fuji apple at the previous time $t(p_{t-1})$, whether the time t is the previous week of Chuseok(Korean Thanks Giving day) or Lunar New Year's Day(BEFORE) or not, whether the time t is the next week of Chuseok or Lunar New Year's Day(AFTER) or not, the days elapsed after shipping of newly harvested apples(DAY), differences in prices between substitution's price level, High Grade Price level, during the last period, and the day-of-the week effects on apple price. The dependent variable is the wholesale price at time t . In case of the shipment quantity, we used total shipment quantity of apples at the auction day because we cannot divide the total shipment volume into the grade or apple type.

$$\begin{aligned} \text{Price}_t = & a_t + b_1Q_{t-1} + b_2p_{t-1} + b_3\text{BEFORE}_t + b_4\text{AFTER}_t + b_5\text{DAY}_t + \\ & b_6\text{DAY} * \text{DAY}_t + b_7\text{SangP}_{t-1} + b_8\text{Mon}_t + b_9\text{Tues}_t + b_{10}\text{Wends}_t + b_{11}\text{Thurs}_t \\ & + b_{12}\text{Fri}_t + b_{13}\text{Sat}_t + b_{14}\text{DayXCom}_t + b_{15}\text{Comulative}_{t-1}. \end{aligned} \quad (1)$$

Where a, b₁ to b₁₅ are parameters to be estimated.

In case of macro variable, this study identified two operational definitions for apple production volume at a given year and applied two variables to dynamic price forecasting modeling for stored apple at daily base, empirically. The first operational definition is the value of the number of days elapsed after the day of first shipment of apples multiplied by the accumulated number of shipments in the period from the day of first shipment to the last elapsed day. This variable will enable apple buyers at the wholesale market to estimate the quantity in storage and the total yield of apples in that year. The second operational definition is the accumulated shipments sent to the market until the day before the applicable day. This is because if the yields are small, the accumulated number of shipments will also be small.

3 Results

We applied the transaction data into formula (1) and estimate the coefficients for each independent variable. The R-square of the modeling was 0.722. The Wald value shows all the independent variables significantly affected the wholesale prices of excellent grade apples during the period (p<0.01) except substitution price effect.

The results are as follows; First, the previous auction quantity, Q_{t-1}, negatively affects the price level at period t (p<0.01). This is normal phenomenon. If the quantity of the auction at a single day for apple was higher, the wholesale price level for Fuji 15kg at excellent grade was lower. Second, the previous auction price level, P_{t-1}, positively affects the price level at time t, P_t, significantly. That is, if the apple's price level was higher at the previous day, the wholesale price level for Fuji 15kg at excellent grade is higher at the relevant day. Third, if BEFORE_t is the previous week of Chuseok or Lunar New Year's Day, BEFORE_t affects the wholesale price level of stored apple. AFTER_t is the next week of Chuseok or Lunar New Year's Day. AFTER_t does affect the wholesale price level of stored apple. Fourth, the high grade Fuji's price was not appeared as substitution fruit for excellent grade Fuji. Fifth, the number of days elapsed after shipping of newly harvested apples affected the apple's price level as quadratic equation formation, significantly. Sixth, among the purchase timing effect, the day-of-the-week effect can be found from the data set. The results showed that, when shipped by the order of Monday, Wednesday, Friday, Thursday, Tuesday, and Saturday, the apples can be sold with higher prices, significantly (Wald test=70.76, p=7.40E-14). Monday recorded the highest price while Saturday recorded the lowest price. Seventh, the value of the number of days elapsed after the day of first shipment of apples multiplied by the accumulated shipments in the period from

the day of first shipment to the last elapsed day did not have a significant effect on the dependent variable. On the other hand, the accumulated shipments had a significant negative effect on the wholesale price of apples (Wald=4.39, $p=0.036$). Sign of the accumulated shipments was negative. In other words, wholesale price increased when the accumulated shipments decreased.

4 Conclusion

Though many studies have identified the variables affecting the wholesale price level of stored apple at the micro perspectives, the report of production volume effect at a given year on wholesale price level at macro perspectives in practice, especially in agricultural industry, has been relatively rare. The researchers aimed to try to fill this gap by developing a forecasting model of daily wholesale price with macro and micro variables for a shipment timing support system for stored. The result of the empirical study showed that the cumulative shipment quantity negatively affected the wholesale price level of stored apple significantly.

This result is comprehensive and empirical proof that annual apple yield, which is a macro variable, has an impact on daily pricing of apples for the wholesale market. However, the affecting power of the total yield of apples is relatively weak compared with the macro variable. Accordingly, a period in which total yields do not have an impact on the wholesale price of apples can be predicted. Future studies need to divide a year into two periods, on in which total yields affect the wholesale price level and the other in which they do not.

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