A Study of the Effect of Production Volume on the Wholesale Price of Apple

Youngsik Kwak\textsuperscript{1}, Yoonsik Kwak\textsuperscript{2} and Yoonjung Nam\textsuperscript{3*}

\textsuperscript{1}Department of Venture and Administration, Gyeongnam National University of Science and Technology
\textsuperscript{2}Department of Computer Engineering, Korea National University of Transportation
\textsuperscript{3}Department of Hotel and Tourism Management, Woosong University
\textsuperscript{1}yskwak@gntech.ac.kr, \textsuperscript{2}yskwak@ut.ac.kr, \textsuperscript{3}yjnam@wsu.ac.kr

Abstract

At the micro perspectives, many studies have identified total shipment quantity, wholesale price at previous day, national holiday effect, as the variables affecting the wholesale price level of stored apples. However, the report of production volume effect at a given year on wholesale price level from the point of 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. The result of this study shows that annual apple yield has an impact on daily pricing of apples for the wholesale market. This study contributes to the daily price forecasting model with an empirical result that macro variable such as accumulated shipments needs to be included in the STSS modeling.

Keywords: Product Volume Effect, Daily Wholesale Price, STSS

1. Introduction

STSS(;The Shipment Timing Decision-making Support System) for apple farmers and wholesalers is subjected to decide the optimal time to ship from warehouse to market. In previous studies of STSS have micro variables. At the micro perspectives, many researchers have identified the variables affecting the wholesale price level of stored apples such as the total shipment quantity of the apples at previous day, apple’s wholesale prices at previous day, national holiday effect, the days elapsed after shipping of newly harvested apples, substitution price level of apples, the day-of-the-week effects and so on. This is because the wholesale price of the apples that STSS sought to forecast was daily wholesale price. In other words, 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.

However, as per traditional economic theory, if total supply increases when demand is constant, price decreases and if total supply decreases when demand is constant, price increases. Table 1 shows the total quantity of apples traded on the Seoul Agricultural & Marine Products market and the average wholesale price of apples from 2009 to 2013. It shows the average wholesale price of apples increase in the years when the annual shipment quantity of apples decreases. However, we cannot conclude that two variables have the significant relationship statistically.

* Corresponding author, Woosong University, yjnam@wsu.ac.kr
Table 1. Annual Wholesale Price and Traded Quantity of Apples in 2009 to 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Average wholesale price of excellent grade Fuji</th>
<th>Average Daily shipment volume of apple</th>
<th>Cumulative shipment volume of apple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 2011 – Aug. 2012</td>
<td>82,652 KRW</td>
<td>100 ton</td>
<td>25997 ton</td>
</tr>
</tbody>
</table>

If interpreted from a macro perspective, Table 1 indicates that the wholesale price decreased when supply was expected to increase. In particular, wholesale prices increased significantly in 2012 when the quantity of annual accumulated shipments was small as figure 1 also shows. Therefore, researchers couldn’t rule out the possibility that the total production of apples in a year was the variable that affected daily wholesale price of apples. In traditional economic theory, Table 1 and Figure 1, there is a basic premise that all the apple wholesalers and farmers know the quantity supplied at a given year before wholesale price of the apples be made. However, the study that empirically investigates this premise has been rare.

The purpose of this study is to explore the production volume effect at yearly base on daily wholesale price level of stored apples at the macro perspectives. Many researchers have identified the variables affecting the wholesale price level for stored apple such as total apples’ shipment quantity at yesterday, apple’s wholesale price at yesterday, national holiday effect, the days elapsed after shipping of newly harvested apples, substitution price level for apple, the day-of the week effects and so on at the micro perspective. However, the report of production volume effect at a given year on wholesale price level from the point of macro perspectives in practice, especially in agricultural industry, has been relatively rare. This study aims to try to full this gap by developing an integrated forecasting model of daily wholesale price with macro and micro variables for a shipment timing support system of stored apples.
2. Data and Modeling

2.1. Data

The dataset used in this study is the same as that used in the study on the construction of the STSS. Use of the same dataset allows comparison of the results’ differences between the existing study and this study.

The resource of the apples’ wholesale prices data used in this study is from the daily announcement sales data released by the Seoul Agricultural & Marine Products Corporation through on-line. Because prices of apples are different in the levels of variety, grade, and package unit, researchers selected excellent graded Fuji in 15kg package as the subjects in this study. The data between October in 2009 and May in 2014 was collected for the analysis. The number of days when the wholesale prices of the apples were released was 1,224.

2.2. Modeling

For choosing micro variables, the researchers used the same independent variables Kwak et al. used at aggregate level for excellent grade Fuji apple. It is expected that the results of this study can be compared with that of Kwak et al.’s study. In this study, independent variables included total apples’ shipment quantity at the previous time \( t \) (\( Q_{t-1} \)), the wholesale price of excellent grade 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, price level of the High Grade (lower grade of excellent grade) apple, 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 for auction day as it is not possible to divide the total shipment volume into the grade or apple type.

\[
\text{Price}_t = a + b_1 Q_{t-1} + b_2 p_{t-1} + b_3 \text{BEFORE}_t + b_4 \text{AFTER}_t + b_5 \text{DAY}_t + b_6 \text{DAY} \times \text{DAY}_t + b_7 \text{SangP}_{t-1} + b_8 \text{Mon}_t + b_9 \text{Tues}_t + b_{10} \text{Wends}_t + b_{11} \text{Thurs}_t + b_{12} \text{Fri}_t + b_{13} \text{Sat}_t + b_{14} \text{DayXCom}_t + b_{15} \text{Cumulative}_{t-1}.
\]

Where $a$, $b_1$ to $b_{15}$ are the parameters to be estimated. (1)

For macro variables, this study provides two operational definitions for apple production volume at a given year and applies two variables empirically to dynamic price forecasting modeling of stored apple at daily base. 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.

Formula 1 is based on the premise that two macro variables affect daily wholesale price. In other words, the basic premise is that all players at wholesale market know production volume, the quantity sold, and the consequent total stock of apples.

3. Results

The transaction data was applied into formula 1 and estimate the coefficients of each independent variable. The $R^2$ of the modeling was 0.722. The Wald value shows all the independent variables significantly affected the wholesale prices of excellent grade Fuji apples during the period ($p<0.01$) except substitution price effect.

Table 2 shows the results and from this, eight analytical results could be found as follows. First, coefficient value of intercept is 14868 which is significant. It means that minimum price of excellent grade Fuji apple in 15kg package can be 14868KRW. In other words, intercept value can be a ground for decision making of apple production volume in comparing with production cost.

Second, 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. In other words, wholesale price at a given day is made based on the quantity traded at previous day.
Table 2. Results of Regression Analysis for STSS Modelling

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Coefficients</th>
<th>Wald</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>14868.32</td>
<td>57.92</td>
<td>2.70E-14</td>
</tr>
<tr>
<td>Q_{t-1}</td>
<td>-21.74</td>
<td>19.34</td>
<td>1.10E-05</td>
</tr>
<tr>
<td>p_{t-1}</td>
<td>0.76</td>
<td>1372.86</td>
<td>1.70E-300</td>
</tr>
<tr>
<td>BEFORE</td>
<td>2367.76</td>
<td>9.22</td>
<td>0.0024</td>
</tr>
<tr>
<td>AFTER</td>
<td>-2568.15</td>
<td>14.93</td>
<td>1.10E-04</td>
</tr>
<tr>
<td>DAY</td>
<td>78.28</td>
<td>9.01</td>
<td>2.70E-03</td>
</tr>
<tr>
<td>DDAY</td>
<td>-0.16</td>
<td>9.50</td>
<td>0.0021</td>
</tr>
<tr>
<td>SangP_{t-1}</td>
<td>0.02</td>
<td>0.50</td>
<td>0.48</td>
</tr>
<tr>
<td>Monday</td>
<td>4312.49</td>
<td>170.76</td>
<td>7.10E-14</td>
</tr>
<tr>
<td>Tuesday</td>
<td>-1455.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td>1111.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td>-347.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td>781.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td>-4402.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DayXCom</td>
<td>-0.16</td>
<td>0.103</td>
<td>0.75</td>
</tr>
<tr>
<td>CumQ</td>
<td>-0.22</td>
<td>4.39</td>
<td>0.036</td>
</tr>
</tbody>
</table>

Third, 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. When the apple’s price level was high at the previous day, players at wholesale market can expect higher level of the wholesale price of apple at the relevant day and then players with stored apples would be motivated to release.

Fourth, if BEFORE_{t} is the previous week of Chuseok (Korean Thanksgiving Day) 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. Therefore, releasing the stored apple in the seasons of Chuseok or Lunar New Year would be profitable, while refraining from releasing is needed after the two seasons when the wholesale price decrease. This result proves empirically the general thoughts that the price of apple increases before the two traditional holiday seasons in Korea.

Fifth, the price of high grade Fuji which is the lower level product than excellent grade Fuji apple was not appeared as substitution fruit for excellent grade Fuji. This result tells that the wholesale price of high grade apple which is in lower category than excellent grade apples
are in doesn’t affect that of excellent grade apple, therefore empirical analysis with the wholesale prices of the apple in other grade or other fruit in other category is needed.

Sixth, the number of days elapsed after shipping of newly harvested apples affected the apple’s price level as quadratic equation formation, significantly. This result empirically proves that the wholesale price of apple increase right after shipment and decrease after a certain period of time. Therefore, stored apples are needed released while the wholesale price takes upturn.

Seventh, among the purchase timing effect, the day-of-the week effect can be found from the dataset. The results showed that, the apples can be sold with higher price significantly when shipped by the order of Monday, Wednesday, Friday, Thursday, Tuesday, and Saturday (Wald test=70.76, p=7.40E-14). Monday recorded the highest price while Saturday recorded the lowest price. This result empirically proves general thoughts on the day of the week effect to price level. With this result, stored apples are needed to be released on Monday as much as possible. As the wholesale price is formed in low level on Saturday, on the other hand, it is needed to refrain from shipment of stored apples.

Finally, 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. That is to say, wholesale price increased when the accumulated shipments decreased. This result shows two insights that only the accumulated shipments affect the daily wholesale price after the day of first shipment of apples while the interaction between the number of days elapsed after the day of first shipment and the accumulated shipments don’t affect daily wholesale price.

4. Conclusion

Many studies, at the micro perspectives, have reported variables affecting the wholesale price level of stored apples. However, the study of production volume effect at a given year on wholesale price level at macro perspectives in practice, especially in agricultural industry, has not been done relatively.

The purpose of this study is 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 apples based on the transaction quantity and the wholesale price information released by Seoul Agricultural & Marine Products Corporation through on-line from October 14, 2009 to May 24, 2014. In particular, this study aims to investigate whether players at wholesale market trade in being aware of the production volume in wholesale price formation. For this purpose, the researchers offers a forecasting model with the micro variables proved empirically in existing study and the macro variables related with production volume.

This study identified two operational definitions for production volume and applied two variables to dynamic price forecasting modeling for stored apple at daily base. The empirical study showed that the cumulative shipment quantity negatively affected the wholesale price level of stored apple significantly. The result of this study 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. This result shows that players at wholesale market make daily wholesale price in being aware of the accumulated shipment after the day of first shipment of apples. In other words, formation of the wholesale price is based on the premise that all players at the wholesale market have information of production volume, quantity traded, and quantity of stock.
However, it needs to be considered carefully that the variable applied interaction between the number of days elapsed after the day of first shipment of apples and the accumulated shipments in the period from the day of first shipment is found insignificant. The number of days elapsed after the day of first shipment of apples affect significantly the wholesale price with the modelling the researchers offer, however, the researchers couldn’t found interactive effect between the number of days elapsed after the day of first shipment of apples and the accumulated shipments. Future studies need to investigate the interaction effect between the number of days elapsed after the day of first shipment of apples and the accumulated shipments in the period from the day of first shipment with forms of a quadratic function.

This study contributes to apples’ daily price forecasting modeling with an empirical result that macro variable such as accumulated shipments needs to be included in the STSS modeling. And the researchers also found that the affecting power of the total yield of apples is relatively weak compared with the macro variable. Therefore, a period in which total yields do not have an impact on the wholesale price of apples can be predicted. Studies that divide a year into two periods, on in which total yields affect the wholesale price level and the other in which they do not would be needed in near future.

Furthermore, future studies need to apply macro variables positively to STSS. For instance, Figure 1 shows that the wholesale price in 2012 was much higher than in other years. It is assumed that the phenomenon was caused by lower level of production volume in 2012, or by Korea-US FTA effect. Therefore

Accordingly, future studies need to positively explore and apply macro variables as the variables affecting daily wholesale price of apples.

Acknowledgements

This work was supported by Gyeongnam National University of Science and Technology Grant in 2014.

References


Authors

Youngsik Kwak, he received a B.B.A. degree from Sungkyunkwan University, Seoul, Korea, in 1990, an MBA degree from Sungkyunkwan University, Seoul, Korea, in 1994, a M.S. degree from Texas Tech University, Lubbock, TX, in 1997, and a Ph. D. from Sungkyunkwan University, Seoul, Korea in 1999, in marketing. He had been a marketing consultant for Daewoo Economic Research Institutes from 1999 to 2002.
Currently he is a professor in the Department of Venture and Business, Gyeongnam National University of Science and Technology, Jinju, Korea. His research interest includes pricing on- and off-line.

**Yoonjung Nam**, she received her B.B.A. degree from Sangmyung University in 1996, her MBA degree from Sungkyunkwan University, Seoul, Korea, in 1999, and now is a Ph.D. candidate in Hanyang University, Korea and a visiting professor of Woosong University, Daejeon, Korea. She has been a marketer for 2 years in IT industry and 11 years for food and beverage industry from 1999 to present. Her research interests include all aspects of hospitality and culinary management.

**Yoonsik Kwak**, he received his B.S. degree in Electrical Engineering from the University of Cheongju in 1984, his M.S.E.E. degree from the University of Kyunghee in 1986 and his Ph.D. degree from the University of Kyunghee in 1994. He works at Korea National University of Transportation in the Department of Computer Engineering and rose to the level of Full Professor. His research interests are in the areas of signal processing, Internet communication, microcomputer system, and applications of these methods to mobile system.