The Day-of-the Week Effects for Cloud-Based Shipment Timing Support System for Stored Apples

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Abstract. The purpose of this study is to empirically analyze whether the wholesale price of apples sold in the Korean action-based wholesale market is statistically significantly different at the aggregate and disaggregate levels, or not. It means that the researchers in this study empirically analyzed to identify day-of-the-week effects in Korean wholesale price of apples.
The results of this study showed that, when shipped by the order of Monday, Thursday, Wednesday, Friday, Tuesday, and Saturday, the apples can be sold with higher prices, with statistical significance. Monday recorded the highest price while Saturday recorded the lowest price. Based on the results of this study, the growers and sellers of apples may control shipping time so that the apples are sold by auction on days of the week when their profits are maximized. Also, when the day-of-the-week effects is applied to the modeling of supporting system for the apple shipping period presented by the previous studies, more accurate system for shipping period can be constructed. Such system can be used by the growers or sellers of apples at the cloud base.

Keywords: Day-of-the Effect, Stored Apples, Cloud-based Shipment Timing Support System Modeling

1 Introduction

The day-of-the-week effect indicates a condition that sales volume, price, and profit of a product are different from days of the week [1]. Studies of the effects mainly focus on stock market, and it is rare to research the effects on agricultural and marine products [2].

The characteristics of the previous studies of the day-of-the-week effects on agricultural and marine products are as follows. First, studies on agricultural products are more than those on marine products. Second, the US has measured the day-of-the-week effects on various grains dealt in futures markets, but Korean researchers have studied only seasonings such as garlic, onion, and red pepper[2], indicating that studies on grains or fruits are insufficient. Third, the analysis unit of the previous

studies is the whole selling period during a year, and thus, they are studies at aggregate level. However, as Seo and Kim(2009) pointed out, analysis of selling price is desirable to be conducted by dividing the whole selling period into several segmented markets [3], indicating that it is needed to be analyzed at segment level or disaggregate level. Fourth, day-of-the-week effects among purchasing time effects has relatively more literature than intra-month or inter-month effects. Fifth, American studies usually focus on future wholesale prices from futures markets, but Korean counterparts are based on prices of present wholesale prices [4]. Future price is a price of certain point of the future and auction wholesale price is sales price of a day, and Korean researchers rather than their American counterparts reflect price interest of sellers or growers more.

Table 1. Dichotomy of Purchasing Time Effect

	Aggregate level	Disaggregate level
the day- of-the-week effect	grains(US), Onion, Halibut, Meat, Rockfish (Korea), Position of this study	Position of this study
intra-month effect	Garlic, Onion(Korea)	
inter-month effect	Garlic, Onion, Spice, Halibut(Korea)	

This study is purported to fill in the research field that has not been dealt in the previous studies. The purpose of this study is to empirically analyze whether the wholesale price of apples sold in a few auction-based wholesale market such as Garak and Gangseo agricultural market is statistically significantly different at the disaggregate levels, or not. It means the authors in this study empirically analyzed to identify the day-of-the-week effect in Korean wholesale price of apples.

Based on the results of this study, the sellers of apples may control shipping time so that the apples are sold by auction on days of the week when their profits are maximized at business perspectives. Also, when the day-of-the-week effects is applied to the modeling of supporting system for the apple shipping period presented by the previous studies, more accurate system for shipping period may be constructed [11]. In terms of academic aspect, this study reports the day-of-the-week effects on fruits, which have hardly been dealt with by the previous studies in agricultural industry.

2 Literature Review for Purchasing time effects

Purchasing time effect indicates that sales volume, price, and profits are different from selling time points (day of the week, intra-month, inter-month) [5]. The purchasing time effect in the previous studies is roughly classified into 1) cases in which analysis unit is different and 2) cases in which analysis time-point is different.

Studies with different analysis unit may be divided into three types as follows. First, there are studies of differences from time points when volume serves as analysis unit, indicating studies of tracking changes in volumes such as frequency of occurrence, selling volume, and shipping volume on certain day of the week. These may be studies of changes in crime rate or selling volume of clothes by days of the

week [6]. Second, there are studies of differences from time points in changes in price level. Such domestic studies include the Korean ones investigating time effects of agricultural and marine products (seasoning vegetables and seafood) on auction prices in Garak market and Noryangjin fish market, and the American ones identifying grain prices in American futures market[2][4][7]. The previous studies have focused on rather wholesale price than retail price. Third, there are studies in which profit is used as analysis unit, indicating studies in which differences in price earnings ratio and bond yield are analyzed in financial management whose time effects have been researched most actively, on bases of days of the week, intra-month, and inter-month.

As for Korean agricultural and marine products, there may be two analysis units in studies of purchasing time effect: volume and price level. The Seoul Agricultural & Marine Products Corporation is making on-line announcement of volume and bid in wholesale markets on a daily basis [8]. Growers or sellers of apple have interest in bid rather than volume, for, in this study, the analysis unit of purchasing time point was the wholesale prices announced by the Garak Agricultural & Marine Products Corporation on-line on a daily basis.

Second, when studies are divided by analysis time-point, purchasing time effects can be classified into day-of-the-week effects, intra-month effects, and inter-month effects. As for the three time effects by industries, certain academic fields tend to focus on certain time effects. Financial management usually have researched day-of-the-week effects, intra-month effects, and inter-month effects, criminology have measured day-of-the-week effects, and agricultural and marine products have studied day-of-the-week effects and intra-month effects. Clothes and sports shoes have researched day-of-the-week effects and intra-month effects, while fashion has rarely studied inter-month effects.

In terms of agricultural and marine products, the sellers are possible to have interest in day-of-the-week effects rather than intra- or inter-month effects. In this context, this study selected day-of-the-week effects as the analysis unit.

Studies of agricultural and marine products have been conducted in the USA and Korea. Most American studies have focused on the day-of-the-week effects of grains in futures markets, while Korean studies have dealt with the daily wholesale bids of seasoning vegetables and some marine products in wholesale markets. Yoon and Yangg (2004) and Ko (2010) identified the day-of-the-week, monthly, and intra-month effects of seasoning vegetable prices, flatfish and Jacopever. Their results showed that time effects were different even in the same seasoning vegetable and fishes [2][0]. Thus, it is indicating that the results of day-of-the-week effects may be different from research subjects. Chiang & Tapley (1983) identified day-of-the-week effects in futures markets. When daily changes in future prices of 21 items were investigated, day-of-the-week effects as in stock market were shown in grains [7]. Chang & Kim (1988) investigated day-of-the-week effects and changes in product prices in future market. Day-of-the-week effects had existed until 1981, but since 1982 such effects had disappeared in future market [4].

The day-of-the-week effects of these American studies showed or did not show based on research period, indicating that determination of research period is a key to studies of day-of-the-week effects. In this context, analysis in this study should be

conducted on the basis of data collected in the sufficiently long term. All the above-mentioned articles investigated day-of-the-week effects of the subject products during only certain period. They can be called aggregate level analysis because day-of-the-week effects were analyzed for the entire sample data.

However, Seo and Kim (2009) divided apple shipping period into six sub-periods in researching the shipping period for Korean apple wholesale prices based on risk bearing tendency of apple growers [3]. This may be called disaggregate level analysis.

Seo and Kim (2009) was not a study of day-of-the-week effects; the average prices of each sub-period were all different and the shipping activities of apple growers were different. Thus, such difference in prices and shipping amount might be shown as day-of-the-week effects different from periods. However, there have been no evidences to prove that the division of six sub-periods for shipping periods of Korean stored apples presented by Seo and Kim (2009) is normatively proper. Based on such inference, therefore, the authors of this study measured day-of-the-week effects 1) when the entire data collection period was analysis unit and 2) when the six sub-periods by Seo and Kim (2009) were analysis unit.

3 Research

The wholesale prices of apples used in this study were on-line daily announcement data presented by the Seoul Agricultural & Marine Products Corporation. Because prices of apples are different from varieties, grades, and package units, Fuji 15kg special grade apples were selected to be the subjects. The data was collected between October 14, 2009 and February 25, 2012. The Fuji apples of special grade were first sold by auction on October 14, 2009, and a total 662 apples were observed.

Table 2. Wholesale prices average of Fuji apples by days of the week in the samples

Day	Average price(KRW)	N	SD
Monday	59,189	111	13,004
Tuesday	57,050	106	11,955
Wednesday	57,184	113	13,315
Thursday	58,646	110	12,893
Friday	57,093	112	13,549
Saturday	53,155	110	11,657
Average	57,057	662	12,855

4 Results

4.1 The day-of-the week effects at aggregate level

4.1.1. Verification of differences in averages by days of the week

The average prices by days of the week during the period of data collection are as shown in Table 1; the average prices (57,057 as median) were lowest on Saturday and

highest on Monday. ANOVA was conducted to verify whether the auction wholesale prices of a 15kg box of Fuji apples with special grade are statistically significantly different by days of the week. The results of the analysis were as shown in Table 3. The samples of this study were reveal differences in the wholesale prices at 99-percent confidence level by days of the week (F=3.022, p=0.01).

Table 2. ANOVA results for difference in average price for the day-of-the effect

	SS	Df	MS	F	P
Bt groups	2.45E+0.9	5	491872887	3.02	0.01
Within groups	1.06E+11	656	162770720		
Total	1.09E+11	661			

Scheffe test was conducted to empirically verify differences in the wholesale prices among days of the week, and the results are as shown in Table 4. The differences in the wholesale average prices were statistically significant only between Saturday and Monday and between Saturday and Thursday. No statistically significant differences were found in the wholesale average prices at 90-percent confidence level between other days of the weeks.

Based on the results of analysis of the entire samples, apple growers can have profits when they avoid Saturday's auction and ship their apples on any day of the week except for Saturday.

Table 3. Scheffe Test among days of the week in the entire samples based on Saturday

Anchor Day	Day	MD	SE	P
Saturday	Monday	-6034	1,716	0.031
	Tuesday	-3895	1,736	0.413
	Wednesday	-4029	1,708	0.353
	Thursday	-5491	1,720	0.072
	Friday	-3938	1,712	0.383

4.1.2. Regression analysis of effects of day-of-the-week

However, there may be several variables affecting the wholesale bid of each day of the week. Regression analysis in which such multi variables are independent variables may be helpful in measuring effects of each day of the week on daily wholesale price.

In this study, independent variables included shipment quantity at the previous time t (Q_{t-1}), apple's wholesale price at the previous time t(p_{t-1}), whether the time t is the last week of Chuseok or Lunar New Year's Day (BEFORE), whether the time t is the next week of Chuseok or Lunar New Year's Day (AFTER), number of days passed after shipping of newly harvested apples (DAY), differences in prices between apple and pear during the last period (AP_PEAR_{t-1}), and nominal scale expressing days of the weeks. The R-square value of the formula was 0.63.

$$Price_t = a_t + b_1 Q_{t-1} + b_2 p_{t-1} + b_3 BEFORE_t + b_4 AFTER_t + b_5 DAY_t + b_6 DAY*DAY_t + b_7 AP\_PEAR_{t-1} + b_8 Mon_t + b_9 Tues_t + b_{10} Wends_t + b_{11} Thurs_t + b_{12} Fri_t + b_{13} Sat_t \quad (1)$$

Where a, b1 to b13 are parameters to be estimated.

Table 4. Results of regression analysis to verify variables affecting apple's wholesale prices

Predictors	coefficients	Wald	p-value
Intercept	20063.47	82.0	1.40E-19
Q_{t-1}	-15.15	10.0	1.50E-03
p_{t-1}	0.63	385.8	6.70E-86
BEFORE	3194.42	16.7	4.50E-05
AFTER	-2920.90	19.9	8.40E-06
DAY	100.85	27.8	1.40E-07
DDAY	-0.40	34.6	4.00E-09
AP_Pear_{t-1}	-0.04	5.6	0.018
Monday	3898.83	54.4	1.70E-10
Tuesday	-1207.58		
Wednesday	716.95		
Thursday	912.67		
Friday	-458.12		
Saturday	-3862.75		

The results are as shown in Table 4. All the independent variables significantly affected the wholesale prices of apples during this period ($p<0.01$). The results showed that, when shipped by the order of Monday, Thursday, Wednesday, Friday, Tuesday, and Saturday, the apples can be sold with higher prices, with statistical significance (Wald test=54.4, p=1.70E+10). Monday recorded the highest price while Saturday recorded the lowest price.

Formula (1) can be used as a predictive model for how much are the wholesale prices of apples per the time t, indicating that it can be used as an apples' shipment decision-making support system. When the model is supplied to those who grow and store apples as a cloud-based application, they may record sufficient profits by using the day-of-the-week effects.

4.2 The day-of-the week effects at disaggregate level

According to the Seo and Kim (2009)'s classification, te shipping period was divided into six sessions to analyze sub-periods: Period 1 (harvest period, between the middle of October and the first of December), Period 2 (year-end and New Year's time, between the middle of December and the first of January), Period 3 (Lunar New Year's Day, between the middle of January and the middle of February), Period 4 (between the last of February and the last of April), Period 5 (between the first of May and the last of June), and Period 6 (between the first of July and the last of August). The observed values by days of the week were different because auction was not performed during Lunar New Year's Day and Chuseok.

According to the results of the ANOVA for the Period 1, 2, 3, 4, and 6, there were no statistically significant differences in the wholesale prices of the 15kg box of Fuji apples with special grade by days of the weeks, respectively. In case of Period 1,

F=0.527, p=0.756. In case of Period 2, F=1.382, p=0.242. In case of Period 3, F=0.598, p=0.701. In case of Period 4, F=0.396, p=0.851. In case of Period 6, F=0.396, p=0.851.

The results of ANOVA for the Period 5 showed that statistically significant differences were found in the wholesale prices of the 15kg box of Fuji apples with special grade by days of the weeks in spring days between May and June (F=2.142, p=0.067). Tukey test was conducted to empirically verify where the differences in the wholesale prices are located between days of the weeks, and the results are as shown in Table 5.

Table 5. Wholesale prices of Fuji apples by days of the weeks during the Period 5

Day	Average price(KRW)	N	SD
Monday	58,861	18	6,651
Tuesday	57,713	18	6,759
Wednesday	59,811	18	7,069
Thursday	58,979	17	7,308
Friday	60,216	16	8,613
Saturday	53,395	17	5,435
Average	58,161	104	7,203

Differences in the wholesale average prices with statistical significance were shown only between Saturday and Wednesday and between Saturday and Friday. Periods between other days of the weeks did now show differences in the wholesale average prices at 90-percent confidence level. During the Period 5, apple growers may have profits when avoided Saturday's auction and shipped their apples on any day of the week except for Saturday.

5 Conclusion

The purpose of this study was to empirically analyze at the aggregate and disaggregate levels whether the differences in the wholesale prices of apples sold in the Korean auction-based wholesale market had statistical significance based on days of the weeks. That is, the researchers empirically analyzed to identify day-of-the-week effects in Korean wholesale price of apples.

The results at the aggregate level showed that apple growers can have profits when they avoid Saturday’s auction and ship their apples on any day of the week except for Saturday. In case of analysis at disaggregate level the results produced when shipped by the order of Monday, Thursday, Wednesday, Friday, Tuesday, and Saturday, the apples can be sold with higher prices, with statistical significance. Monday recorded the highest price while Saturday recorded the lowest price. At least, if the apple growers ship the apples on Monday than Saturday, they can improve the profit 7761.59(=3898.83+3862.75) KRW.

On the basis of the results of this study, the growers and sellers of apples may control shipping time so that the apples are sold by auction on days of the week when their profits are maximized at business level. Also, when the day-of-the-week effects is applied to the modeling of supporting system for the apple shipping period

presented by the previous studies, more accurate system for shipping period can be constructed as follows;

$$Price_t = 20063.47 - 15.15*Q_{t-1} + 0.63*p_{t-1} + 3194.41*BEFORE_t + -2920.9*AFTER_t + 100.85*DAY_t - 0.4*DAY*DAY_t - 0.04*AP\_PEAR_{t-1} + 3898.83*Mon_t + -1207.58*Tues_t + 716.95*Wends_t + 912.67*Thurs_t - 458.12*Fri_t - 3862.75*Sat_t$$

Such system can be used by the growers or sellers of apples at the cloud base.

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