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Abstract: In recent years, agricultural e-commerce sales model is in full swing. As the nation's largest B2C e-commerce company of agricultural products, ShanXi GongTianXia E-commerce Co., Ltd. (hereinafter referred to as "GongTianXia ") launched the "7-day auction" and "15-minute auction" since the end of 2014 on their official Wechat platform. Through these two new sales patterns, GongTianXia wants to attract more customers' attention to agricultural products, and thus lead to greater trade volume and profits.Many studies have shown that "calendar effect" has a wide range of use in financial markets. Likewise, as temporal-series data, did GongTianXia's two kinds of price reduction auctions have similarities with the laws of financial markets? There's no research to prove it so far. Taking GongTianXia's over 200,000 transactions data occurred during 432 instances of "7-day auction" and 943 instances of "15-minute auction" within 2015, this paper discusses the impacts of different periods of "significant time points" under both "7-day auction" and "15-minute auction" on different types of commodities, then explain why those results may happen. With the findings, we can improve calender effect theory and make a theoretical complement for Dutch auction as Mobile commerce, and give more optimization advices on mobile commerce companies.

Keywords: Mobile commerce; Agricultural Products; Price Auction; Calendar Effect

1. INTRODUCTION

1.1 Research background

Our study of calendar effect in the agricultural byproduct e-commerce market is mainly based on the following research motivations: First, there were deep research about calendar effect's influence as a time factor on the multiple-asset markets(represented by the stock market), which had confirmed that there existed a significant calendar effect in these markets; Second, China's agricultural byproduct e-commerce market has boomed in recent years, especially since 2014, it has developed increasingly mature; Third, GongTianXia introduced Dutch Auction into their sales model and formed two price-reduction promotion modes called "7-day auction" and "15-minute auction", besides, it has accumulated a large amount of research data since the on-line activities by the end of 2014.

From the above points, taking GongTianXia as the representative of agricultural byproduct e-commerce price-reduction auction, it's highly feasible both in theory and practice to study whether calendar effect exists and how it affects the trading volume of goods.

In addition to controlling the selling price on cost, GongTianXia has been continuously carried out a variety of new attempts at changing the form of price promotion. After a month of internal test run, at the end of 2014, GongTianXia launched an innovative promotional model named "7-day auction ", which last totally seven days to drop from the original price(1^{st} level) to 1 yuan(7^{th} level) or until goods is sold out. With more feedback on low frequency of price reduction, to meet such demands of consumers and increase entertainment, GongTianXia sped up the frequency and launched another kind of promotion mode named "15-minute auction" in January 2015, which still set seven price levels from the original price to 1 yuan, but the price will drop a level every 15 minutes and this activity will last totally 105 minutes to drop to 1 yuan or until goods is sold out.

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However, we can't ignore that the average transaction price of each product in these two promotion modes is slightly lower than the average market price. Behind these successful innovative marketing modes, there are much pressure of operating costs, high sales may only bring slim profits. Therefore, these are to be solved how to accurately grasp the change rule of auction time in future, how to carry out promotional activities in time to meet consumer's demand for different commodities, how to maintain a reasonable promotional frequency, how to make a choice between "7-day auction" and "15-minute auction".

1.2 Research questions

From above research background, we can learn that although the study of calendar effect in the financial securities market has been relatively mature and the Price-reduction auction has been gradually applied to the agricultural market, there is no study of calendar effect in the agricultural byproduct e-commerce market, therefore, this paper focuses on such a question that how the calendar effect influences the trading volume of the Price-reduction auction in the agricultural byproduct e-commerce company. Therefore, research content of this paper is mainly divided into the following two aspects:

First, verify whether there exists calendar effect in the agricultural byproduct price-reduction auction e-commerce market. By analyzing the common price factors that influence the trading volume and identifying the "significant time point", take the calendar effect as a influence factor. Then exclude the factors of smaller effect by establishing a linear regression model and judge whether the factor that represents calendar effect exists, if it exists, compare the coefficient value of the remaining stronger factors, and then size the relative influence degree of calendar effect.

Second, analyze the specific impact of calendar effect on different types of commodities under different auction models. We will further subdivide the auction model, "significant time point" and commodity category, and we'll classify the calendar effect in different situations. By observing the data, we found that the trading volume of agricultural byproduct e-commerce Price-reduction auction also had a certain "volatility aggregation", which was similar to that of stock market. Therefore, on the basis of the research methods of calendar effect in the stock market, we chose the GARCH (Generalized Auto Regressive Conditional Heteroskedasticity) model which can accurately simulate the fluctuation change of time series variables, and then we determined the impact of various types of calendar effect by comparing the coefficient factor under three dimensions. Finally, the reasonable suggestions for the improvement of the Price-reduction auction rules are given.

1.3 Research meanings

The rapid rise of the agricultural byproduct e-commerce market drives both enterprises and consumers to pay more attention to a question that whether there is a certain time regularity between the market sales and profits. Similarly, GongTianXia is also concerned about this question that whether they've attracted a large number of new customers and kept old customers of good quality by those innovative promotion activities as their expectation. Therefore, this study is of great significance no matter from the perspective of innovation and breakthrough of theoretical research, or from the perspective of improving the trading volume of their auction. In summary, research on the calendar effect of "7-day auction" and "15-minute auction" can not only help to improve the trading volume, but also provide a better shopping experience for its consumers.

2. LITERATURE REVIEW

2.1 Current research and literature review at home and abroad

The calendar effect research is more common in the securities market. A large amount of literature has demonstrated the existence of various kinds of "calendar effects" in the stock market in different regions.

Rozeff et al. (1976) according to all the stock index analysis of the New York stock exchange in 1904 to 1974 years, found that the average rate of return rate to the U.S. stock market in January was significantly

higher than that in other months, which confirmed the existence of the "January effect in the stock market". Lakonishok et al. (1988) according to the study of the Dow Jones industrial index from 1897 to 1965 in the United States,found that there was a high rate of return on the trading day before the holidays, which was called “holiday effect”. In addition, Cross (1973) confirmed that the U.S. market has a significant negative return on Monday, which confirmed the existence of the “week effect”. In the domestic research, Feng Li-cheng (2003) confirmed the existence of “Beginning-of-a-Month Effect” in Shanghai and Shenzhen stock. Yu Qiao (1994) according to the relevant research of “week effect” on the stock market of China, found the positive Thursday effect and negative Monday effect. Lu Lei et al (2008) confirmed the "holiday effect" exists in China's stock market after the studyof the Shanghai Composite Index. To the securities and financial markets, research of the calendar effect has been more mature.

Interpretation studies on return rate “vision” gradually extended to the futures and spot markets,while lesser in depth compared to the research on calendar effects of stock market, but also made some achievements,for example, Chiang et al. (1983) studied on the week calendar effect of commodity futures of the Chicago futures market. Lucey et al. (2007) studied on the gold spot and futures in the GARCH model and found that there is a Monday effect in the gold spot market. In domestic, Huaren Hai (2004) studied on the Zhengzhou Exchange wheat futures prices gains,and the results show it has the weekday effect. Yanfeng Guo et al.(2008) did related research on “Week Effect” of the Shanghai futures market. Kaida Qin(2015) also confirmed by the analysis of China's flower market in the auction, the price fluctuation and the "month effect" and "the effect" or even "twenty-four solar term effect" is closely related to.

2.2 The concept of iconic point in time

Research shows that, in addition to the traditional financial securities market, the daily life of people in all kinds of behavior is also affected by the time factor. The survey found that people tend to be determined to achieve a goal, or to complete a change etc at the beginning of the new year(Marlatt and Kaplan 1972, Norcross et al.2002). In addition to the new year, the first day of a week, the first day of each month or holidays, birthdays or other special points of time, people are more ambitious to change the behavior.

Psychological research shows that people's decision-making is often due to the emergence of a clear boundary of time and change.(Thaler 1999, p.197)The “iconic point of time” is those having a significant milestone time event or stage. One is a social universal time, such as the begining new semester holidays or weekly, and other natural beginning of time; the other is the significant time point in life, such as birthdays, anniversaries or starting a new attempt at the time. But no matter what kind of the above, they will have a certain change and impact on the behavior of people at present,even determines the plans and arrangements after the fact. (Kurbatet al. 1998, Robinson 1986)In addition, people are more inclined to make the middle of the two iconic time stage, naturally as complete time of an event, so as to have a more clear point in time to complete a task.(Peetz and Wilson2013, Soster et al. 2010, Tu and Soman 2014)

3. STUDY DESIGN

3.1 Data Collection

This article will explore the impact of “significant time point” on trading of different commodities. According to the life cycle of the price-reduction auction, we divided the data into two groups: “7-day-auction” and “15-minute-auction”. In 2015, GongTianXia had totally carried out “7-day auction” 432 times and the total trading volume was nearly 120 thousand, while “15-minute auction” 943 times and the total trading volume was nearly 270 thousand. Besides, there were 431 kinds of goods participating in “7-day auction” and 943 kinds of goods participating in “15-minute auction”.

In order to make a more comprehensive analysis of whether calendar effect has different impact on different

types of goods, according to the commodity attribute, We further divided the goods participating in the auction into five categories: fruit and fresh food (such as pears , seafood , etc.) , whole grains (such as rice, mung bean , etc.) , non-staple food (such as fungus , Tricholoma matsutake , etc.) , specialty of snacks (such as Taigu cake , fried dough twist, etc.) and nutritious products (such as jujube , honey, etc.).

3.2 Research methods

Our research methods can be divided into two steps: first, determine the research methods to verify whether there exists calendar effect in the agricultural byproduct price-reduction auction e-commerce market and whether the degree of the impact is significant; if exist, then further analyze the commonness and differences. Therefore, we need to build model and make verification for the above two parts separately, while the first part of this paper using the linear regression model and the second part drawing on the GARCH model of the calendar effect research in the financial securities market. The details are as follows:

3.2.1 Regression analysis

In first part, we will take calendar effect as a factor that influence the trading volume, and then compare it with other factors (such as promotion intensity, promotional frequency). The most common method of analyzing this kind of problems is linear regression model.

The common factors that affect the trading volume of goods are promotion intensity, promotional frequency and duration of promotion, etc. Therefore, we will introduce some independent variables (such as a series of promotional factors, calendar effect and attribute of commodity themselves, etc.) to establish regression model for analysis and research. Through model analysis, after verifying the feasibility of the model, we can get the fitting coefficients corresponding to different independent variables and excluded variables corresponding to smaller fit coefficients, and then focus on comparing some key factors. Observe whether the independent variable factor corresponding to the calendar effect is excluded, besides, its value of the fitting coefficients marks the degree of the impact of the commodity trading volume.

3.2.2 GARCH model

By the linear regression model, we can determine that overall there exists calendar effect in the agricultural byproduct price-reduction auction e-commerce market and the degree of the impact is significant. Therefore, we can further analyze the different impact of calendar effect on the trading volume of different types of goods in the “7-day auction” and “15-minute auction”.

Referring to the formula of Stock Returns, we defined the single transaction rate of GongTianXia’s price-reduction auction market as follows:

$$\Pi_t = \ln\left(\frac{Q_t}{Q_{t-1}}\right) \times 100$$

Among them, *Qt* is the commodity trading volume on date *t*, Q_{t-1} is the commodity trading volume last time, Π_t is the transaction rate of the *t* -th price auction.

In order to show a more intuitive change of the transaction rate, we enlarged the single transaction rate of “7-day auction” to 100 times, and got the trading volatility of more obvious changes as shown in figure 3-1:

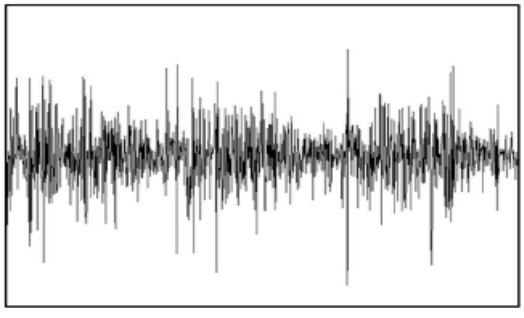

Figure 3-1. The Single transaction rate trend in GongTianXia’s “7-day auction”

From the above figure, we can find the volatility of trading rate in the whole sample range. It is not difficult to find that the mean value of commodity transaction rate in **"**7-day auction" is relatively stable, but the volatility of the variance is larger.

In view of the data regulation of stock trading in financial market, we find that there exists "volatility clustering " among the transaction data of these two sales patterns. The traditional linear regression model can't solve the problem of volatility of time-series data, therefore, this paper introduces the ARCH model which is of wide application in the empirical study of financial engineering, and thus describe and predict the variance of the dependent variable. ARCH model can depict the time-dependent conditional variance, which is an effective tool to measure the volatility of time series.The model used in this paper is a generalized ARCH model, that is, the GARCH model. Compared with the ARCH model, it can better reflect the long-term memory nature of the actual data, which is more suitable for GongTianXia's annual data in 2015.

4. VERIFICATION OF THE CALENDAR EFFECT OF PRICE-REDUCTION AUCTION

This chapter will use linear regression model to determine whether the calendar effect exists in the agricultural byproduct electronic commerce, and compare it with other price factors, and observe the influence degree.

4.1 Hypothesis proposed

Based on previous literature research and empirical research, the following hypotheses are put forward:

(1) The calendar effect of agricultural byproduct in the electronic commerce exists in the price-reduction auction;(2) Iconic point in time is a factor of the regression equation.Its fitting coefficient is bigger, that is, the calendar effect is an important factor that affects the price-reduction auction of agricultural byproduct electronic commerce, and can not be ignored.

4.2 Construction of regression model

Taking into account the common impact of trading volume of commodity, the main factors are the frequency of promotion, promotional efforts, as well as the duration of promotions, etc. Therefore,to test that significant time point has an impact on the trading volume of commodity like these promotions factors, introduce T, X, P1, P2, P3, D1, D2, W and other independent variables to establish regression model for model setting and research.

The T is used to reflect the frequency of promotion; X is used to directly reflect the product promotion degree; P1,P2,P3,D1,D2 is used to compare with other goods which belong to the same category; W is used to mark whether promotion time is the significant time point. The specific form of the model is as follows:

$$Yi = \beta 0 + Xi\beta + \varepsilon i, \quad i=1,2,\ldots,n \qquad (1)$$

Among them, i marks the number of promotion;

Yi represents promotion trading volume of the number i times;

Xi is a p-dimensional vector, p is the number of products, Xi = (Xi1, Xi2, ... ,Xip), each Xij correspond to j-th product's promotion degree on i-th promotion;

β andβ0 are to be estimated coefficient: β=（β1,β2, …,βp）T is a coefficient among which each element βj is the trading volume of commodity for the j-th kind of products sensitive to changes in the degree of promotional efforts; β0 is the intercept;

εi is a random error term, εi random distribution, satisfying $E(\varepsilon i \mid Xi)=0$ and other basic assumptions.

However, we find that this linear model can not be estimated in empirical analysis. Because there are a variety of goods sold in GongTianXia,and the number of observations that we can get is limited, so that the model parameters are far greater than the sample size of the problem (p>>n), so it can not be estimated.

Because the goods are affected by many factors such as the type, nature, area and so on, even if the same

price reduction promotion plan also has the different effect. Therefore, we will also include the characteristics of promotional products into the scope of the investigation. Further set β is the linear function of various product features:

$\beta_{ij} = Z_{ij} + \gamma + \zeta_{ij}$， i = 1,2,…,n， j = 1,2,…,p (2)

Among them, Zij=(1, Tij, P1j, P2j, P3j, D1j, D2j, Wi) is explanatory vector:

Tij is promotions frequency,namely the j-th product's total sales promotion from the beginning to the i-th times;

P1j, P2j, P3j are the characteristic variable of the product category;

D1j, D2j are the characteristic variables for a single product;

In addition, to study the calendar effect, introduce variables Wi which reflects promotional opportunity. Wi is to indicate whether the i-th time promotion is a significant time point;

γ=（γ0,γ1, …,γ7）T are coefficients to be estimated, corresponding 8 explanatory vector,and is a an 8-dimensional vector;

ζij is a random error term, satisfying E(ζij | Zij)=0 and other basic assumptions;

Equation (2) into equation (1), we will get:

$Yi=\gamma 0 \sum_{j=1}^{p} X_{ij} + \gamma 1 \sum_{j=1}^{p} X_{ij} T_{ij} + \gamma 2 \sum_{j=1}^{p} X_{ij} P_{1j} + \gamma 3 \sum_{j=1}^{p} X_{ij} P_{2j} + \gamma 4 \sum_{j=1}^{p} X_{ij} P_{4j} + \gamma 5 \sum_{j=1}^{p} X_{ij} D_{1j} + \gamma 6 \sum_{j=1}^{p} X_{ij} D_{2j} + \gamma 7 \sum_{j=1}^{p} X_{ij} W_i + \mu i$

Among them, $\mu i = \sum_{j=1}^{p} X_{ij} \zeta ij + \varepsilon i$， We still assume E(μi | Xi， Z)=0.

In this paper, the empirical analysis of the data is from GongTianXia's "7-day auction" and "15-minute auction" from January 2015 to December 2015.

4.3 Empirical analysis

First of all, we select the general characteristics of the 10 kinds of goods, which participate in GongTianXia's"7-day auction" the most, for statistical analysis, and the results are shown in table 4-1:

Table 4-1. Sales of hot goods of "7-day auction" of GongTianXia in 2015.

Product number	Promotional efforts(%)	Promotional frequency(times/year)	Single product promotion investment(¥)	Promotional volume(piece)	Average price of products(¥)	Relative price of relative class	Product sales(¥)	Relative sales relative to the class
1	22. 8	19	82635	3119	19. 3	1. 3	60190	0. 772
2	60. 3	9	498294	4272	23. 8	4. 9	101466	0. 205
	51. 5	9	511454	5110	29. 1	3. 4	148426	0. 291
3	8. 9	5	17098	1152	16. 4	0. 9	18902	1. 108
	48. 3	8	12546	904	6. 2	2. 2	5574	0. 523
4	46. 7	5	25398	962	8	3. 3	7692	0. 303
	38. 3	8	19426	897	18. 5	1. 2	16634	0. 853
5	46. 6	8	36976	974	18. 7	2. 0	18184	0. 492
	20. 3	4	5064	396	23. 1	0. 6	9146	1. 805
6	34. 5	11	11352	772	7. 2	2. 0	5588	0. 490
7	48. 5	10	40349	1196	23. 7	1. 4	28375	0. 703
8	45. 0	1	12592	310	20. 9	1. 9	6484	0. 515
	20. 8	5	80260	1588	30. 1	1. 7	47724	0. 596
	28. 0	3	30186	538	35. 3	1. 6	19010	0. 629
9	35. 1	7	291528	3500	38. 3	2. 2	134098	0. 460
10	52. 5	7	15448	576	13. 3	2. 0	7680	0. 496

Among them,there are the same kind of goods with different promotions to promote on different time, so all take the mean as the product's promotion degree and promotion maintenance time to carry out the analysis below. Analyze table 4-1,get table 4-2:

Table 4-2. Descriptive statistics on the sales promotion of hot selling goods of "7-day auction" of GongTianXia in 2015.

variables	meaning	Mean	Standard deviation	Minimum value	median	Maximum value
X	Price reduction efforts	38	14.4	8.9	41.7	60.3
T	Auction frequency	7.4	4.1	1	7.5	19
P1	average price of the class	20.7	—	—	—	—
P2	Sales in the class	39698	—	—	—	—
P3	the number of products in the class	18	—	—	—	—
D1	relative price of the relative class	2	1.1	0.5	1.98	4.9
D2	Relative sales relative to the class	0.64	0.4	0.2	0.5	1.8
W	Whether it is a significant time point	0.033	0.18	0	0	1

We can see that trading volume is a complex variable with many factors, through the analysis of the general sales characteristics of the ten commodities which are the top ten of "7-day auction" of GongTianXia in 2015. Therefore, further use SPSS software to do regression analysis on activity data of "7-day auction" of GongTianXia in 2015. The results shown in Figure 4-1:

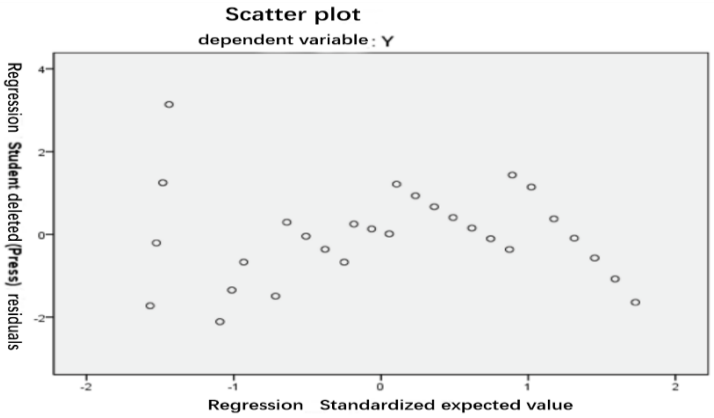

Figure 4-1. Standardized regression forecast map.

Analysis of the above regression results:

Since the beginning of the choice is "step by step" method, which is "forward" and "backward" combination, we can see that the first to enter the "linear regression model" is ∑pj=1XijTij and then established model 1, followed by ∑pj=1Xij with model2 established and so on. Therefore, the model used in this method has a probability value. If less than or equal to 0.05, enter the "linear regression" (the first to enter the model, most relevant, most closely, so promotional maintenance time for businesses is the biggest reason for profit) .When greater than or equal to 0.1, remove from the "linear model". From the "model summary", we can see that there are five models (model 1, 2, 3, 4, 5). From the R2 goodness of fit, the goodness of fit of model 5 is obviously best (0.997>0.996>0.993>0.982>0.955). According the probability of behind the "F statistic value is 0.00, since 0.00 <0.01, with the introduction of "argument", the significance probability value was much less than 0.01, so it is possible to significantly reject the null hypothesis that the overall regression coefficient is zero. Through the ANOVA analysis of variance table, it can be seen that there is a linear relationship between "sales" and "price" and "wheelbase".As for the strength of the linear relationship, need to be further analyzed.

Combined with the "excluded variables" table and the "coefficient a" table, the standardized regression equation is obtained:

Yi=0.720∑pj=1Xij+0.858∑pj=1XijTij-0.196∑pj=1XijD1j-0.339∑pj=1XijD2j+0.503∑pj=1XijWi .

Table 4-3. Model parameter estimation.

Attribute	Factor	Parameter Estimation
Non-promotional factors	Intercept	0.000
Promotional factors	Whether it is a significant point in time	0.503
	Promotion efforts	0.720
	Promotion frequency	0.858
Factors affecting the promotion effect	Sales in the class	0
	Number of product categories in the class	0
	Average price of the class	0
	Relative price of a single product in the same category	-0.196
	Relative sales of a single product in the same category	-0.339

4.4 Conclusion

By regression analysis, we found that the model above mentioned has a significant explanatory power for the change of the trading volume of commodity of “7-day auction” of GongTianXia,and the goodness of fit is 99.7%. The factor of "whether is significant time point" is positive and significant, which indicates that the "calendar effect" also has a certain stimulating effect on consumer behavior. Without taking into account the product and the time factor ,the "significant time point" is indeed able to promote the increase in trading volume of commodity.And with the increase in sales promotion, the retailer's profit will increase.

5. RESEARCH MODEL OF THE CALENDAR EFFECT IN GONGTIANXIA’S PRICE-REDUCTION AUCTION

This chapter we’ll further study the impact of calendar effect on the agricultural byproduct price-reduction auction e-commerce market. Because of the existence of the "volatility aggregation ", in order to get a better fitting result, we need to model and analyze by using GARCH model rather than directly conduct regression analysis using OLS (Ordinary Least Squares). Moreover, to verify the validity of the model, we’ll take the “Monthly calendar effect” of GongTianXia’s annual transaction data of **“**7-day auction” in 2015 as an example.

5.1 Regression analysis

5.1.1 The establishment of OLS regression model

Conduct regression analysis using OLS (Ordinary Least Squares). Taking the “Monthly calendar effect” of GongTianXia’s **“**7-day auction” as an example, set the null hypothesis H0 as there doesn’t exist “Monthly calendar effect”. We use dummy variables to build the following regression:

$$\Pi_t = \sum_{i=1}^{12} \beta_i D_{it} + \varepsilon_t$$

Among them, Π_t is the transaction rate on date *t;* D_{it} is the dummy variable(the value is 0 or 1), the subscript i(i= 1,2,3，…,12) represents month, define D_{it}=1 when the transaction rate Π_t belongs to the i-th month, otherwise D_{it} =0; ε_t is the residuals.

During the year, the transaction rate of **“**7-day auction” is highest in February and lowest in November, so we guess there exists positive "February effect" and negative "November effect". But there still need further test to determine the existence of such effects.

5.1.2 The test of OLS regression model

1）Stationary Test

We need to carry out the stationarity test because the selected data is time-series data. According to the Schwert rule, namely $K_{max} = 12\left(\frac{n}{100}\right)^{0.25}$, we selected the appropriate lagged rank to test. Because the absolute value of the ADF statistic obtained by the test is greater than the critical value of McKinnon, we

believe that the original sequence is a stationary sequence, thus rejecting the null hypothesis. Besides, there is no unit root in the sequence so we don't need to carry out the difference treatment.

2）Autocorrelation Test

Next we need to carry out the autocorrelation test of the time-series data by using LM (Breush-Godfrey Lagrange Multiplier) test. According to the test results, the P value of LM statistic is greater than 0.05, so we reject the null hypothesis, which means there doesn't exist first-order autocorrelation in the residuals of time series, that is to say , the disturbance term of any observed value is not affected by other observed values.

3）ARCH Test

As the fluctuation shown in Figure 3-1, we can infer that the daily average transaction rate of **"**7-day auction" may have the characteristics of "volatility aggregation", so we need to carry out ARCH Test. First, test it using Lagrange Multiplier Approach.

According to the test results, values of F and chi square statistics are smaller than 0.005, the result of the ARCH-LM test that the original sequence has ARCH effect can prove the existence of "volatility aggregation ", which is consistent with the conclusion about single transaction rate of "7-day auction" in Figure 3-1. That is to say, we need to carry out GARCH modeling analysis of the data to achieve an ideal fitting effect.

5.2 GARCH model

Because of the existence of "volatility aggregation" and dissatisfaction with the normal distribution, this paper uses GARCH model (p,q) proposed by Clive Granger to conduct empirical research. The model can achieve a better fitting effect when there exists GARCH effect. The basic form of the model is as follows:

$$y_t = x_t\gamma + u_t$$

$$u_t \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \delta + \alpha_1\varepsilon_{t-1}^2 + \alpha_2\varepsilon_{t-2}^2 + \cdots + \alpha_q\varepsilon_{t-q}^2 + \beta_1\sigma_{t-1}^2 + \beta_2\sigma_{t-2}^2 + \cdots + \beta_p\sigma_{t-p}^2$$

$$= \delta + \sum_{i=1}^{q}\alpha_i\mu_{t-i}^2 + \sum_{j=1}^{p}\beta_j\sigma_{t-j}^2$$

In the formula, p is the degree of GARCH term, q is the order of ARCH term, $p>0$ and $\beta_j \geq 0$, $1 \leq i \leq p$, σ_t^2 is the conditional variance.

Therefore, the GARCH (p ,q) model established on the basis of the OLS (Ordinary Least Squares) model is as follows:

$$\Pi_t = \sum_{i=1}^{N}\beta_i D_{it} + \varepsilon_t$$

$$\varepsilon_t \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \gamma + \sum_{i=1}^{q}\alpha_i\varepsilon_{t-i}^2 + \sum_{j=1}^{p}\beta_j\sigma_{t-j}^2$$

Among them, N is the number of "significant time points", σ_t^2 is the conditional variance, the meanings of the remaining variables are as previously described.

The Common used GARCH models are GARCH (1, 1), GARCH (1, 2) and GARCH (2, 1). We used an ARCH modeling tool named Eviews to model for the above three models and got the results of parameter test. By comparing the models, we knew that all coefficients of GARCH (1,1) passed T test and this model had the best fitting effect, so we chose the simplified GARCH (1,1) model for further analysis.

5.3 Research hypothesis

Based on previous literature research and empirical experience, we made the following hypotheses:

1. GARCH (1, 1) model can better fit the calendar effect of the transaction data;

2. Different types of "significant time points" have distinct fitting coefficient values with different types of

commodities, which means calendar effect has obvious different influence to different types of commodities.

5.4 Empirical analysis

According to the previous analysis, the GARCH model in the financial market is also effective in agricultural byproduct e-commerce price-reduction auction. First, according to the characteristics of the natural day, we divided "significant time points" into national holidays (such as Spring Festival, National Day, etc.), popular festivals (such as Valentine's day, Christmas, etc.), Shopping Festivals (such as TaoBao festival in the middle of the year, Double Eleven, etc.) and "natural significant time points"(such as Monday, weekend, beginning of the month, etc.). Then we need to discuss the influence of time factor to the five kinds of commodities.

Plug the classification data into the following GARCH (p, q) model, analysis results are shown in table 5-5:

$$\Pi_t = \sum_{i=1}^{N} \beta_i D_{it} + \varepsilon_t \quad (N \text{ is the number of "significant time points"})$$

$$\varepsilon_t \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \gamma + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

Table 5-1. Results of GARCH model analysis of the trading volume of GongTianXia's price-reduction auction

Regression Outcome Variable	7-day auction					15-minute auction			
Goal Category:	Whole grains	The nutritious products	Fruit& fresh food	Non-staple food	Specialty of snacks	Fruit& fresh food	Non-staple food	The nutritious products	Specialty of snacks
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Generic Calendar Predictors									
Days since the start of the month	1.85** (0.59)	0.63 (0.67)	−0.08* (0.03)	−0.95*** (0.13)	−1.03*** (0.16)	−2.30*** (0.41)	−0.04** (0.01)	−0.17*** (0.03)	−0.09*** (0.02)
Days since the start of the week	−0.01 (0.01)	−0.02 (0.01)	−0.02* (0.01)	−0.06* (0.03)	−0.07* (0.04)	−0.29** (0.09)	−2.1e−03 (2.7e−03)	−0.01 (0.01)	8.1e−05 (4.0e−03)
Days since the end of the week	0.16 (0.64)	−0.30*** (0.03)	2.21*** (0.37)	7.48*** (1.42)	13.22*** (1.72)	36.64*** (4.42)	−0.02** (6.5e−03)	1.16** (0.35)	0.55* (0.21)
Special Calendar Predictors									
Days since the start of a federal holiday	−0.59*** (0.05)	1.93** (0.73)	0.94* (0.41)	6.77*** (1.54)	7.37*** (1.87)	20.10*** (4.80)	0.05 (0.14)	1.42*** (0.33)	0.34^ (0.20)
Days since the start of a shopping day	−0.33*** (0.03)	−0.25*** (0.06)	−0.13*** (0.02)	−1.05*** (0.07)	−1.08*** (0.09)	−2.41*** (0.22)	9.6e−03 (0.13)	−0.12*** (0.02)	−0.07*** (9.8e−03)
Days since launch	−1.3e−03 (1.7e−03)	−1.3e−03 (2.0e−03)	9.0e−05 (1.1e−03)	9.2e−03*** (1.0e−03)	−3.8e−03 (5.1e−03)	4.8e−03 (0.01)	6.6e−04^ (3.8e−04)	6.9e−04 (9.6e−04)	−6.4e−04 (5.8e−04)
Days since launch ²	7.0e−06*** (1.9e−06)	5.5e−06* (2.2e−06)	1.2e−06 (1.2e−06)	1.9e−06 (1.0e−03)	9.4e−06 (5.7e−06)	1.9e−06 (1.5e−05)	−6.7e−07 (4.3e−07)	−1.4e−07 (1.1e−06)	8.3e−07 (6.4e−07)
Observations	866	866	866	866	866	866	866	866	866
Numbers of stick K users ²	3,068	2,944	1,399	8,493	9,695	20,273	327	1,329	700
R^2	0.31	0.16	0.13	0.33	0.27	0.25	0.03	0.14	0.10

Among them, ^p <0010; *p <0005; **p <0001; ***p <00001

5.5 Comparative analysis of"7-day auction" and "15-minute auction"

According to the results of GARCH model analysis, we can infer that both the impact of calendar effect on different types of commodities in "7-day auction" and "15-minute auction" are basically the same, which is determined by the price-reduction auction modes. On the other hand, because "15-minute auction" has obvious advantage in transaction cycle compared with "7-day auction", there exists a certain difference in the impact of calendar effect, which is consistent with the hypothesis in section 5.3.

5.5.1 Similarities

First, in the aspect of characteristics of "significant time points", both of "weekend time point" and "holiday time point" has a significant positive effect on most commodities, but due to the limited number of annual holidays, in general the degree of influence of "weekend time point" is slightly better than that of "holiday time point". As for the "new time points" like Monday, different from the previous estimate, they have little effect on the purchase behavior of consumers and most of them has a slight negative effect on most commodities. The reason may be that when people make a decision at a new time point there is often a certain lag of their concrete actions.

Besides, the promotional activities of other e-commerce websites have an inhibiting effect on GongTianXia's price-reduction promotional activity. So we advise that GongTianXia further establish promotional activities with distinctive characteristics in addition to their daily price-reduction auction, or choose one of the two current auction models and gradually evolve into an "auction festival" with ritual sense.

In terms of the type of commodities, “specialty of snacks” is affected most by calendar effect, as reflected in the significant growth of trading on weekends and holidays, so we advise that GongTianXia choose weekends and holidays to carry out auction activities aiming at this kind of commodity. The nutritious products is affected most by “holiday time point” both in these two activities. The impact of calendar effect on fruit and fresh food is basically the same, which is mainly represented in weekend and holiday time points. Although whole grain commodity appears less in “15-minute auction”, due to the rigid demand of consumers, basically it is not affected by the calendar effect. Therefore, it can be sold in the ordinary natural days to maintain the persistence of the two types of price-reduction auction activities.

5.5.2 Differences

Since the transaction cycle of “15-minute auction” is much shorter than that of “7-day auction”, in general the impact of calendar effect on commodities in “15-minute auction” is also less than that in “7-day auction”. Therefore, in future the role of calendar effect should be paid more attention to in “7-day auction” activities.

However, the difference of commodity properties and shopping needs of consumers determine a certain difference in calendar effect of different commodities. For example, the impact of calendar effect on snacks in “15-minute auction” is stronger than that in “7-day auction”, which is determined by the fast- consumption and fast- demand property of snacks itself.

Besides, calendar effect of “weekend time point” on nutritious products also has a significant difference between “7-day auction” and “15-minute auction”. In “7-day auction”, there is a slight negative correlation between nutritious products and “weekend time point”, while in “15-minute auction” the impact of “weekend time point” on nutritious products is significant and positive. Therefore, if the auction of nutritious products are to be carried out on weekends, GongTianXia should give priority to the form of “15-minute auction”.

Totally contrary to nutritious products, in “15-minute auction”, there is a slight negative correlation between non-staple food and “weekend time point”, while in “7-day auction” the impact of “weekend time point” on non-staple food is significant and positive. Therefore, we advise that GongTianXia carry out price-reduction auction of the non-staple food on weekends and give priority to the promotional form of “7-day auction”.

6. CONCLUSION AND PROSPECT

Based on the above modeling methods and classification, the main results are as follows:

There is a significant "calendar effect" in the sale of electronic commerce platform GongTianXia".

Based on the conclusions above, we can continue to explore the impact of calendar effect on the transaction volume of the price-reduction auction by using the GARCH model which can deal with the volatility aggregation.

In the properties of significant time point, the weekend time point of natural day,with its own characteristics of entertainment and advantages of the number, has brought the biggest influence to the trading volume in the price-reduction auction of goods. The traditional holidays because of its natural characteristics that can be separated from the normal living conditions, also greatly promoted the sale of goods. As to the beginning of the month and week and other starting points, though the previous research shows that people tend to make new decisions in this kind of time, but tend to weaken the consumer's purchase behavior because of the lag and entertainment of consumer behavior . In addition, this study will also make a mark on non natural time node and no special time point of traditional holiday,which are consumers generally accepted point of time that other e-commerce platform through strong promotional way , referred to as “Shopping Festival”. Because the promotion of the price factor is bigger, this kind of significant time point is generally negative impact to the consumer in the purchase of the platform of GongTianXia.

Of course, there are some deficiencies in the research of this paper.First, the data of the example herein taken is transactions from a single e-commerce platform named GongTianXia.So it needs to be confirmed whether

the findings are universal.Secondly, since the limitations of the data, we can only use the trading volume of commodity to reflect the operations of auction activities. In addition, consumers' purchasing behavior is more subjective. This research will focus on the effect of the calendar effect on the electronic commerce products which participate in the auction. But in addition to its own property and commodity price factors, whether other non-price factors has a significant impact as the calendar effect (time), such as the purchase of the environment, geographical features (space), and so on. These are the places that are not considered in this study.

REFERENCE

[1]Dai H, Milkman K L, Riis J. The fresh start effect: Temporal landmarks motivate aspirational behavior[J]. Management Science, 2014, 60(10): 2563-2582.

[2]Ailawadi K L, Harlam B A, Cesar J , et al. Promotion profitability for a retailer : the role of promotion , brand , category, and store characteristics[J], Journalof Marketing Research,2006,43(4):518-535.

[3]Srinivasan S, Pauwels K , Hanssens D M , et al . Do pro motions benefit manufacturers, retailers or both? [J]. Management Science, 2004,50(5):617-29.

[4]Priya Raghubir andKimCorfman,When DoPrice Pro-motions Affect Pretrial Brand Evaluations? [J]1Journal of Marketing research,Vol136,May,1999:211-2221.

[5]Yizheng Shi et al. Behavioral response to sales promotion tools A Hong Kong study[J].International Journal ofAdvertising, 2005, 24(4): 467-486.

[6]H. Moulin, Axioms of cooperative decision making, Cambridge University Press, 1998 &H. Moulin, Cooperative Microeconomics: A Game-Theoretic Introduction, PrinceonUniversity Press, 1995.

[7]Briesch，Richard.A.，Lakshman Krishnamurthi，Tridib Mazumdar and S．P．Raj．A Comparative Analysis of Reference Price Models[J] ． Journal of Consumer Research,1997, 24(2):202-214.

[8]Kalyanaram，G.and Russell S．Winer．Empirical Generalizations from Reference Price Research[J]．Marketing Science，1995，14(3)：16l-169.

[9]Mazumdar，Tridib，S.P.Raj，and Indrajit Sinha．Reference Price Research:Review and Propositions[J]．Journal of Marketing，200569(10):84-102.

[10]Etgar，Michael and Naresh K.Malhotra.Determinants of Price Dependency：Personal and Perceptual Factors[J]．Journal of Consumer Research,l981,8(2)：217-232.

[11]Rao，Akshay R．and Kent B．Monroe．The Moderating Effect of Prior Knowledge on Cue Utilization in Product Evaluations[J]．Journal of Consumer Research,1988，15(9):253-264.

[12]Lichtenstein，Donald R．and William O．Bearden．Measurement and Structure of Kelley’sConvariance Theory[J]．Journal of Consumer Research，1986，13(2):290-296.

[13]Lichtenstein，Donald R．，Scot Burton，and Bradley S，0’Hara．Marketplace Attributions and Consumer Evaluations of Discount Claims[J]. Psychology &Marketing，l989，6(3)：163-l 80.

[14]Rothschild，M．L．and William C．Gaidis．Behavioral Learning Theory：Its Relevance to Marketing and Promotions[J]．Journal of Marketing，l98l，45(Spring):70-80.

[15]LEON G. SCHIFFMAN and LESLIE LAZAR KANUK,Consumer Behavior[M], Prentice-Hall Press,Tsinghua UniversityPress, 5th edition, 1996.

[16]V. KUMAR, KIRANKARNADE and WERNER J. REINARTZ, The Impact of Internal and External Reference Prices on BrandChoice: The Moderating Role of Contextual Variables[J].Journal of Retailing, Vol.74(3), 2001:401-426.

[17]Sinha I. Smith M F. Consumers' Perceptions of Promotional Framing of Price [J].Psychology &Marketing. 2001.17(3):257-275.

[18]Martin Kocher. Matthias Sutter. Time is money-time press, incentives and the quality ofdecision-making [J]. Journal of Economic Behavior Organization. 2006.61:375-392

[19]Katok E, Alvin E. Auctions of homogeneous goods with increasing returns: Experimental comparison of alternative ”Dutch” auctions[J].Management Science, 2004,50(8):1044 －1063.