

The impact of COVID-19 on Fresh food e-commerce in China

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Abstract. The COVID-19 pandemic has brought about varieties of changes in human beings' lifestyles, including shaping consumer's behavior. In this paper, fresh food industry was taken as an example to test whether there is a significant change in fresh food e-commerce under the epidemic from the perspective of the whole industry. Afterwards, from the perspective of consumers, structural equation model was used to analyze the influencing factors and paths of such a change. On this basis, this paper can not only effectively analyze the trend of fresh e-commerce, but also put forward suggestions for the fresh industry to attract consumers more efficiently. These results shed light on guiding further exploration of the impact of COVID-19 on different industries.

Keywords: Fresh Food; Consumer Behavior; Structural Equation Model.

1. Introduction

With the increasing maturity of China's logistics industry and the wide popularization of Internet sales model, e-commerce has gradually become a new consumption preference of Chinese consumers and a strong economic driving force. China e-commerce report 2020 shows that China's e-commerce transaction share has reached 37.21 trillion yuan in 2020. Fresh e-commerce, as one of the components of e-commerce, is an emerging industry that combines the traditional fresh commodities such as vegetables, fruits, meat, poultry and eggs with the new online shopping model. It is chosen by consumers because of its convenient operation, transparent price and diversified goods. Contemporarily, consumers' consumption concept of fresh goods is also slowly changing from traditional stores to e-commerce. According to Annual e-commerce fresh Chinese market data 2021, the transaction scale of fresh e-commerce reached 465.81 billion yuan in 2021, with a year-on-year increase of 27.92% [1]. The huge commercial potential and market volume of the industry also attract the establishment of more platforms and the entry of brands.

The outbreak and large-scale spread of COVID-19 in early 2020 has caused significant and far-reaching negative impacts on most real industries, but it has provided new business opportunities and injected strong market vitality into the online shopping industry [2]. Due to the strong infectivity of COVID-19, governments often adopt the policy of quarantine in areas seriously affected by the epidemic. Meanwhile, consumers also tend not to shop in conventional stores where crowds gather easily owing to the risk of infection. These two factors eventually lead to a significant increase in the demand of fresh e-commerce.

On account of the variability of COVID-19, the impacts of COVID-19 on business development are likely to remain for a long time in the post epidemic era. Based on this consideration, studying the impacts of the COVID-19 on the development of the fresh e-commerce industry can provide implications for the business decision-making of e-commerce platforms and academic reference for the driving force of e-commerce development.

Home isolation is one of the main non-pharmaceutical interventions and low-cost measures to contain COVID-19, since novel coronavirus transmission through droplet, contact and airborne transmission. As a result, consumers are more willing to buy their daily necessity online, rather than going out for shopping [3]. According to i-Research, in March 2020, both the number of monthly activated users and daily activated users of fresh produce online platform, including Sauma, Jingdong to Home, Miss Fresh, Dingdong and so on, experienced high growth during the epidemic period. To be specific, Sauma's online orders increased 2.2 times from year to year, while during the Spring Festival, Miss Fresh's transaction volume increased 3.5 times year-on-year, and the customer unit

price reached 120 yuan; From New Year's Eve to the third day of the New Year, the sales volume of Jingdong to Home increased 5.4 times compared with the same period last year [4].

Fresh e-commerce is a relatively new sales model of fresh agricultural products, and it has gradually become a new "blue ocean" in the field of e-commerce [5]. In modern society, especially for youth entrepreneurial groups and urban white-collar workers are under great pressure from study and work, so their pace of life is generally accelerated. Online fresh produce apps can save the time of offline market procurement, and increase the time for study, work or leisure [6].

As for the COVID-19's impact on fresh produce online platform, Wang et al. found out that the outbreak of COVID-19 has resulted in a change on the supply chain of fresh agricultural products in China, but it also provides an opportunity for the transformation and upgrading of the supply chain of fresh agricultural products [6]. Li and Gui pointed out that the outbreak of COVID-19 has activated the development of a series of "online new economic business mode" [7]. The way to promote the development of community fresh delivery and improve the efficiency of enterprise distribution in the post- epidemic era is becoming more and more important. However, none of these researches analyze COVID-19's impact on fresh product apps in detail, and most of them just pointed out the existence of the positive relationship. Therefore, this paper can fill the blank in such a topic, to specifically test the relationship and explore its influence path. In detail, this paper verifies the impact of COVID-19 on the use of fresh food e-commerce, and this paper also takes advantage of the structural equation model to analyze the relationship among different variables and the possible consequences. The rest part of the paper is organized as follows. The Sec. II will present 3 assumptions, and describe the data sources and selection methods on which the analysis is based. The Third. III will elaborate the data analysis results and their significance. Eventually, a brief summary will be given in Sec. IV.

2. Methodology

2.1 Hypothesis

Based on the theory of buyer behavior, consumer behavior is influenced by stimulus or input factors, external factors, and internal factors. Stimulus or input factors include product quality, price, service and other products themselves.

Li and Sheng indicated that the epidemic will further promote industrial upgrading by changing expectations and consumer behavior [8]. Moreover, with the widespread use of modern information technology, more and more offline consumers change to shop online, which accelerates the growth of online retail, fresh e-commerce, express logistics in China. The similar phenomenon can be found in Turkey, which is accompanied by changes in consumer's eating habit [9]. As an external factor, COVID-19 may have a significant impact on consumer's willingness to buy fresh product online. With this in mind, the first hypothesis is proposed:

H1: After the COVID-19 outbreak, consumers are more likely to use online platforms to buy fresh food.

Taking Sauma as an example, Xu and Chen found that substantial incentives, (e.g., the quality and price of the product itself) are the most important factors influencing consumer purchases. Therefore, the following assumptions are made in this paper:

H2: The price of a product on the fresh produce apps and consumers' perception of its quality significantly affects their willingness to buy.

According to Qi and Lin's survey, the main consumers of fresh e-commerce are purchasing fresh food to meet their needs for cooking at home, since most of these people have limited free time due to their work, so online platforms can satisfy their demands [10].

H3: The increased willingness to use fresh produce apps has further promoted consumers' willingness to cook at home.

2.2 Selecting Data

In this paper, there are two different kinds of data. Firstly, 12 representative fresh food apps' data from 2018 to 2021 were selected as secondary samples, and 432 observed values were obtained after removing the samples with missing variables. In order to prevent the influence of extreme values, winsorize indentation of 1% or so is applied to all continuous variables. Stata15 is used for data statistics in this paper, and the data are all from the Qianfan Analysis database. Secondly, in structural equation model, this paper distributed questionnaires online questionnaires from May 2nd to May 7th. A total of 314 questionnaires were collected in this survey. After deleting some invalid samples, the final number of valid samples was 227.

2.3 Model construction

To test the hypothesis 1 of this paper, this paper sets the model to be tested as follows:

$$User_{i,t} = \alpha_0 + \beta_1 Virus_i + \beta_i Controls + \varepsilon_{i,t} \quad (1)$$

Where $User_{i,t}$ is used to measure an app's number of active users at a given time. The $Virus_i$ measures whether the COVID-19 outbreak in China, and the control variables are introduced as follows

Score: A comprehensive score of apps at the end of each month. The higher the score, the more satisfied the user is with the software

Update: Frequency of application software updates in each month.

Duration: The average daily usage time (hours/times) of fresh App installed on smart mobile terminals is equal to daily usage time of fresh App/daily start-up times of fresh App.

2.4 Variable description

In order to eliminate the influence of possible outliers on the research conclusions, winsorize treatment was carried out on continuous variables at the level of 1%-99%. Specific descriptive statistics are shown in Table I. After logarithmic processing of the number of active users, the maximum value is 7.501, and minimum value is 2.369, i.e., the heteroscedasticity of the model is greatly reduced.

Table 1. Variable Description

Variable	Obs	Mean	Std. Dev.	Min	Max
User	432	5.45	1.501	2.369	7.501
Virus	432	.667	.472	0	1
Score	432	4.34	.632	2.051	4.973
Duration	432	.074	.032	.022	.255
Update	432	2.296	1.531	0	7
Download	432	12.314	1.3	8.395	13.928

3. Results & Discussion

3.1 Correlation analysis

Seen from the Table. II, the Pearson correlation coefficient between the external environment and the number of active people in the fresh food App users is 0.131, which is significantly positive. In this case, it indicates that after the outbreak of COVID-19, the demand for buying fresh food online is greater, which verifies the hypothesis of this paper. Furthermore, the correlation coefficients between the number of active user and other variables are 0.506, 0.283, -0.083 respectively, which are also significant related with it.

Table 2. Correlation analysis

Variable	User	Virus	Score	Update	Duration
User	1.000				
Virus	0.131	1.000			
Score	0.506	0.150	1.000		
Update	0.283	0.169	0.155	1.000	
Duration	-0.083	0.026	-0.072	0.091	1.000

3.2 Empirical analysis

According to the results, the regression coefficient of the interaction term is 13.42 and it is statistically significantly positive at 1% confidence level, which means that the outbreak of COVID-19 has indeed significantly increased the number of active users. Besides, the regression results also show that the score level of the app and its monthly update frequency exert statistically significant impacts on the download of the app. Specifically, the monthly update frequency of the software and the increase of APP score both promote the increase of download.

The monthly update frequency of an app reflects the platform's attention to improving the service quality of the system. On the one hand, within a reasonable range, relatively high update frequency is likely to make customers realize the positive attitude of service providers, which leads to selection bias and customer loyalty. On the other hand, targeted version updates can continuously improve the system quality of the platform. The coefficient of “update” is 0.0824, denoting that the system quality of fresh e-commerce app has a significant positive effect on users' use intention [11].

Table 3. Regression results of COVID-19 and fresh e-commerce activation

	User (XX)
Virus	13.42*** (29.32)
Update	0.0824*** (3.95)
Score	0.249*** (4.02)
Duration	-9.093*** (-7.08)
_cons	-1.667*** (-5.05)
N	432
adj. R^2	0.808
Individual Fixed Effect	Yes
Time Fixed Effect	Yes

*** p < .01

The coefficient for “Score” is 0.249, which is also significant at 1% level. When choosing shopping app, customers tend to compare among multiple platforms. The comprehensive score of the software in the application store provides an intuitive reference standard for customers who have not downloaded it. The higher score reflects the good experience of previous users, which makes the customers who have not downloaded the software have higher psychological expectations and makes the software stand out in the competition.

In order to further determine the accuracy of the regression results, this part makes a robustness test. The specific approach is to use the amount of software downloads instead of the original monthly active amount of software as a new explanatory variable. The robustness test results are shown in the table IV.

Table 4. Robustness test

	Download
Virus	8.302*** (10.51)
Update	0.115*** (3.77)

Score	0.373*** (4.94)
Duration	-1.072(-0.84)
_cons	6.112*** (10.25)
N	432
adj. R ²	0.502
Individual Fixed Effect	Yes
Time Fixed Effect	Yes

*** p < .01

The regression results of robustness test are basically consistent with the main regression results. The regression coefficients of Virus item, monthly update frequency of app and app's comprehensive score are statistically positive, which shows that the previous regression results are accurate, reliable and robust.

It is worth noting that the regression coefficient of duration of each use is statistically significantly negative in both regressions, which are -9.093 and -1.072. The possible explanation is that customers often carry out fresh shopping with purpose. They want to complete each fresh shopping experience efficiently. The duration of each use of software indirectly measures the convenience of each transaction. According to Wang, customers tend to be more willing to purchase on the platform where they perceive the most convenient transaction process. In other words, the number of active people would decrease when the single completion time of shopping becomes longer, which indicates the convenience of using the software decreases [12].

3.3 Structural Equation Model

According to Chen's research, with the improvement of their living, they pay more and more attention on the quality of their daily fresh food [13], which puts their perception of fresh food's quality as an important factor during their online shopping. Based on the theoretical basis and previous studies, this paper establishes the following index system from four aspects: willingness to buy, willingness to cooking at home, quality perception and external environmental, as listed in the Table. V.

Table 5. List of questions in the questionnaire

Class	Questions
External environmental	E1: The outbreak of COVID-19 has inspired me to buy fresh products online
	E2: Since the outbreak of COVID-19, I have found more people around me buying fresh products online through fresh food e-commerce platforms
	E3: Since the COVID-19 outbreak, I have noticed that there are many media platforms promoting fresh food e-commerce platforms
Quality perception	Q1: I think the quality of fresh products on fresh produce app is good
	Q2: I think the introduction of the products on the fresh produce app, such as pictures and texts, is consistent with the objects received
	Q3: In conclusion, I think the quality of fresh products bought online is guaranteed
Willingness to buy	B1: After the COVID-19 outbreak, I prefer to buy fresh products online
	B2: In the future, I will buy fresh products on the fresh food produce app.
	B3: In the future, I will buy fresh products on the fresh food e-commerce platform
Willingness to cook	C1: My willingness to cook at home has increased since I used the fresh produce app to buy food online
	C2: I spent less time cooking at home (including buying ingredients) after using the fresh produce app to buy food online.

	C3: Using the fresh produce app for online shopping, I cook at home more frequently
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As presented in Table VI, the Cronbach's α values of four dimensions studied in this paper: willingness to buy, willingness to cooking, quality perception and external environmental and overall Cronbach's α values are all greater than 0.7. In this case, the reliability of the questionnaire variables used in this paper is effective.

Table 6. Reliability test

Dimension	Cronbach's Alpha	Number of observed variables
External environmental	0.754	3
Quality perception	0.813	3
Willingness to buy	0.767	3
Willingness to cook	0.744	3
Overall	0.887	12

According to validity test, KMO was 0.895, which is greater than 0.7, the P value of Bartlett's sphericity test is 0.000, less than 0.05. Therefore, it can be considered that the questions designed in this paper are effective and reliable, and can be analyzed in the next step.

Table 7. Validity test

KMO		0.895
Bartlett's test of sphericity	Approx. Chi-Square	1017.993
	Df	66
	Sig.	0.000

It can be seen from the fig. 1 that the standardized factor loads in the model in this paper are all greater than 0.5 and less than 0.95, which means the estimated coefficient does not exceed the acceptable range.

Moreover, absolute fitness index, incremental fitness index and parsimonious fitness index are selected to identify whether the structural equation model established in this paper is effective. The fitting indexes are summarized in the table VIII. It can be seen from the table that each fitting index conforms to the standard, so the model matches the actual data.

Table 8. Model fitting index and measurement value

	Indicator	Range	Outcome
Absolute Fit Measures	CMID	\	55.785
	Df	\	50
	CMID/Df	<3	1.116
	RMSEA	<0.08	0.023
	GFI	>0.9	0.959
	AGFI	>0.9	0.936
Incremental Fit Measures	CFI	>0.9	0.994
	TLI	>0.9	0.992
	NFI	>0.9	0.946
	IFI	>0.9	0.995
Parsimonious Fit Measures	PCFI	>0.5	0.753
	PGFI	>0.5	0.615
	PNFI	>0.5	0.717

According to the results, P values of external environment, quality perception, willingness to buy and willingness to cook are all less than 0.05, and the absolute values of standardized path coefficients are all less than 1. Based on the significance test, it can be concluded apparently that hypotheses H1, H2 and H3 are valid.

Table 9. Path coefficient

			Unstd.	S.E.	C.R.	P	Std.	R ²
Willingness to buy	<---	Quality Perception	0.473	0.078	6.053	***	0.501	0.781
Willingness to buy	<---	External Environment	0.701	0.13	5.392	***	0.512	
Willingness to cook	<---	Willingness to buy	0.889	0.097	9.177	***	0.811	0.657

*** p < .01

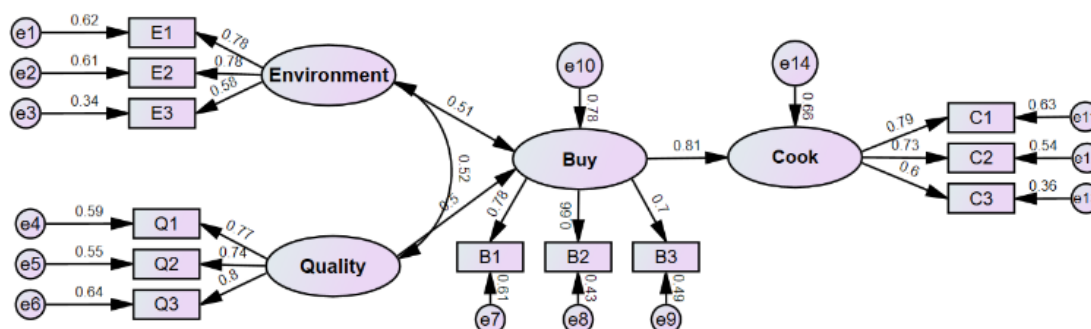


Fig. 1 Structural Equation Model

3.4 Limitation

However, this research has some shortcomings and drawbacks. There may be more than two kinds of factors that could have an impact on customers' willingness to pay. Therefore, in the future studies, extra variables could be considered to improve this model. Additionally, some questions can be replaced or added to raise the fitness of the model based on consumer behavior theory.

4. Conclusion

In summary, this paper investigates the impact of pandemic on consumer's behavior during fresh food shopping, and based on the analysis in this paper, the spread of COVID-19 significantly promotes the sales volume of online fresh produce platforms, since one need to keep a reasonable social distance. According to the theoretical model of buyer behavior and in combination with the background of COVID-19, two factors influencing consumers' willingness are evaluated to use fresh food APPs: external environment and quality perception. Nevertheless, this study also finds out that with the increasing in customer's willingness to buy fresh food online, they are more likely to cook at home. In the future, more dimensions will be taken into consideration during model construction, to explore and verify the relationship between the main variables more precisely. Overall, these results offer a guideline for the development of fresh food e-commerce.

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