Yield and Volatility of Service Industry in Long-term Uncertain Market: a Post-pandemic Era Perspective

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Abstract. The service industry, where hotels, restaurants, and tourism have experienced a cliff-like decline due to the Covid-19 pandemic. This paper evaluates the impact in both China and oversea situations on service industries. We build a VAR model to analyze the changes in returns and the ARMA-GARCH model which analyzes the changes in volatility in these service industries. This paper focuses on previous stock returns to predict the future influence of volatility in hotel, tourism, and catering industries. It finds out that pandemic outbreaks have a negative influence on service industry's rate of return in both the short term and long term as the epidemic gradually normalizes. Therefore, if service industry wants to have a sustainable return, it must come up with new business models to attract customers both in person and online. In addition, market advertising and improving consumer experiences also play important roles since now a lot of young consumers care much about their living experiences.

Keywords: COVID-19, Service industries, Long-term impact.

1. Introduction

The unexpected outbreak of Covid-19 pandemic interrupted our life at the beginning of 2020. It's spread and resulting repercussions have led to an unprecedented global crisis. As the Covid-19 pandemic spread, a lot of countries and cities went into lockdown, closing schools, restaurants, and all non-essential business operations, also restricting domestic and international travel. The quarantine policy imposed a huge impact on the labor market, and at the same time has led to layoffs in a large number of companies and difficulties in economic operation. These situations are particularly pronounced in the service industry, where hotels, restaurants, and tourism have experienced a cliff-like decline in the short term. The UNWTO has estimated that there is a loss of about 1.1 billion international tourist in addition with a loss of US$ 910 to 1.1 trillion in export revenues and 100-120 million jobs because of the hugh spread of the unexpected pandemic [1]. According to the World Tourism Organization, the number of international tourists reduced by around 1 billion in 2020 declining by 73% compared with that in 2019, and the decline further by 11% in the first quarter of this year. According to the report, global tourism-related economic losses in 2020 reach to about US$2.4 trillion [2]. The great decrease in traveling led to a decline in businesses in hotels and catering as well.

Some researchers have found that Covid-19 pandemic has lead to disasterous impact to the tourism experience and may lead to great changes in tourists' behavior in the coming years. It is one of the most sensitive industries in the world. Leisure, travel and inbound tourism activities registered a sharper decline which caused a loss of 2.86 trillion in US dollars that made up 50% plus loss in

revenues [3]. According to what Yenişehirlioğlu and Salha found, most studies suggest that the restrictions imposed during the pandemic contradict tourism spirit which makes tourists no longer go on vacations thanks to the pamdemic. [4]. In addition, they suggested that engaging in holidays and accommodations such as camping might be a more preferable choice. Moreover, the authors made the illustration that rural tourism demand is on the rise and that the market may emerge in a different way due to the increasing interest in alternative travelling options [5].

Besides the tourism industry, the literature shows that the catering industry has been the most affected especially those small and medium-sized enterprises. This is because outdated business models mean that many foodservice companies need to follow the consumption trends of contemporary restaurants. As a result, the study aims to determine how consumer can be better served in the food industry after the pandemic in order to boost corporate profits. In addition, consumers cannot take advantage of culinary experiences, either completely or at least partially because of severe restrictions to food services during the pandemic [6]. Even if the government does not impose restrictions on the restaurant service, many consumers were and are reluctant to eat at a restricted food service facility due to the potential for COVID-19 transmission [7]. These results imply companies need to implement more personalized marketing and production strategies to make sure food safety and quality and, at the mean time, collaborate with internet influencers to attract more attention and boost sales [8].

What is more, the literature also suggests that for the whole hotel industry, COVID-19 will influence China's hotel industry in a significant and permanent way given that many hotel owners, particularly individual hotel owners, have temporarily closed their doors or transferred their properties to others, resulting in a significant decline in market value. As per the China Hospitality Association (2020), China's hotel industry lost more than 67 billion Yuan (approximately US$9.44 billion) in its revenue. In some major cities, revenue per available hotel room declined by more than 85% in February 2020 [9].

All these findings show how these industries are negatively impacted in profit during pandemic, further leading to depression in global economy as well. In addition, as the COVID-19 pandemic gets normalized, people are used to the changes in their lives. Service industries also began to create new business models to accommodate the current situation. However, even though life is becoming more adjusted to pandemic, the impact in both the short term and long term still exists. Therefore, analyzing deeply about hotel, catering, and tourism industry enables us to understand how economy operates since all these three industries take up a great proportion of global GDP and economy growth.

This paper researches the stock price fluctuation under the pandemic, including the day price and the closing price. First, for the Stata part, the research engages in the stock price of Tourism index, catering industry index, hotel industry index, the number of new confirmed cases in China, the number of new cases overseas from January 24 until now and organize the data, then begin the demonstration phase by checking the stationarity of logarithmic original series and logarithmic return series. The paper uses varsoc to determine the order of the logarithmic rate of return of tourism, catering, and hotels, as well as the new logarithm in China and the new overseas logarithm, build a VAR model, and draw a pulse graph. Then the research uses the PACF and ACF pairs of the logarithmic return series for travel, dining, and hotels to order (determine the order of the AR part and the order of the MA part), and build the ARMA-GARCH model, and the logarithmic new sequence is placed in the variance equation as an exogenous variable. Finally, the research obtains the ARMA-GARCH valuation results through the above steps and obtains the target conclusion of this study based on the model performance.

2. Research Design

2.1 Data sources

Data of daily new confirmed COVID-19 cases in both China and overseas in this paper are obtained by Choice Financial Terminal. Choice has compiled all crucial data about the pandemic

including Cases, Frequency, and Date with solid sources from the datasets of National Health Commission of the People's Republic of China and the World Health Organization. The main line graphs in the Choice dashboard show the total number of people diagnosed with COVID-19 in China and overseas from January 21, 2020, to July 21, 2022, and January 20, 2020, to July 20, 2022, respectively.

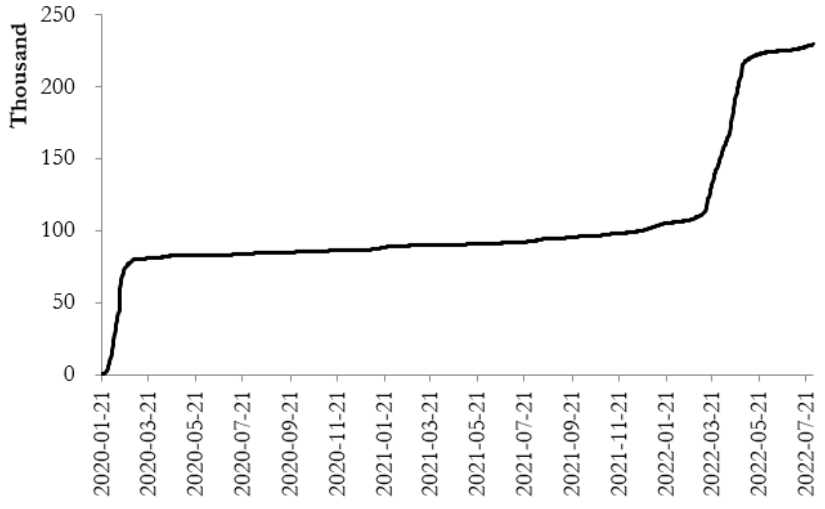

Figure 1 The number of confirmed cases, China

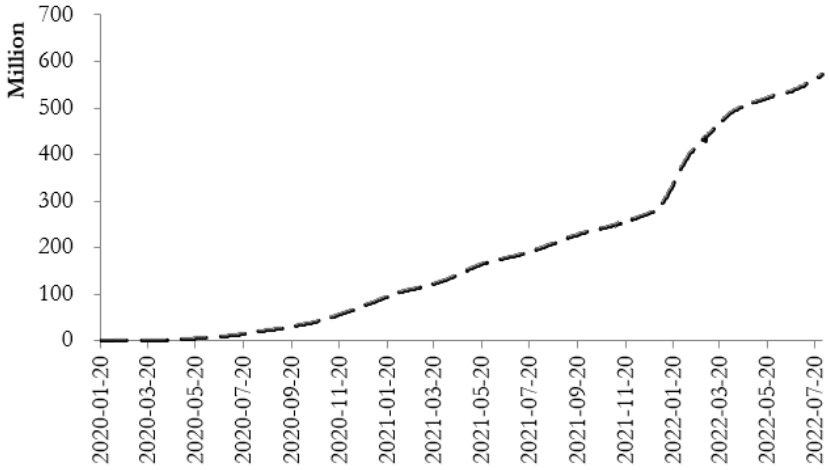

Figure 2 The number of confirmed cases, overseas

The price data of stock indexes of hotel, catering, and tourism are derived from Choice Financial Terminal, which is a software that provides service such as financial data analysis for financial institutions, academic research institutions, and professional investors. Choice provides application tools such as Excel plug-ins that organize all the historical data, integrates information query, and generates statistical analysis. This paper selects the adjusted closing prices, which reflects the value of the stock after taking into account any corporate actions. [6]. In this case, the fluctuation of the market expectation of the three industries over the pandemic period is obtained and thus making it feasible to continue analyzing.

This paper matches daily new confirmed COVID-19 case data with stock index price data based on date. Concerning the difference between trading days and non-trading days, the research adds a logarithmic sequence to the original sequence in order to fix the issue of the missing stock indexes price data on non-trading days, without influencing the result of the research. Stata is chosen as the tool to solve mathematical problems when doing analysis.

2.2 Logarithmic Price and Logarithmic Yield

This paper selects logarithmic terms as the stock index price and yield, and the calculations are as follows:

$$Price = \ln(1+p)\,, p \text{ is the adjusted closing price} \quad (1)$$

$$Price = \ln(1+p)\,, p \text{ is the adjusted closing price} \quad (2)$$

$$Yield = \ln(1+r)\,, r \text{ is the rate of return} \quad (3)$$

$$r = \frac{p_t - p_{t-1}}{p_{t-1}} \quad (4)$$

2.3 Unit Root Test

In this research, Unit Root Test can be used to verify the stationarity assumption. The test refers to testing the existence of a unit root in the series as a symbol of non-stationary time series that leads to false regression. When starting the research, the premise is set as the series is stationary and thus making it necessary to first check the stationarity condition to confirm whether further improvements should be made.

When applying the test, z_t can be typically written as:

$$z_t = a_t + \beta z_{t-1} + \sum_{i=1}^{p-1} \emptyset_i \Delta z_{t-i} + e_i \quad (5)$$

The null hypothesis H_0 for the test states that the coefficient $\beta = 1$, which demonstrates the existence of a unit root, so the series is not stationary. The alternative hypothesis H_1, which indicates stationarity, states that $\beta < 1$.

Table 1 is the Augmented Dickey-Fuller Test results:

Table 1 ADF test result

Variables	t-statistic	p-value
	Price (raw data)	
Hotel	-2.9390	0.1499
Catering	-2.1200	0.5351
Tourism	-2.9920	0.1342
	Yield (processed data)	
Hotel	-29.9480	0.0000***
Catering	-35.4810	0.0000***
Tourism	-38.0440	0.0000***
	Covid-19 pandemic	
China	-3.7310	0.0204**
Overseas	-16.7120	0.0000***

Note: ***, **, and * indicate the significance level of 1% (0.01), 5% (0.05), and 10% (0.1), respectively.

The stationarity test results of the raw data series show relatively high p-value, which means the daily new confirmed COVID-19 cases in both China and overseas are not appreciably stable below 95% confidence intervals. On the contrary, the logarithm series show obvious improvement in stationarity under 95% confidence intervals, and even under over 99% confidence intervals. The enhancement justifies the set-up of the following model.

2.4 Vector-autoregression

2.4.1 VAR Specification

The Vector Autoregressive Model is an econometric model of common use that was put forward by Christopher Sims in 1980 [7]. In the VAR model, we put several economic variables together as a system to predict, so that the predictions are mutually consistent. Besides, each time series in a set of vectors is modeled as determined by its own lag, and the lags of all other variables in the set of vectors.

For example, for a VAR Model with two variables(z_1, z_2) and the lag term ($p = 1$):

$$z_{1,t} = c_{11}z_{1,t-1} + c_{12}z_{2,t-1} + \varepsilon_{x_1 t} \tag{6}$$

$$z_{2,t} = c_{21}z_{1,t-1} + c_{22}z_{2,t-1} + \varepsilon_{x_2 t} \tag{7}$$

In this case, a vector group can be obtained:

$$Z_t = C \cdot C_{Lag} + E_t \tag{8}$$

where $Z_t = \begin{bmatrix} z_{1,t} \\ z_{2,t} \end{bmatrix}$, $C = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}$, $Z_{Lag} = \begin{bmatrix} z_{1,t-1} \\ z_{2,t-1} \end{bmatrix}$, $E = \begin{bmatrix} \varepsilon_{x_1 t} \\ \varepsilon_{x_2 t} \end{bmatrix}$.

It is possible to use a VAR(p) template with the three variables (stock index price, China case, overseas case):

$$y_t = \Gamma_0 + \Gamma_1 y_{t-1} + \cdots + \Gamma_p y_{t-p} + \varepsilon_t \tag{9}$$

Where $y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{bmatrix}$, the three response variables, $\Gamma_0 = \begin{bmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \end{bmatrix}$, $\Gamma_1 = \begin{bmatrix} \beta_{11} & \gamma_{11} & \lambda_{11} \\ \beta_{21} & \gamma_{21} & \lambda_{21} \\ \beta_{31} & \gamma_{31} & \lambda_{31} \end{bmatrix}$, …, $\Gamma_p = \begin{bmatrix} \beta_{1p} & \gamma_{1p} & \lambda_{1p} \\ \beta_{2p} & \gamma_{2p} & \lambda_{2p} \\ \beta_{3p} & \gamma_{3p} & \lambda_{3p} \end{bmatrix}$, the coefficient matrices, $\varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix}$, the error term matrix.

2.4.2 Impulse Response Graph

An impulse response is a dynamic system's response to any external change. A response effect, which is a function of time, can be typically calculated as:

$$\psi_s = \frac{\partial y_{t+s}}{\partial \varepsilon_{t'}} \tag{10}$$

This equation states that when variable j is one unit higher in the disturbance term ε_{jt} at timestamp t, the response effect is supposed to be the change in the value of $y_{i,t+s}$, the value of variable i at timestamp $t + s$. If we describe the equation in relation to the time interval s, it is turned into an IRF, which stands for the Impulse Response Function.

With all impulse responses illustrated by graphs, the interaction between variables in the VAR Model can be perfectly visualized, which makes the whole model easier to understand.

2.5 ARMA-GARCH Model Specification

2.5.1 ARCH Model Specification

The ARCH model refers to Autoregressive Conditional Heteroskedastic Model, which describes the variance of the variable and is proposed by Robert Fry Engle in 1982 [8]. The ARCH model takes into account the volatility of the variance, allowing it to better predict the variance.

An example of the ARCH(p) Model writes:

$$\sigma_t{}^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}{}^2 + \cdots + \alpha_p \varepsilon_{t-p}{}^2 \quad (11)$$

where σ_t is the predicted variance, ε_t is the true variance, α_0 is a constant.

2.5.2 GARCH Model Specification

The Generalized Autoregressive Conditional Heteroskedasticity Model, which was proposed by Bollerslev, further models the variance of errors.

For example, a GARCH (1,1) with three terms can be written as:

$$\sigma_t{}^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}{}^2 + \beta_1 \sigma_{t-1}{}^2 \quad (12)$$

This equation can be finalized with infinite terms, as follows:

$$\sigma_t{}^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}{}^2 + \alpha_2 \varepsilon_{t-2}{}^2 \ldots + \alpha_p \varepsilon_{t-p}{}^2 + \cdots \quad (13)$$

Or

$$\sigma_t{}^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}{}^2 + \cdots + \alpha_p \varepsilon_{t-p}{}^2 + \beta_1 \sigma_{t-1}{}^2 + \cdots + \beta_q \sigma_{t-q}{}^2 \quad (14)$$

2.5.3 ARMA-GARCH Model Specification

In ARMA, the variance equation is commonly ignored, while in the GARCH model, the mean value equation is usually regarded as a constant. In an ARMA-GARCH Model, the mean equation of the GARCH model is set as an ARMA process to predict both returns and volatility.

3. Empirical Findings

3.1 VAR identification

In this part, a VAR model is constructed for the log return series of tourism, restaurants, and hotels, as well as for Chinese log additions and overseas log additions using the varsoc definite order, and the corresponding impulse plots are drawn. The result is shown in Table 2 which indicated a VAR with 11 orders can be taken into account.

Here it can be seen that the AIC is smallest at Lag=7, while both its data are marked with '*', and therefore in this model, this conclusion is drawn by choosing Lag=7.

Table 2 VAR model identification

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	2471.93				1.2e-09	-6.3499	-6.33837	-6.31994
1	3451.41	1958.9	25	0.000	1.0e-10	-8.80671	-8.73757	-8.62697
2	3569.55	236.28	25	0.000	8.1e-11	-9.04645	-8.91969	-8.61692
3	3621.95	104.81	25	0.000	7.6e-11	-9.11699	-8.9326	-8.63766
4	3641	38.104	25	0.045	7.7e-11	-9.10168	-8.85967	-8.47257
5	3655.05	28.105	25	0.303	7.9e-11	-9.0735	-8.77387	-8.2946
6	3853.94	397.76	25	0.000	5.0e-11	-9.52107	-9.16382	-8.59238
7	4310.59	913.31	25	0.000	1.7e-11	-10.6322	-10.2173*	-9.55368*
8	4324.13	27.067	25	0.353	1.7e-11	-10.6026	-10.1301	-9.37437
9	4344.62	40.99	25	0.023	1.7e-11	-10.591	-10.0609	-9.21299
10	4361.95	34.657	25	0.095	1.8e-11	-10.5713	-9.98356	-9.04345
11	4375.68	27.439	25	0.333	1.8e-11	-10.5423	-9.89693	-8.86465
12	4399.63	47.902*	25	0.004	1.8e-11	-10.5396	-9.83661	-8.71216

3.2 Impulse response

Fundamentally, the 2020 Newcastle Pneumonia outbreak was a huge shock, with the global economy trending towards recession in the short term. The labor market was also hit harder by the

quarantine policy, which also led to a large number of business layoffs and difficulties in running the economy.

These conditions were particularly pronounced in the service sector, with the hotel, restaurant, and tourism industries experiencing a precipitous decline in the short term. It is clear that the shock of the COVID-19 pneumonia pandemic was not short-lived, and empirical evidence is needed on how the standing pandemic affected these sectors.

Based on the estimation results, this paper finds that the impact of new confirmed and overseas confirmed numbers in China in period t=0 on the hotel and tourism industries is almost relatively small, with the net effect close to zero, as shown by the fact that the positive and negative effects largely cancel each other out.

However, the impact of new Chinese numbers on the hospitality sector remains, with on average a 1% increase in the number of new domestic confirmations in period t=0, the largest negative net effect in period t=2, and a 0.1% decrease in hospitality returns, and slightly less than 0.1% in period t=5. In terms of time effects, the shock fades out after period 10.

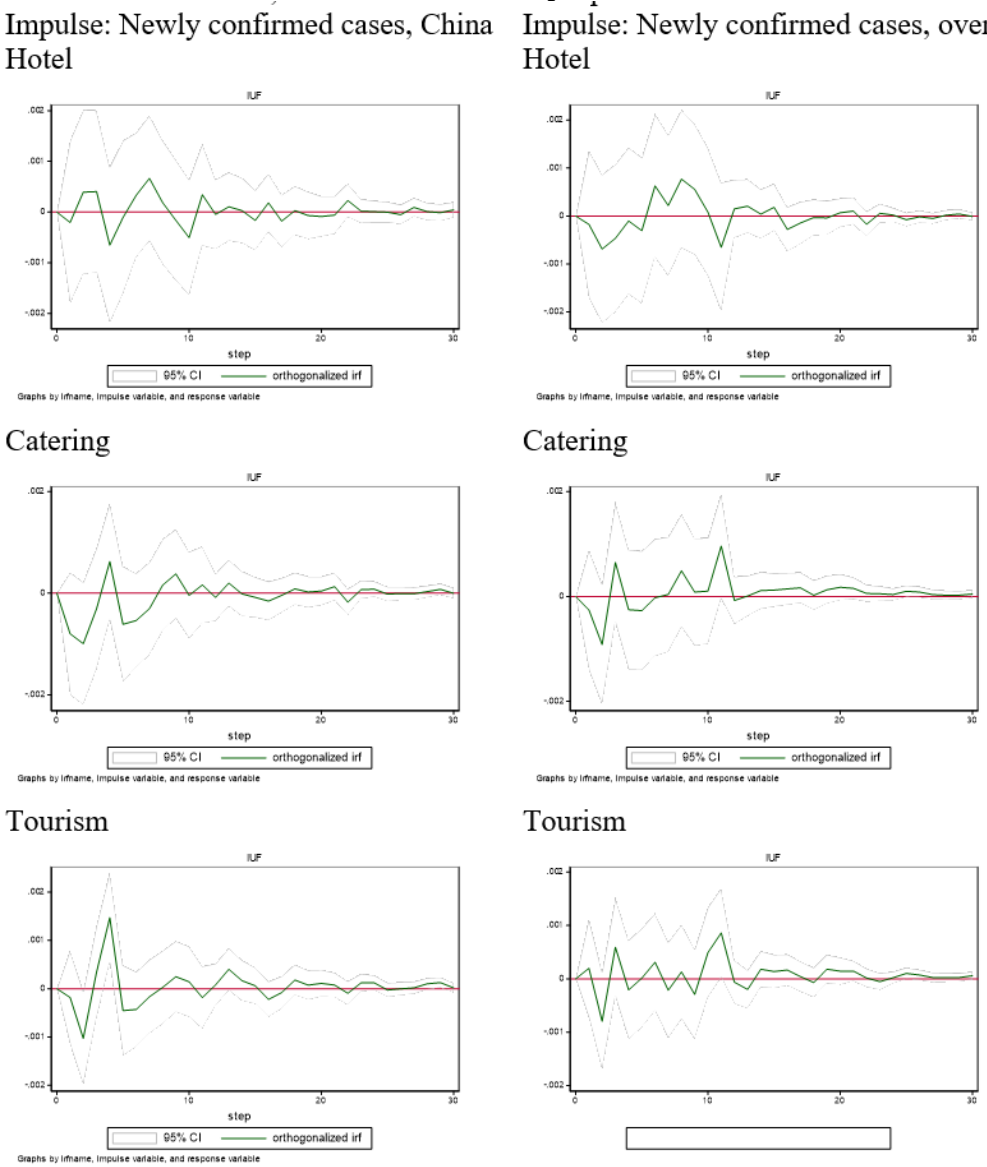

Figure 3 Impulse and response

3.3 ARMA Identification

In this section, its log-return series for tourism, restaurants, and hotels using PACF and ACF pairs are ordered to predict the future using past realizations and past shocks.

For both results of the part of hotel, catering, and tourism, the result is that this is an ARMA (1,1) model, with p=1 and q=1.

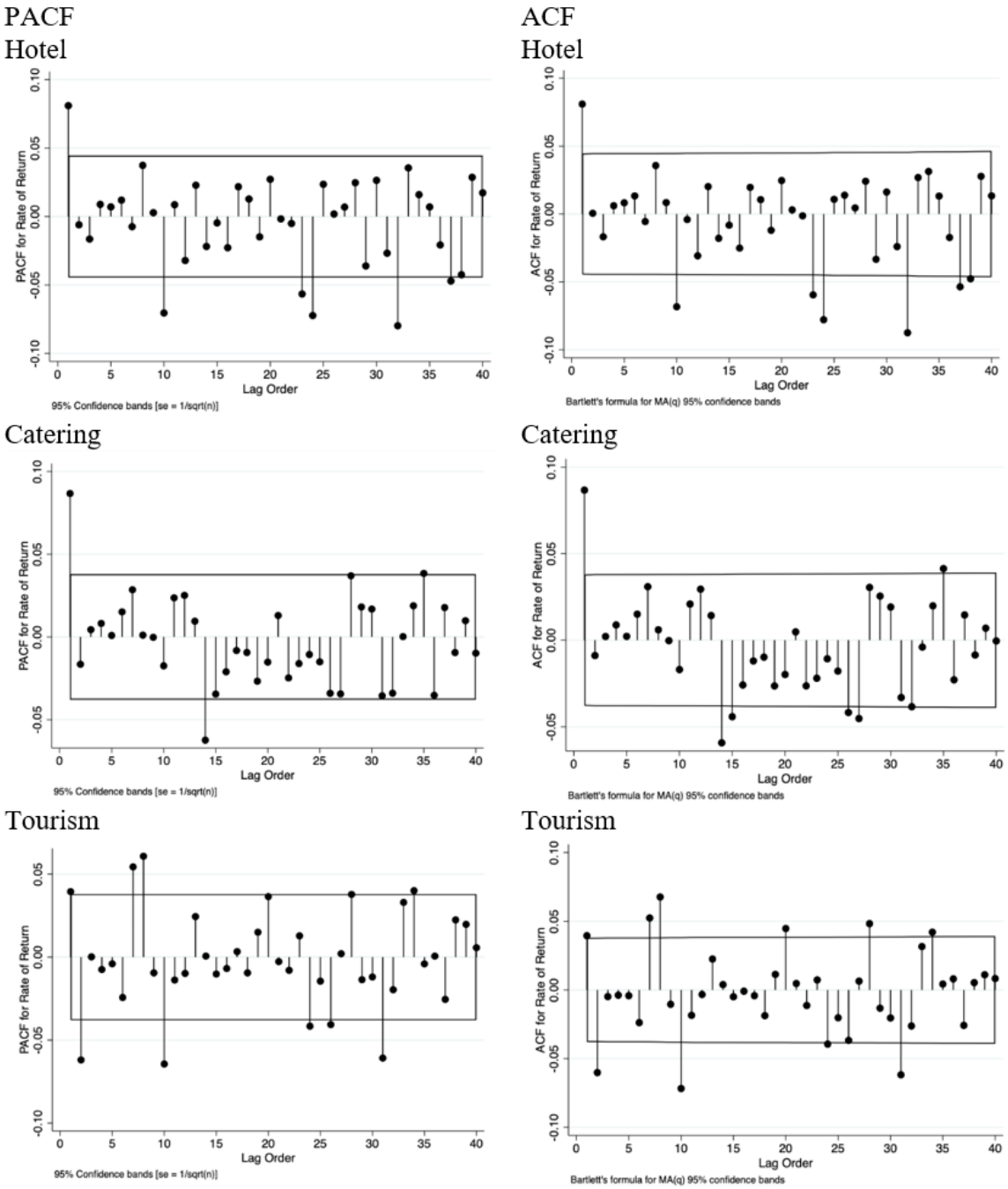

Figure 4 PACF and ACF

3.4 ARMA-GARCH Estimation Results

In this section, the paper uses an ARMA-GARCH model to examine the impact of a standing pandemic on the volatility of returns across industries.

It is important to note that no estimates are given for the tourism sector in this paper as the maximum likelihood function never converges in the numerical calculation of the modeled returns.

Firstly, the ARCH and GARCH terms in columns (1) to (4) are significant, indicating that there is significant conditional heteroskedasticity in the hotel and restaurant industry returns, which allows for GARCH modeling.

In terms of the coefficients of new confirmations, a 1% increase in the number of new domestic confirmations raises the daily volatility of hospitality and restaurant returns by 0.2751 and 0.0931 respectively, with coefficients significant at the 5% and 10% levels.

In addition, overseas additions did not increase the daily volatility of the above sectors.

Table 3 ARMA-GARCH estimation results, variance equation

	(1)	(2)	(3)	(4)
	Hotel		Catering	
Covid-19 pandemic, newly confirmed cases				
China	0.2751**		0.0931*	
	(0.1226)		(0.0484)	
Overseas		-0.0094***		0.1126
		(0.0712)		(0.1133)
GARCH (1, 1)				
ARCH (-1)	0.0720***	0.1214***	0.0401**	0.0332***
	(0.0114)	(0.0173)	(0.0102)	(0.0094)
GARCH (-1)	0.9223***	0.8753***	0.9174***	0.9427***
	(0.1030)	(0.0149)	(0.0218)	(0.0172)
Constant	-13.8294***	-11.8730***	-11.4302***	-13.2079
	(0.6858)	(0.6196)	(0.4105)	(1.7277)

4. Discussion

The unprecedented impact of the pandemic on tourism can be explained by the following. Firstly, travel restrictions were implemented by nations all around the world to stop the coronavirus from spreading. A few of the steps that countries are taking to try to limit the pandemic include airport closures, the suspension of incoming and departing aircraft, and statewide lockdowns [10]. In addition, during the worst period of the outbreak, people's desire to travel has also decreased, whether it is to reduce the burden on the world, to rest and recuperate, or even to have no income, etc.

However, the operationalization of some variables in this paper has certain limitations. And different countries have different policies and attitudes towards the virus. Based on the national conditions and policies of various countries in the world, the data and results may change. Although this study separates the impact of the pandemic in China and overseas, the analysis can be broken down by country. Because China's pandemic prevention policy is very different from that of the United States and other countries, the difference in prevention and control policies will also affect the results of the study. In addition, many countries no longer record daily new cases in detail, so the data support for this study is based on official reports.

Future research can further refine the region, and then take into account the factors of pandemic prevention policies in different regions and build models to obtain the impact of tourism and the COVID-19 pandemic.

5. Conclusion

This research finds that the stock price and rate of return of hotels, Catering, and Tourism are highly influenced by the pandemic. The outbreak of the pandemic has led to a sharp decline in global employment, with tourism and related industries among the most affected sectors. Based on past data and the assessment and the model of the future, the impact of the COVID-19 pandemic on the tourism industry is not only short-term but also fluctuates in the long term.

COVID-19 pandemic makes a considerable shock to the global economy. Due to different reactions to the pandemic outbreaks, tourism, hotel, and catering industries reflects the influences of pandemic on the economy. These industries display co-related behavior under the pandemic. The actions taken by different countries are distinctive to prevent the outbreaks and restrain the situation.

Regardless of how each country adopts policies to counter the negative influences of pandemic. This paper mainly focuses on the stock return from its historical price behaviors and makes a further prediction on the volatility of stock price. The research shows the positive correlation between newly confirmed cases (China and overseas) and stock volatility with the reference to VAR model and ARMA model.

References

[1] UNWTO. COVID-19 related travel restrictions–a global review for tourism. Eighth report as of 2 December 2020, 2020.

[2] Zhongming Z, Linong L, Xiaona Y, et al. COVID-19 impact on tourism could deal $4 trillion blow to global economy: UN report. 2021.

[3] Abbas J, Mubeen R, Iorember P T, et al. Exploring the impact of COVID-19 on tourism: transformational potential and implications for a sustainable recovery of the travel and leisure industry - ScienceDirect[J]. Current Research in Behavioral Sciences, 2021.

[4] Yenişehirlioğlu E, Salha H. COVID 19 PANDEMİSİNİN TÜRKİYE İÇ TURİZMİNE YANSIMALARI: DEĞİŞEN TALEP ÜZERİNE BİR ARAŞTIRMA. İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi, 2020, 19(37): 355-368

[5] DEMİR M, DEMİR Ş Ş, DALGIÇ A, et al. Impact of COVID-19 pandemic on the tourism industry: An evaluation from the hotel managers' perspective. Journal of Tourism Theory and Research, 2021, 7(1): 44-57.

[6] Kim K, Bonn M A, Cho M. Clean safety message framing as survival strategies for small independent restaurants during the COVID-19 pandemic. Journal of Hospitality and Tourism Management, 2021, 46: 423-431.

[7] Gursoy D, Chi C G. Effects of COVID-19 pandemic on hospitality industry: review of the current situations and a research agenda. Journal of Hospitality Marketing & Management, 2020, 29(5): 527-529.

[8] Hao F, Xiao Q, Chon K. COVID-19 and China's hotel industry: Impacts, a disaster management framework, and post-pandemic agenda. International journal of hospitality management, 2020, 90: 102636.

[9] Xu C, Qian Z, Zhang Z. Analysis of Chinese Consumer Behavior on Catering Services and Research on Corporate Marketing Strategies in the Post-Pandemic Era. 2021 International Conference on Enterprise Management and Economic Development (ICEMED 2021). Atlantis Press, 2021: 387-392.

[10] Sbai A. How COVID-19 Impacted Travel & Tourism Industry Globally. 2020.