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# Resilience and recovery: Analyzing the economic impact of COVID-19 on Beijing's catering industry

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**Abstract.** The COVID-19 pandemic, which emerged in late 2019, had far-reaching economic consequences, impacting industries worldwide. This study examines the specific case of Beijing's catering industry to understand how it undergoes the pandemic's challenges and what lies ahead. Using quarterly revenue data from 2017 to 2022 sourced from the Beijing Municipal Bureau of Statistics, an ARIMA model is employed for analysis. The model not only reveals the pandemic's impact on revenue but also provides forecasts for the future. In 2022, quarterly analyses illustrate a complex narrative of the industry's resilience. Revenue fluctuations reflect the influence of government policies, highlighting the need for businesses to remain adaptable and monitor policy changes closely. The predictive ARIMA model suggests relative stability for the catering industry in the coming quarters, serving as a useful reference for strategic planning. However, external factors such as market dynamics and policy shifts must be considered. Furthermore, actionable recommendations for catering businesses are offered. These include remaining agile in response to policy changes, investing in employee training and development, and embracing digital marketing strategies.

**Keywords:** COVID-19 Pandemic, Catering Industry, ARIMA Analysis.

## 1. Introduction

Since its emergence at the end of 2019, COVID-19 spread rapidly and become a global pandemic, casting a colossal shadow over the world economy. Historically, pandemics have exhibited a propensity to hinder economic growth, even, in some cases, exert a substantial adverse influence on economies. Given their profound implications, it is critical to acknowledge the economic impact of pandemics, which is a vital research priority in the subject of disaster economics. Many previous studies on serious health crises focused on Severe Acute Respiratory Syndrome (SARS). Sun et al. demonstrated that the SARS outbreak had a more negative impact on enterprises that are more susceptible to economic cycles and labor supply shocks [1]. Furthermore, Beutels et al. harnessed the cross-correlation function to analyze the economic impact of the SARS outbreak in Beijing in 2003 and found that the decline in tourism and discretionary consumption is at least partially irreversible [2]. Now, there exists a growing number of study that dives into the COVID-19 outcomes across a wide range of fields. For instance, Zhao et al. investigated the economic impact of COVID-19 with a particular emphasis on disparities between industries and discovered that it disturbed highly liquid industries such as catering while providing potential for growth in fields such as internet services and healthcare [3]. Employing an input-output model, Liang et al. discovered that tourism alone might

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reduce China's tax revenue by 180.22 billion to 270.33 billion yuan in 2020, comparable to 1.1% to 1.7% of the aggregate tax revenue in 2019 [4].

The pandemic profoundly affected the global hospitality and catering industries, and China bore no exception to its ramifications. Lockdowns, social distancing measures, and changing consumer behaviors disrupted the traditional workings of this industry [5]. At present, China has successfully controlled the pandemic and most industries have resuscitated their operations and production. As the primary and secondary sectors slow, the Chinese government focuses a greater emphasis on the developing tertiary industry due to its rising GDP contribution [6]. In the year 2022, the tertiary sector in China accounted for 52.8% of the Gross Domestic Product (GDP) [7]. The catering industry, an important part of the tertiary industry, plays a central role in Chinese society and economy. As China gradually recovers, it is imperative to gain a deeper understanding of the current state of the industry and its performance, both in the midst of the pandemic and in the prospective future, especially given its outsized influence.

This study aims to bridge the gap in our knowledge by examining the catering industry in Beijing. This endeavor not only helps us comprehend the economic impact of COVID-19, but it also sheds light on the opportunities and challenges that lie ahead for this critical field. Analyzing Beijing's condition is especially crucial since Beijing is both China's capital and a major economic hub. It could serve as a microcosm of the broader economic recovery and reshaping occurring within China's tertiary industry. Understanding how the catering businesses in Beijing coped with the pandemic and positioned themselves for future growth provides valuable insights that could assist policymakers, businesses, and stakeholders within the industry in making informed decisions and strategic plans in a rapidly changing economic landscape.

## 2. Data and Methodology

### *2.1. Data Source*

The dataset used in this study is sourced from Beijing Municipal Bureau of Statistics. The dataset is composed by quarterly catering revenue data, spanning a critical period from 2017 to 2022 as such temporal depth allows for the examination of trends and changes over time. The rationale behind the selection of this dataset is multifaceted. First, Beijing Municipal Bureau of Statistics provides an extensive array of statistical variables which collectively provided a comprehensive view of the landscape within which the catering industry operates. Moreover, the fact that the dataset is sourced from the Beijing Municipal Bureau of Statistics enhances its reliability and legitimacy which provides a solid base for this study.

### *2.2. Model Selection*

An AutoRegressive Integrated Moving Average (ARIMA) time series model is a great choice as the analytical framework to analyze the effect of the pandemic on Beijing's catering revenue. ARIMA models are widely employed in time series analysis due to their capacity to capture temporal dependencies and inherent autocorrelation within data, making them suitable for modeling revenue trends over time [8]. It ensures data stationarity through differencing and provides valuable forecasting capabilities, aiding in post-pandemic revenue projections. ARIMA also offers interpretability through its model parameters and undergoes testing to select the most appropriate specification, making it a trusted choice for modeling time series data.

### *2.3. Data Preprocessing*

The initial phase of the analysis involved meticulous data preprocessing to ensure the quality and suitability of the dataset. The first step of data preprocessing is to convert the quarterly catering revenue data from 2017 to 2022 into a date-time-based format. This step is crucial because the original quarterly revenue data is typically reported by quarter rather than specific dates. Converting it into a

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date-time format allows for a more precise representation of the changes and trends in the time series data.

### *2.4. Stationarity Testing*

The stationarity assumption necessary for ARIMA modeling need to be confirmed so that the reliability of the subsequent analysis can be ensured. Two widely recognized stationarity tests are the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test[9]. Both tests are employed in this study to check for stationarity. As shown in Table 1, the ADF test yielded a statistic of -3.1189 with a corresponding p-value of 0.0252, leading to the rejection of the null hypothesis at a 5% significance level, indicating that the time series does not possess a unit root and is indeed stationary.

**Table 1.** Augmented Dickey-Fuller (ADF) Test Results.

| Test | Statistics | P-value | Critical Values | Conclusion |
|---|---|---|---|---|
| ADF | -3.1189 | 0.0252 | 1%: -3.7884 | Stationary (Reject) |
| | | | 5%: -3.0131 | |
| | | | 10%: -2.6464 | |

Similarly, as shown in Table 2, the KPSS test produced a statistic of 0.4364 with a p-value of 0.0615. In this case, we could not reject the null hypothesis, suggesting that the time series may contain a unit root and thus is stationary.

**Table 2.** Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test results.

| Test | Statistics | P-value | Critical Values | Conclusion |
|---|---|---|---|---|
| KPSS | 0.4364 | 0.0615 | 1%: 0.739 | Stationary (Not Reject) |
| | | | 5%: 0.574 | |
| | | | 10%: 0.463 | |

Given the result, it is safe to say that the data's original series meet the criteria for stationarity. There is no need to difference the original series. Consequently, when conducting ARIMA regression on the quarterly catering revenue for Beijing, it is advisable to ultimately select the original series.

### *2.5. Residual analysis*

The residual white noise test is essential as it helps ensure that the model captures all relevant patterns in the data and that any remaining signals in the residuals are not indicative of systematic patterns. In order to assess the quality of the fitted ARIMA model, an examination of the model's residuals was conducted through the Q-statistic test to determine if they exhibit autocorrelation, a critical aspect in evaluating model adequacy. The Q-statistic results are shown in Table 3. The Q-statistic values range from 0.6154 to 3.0944, with corresponding p-values ranging from 0.4328 to 0.9791. At a significance level of 0.05, the null hypothesis that the residuals are white noise cannot be rejected, indicating that the residuals may indeed be white noise. The result affirms that the residuals of the ARIMA model do not exhibit significant autocorrelation and are likely white noise, supporting the model's adequacy for capturing the underlying patterns in the data.

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**Table 3.** Q-Statistic test results for residuals.

| Q-Statistic | P-Value | Conclusion |
|---|---|---|
| 0.61541839 | 0.43275495 | White Noise (Not Reject) |
| 0.78395834 | 0.67571819 | |
| 1.04242449 | 0.79098798 | |
| 1.04284395 | 0.90323134 | |
| 1.48237022 | 0.91509528 | |
| 1.96416122 | 0.92296498 | |
| 2.04037758 | 0.95757177 | |
| 2.13207946 | 0.97669258 | |
| 2.52007325 | 0.98033877 | |
| 3.0943825 | 0.97911478 | |

*2.6. ARIMA model*

The ARIMA (3,0,3) model was chosen as the prediction model as it demonstrated great fitting performance. This model effectively captures the complexity and trends in the time series while maintaining simplicity. The selection of these orders (3,0,3) resulted from multiple iterations and model evaluations, ensuring a good fit to historical data and reasonable forecasting capabilities for the future.

*2.6.1. The equation for ARIMA (3,0,3) model*

$$X_t = \phi_1 \cdot X_{t-1} + \phi_2 \cdot X_{t-2} + \phi_3 \cdot X_{t-3} + \varepsilon_t - 0.4521 \cdot \varepsilon_{t-1} + 0.4521 \cdot \varepsilon_{t-2} - 0.99999964 \cdot \varepsilon_{t-3} \quad (1)$$

The estimated autoregressive (AR) coefficients for lags 1, 2, and 3 are 0.7301, -0.5562, and 0.7215, respectively. The coefficients -0.45213606, 0.4521357, and -0.99999964 are the estimated moving average (MA) coefficients for lags 1, 2, and 3, respectively.

## 3. Result Analysis

*3.1. Quarterly analysis in 2022*

Using the ARIMA (3,0,3) model, a forecast for the Beijing city catering industry's revenue for the year 2022 was generated, as presented in Table 4. The impact of the pandemic on the revenue of Beijing city's catering businesses was assessed by calculating the difference between the actual revenue values and the forecasted revenue values.

**Table 4.** Impact of the pandemic on Beijing city catering industry revenue (2022).

| Year/Quarter | Revenue (million yuan) | | |
|---|---|---|---|
| | Actual Value | Forecast Value | Pandemic Impact |
| 2022/Q1 | 1.928255 | 1.639363 | 0.288892 |
| 2022/Q2 | 1.508713 | 1.620317 | -0.111604 |
| 2022/Q3 | 2.151202 | 1.821577 | 0.329625 |
| 2022/Q4 | 1.687345 | 1.844027 | -0.156682 |

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When comparing the actual values with the forecasted values, it's evident that the model captured some of the underlying trends and patterns in the data. The pandemic's impact on the Beijing catering industry's revenue is observable in the quarterly results. In the first quarter of 2022, the actual revenue exceeded the forecasted revenue by 288892 yuan, indicating that there is a positive deviation. However, in the second quarter, the actual revenue was lower than the forecasted revenue by 111604 yuan. In the third and fourth quarter, a similar trend was exhibited with the actual revenue surpassing the forecast in the third one, and a negative deviation in the fourth quarter. We can observe some fluctuations in the Beijing catering revenue indicating that the impact of the pandemic is mixed with some periods experiencing positive influence and others negatively impacted. This pattern is highly related to the relaxation and tightening of policies regarding the pandemic. When policies are relaxed, the revenue of the catering industry tends to rise rapidly. Such result indicates that while the industry may have faced challenges due to the pandemic, it also had periods of resilience and recovery.

### *3.2. Future revenue prediction*

The ARIMA (3,0,3) model constructed before is then utilized to predict the catering revenue in Beijing in the next two years. The visualization of the prediction is shown in Figure 1.

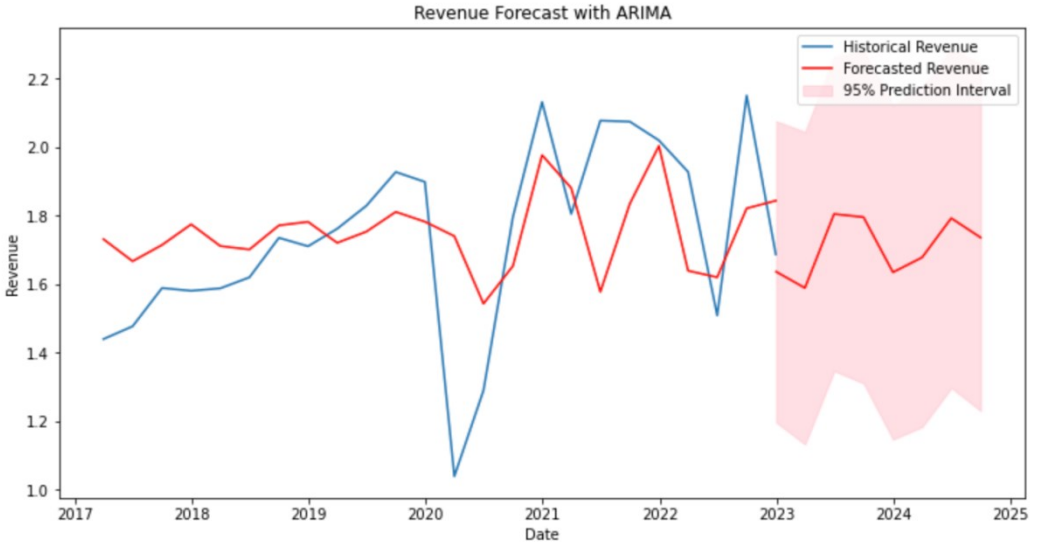


**Figure 1.** Catering Industry Revenue: Historical vs. Predicted (2017-2024).

In the eight forecasted quarters, catering revenue shows some fluctuations, but the overall trend appears relatively stable. The revenue forecasts for the first four quarters fluctuate between approximately 1.59 and 1.80 million yuan, while the forecasts for the last four quarters maintain a similar level. This may indicate a degree of stability in the catering industry during the forecast period. The forecasts for these eight quarters can serve as a reference for the future of the catering industry. They can be used as a baseline when planning business strategies and budgets. However, it's crucial to factor in uncertainties such as market competition, economic fluctuations, and potential policy changes.

## 4. Discussion

Looking ahead, the predictive model provides a baseline for future revenue expectations. While the forecasts suggest relative stability in the catering industry during the forecast period, it is imperative to consider external uncertainties, such as market competition and policy shifts, in strategic planning. Thus, catering business should be prepared to deal with potential challenges in the furture. There are some recommendations for them.

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### *4.1. Future revenue prediction*

Policy monitoring and emergency preparedness stand out as critical factors for survival and success of businesses when facing crisis. They not only help mitigate risks but also enable businesses to leverage new opportunities, ensuring long-term stability and growth. With governments continually crafting and revising policies in response to crises, businesses need to remain highly vigilant to any policy changes and rapidly assess their impact on operations. For instance, in the face of lockdowns or restrictions, businesses should have the capability to transition to delivery and takeout models to maintain operational continuity.

### *4.2. Employee training and development*

Investing in employee training and development programs is essential for enhancing staff skills, deepening product knowledge, and improving customer service. Being prepared to efficiently and courteously handle peak periods is crucial to maintaining consistent service quality. Such investment could result in customer loyalty, and ultimately, business growth. Such investment is proven to be effective by the success of Haidilao Hot Pot where employees are trained to be extremely warm and hospitable.

### *4.3. Digital marketing channels*

In terms of marketing, an agile marketing approach is highly advisable as rigid marketing strategy can be obsolete quickly as the business landscape is fast-paced. It would be great to utilize the digitalization of consumer behavior. For instance, they could use tools that take data to predict traffic, then to enhance demand with ingenious promotions [10]. Leveraging digital marketing channels, such as social media and online advertising, can significantly boost visibility and customer engagement. In addition, tailored promotions and loyalty programs can be designed to cater to the specific needs and preferences of customers. These initiatives not only attract new customers but also incentivize existing ones to continue their patronage, promoting customer retention.

## 5. Conclusion

COVID-19 has left an indelible mark on economies and industries worldwide, and the catering industry in Beijing has not been exempt from its far-reaching influence. This study sought to explore the effects of the pandemic on Beijing's catering industry, shedding light on both the challenges it faced and the opportunities it uncovered. The analysis of quarterly revenue data from 2017 to 2022 revealed a complex narrative. The impact of the pandemic on the Beijing catering industry was not a uniform tale of decline but contains the process of resilience, adaptability, and recovery. The ARIMA(3,0,3) model, carefully selected through iterative evaluations, effectively captured the industry's underlying trends and allowed us to generate forecasts for 2022. Quarterly assessments in 2022 indicated a fluctuating pattern in catering revenue. The pandemic's influence on revenue was intertwined with policy fluctuations, where relaxed restrictions often led to revenue spikes, while tighter measures resulted in declines. These fluctuations underscore the importance of policy monitoring and preparedness, with businesses needing to remain agile in responding to changing regulations.

The Beijing catering industry's journey through the COVID-19 pandemic is a testament to its adaptability and resilience. While challenges persist, the industry has exhibited the capacity to recover and evolve. Our study contributes to a deeper understanding of the economic impact of pandemics and provides practical insights for businesses and policymakers as they navigate an ever-changing landscape. As Beijing and the broader world continue to grapple with the consequences of the pandemic, the lessons learned from this study can inform strategies for building a more resilient and prosperous future for the catering industry and beyond.

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