Impact of COVID-19 on U.S. Travel Agencies: Evidence from Producer Price Index of Hotel and Car Rental Bookings

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Abstract. This study examines the effects of the COVID-19 epidemic on the tourism industry in the United States, specifically looking at the influence on hotel and car rental reservations. The study applies the ARIMA model to perform a time series analysis. COVID-19 caused severe disruption, including travel restrictions, decruitment, and business closure, which severely affected businesses and the economy related to the tourist industry. By checking the PPI (producer price index) of hotel and car rental bookings, this study evaluates the effects of COVID-19, and forecasts the PPI trend in 11 months after May 2020. ARIMA model has high accuracy and efficiently captures the changes caused by the pandemic. According to the analysis, during the COVID-19 period, the actual PPI value is much higher than the predicted PPI value. This shows that the pandemic had a significant effect on hotel and car rental bookings. These findings provide crucial insights to policymakers and business owners and help them construct efficient strategies and reduce loss in the future.

Keywords: COVID-19, Producer Price Index, Travel Agencies, ARIMA Model, Economic Impact.

1 Introduction

The COVID-19 pandemic caused significant impacts on various industries in the United States. Manufacturing enterprises ceased production due to the isolation policy. The output of many products was reduced, and the logistics were stopped. Since the quantity demanded is higher than the quantity supplied, product prices continuously increase [1]. The PPI of all commodities had a sharp increase between 2021 and 2023 [2].

Hotels were also facing this problem. The fixed assets, such as televisions, washing machines, and air conditioners experienced a supply shortage, so the costs inevitably rose. Simultaneously, consumable materials in hotels, such as tissues and hand soaps, also experienced a risen cost due to the supply shortage.

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The prices of epidemic prevention materials even had a more obvious increase because of the large demand. Some appropriate examples are disinfectants and masks. Food prices also rose significantly. This is primarily because food cannot be stored for a long period, and the demand will not decrease. Because of the logistics restrictions, some food, particularly fresh fruits and vegetables, had severe shortages [3, 4].

As COVID-19 spread, on the one hand, the labor force in the economic market significantly reduced. On the other hand, the quantity demanded for nursing staffs increased. This destroyed the balance of the labor market, which means that the price of labor rose. Being part of the service industry, the relationship between the supply and demand of hotel labor was also affected [5].

Isolation policies and travel bans also influenced hotel and car rental bookings. Some hotels might be overcrowded, while others might be prohibited from operating. In most cases, COVID-19 has influence to the operation costs [6].

In order to accurately predict the fluctuation of operating costs after the COVID-19 period, it is essential to study the fluctuation of operating costs during the COVID-19 period and assess the effects of COVID-19 on the tourist industry. This would help policymakers to construct logical policies and help investors and entrepreneurs to develop recovery strategies. A beneficial fact for them is that, after the COVID-19 period, the public would have compensatory travel intentions [7].

To analyze the PPI of the tourist industry during the COVID-19 period, based on the historical data from the past 20 years, this paper uses a time series model to analyze the fluctuation of PPI of hotel and car rental bookings. Standing on the side of producers, this paper also evaluates the costs of the hotel and car rental industries.

2 Research Design

2.1 Data Source

The primary source of the data is a comprehensive economic database known as Federal Reserve Economic Data (FRED). The Producer Price Index (PPI) quantifies the average change in the selling prices received by domestic producers for their goods or services over a specific time period. This specific series uses December 1, 1989, as its base period, with an index value set at 100. The data is updated monthly and is not seasonally adjusted. Overall, the index shows a steady increase, indicating that the prices travel agencies charge for services to individuals have generally risen over time. This upward trend can be attributed to rising costs within the industry or increased demand for travel services. However, the index also displays periodic fluctuations, reflecting the impact of various economic cycles, seasonal travel patterns, global events such as pandemics, and changes in fuel prices. In recent years, the index exhibited significant volatility due to the COVID-19 pandemic. During 2020 and 2021, travel demand plummeted, leading to a noticeable drop in the index. As more and more people are getting vaccinated and travel restrictions opened, travel demand gradually recovered, resulting in a rebound of the index. The current upward trend suggests that as the economy recovers, both travel demand and industry costs are

normalizing, driving the prices higher. Travel agencies are likely facing increased operational costs, including labor and fuel, which contribute to the rising index.

2.2 Augmented Dickey-Fuller Unit Root Test

To analyze the original PPI data, the initial step is to perform an ADF test. The ADF unit root test is a method used to check the stationarity of a time series. The null hypothesis (H0) of this test states that the time series contains a unit root, which means that the time series is non-stationarity. If the test statistic is below the critical value (e.g., 1%, 5%, 10%), the series is considered stationary. Otherwise, it is classified as non-stationary. The p-value for both the first and second order difference, as shown in Table 1, is 0. This result is lower than any critical value. Thus, the null hypothesis may be refuted, indicating that the model is stable.

Table 1. Weak stationarity test

	t	p
Ln PPI	-1.144	0.9214
1st order difference	-7.744	0.0000
2nd order difference	-12.599	0.0000

2.3 ARIMA Model

ARIMA is a time series method used to forecast the future trend. It is specified by three parameters: p, d, and q. The formula incorporates components of Autoregressive (p), Integrated (d), and Moving Average (q) models. In the ARIMA (p, d, q) model: The AR part's mathematical form is:

$$x_t = \varphi_0 + \varphi_1 x_{t-1} + \varphi_2 x_{t-2} + \cdots + \varphi_p x_{t-\mathrm{p}} + \varepsilon_t \tag{1}$$

The MA part's Its mathematical form is:

$$x_t = \mu + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \epsilon_{t-2} - \cdots - \theta_p \epsilon_{t-\mathrm{p}} \tag{2}$$

3 Results and Analysis

3.1 Order Determination and Residual Test

In this section, PACF and ACF are used to determine the value of p and q in the ARIMA model. The results are shown in Figure 1.

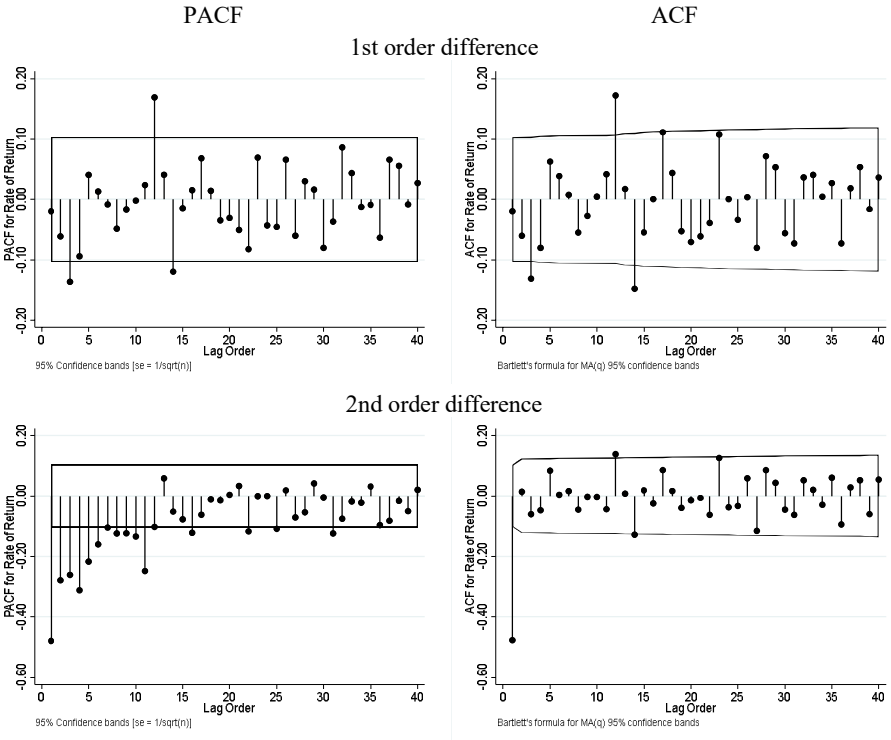

Fig. 1. ARMA (p, q) identification.
Photo credit: Original

The method to observe p and q is identify the lag at which the PACF and ACF plot cuts off. Since after the first-order difference, p and q are not obvious, it is necessary to proceed with a second-order difference. Then it is clear that p equals 11; q equals 1; d equals 2. The residual test of the ARIMA model is showed below:

Table 2. Residual test

Model	Portmanteau (Q) statistic	Prob > chi2
ARIMA(11,2,1)	34.3201	0.7232

According to Table 2, since the error term is consistent with the white noise, the ARIMA model passes the residual test. And the error is unpredictable.

3.2 Forecast Results and Interpretation

Through a comprehensive analysis of Figure 2, Table 3, and Figure 3, it is evident that COVID-19 has had a profound impact on the relationship between the Producer Price Index (PPI) and predicted values (PV). Before the pandemic, the discrepancy between actual values and predictions was minimal. However, starting in March

2020, the gap between actual values and predictions widened significantly, reflecting the substantial shock the pandemic delivered to the market. The PPI exhibited an overall downward trend, while PV began from March 2020. According to Figure 2, the actual PPI value is obviously higher than the predicted value. So COVID-19 exactly affected the tourist industry. With the higher costs, the actual PPI will also be higher than the predicted PPI.

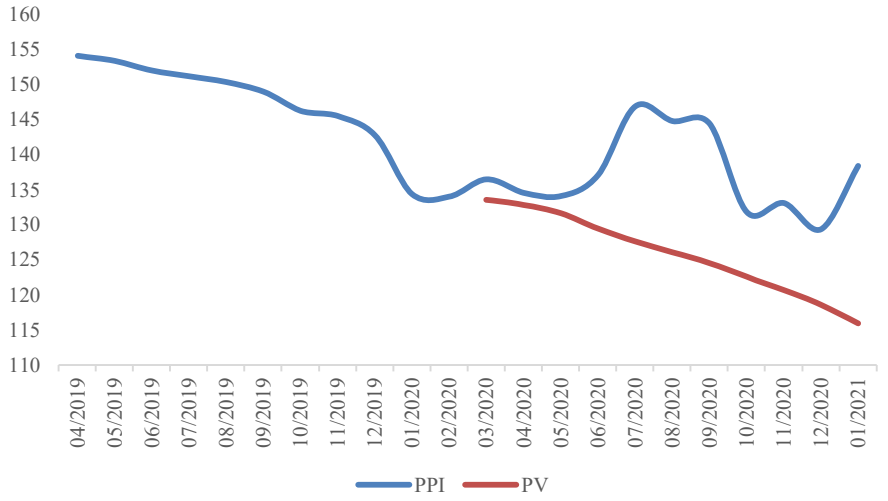

Fig. 2. PPI before and after Covid-19.
Photo credit: Original

Specifically, in March 2020, the difference between PPI and PV was 2.91908 (2.19%), which increased to 22.42184 (19.33%) by January 2021. The line chart illustrating the percentage difference further underscores this trend, with the percentage difference rising rapidly from 2.19% in March 2020, peaking at 15.06% in July 2020, and reaching 19.33% in January 2021. These data clearly show that the gap between actual and predicted market conditions widened significantly during the pandemic, highlighting the major challenges producers faced in maintaining price stability. This could be attributed to reduced travel demand, increased operational costs, or changes in consumer behavior.

Table 3. PPI, predicted value and difference

	PPI	PV	Difference	Difference (%)
04/2019	154.1			
05/2019	153.4			
06/2019	152			
07/2019	151.2			

08/2019	150.4			
09/2019	149			
10/2019	146.3			
11/2019	145.5			
12/2019	142.8			
01/2020	134.4			
02/2020	134			
03/2020	136.5	133.5809	2.91908	2.19%
04/2020	134.6	132.8688	1.73116	1.30%
05/2020	134.1	131.6479	2.45206	1.86%
06/2020	137.1	129.4897	7.61035	5.88%
07/2020	146.9	127.6754	19.22456	15.06%
08/2020	144.8	126.129	18.67104	14.80%
09/2020	144.4	124.5873	19.8127	15.90%
10/2020	131.8	122.5891	9.21091	7.51%
11/2020	133.1	120.7166	12.38345	10.26%
12/2020	129.4	118.6011	10.79888	9.11%
01/2021	138.4	115.9782	22.42184	19.33%

The historical data on the tourism industry's PPI from December 1989 to May 2024 show that the PPI has experienced several fluctuations over the years, such as during the 2008 financial crisis. However, the volatility induced by COVID-19 has been more severe and prolonged. This historical context helps us understand the recent changes in PPI and underscores the unprecedented nature of the pandemic's impact on the market. By May 2024, the PPI had risen to 189.926, indicating a strong recovery post-pandemic. This recovery could be driven by the reopening of economies, a rebound in travel demand, and adjustments in pricing strategies. Combining historical data with future trends provides a more comprehensive understanding of the pandemic's impact on the market and the industry's recovery trajectory.

Overall, COVID-19 has significantly affected the relationship between PPI and PV. Here are several reasons to explain why PPI is higher than PV. Firstly, the supply chain was disrupted [8] Factories closed and resources were limited. Second, in many fields, the production costs increased [9]. Lastly, transportation was restricted. Entrepreneurs all over the world did not have timely interaction [10].

The difference between PPI and PV also reflects high market uncertainty and rapid changes. Future prediction models must account for greater uncertainty and market dynamics to improve accuracy. These analyses are crucial for policymakers and industry stakeholders in formulating strategies and policies in the post-pandemic era. By enhancing the accuracy of predictions and adopting more flexible policies, future market fluctuations and uncertainties can be better managed, thereby promoting economic stability and growth.

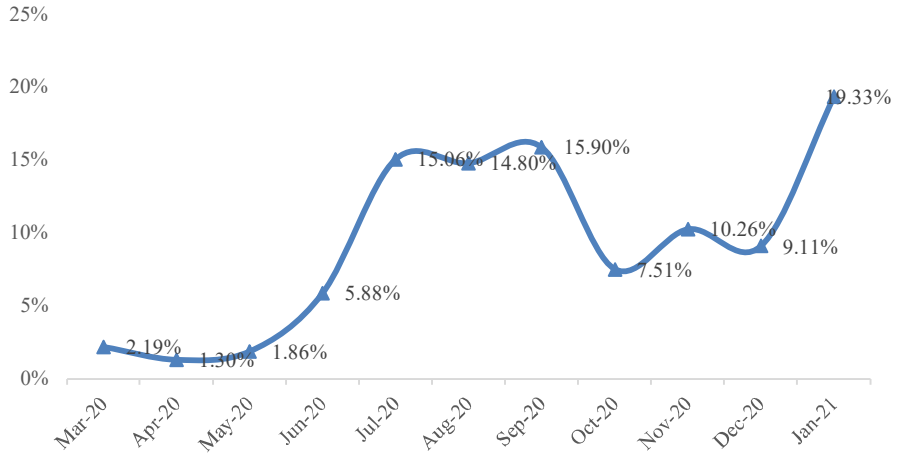

Fig. 3. The impact of Covid-19 on PPI.
Photo credit: Original

4 Conclusion

In conclusion, this paper illustrates the significant effect of the COVID-19 on the Producer Price Index for hotel and car rental bookings within the tourist industry in the United States. By applying the ARIMA model to a time series analysis, the research provided a comprehensive analysis of the difference between actual PPI values and predicted values (PV) during the pandemic period.

From March 2020, the COVID-19 began to spread, which caused a significant increase of actual PPI. On the contrary, PV showed a notable downward trend. These two opposite trends resulted in a wide gap. This divergence highlighted the challenges in maintaining price stability during the pandemic. There were many negative factors such as reduced travel demand, increased operational costs, and shifts in consumer behavior.

The empirical data indicated that the difference between PPI and PV grew from 2.91908 (2.19%) in March 2020 to 22.42184 (19.33%) by January 2021. The percentage difference chart further underscored this trend, showing rapid increases during mid-2020 and peaking at 19.33% in January 2021. These findings emphasize the significant market disruptions caused by the pandemic and the challenges producers faced in adjusting to the new economic environment.

Furthermore, historical data from December 1989 to May 2024 contextualized the severity of the pandemic's impact compared to previous economic fluctuations, such as those during the 2008 financial crisis. The data showed that the volatility induced by COVID-19 was more severe and prolonged. By May 2024, the PPI had risen to 189.926, indicating a strong post-pandemic recovery driven by the reopening of economies, increased travel demand, and strategic pricing adjustments.

Overall, the study underscores the necessity for future prediction models to account for greater market uncertainty and dynamics to improve accuracy. The insights gained from this research are crucial for policymakers and industry stakeholders in formulating strategies and policies to mitigate future market fluctuations and uncertainties. Enhancing prediction accuracy and adopting flexible policies will be vital in promoting economic stability and growth in the post-pandemic era.

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