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The Impact of Lockdown on Hotel Performance: A Difference-in-Differences analysis for the US

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Abstract

This note investigates the impact of the national lockdown on the US hotel industry performance. A difference-in-differences (DID) methodology is applied on a daily balanced panel data set. The empirical findings reveal that the national lockdown measure adopted by the 43 US states as an integrated policy measure to stem the COVID-19 spread decreased the average daily level of total room revenues by 5.9%. on average. Our findings survive robustness checks accounting for alternative proxies of hotel performance such as the occupancy rate and the average daily revenue per room.

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1. Introduction

The US hotel industry has been hit hard by the ongoing COVID-19 pandemic crisis because of the novel coronavirus outbreak. As a result, many researchers have stressed their attention to the economic consequences of COVID-19 in the tourism industry (Hoarau, 2020; Assaf and Scuderi, 2020; Tsionas, 2020).

However, little attention has been paid to the impact of the adopted policy measures to protect public health on the financial performance of the hotel industry. This study contributes to the current knowledge of quantifying the effects of national lockdown on the hotel industry during the COVID-19 pandemic crisis.

To address the following research hypotheses, we rely on the Difference-in-Differences (DID) econometric methodology. The latter constitutes a quasi-experimental design that makes use of longitudinal data from treatment and control groups to obtain an appropriate counterfactual to estimate a causal effect. DID is typically used to estimate the effect of a specific intervention or treatment (here the lockdown imposition) by comparing the changes in outcomes over time between a "*population*" (treatment group) that is enrolled in the program such as the US states that adopted the lockdown and a "*population*" (control group) that is not (i.e., the US regions that did not impose a general state-wide lockdown).

Following the appropriate DID analysis, the effect of national lockdown on the US hotel industry can be disentangled by identifying two groups. The first group includes 43 US states (e.g., treatment group), that pursued the measure of the national lockdown taking its effect in 13.3.2020.[1] The second one (e.g. control group), comprises of the rest seven states (Arkansas, Iowa, Nebraska, North Dakota, South Dakota, Utah, and Wyoming) that did not impose a state-wide lockdown but only transitory protective measures (e.g. social distancing, COVID testing, health checks, etc).

Based on the above, this study tests the following hypotheses (H_1, H_2, and H_3) by employing three different aspects of the hotel performance, namely the total room revenue generated from the guestroom rentals or sales, the percentage of available hotel rooms sold (occupancy rate) and the revenue per available room. The latter is a different measure than the total room revenue and can be calculated as the total room revenue divided by the total number of available rooms.

H_1: *There is a negative effect of the national lockdown on total hotel room revenue.*

H_2: *The national lockdown has a negative impact on the percentage of available hotel rooms sold (occupancy rate).*

H_3: *The national lockdown decreases the hotel revenue per available room.*

2. Data and variables

The sample consists of a balanced panel data set comprising of 50 cross-section identifiers (US states), over the period 01.12.2019 to 26.07.2020 (T = 239) yielding 11,950 observations. The hotel variables (e.g., room revenues, occupancy rate, room supply, etc) are obtained by the Smith Travel Research (STR) hotel database, which tracks global hotel supply and demand and is frequently used in the tourism-related

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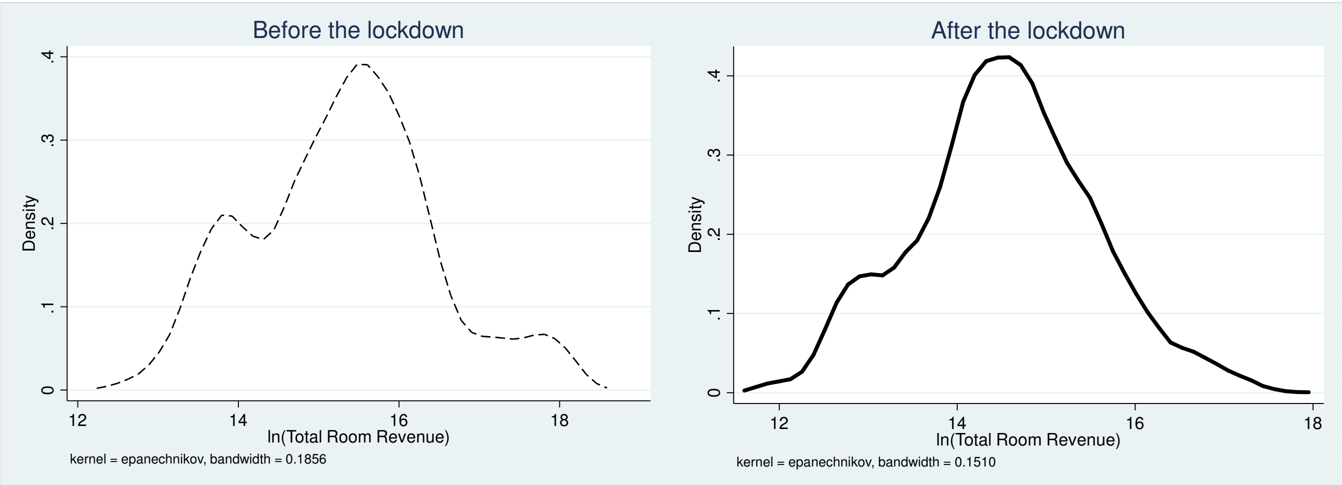
[1] Actually, this day, the President Donald Trump declared a national emergency, which resulted in travel and entry restrictions along with the closure of schools and public meeting places (see https://edition.cnn.com/2020/03/13/politics/donald-trump-emergency/index.html).

industry (see for example Polemis, 2021). The sample reports mean variables from all the available hotel categories namely luxury, midscale, upper midscale, upper-upscale, and upscale.

Figure 1 reports the distribution of total room revenue before and after the lockdown. As it is evident, there is a substantial change in the distribution after the policy change, mainly due to a downward shift in the left tail of the distribution.

Figure 1: Kernel density estimates for the treatment group.



The main reason for relying on the non-parametric kernel distribution function for fitting the data is related to the absence of a normal distribution of the sample variables (see Table 1 last column).[2] Moreover, Kernel density estimates have the advantages over other graphical approximations (i.e., histograms) of being smooth and of being independent of the choice of origin corresponding to the location of the bins in a histogram (see Cox, 2005; 2007).

Table 1 presents the summary statistics. As it is evident, the occupancy rate is positively skewed (2.536) and the (excess) kurtosis value suggests a leptokurtic distribution (9.650>3). Most of the rest variables are heavy tailed revealing a leptokurtic distribution positively skewed. Moreover, to check the existence of normality among the sample variables, we used the classical normality test of Jarque-Bera. Based on the related test, the null hypothesis of normality cannot be accepted in all the sample variables (see Table 1 last column). The absence of normal distribution has led us to employ a logarithmic transformation of sample variables as described below in the research design.

[2] Kernel density estimators approximate the density f(x) from observations on x.

Table 1: Descriptive statistics

Variables	**Mean**	**Median**	**Min**	**Max**	**Standard Deviation**	**Skewness**	**Kurtosis**	**Jarque-Bera test Chi(2) value**
Dependent variables								
Total Room Revenue (in 000 USD)	5,091	2,344	127.9	98,537	9,041	4.855	31.84	0.000***
Occupancy Rate (in percentage)	42.57	42.40	6.251	94.19	15.12	0.329	2.687	0.000***
Revenue per Room (in USD)	43.92	37.21	7.342	570.5	33.42	4.609	45.24	0.000***
Covariates								
Rooms sold (in absolute numbers)	46,101	28,442	1,631	482,493	60,224	3.446	16.99	0.000***
Room Supply (in absolute numbers)	101,399	75,991	9,399	537,900	105,423	2.536	9.650	0.000***
Average Daily Rate (in absolute numbers)	95.98	88.17	55.04	624.2	34.65	4.383	39.95	0.000***

Notes: In the Jarque-Bera test, the null hypothesis denotes normal distribution. *** Statistical significance at 1%.

In line with Yeon et al, (2020), and other related studies (see for example Pan et al, 2021; Fotiadis et al, 2021; Anguera-Torrell et al, 2020; Yang et al, 2020; Le and Phi, 2020)
the empirical specification is given by the following equation:

$$\ln(Total\ Room\ Revenue)_{jt} = a_{it} + a_t + b_o + b_1 Post_t + b_2 Treated_i + b_3\, Post_t \times Treated_i + Z_{it} d + u_{it} \quad (1)$$

The dependent variable in Eq. 1 is the logarithm of total room revenue in state *i* at day *t*, which serves as a proxy for hotel performance (Yeon et al, 2020). $Post_t$ is a dummy variable equal to one after the national lockdown (13.3.2020) and zero otherwise, $Treated_i$ is a dummy variable equal to one for the states that adopted the lockdown and zero otherwise, $Post_t X Treated_i$ is their interaction effect. Z_{it} is a matrix of covariates to control for size effects, while a_{it} and a_t denoting state and time fixed effects accounting for global trends and state characteristics. This study uses three independent variables (e.g., average daily rate, rooms sold, and room supply). The former indicator is a measure of the average rate paid for rooms sold, calculated by dividing room revenue by rooms sold, while the latter reflects the number of rooms in a hotel multiplied by the number of hotels. The other independent variable (rooms sold) denotes the number of rooms sold in a specified period (excludes complimentary rooms). Finally, u_{it} is the error term.

Before we proceed to the estimation results, we test the necessary validity of the existence of parallel paths of the dependent variable across the two groups. The test result cannot reject the null hypothesis on the equality of the effect on all post-treatment periods (p-value = 0.999) suggesting the existence of common pre-treatment trends of the two groups.

3. Results and discussion

In Table 2, the DID estimator, with additional controls, shows that the average total room revenue of the treatment group significantly fell by about 2.8% (see columns 1&2).

During the period of our study, there has been a lockdown on 43 US states, and globally. As a result, there have been major limitations in traveling globally and within the US territory. The hotel industry in all the US states regardless of the imposition of a general lockdown has been negatively affected. To check the validity of the control units (i.e., seven US states) we split the sample before (<13.03.2020) and after the treatment (>13/03/2020) for both the treated and control states to estimate the convergence path to equilibrium. As it is evident, from columns 3 and 4, the estimated coefficients of the explanatory variables (lnRooms Sold and lnRooms Supply) are statistically significant not alternating their signs. This means that there is no change in the control units' path between the pre-treatment and post-treatment period. In other words, we declare the absence of spillover effects between the two groups, distorting the eligibility of the control units.[3]

In columns 5-8, the negative impact of the national lockdown survives the inclusion of year, month, and day fixed effects, and the effect is more pronounced compared to the OLS estimates (-5.9% on average). Controlling for the interacted state fixed effects leads to a negative and statistically significant estimated impact of the national lockdown on total room revenue equal to 5.86% (see column 6). As a result, Hypothesis 1 cannot be rejected.

The rest of the estimated coefficients (covariates) exert a positive and statistically significant correlation with the dependent variable, as has been documented by previous studies (see for example Yeon et al, 2020).

The above findings imply significant economic interpretations for the US hotel industry. Specifically, a 5.9% drop in the average hotel performance because of the national lockdown, corresponds to a decrease of 283.650 USD (= 5,091,281 USD /1.059) per day in total room revenue at the state level (factual).[4]

Lastly, to test the robustness of our findings, we employed two alternative hotel performance indicators namely occupancy rate and revenue per available room. Specifically, there is extensive literature that supports other hotel performance indicators, namely occupancy rate and revenue per available room (see among others Dogru et al, 2020; Yeon et al, 2020; Phillips et al, 2017; Xie and Kwok, 2017; Haywood et al., 2016; Viglia et al., 2016; Neves and Lourenço, 2009). The occupancy rate denotes the percentage of available rooms sold during a specified period and is calculated by dividing the number of rooms sold by rooms available, while the other proxy considers the total room revenue divided by the total number of rooms. The former proxy represents consumers' demand, which can be a consequent outcome of the regulation effect (Yeon et al, 2020). In line with other related studies (see Polemis, 2021; Yeon et al, 2020; Li and Srinivasan, 2019; Manson, 2006) we have also employed the (logged) revenue per available room, that addresses competition concerns, to provide robust estimates of the impact of coronavirus government regulation on hotel performance.

The profitability level would also serve as an alternative indicator for quantifying hotel performance. The reason is that occupancy rate or hotel room revenue provides partial insight into the study of performance compared to profit levels and costs since an increase in the costs of keeping up hotel services has crowded out the profits. This is attributed to the increased costs of keeping open under state protocols published for COVID-19 protections forcing many hotels to exit the industry. However, due to data availability, this robustness check remains an open question for future research.[5]

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[3] We thank an anonymous reviewer for spotting this.

[4] The average total room revenue for the 50 US states over the sample period is equal to 5,091,281 USD per day.

[5] We greatly thank an anonymous reviewer for raising this comment.

As it is evident from Table 3, we uncover a negative and statistically significant relationship between the DID estimator and the occupancy rate ranging from -13.9% to -17.5%.[6] Moreover, the results indicate that the lockdown imposed at the state level has a negative and statistically significant impact also on the average daily revenue per room, ranging from 2.8% to 6.4% (Table 3). All in all, there is enough evidence to support the validity of Hypotheses 2 and 3.

[6] Since the occupancy rate is a percentage taking values that are greater than or equal to 0 and less than or equal to 1, we also fit a fractional response model. Specifically, we use the Probit model to estimate the conditional mean, and the results do not reveal substantial differences. To preserve space, the results are available upon request.

Table 2: DID results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimation method	OLS	OLS	OLS	OLS	FE	FE	FE	FE
Sample	*Control & Treatment*	*Control & Treatment*	*Post-treatment period*	*Pre-treatment period*	*Control & Treatment*	*Control & Treatment*	*Control & Treatment*	*Control & Treatment*
$Post_i$ *Dummy =1 after 13 March 2020*	-0.128*** (0.0103)	-0.128*** (0.0104)	-	-	-0.128*** [0.00504]	-0.0698*** [0.007]	-0.0639*** [0.00752]	-0.0639*** [0.00753]
$Treated_i$	0.0998*** (0.0096)	0.0995*** (0.00954)	-	-	-	-	-	-
$Treated_i \times Post_{it}$	**-0.0277*** (0.0104)**	**-0.0280*** (0.0104)**	**-**	**-**	**-0.0624*** [0.00532]**	**-0.0577*** [0.0052]**	**-0.0585*** [0.00513]**	**-0.0586*** [0.00514]**
ln(Rooms $Sold_{it}$)	1.326*** (0.0104)	1.328*** (0.0106)	1.187*** (0.0121)	1.683*** (0.0196)	1.326*** [0.00329]	1.333*** [0.0042]	1.339*** [0.00436]	1.339*** [0.00436]
ln(Room $Supply_{it}$)	-0.336*** (0.0108)	-0.338*** (0.0110)	-0.228*** (0.0123)	-0.679*** (0.0215)	0.258*** [0.0158]	0.147*** [0.018]	0.133*** [0.0171]	0.133*** [0.0171]
Constant	4.907*** (0.0278)	4.910*** (0.0306)	5.098*** (0.0374)	5.075*** (0.0482)	-1.647*** [0.160]	-0.483*** [0.169]	-0.386** [0.170]	-0.387** [0.170]
Observations	11,950	11,950	5,848	4,429	11,950	11,950	11,950	11,950
Adjusted R^2	0.964	0.964	0.961	0.965	0.972	0.974	0.975	0.975
Clusters	50	50	50	50	50	50	50	50
Year FE					✓	✓	✓	✓
Month FE						✓	✓	✓
Day FE (Dummies for OLS)		✓					✓	✓
Day × State FE								✓

Notes: Robust standard errors in parentheses. Standard errors in brackets. DID estimators in bold. State FE are included but not reported. ***1%, **5% and *10% respectively.

Table 3: Alternative Difference-in-Differences estimation results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Estimation method	OLS	FE	FE	FE	FE	OLS	FE	FE	FE	FE
Dependent variable	*ln(Occupancy Rate)* $_{ijt}$	*ln(Occupancy Rate)* $_{ijt}$	*ln(Occupancy Rate)* $_{ijt}$	*ln(Occupancy Rate)* $_{ijt}$	*ln(Occupancy Rate)* $_{ijt}$	*ln(Revenue per Room)* $_{ijt}$	*ln(Revenue per Room)* $_{ijt}$	*ln(Revenue per Room)* $_{ijt}$	*ln(Revenue per Room)* $_{ijt}$	*ln(Revenue per Room)* $_{ijt}$
Sample	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment	Control & Treatment
Post$_i$ *Dummy =1 after 13 March 2020*	-0.144*** (0.0415)	0.0263 (0.0481)	-0.325*** (0.0446)	-0.400*** (0.0439)	-0.400*** (0.0440)	-0.128*** (0.0104)	-0.128*** [0.00504]	-0.0698*** [0.00711]	-0.0639*** [0.00752]	-0.0639*** [0.00753]
Treated$_i$	0.0527 (0.0410)	-	-	-	-	0.0995*** (0.00954)	-	-	-	-
Treated$_i$ × Post$_{it}$	**-0.175*** (0.0409)**	**-0.139** (0.0591)**	**-0.143*** (0.0458)**	**-0.142*** (0.0435)**	**-0.142*** (0.0436)**	**-0.0280*** (0.0104)**	**-0.0624*** [0.00532]**	**-0.0577*** [0.00516]**	**-0.0585*** [0.00513]**	**-0.0586*** [0.00514]**
ln(Average Daily Rate$_{it}$)	0.558*** (0.157)	1.386*** (0.122)	1.053*** (0.115)	0.997*** (0.111)	0.997*** (0.111)	-	-	-	-	-
ln(Room Supply$_{it}$)	0.0516** (0.0242)	0.156 (0.270)	0.286 (0.430)	0.335 (0.430)	0.336 (0.431)	-1.338*** (0.0110)	-0.742*** [0.0158]	-0.853*** [0.0169]	-0.867*** [0.0171]	-0.867*** [0.0171]
ln(Rooms Sold$_{it}$)	-	-	-	-	-	1.328*** (0.0106)	1.326*** [0.00329]	1.333*** [0.00416]	1.339*** [0.00436]	1.339*** [0.0044]
Constant	0.597 (0.576)	-4.290 (2.746)	-4.204 (4.687)	-4.616 (4.709)	-4.619 (4.718)	4.910*** (0.0306)	-1.647*** [0.160]	-0.483*** [0.169]	-0.387** [0.170]	-0.387** [0.170]
Observations	11,950	11,950	11,950	11,950	11,950	11,950	11,950	11,950	11,950	11,950
Adjusted R^2	0.472	0.700	0.793	0.810	0.810	0.865	0.967	0.970	0.970	0.970
Clusters	50	50	50	50	50	50	50	50	50	50
Year FE		✓	✓	✓	✓		✓	✓	✓	✓
Month FE			✓	✓	✓			✓	✓	✓
Day FE (Dummies for OLS)	✓			✓	✓	✓			✓	✓
Day × State FE					✓					✓

Notes: Robust standard errors in parentheses. Standard errors in brackets. DID estimators in bold State FE are included but not reported. ***1%, **5% and *10% respectively.

4. Conclusion

This study investigates the impact of the national lockdown on the US hotel industry performance. A difference-in-differences (DID) methodology is applied on a daily balanced panel data set.

The empirical findings reveal that the national lockdown measure adopted by the 43 US states as an integrated policy measure to stem the COVID-19 spread decreased the average daily level of total room revenues by approximately 6%. Our findings survive robustness checks accounting for alternative proxies of hotel performance. Therefore, this study confirms the validity of the three research hypotheses.

This study is not free from limitations. First, the relevant dataset covers over seven months (until July 2020), and the pandemic is still ongoing in the sample destinations. As a result, the conclusions reached apply only to the first pandemic wave and do not provide much of an insight that can be generalized. Therefore, the data set and the technical results might seem limited in scope to draw policy implications concerning the COVID-19 pandemic crisis. We believe that further extensions of this study and policy analysis could strengthen the validity of the empirical findings. Another shortcoming is the absence of the investigation of spatial characteristics in the hotel industry as suggested by Cook et al, (2020), who argue that social distancing is affected by the policies set in neighboring counties (here US states), even after controlling for confirmed COVID cases.

Moreover, in this paper, the treatment and the control groups are not as balanced as desired. Therefore, enriching the dataset with more covariates across a larger time span could help us to analyze in depth not only the impact of the first but also the second pandemic wave on the tourism industry. Future research could touch upon the examination of the (welfare) effects of the national lockdown on each hotel class category. Lastly, this study uses hotel revenue as the basic proxy for hotel performance ignoring the possibility of increased costs due to COVID-19 measures (Anguera-Torrell et al, 2020). In addition, closures of hotels and subsequently the role of rising costs of maintaining business under COVID-19 protocols alongside the profitability level are several other indicators that might be of interest to quantify the performance of the industry under the pandemic situation. Future research could shed light on this caveat by employing alternative hotel performance indicators to better test the robustness of the empirical findings.

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