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Hotel recovery strategies in the post-COVID-19 era: Evidence on revenue, employment, and labor market rigidity from Taiwan

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ABSTRACT

This study examines the recovery trajectory of the hotel industry in the post-COVID-19 period in Taiwan, with a particular focus on revenue performance, employment dynamics, service quality, and guest demand. It further evaluates the role of labor market rigidity and heterogeneous recovery patterns across hotel types and locations. Using a comprehensive panel dataset covering all tourist hotels in Taiwan from January 2015 to September 2024, this study employs fixed-effects regression models to estimate the impacts of different pandemic phases on hotel performance. The analysis controls for time-invariant hotel characteristics, seasonal variation, and weather conditions, and further incorporates dynamic specifications and simulation analyses to assess recovery mechanisms. The total and room revenues recovered in the post-COVID period were approximately 9% and 13%, respectively. Moreover, this rebound was primarily driven by higher room rates rather than occupancy. In contrast, employment, service quality, and guest visits remained below pre-pandemic levels, indicating persistent labor shortages consistent with labor market rigidity. Heterogeneity analysis reveals that rural and non-five-star hotels experienced faster recovery than urban and luxury hotels. Simulation results suggest that restoring employment to pre-pandemic levels could increase revenues by up to 17.8%, exceeding the gains from demand recovery alone. The findings highlight the critical importance of workforce recovery in the hotel industry. Managers should prioritize employee retention and recruitment alongside demand stimulation strategies, while policymakers may consider labor market interventions to facilitate a more balanced and sustainable recovery.

Contribution/Originality: This paper offers a quantitative analysis of how Taiwan's tourist hotels have recovered after COVID-19. The results improve academic understanding of post-pandemic recovery and provide hotel managers with practical recommendations for enhancing operations in a changed industry landscape.

1. INTRODUCTION

The global industry has been severely impacted by the COVID-19 pandemic. Travel restrictions and public health measures led to a sharp drop in demand, resulting in record-low occupancy rates and significant revenue losses. In the United States, hotels lost over $38 billion due to increased public health concerns in early 2020 (Yu, Cheng, Yang, & Yu, 2022). Annual occupancy was expected to decline to 41 percent in 2020, the lowest recorded level (Simon, 2020). Many hotels closed or operated at reduced capacity, and those that stayed open faced additional operational challenges and costs.

Many recent studies have examined the impact of COVID-19 on the hotel industry. Data from countries like the United States (Kim, Kim, Badu-Baiden, Giroux, & Choi, 2021), Italy and Turkey (Polemis, 2021), Spain (Robina-Ramírez, Medina-Merodio, & Estriegana, 2022), South Korea (Kim & Han, 2022) and Taiwan (Lin & Chen, 2022) All show significant declines in hotel revenues and occupancy rates. These drops are mainly caused by restrictions on both domestic and international tourism travel.

Emerging research examines recovery trends in the hotel industry during the post-COVID period. Marco-Lajara, Ruiz-Fernández, Seva-Larrosa, and Sánchez-García (2022), analyzing 212 Spanish hotels, document a positive link between dynamic capabilities and post-pandemic business performance. Their findings suggest that hotels with a greater ability to reconfigure and redeploy resources are better equipped to withstand and adapt to large external shocks such as COVID-19. Using regional data from Portugal, Mueller and Sobreira (2024) forecast tourism demand and show that pre-pandemic seasonal patterns dissipated relatively quickly. They further find that regions more reliant on domestic tourism experienced comparatively smaller contractions in tourism activity, underscoring the role of market composition in directing restoration paths.

Some studies examine labor market rigidity in shaping the industry's recovery, a particularly important issue in hospitality, where business closures disproportionately impacted non-salaried workers. Huang, Makridis, Baker, Medeiros, and Guo (2020) demonstrate that during the peak of the pandemic in March and April 2020, closure policies were linked to a 20-30 percent decline in non-salaried employment in the hospitality sector. This contraction indicates limited labor-market flexibility and aligns with theories of labor-market rigidity. Under this system, wages and employment adjust slowly to fiscal shocks, thus extending the negative effects of crises (Drechsler, 2004; Forteza & Rama, 2006).

Despite these recent discoveries, important questions about hotel recovery after COVID-19 still remain. There is limited understanding of the shift from crisis to recovery, the success of specific strategies, and whether recovery patterns vary by hotel type, location, or business model. Current research only partially addresses these issues, highlighting the need for further studies to clarify the different recovery paths within the hotel industry. [1]

To fill these gaps, this paper uses data from Taiwan's tourist hotels to analyze how hotels recovered after COVID-19. The study draws on theories such as dynamic capabilities, contingency theory, stakeholder theory, and labor market rigidity to examine the effects of major shocks on hotels (Marco-Lajara et al., 2022). We analyze how COVID-19 impacted hotel revenues, jobs, service quality, and guest numbers during and after the pandemic. The study also explores whether recovery varied across different hotel types and how performance evolved as staffing levels and occupancy rates returned to normal. By examining these recovery patterns, our research helps deepen understanding of post-crisis recovery and provides valuable guidance for hotel managers and policymakers. The panel dataset includes all tourist hotels in Taiwan from January 2015 to September 2024. Data are recorded monthly, enabling us to observe both the immediate impacts of COVID-19 and the subsequent recovery process in detail. In line with official classifications by Taiwan's Centers for Disease Control, the pandemic period is segmented into phases that reflect the outbreak's severity and progression. This extensive time span allows for a detailed analysis of both disruption and recovery dynamics. Empirically, we employ panel fixed-effects models to measure the impact of COVID-19 on hotel performance. The model accounts for hotel-specific characteristics that remain constant over time and for shared temporal shocks, helping to address concerns about unobserved heterogeneity and producing more reliable estimates of the pandemic's effects.

This study contributes to post-COVID-19 hotel research in several key ways. First, it offers a detailed, data-driven analysis of hotel recovery, filling gaps left by mainly descriptive studies. Second, it examines staffing and guest numbers, both of which are critical to hotel operations and cost management. Finally, by using longitudinal data from

[1] Assaf, Kock, and Tsionas (2022) highlighted the importance to conduct tourism research post COVID-19. The authors provide a guideline to address the relevant future research topics in the post-COVID-19 period.

individual hotels, the study accurately captures the effects of COVID-19 while accounting for differences across hotels and over time, thereby improving the reliability of the findings.

2. DATA

2.1. COVID-19 Data

The CDC held daily press briefings throughout the pandemic, offering a consistent and reliable source of information. These data have been extensively used in research and are considered an accurate indicator of the pandemic's progression in Taiwan (Chang & Meyerhoefer, 2021; Yang, Chang, & Wang, 2022). Figure 1 shows the trajectory of confirmed cases on a logarithmic scale to better visualize temporal variations. The solid line indicates the daily number of new confirmed cases, while the dashed line represents the cumulative number of cases. Vertical dotted lines mark the transitions between pandemic phases, according to the CDC's official classification. The timeline is divided into five periods: (1) Pre-COVID period (January 2015–January 2020), before the first confirmed case; (2) Initial period (February 2020–April 2021), from the first confirmed case to the implementation of the Level 3 alert; (3) Alert period (May 2021–March 2022), characterized by strict public health measures restrictions; (4) Severe period (April 2022–April 2023), during which daily confirmed cases surged from approximately 100 to over 10,000; and (5) Post-COVID period (beginning May 2023), defined by the dissolution of the CDC's dedicated COVID-19 task force, extensive vaccination coverage, and the transition to endemic management. As shown in Figure 1, confirmed cases increased rapidly during the Alert and Severe periods and decreased in the post-COVID phase as vaccination coverage expanded and public health conditions stabilized.

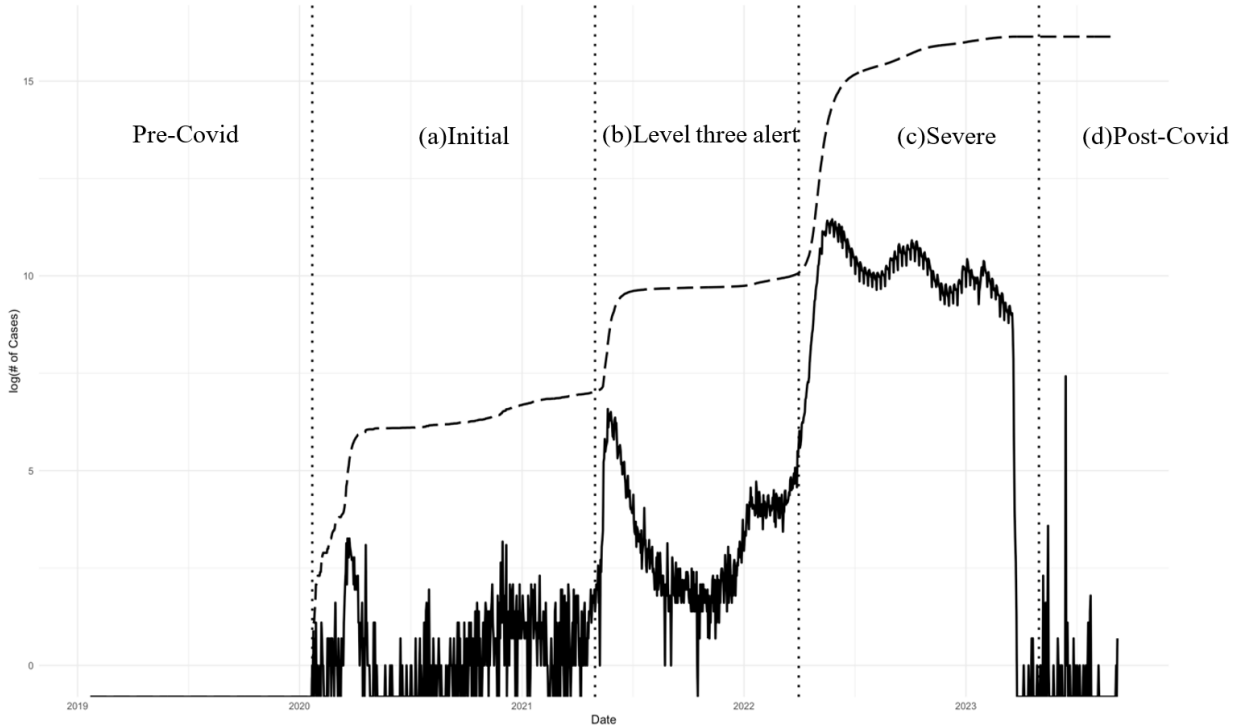

Figure 1. The number of confirmed cases of Covid in different time periods in Taiwan.

Note: Drawn from official reports of the CDC in Taiwan between January 1, 2020, and September 30, 2024. Dashed and solid lines indicate the daily cumulative and new COVID-19 cases in Taiwan, respectively. The labels a, b, c, and d represent the initial, level-three alert, severe, and post-COVID periods, respectively.

2.2. Hotel Data

The tourism and leisure sector is a vital part of Taiwan's economy. Hotels are mainly divided into two categories: tourist hotels and non-tourist hotels. Tourist hotels are known for higher service standards and a range of facilities, such as on-site restaurants, retail shops, conference rooms, fitness centers, and business services. In contrast, non-

tourist hotels usually offer basic accommodations with fewer additional services. By the end of 2024, Taiwan had 114 registered tourist hotels with a total of 26,688 rooms (Tourism Bureau Taiwan, 2024). While hotels can set their room rates freely, they are legally required to submit detailed monthly operation reports to the Taiwan Tourism Bureau (TTB). These reports contain data on revenues, occupancy rates, visitor numbers, and other financial and operational metrics, and failure to comply can result in administrative penalties. To promote transparency and ensure service quality, the TTB uses a star-rating system to classify tourist hotels from one to five stars based on facilities, standards, and service performance. Five-star hotels represent the highest-quality segment, while four-star and lower ratings correspond to mid- and lower-tier establishments (Huang, Chen, & Lai, 2018). This study uses the monthly business performance reports compiled by the TTB, which offer comprehensive coverage of all tourist hotels in Taiwan. The dataset spans from January 2015 to September 2024 and includes 13,890 hotel-month observations across 139 hotels over 117 months.[2]

2.3. Specification of the Variables

We build variables using the available dataset and adopt empirical specifications consistent with prior studies (Hung, Shang, & Wang, 2010). The main business outcome variables include the average monthly occupancy rate, average daily room rate, hotel capacity (the number of rooms available each month), and total monthly revenues. Revenues are further broken down into the sales value of rooms and food and beverage (F&B). Employee and service quality variables are also defined, including the number of employees and those working in the room and food and beverage departments, respectively. Service quality is measured by employee-to-room ratios, both overall and by department, following previous research (Lin & Chen, 2014; Wang, Royo Vela, & Tyler, 2008). Higher employee-to-room ratios suggest higher service quality, driven by more personalized service and shorter customer wait times. Guest characteristics are represented by the total number of guests, further broken down by domestic versus international travelers, free independent travelers (FITs), and group bookings. Weather variables, such as daily average precipitation, wind speed, and temperature, are also included for each township. These data are collected from the Taiwan Weather Bureau and assigned to each hotel based on its township location.

We present the sample statistics of the selected variables across five COVID-19 phases: pre-COVID, Initial, Alert, Severe, and post-COVID in Table 1. It also shows changes in hotel performance between the pre- and post-COVID periods. Consistent with earlier studies, hotel business performance declined significantly during the Initial, Alert, and Severe phases. In the post-COVID period, total revenue rose by 6.8 percent compared to the pre-COVID period, mainly driven by a 21 percent increase in average room rates. However, occupancy rates dropped by 8.3 percent, and hotel capacity decreased slightly by 0.4 percent. Employee numbers and guest counts also declined, reflecting reduced domestic and international mobility during the pandemic. Guest numbers recovered in the post-COVID period, supported by Taiwan's proactive border reopening and efforts to promote international tourism (Rickards, 2024; Tourism Bureau Taiwan, 2024).

[2] The sample included hotels that were open or closed during our sample period. Therefore, the number of hotels in our sample is larger than 114 hotels effectively operated in September 2024.

Table 1. Sample statistics of selected variables.

Variable	(1) All sample 2015. Jan-2024. Sep		(2) Pre-covid 2015. Jan-2020. Jan		(3) Initial 2020. Feb.-2021. Apr.		(4) Alert 2021. May-2022. Mar.		(5) Severe 2022. Apr.-2023. Apr.		(6) Post-covid 2023. May-2024. Sep.		(7)=(6)-(2)	(8)=(7)/(2)
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Difference	%
Panel A. Business performance (Per hotel per month)														
Total revenue (Million NT$)	37.2	43.7	40.8	46.5	26.0	28.8	24.5	28.6	36.0	40.7	43.5	50.7	2.8	6.8%
Room revenue (Million NT$)	15.9	17.3	17.7	18.4	9.1	10.5	9.9	10.9	16.0	16.4	19.6	19.4	1.8	10.4%
F&B revenue (Million NT$)	16.9	23.4	18.3	23.7	13.4	18.5	11.8	18.5	16.0	23.7	19.0	28.0	0.7	3.9%
Occupancy rate (0~1)	0.6	0.2	0.6	0.2	0.4	0.2	0.4	0.2	0.5	0.2	0.6	0.2	-0.1	-8.3%
Room rate (1,000 NT$)	3.8	2.6	3.7	2.3	3.3	2.5	3.9	3.1	4.4	3.2	4.5	2.9	0.8	21.1%
Capacity (Number of hotel rooms)	232.7	148.9	233.4	146.9	229.5	146.6	235.3	157.0	231.7	151.7	232.5	151.2	-0.9	-0.4%
Panel B. Number of employees and service quality (Per hotel per month)														
All employees (People)	214.5	185.6	232.7	193.4	202.9	180.1	186.1	166.7	188.8	172.1	193.6	174.0	-39.1	-16.8%
Room department employees (People)	60.5	46.1	67.0	49.4	56.3	43.0	50.1	37.4	51.1	39.1	53.8	41.8	-13.2	-19.7%
F&B department employees (People)	95.1	100.7	103.7	103.0	89.7	98.9	82.4	95.2	83.6	96.8	84.5	96.6	-19.1	-18.4%
Overall service quality (All employees/Rooms)	0.9	0.6	1.0	0.6	0.9	0.6	0.8	0.6	0.8	0.6	0.8	0.6	-0.2	-15.3%
Room service quality (room employees/Rooms)	0.3	0.1	0.3	0.1	0.3	0.1	0.2	0.1	0.2	0.1	0.2	0.1	-0.1	-17.3%
F&B service quality (F&B employees/Rooms)	0.4	0.3	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-0.1	-18.3%
Panel C. Number of guests (1,000 people, per hotel per month)														
All guests	7.6	6.4	8.4	6.3	5.7	6.5	4.7	4.5	7.3	6.8	8.3	6.3	-0.1	-1.1%
Domestic guests	4.4	4.7	3.7	4.3	5.1	5.4	4.4	4.4	6.0	5.9	5.2	4.4	1.5	40.3%
International guests	3.2	4.6	4.7	5.0	0.6	3.0	0.4	0.7	1.3	2.5	3.1	4.3	-1.6	-33.4%
Free independent travelers, FITs	5.3	5.1	5.4	4.9	4.4	5.6	3.8	3.5	5.7	5.9	6.4	5.3	1.0	18.6%
Group guests	2.3	2.7	3.0	3.0	1.3	2.1	1.0	1.7	1.6	2.1	1.9	2.2	-1.1	-36.3%
Panel D. Weather variables (Monthly average)														
Precipitation (mm)	204	203	213	212	154	147	246	226	195	221	204	173	-8.4	-4.0%
Wind speed (m/s)	1.9	0.8	1.9	0.7	1.9	0.8	1.9	0.8	1.9	0.8	1.7	0.6	-0.2	-12.1%
Temperature (C)	22.3	4.7	22.1	4.7	21.9	4.6	22.1	5.0	22.0	4.5	23.9	4.4	1.8	8.3%
N*T	13,980		7,401		1,955		1,169		1,507		1,948			

Note: The data were drawn from the monthly reports of tourism hotels in Taiwan between January 2015 and September 2024. % is calculated to the mean of the outcome variable in the pre-COVID period.

Figure 2 shows monthly trends for key business outcomes, while Figures A1 and A2 in the appendix display changes in employee numbers and guest counts. In the post-COVID period, room revenues and room rates have steadily increased, while employee numbers and service quality measures have not fully returned to pre-COVID levels (Figure A1). Guest visit patterns shifted during the pandemic, with international arrivals dropping sharply and domestic tourism rising due to border restrictions (Figure A2). The descriptive statistics and visualizations in Table 1, Figure 2, and Figures A1–A2 do not account for external influences such as weather or seasonal demand changes. The subsequent empirical analysis addresses these limitations by isolating the specific effects of COVID-19 while controlling for these confounding factors.

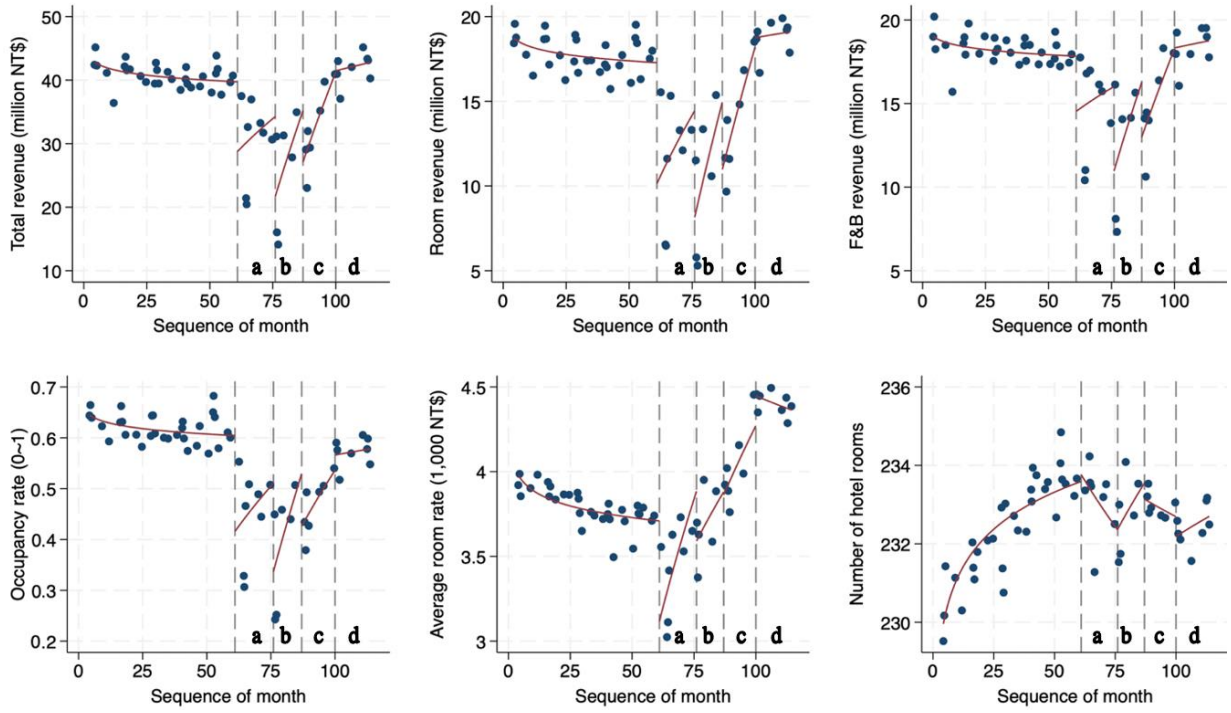

Figure 2. Sample statistics of hotel business performance.

Note: The dotted points are sample averages, and straight lines are fitted lines of the sample trend. a, b, c, and d indicate the initial, level three alert, severe, and post-period of COVID, respectively.

3. METHOD

We estimate an econometric regression model that links key outcome variables, including hotel performance measures, to COVID-19 indicators and other relevant covariates that may affect hotel operations. The empirical approach begins with the following model specification.

$$Y_{ictmy} = \alpha + \gamma_1 \times I_{my} + \gamma_2 \times A_{my} + \gamma_3 \times S_{my} + \gamma_4 \times P_{my} + \beta' X_{ictmy} + \varepsilon_{ictmy} \quad (1)$$

Where Y_{ictmy} denotes the outcome variable representing the business performance of hotel i located in county c and township t during month m of year y. The sample period is divided into five distinct phases. The indicator variables I, A, S, and P correspond to the initial outbreak period, the Level Three alert period, the severe period, and the post-COVID-19 period, respectively. The pre-COVID-19 period acts as the reference category. Equation 1 includes a vector of explanatory variables (X_{ictmy}) capturing factors that may influence hotel performance, including weather conditions that vary across areas and time, as well as other relevant covariates that may affect outcomes during the pandemic. The model includes fixed effects for individual hotels (η_i), months (η_m), and years (η_y) to control for unmeasured heterogeneity. Because geographic location does not change over time, these fixed effects capture unobserved county- and township-level factors. Month- and year-fixed effects account for temporal variation common to all hotels, including seasonal demand changes and yearly cycles, ensuring that observed performance changes are not confounded by these recurrent patterns. The error term ε_{ictmy} captures unexplained variability. α, γ_1, γ_2, γ_3, γ_4,

and β are the parameters to be estimated. Our primary focus is on the coefficients that measure performance differences across pandemic stages relative to the pre-COVID period. These estimates provide insights into how hotel outcomes changed throughout the different phases of the pandemic. Reliable estimates are obtained using panel data fixed-effects models, which control for both observed and unobserved heterogeneity across hotels and over time. To ensure robust inference, standard errors are clustered at the individual hotel level (Abadie, Athey, Imbens, & Wooldridge, 2023). The specification in Equation 1 captures only the average impact within each period.

To analyze more closely how business performance changed specifically during the post-COVID period, we expand the model in Equation 1 with a more detailed specification. This approach helps to better understand the dynamic shifts in hotel performance during the post-COVID phase and is expressed as follows:

$$Y_{ictmy} = \alpha + \gamma_1 \times I_{my} + \gamma_2 \times A_{my} + \gamma_3 \times S_{my} + \sum_{j=1}^{J}[\delta_j \times P_{my}^{j}] + \beta' X_{ictmy} + \varepsilon_{ictmy} \quad (2)$$

The specification of Equation 2 follows that of Equation 1, with the primary distinction relating to the post-COVID-19 period. Rather than using a single binary variable to capture the average effect over the entire post-COVID-19 period, we divide it into multiple sub-periods. Let there be J sub-periods within the post-COVID-19 phase. The parameter δ_j measures the impact on hotel outcome variables in the j-th sub-period relative to the pre-COVID-19 period, which serves as the reference category. By disaggregating the post-COVID-19 period, Equation 2 enables identification of the dynamic effects of COVID-19 on hotel performance, including both short-term and longer-term changes. Consistent with Equation 1, the estimation uses a panel data fixed-effects model using individual hotel data.

4. RESULTS AND DISCUSSIONS

4.1. Impacts on Hotels' Business Performance

Table 2 shows the estimated results for total revenue, room revenue, food and beverage (F&B) revenue, occupancy rates, room rates, and operational performance across different pandemic phases. The estimates are derived from regression models that control for weather conditions, year, month, and hotel fixed effects. Full estimation results are provided in Appendix Table A1.

Table 2. Summarized results of the impacts of Covid-19 on hotels' business performance.

Variable	Total revenue		Room revenue		F&B revenue	
	Coef.	S.E	Coef.	S.E	Coef.	S.E
Initial	-13.714 ***	0.581	-8.326***	0.326	-4.391***	0.265
%	-33.65%		-46.97%		-23.99%	
Alert	-17.787***	0.879	-8.510***	0.435	-7.331***	0.421
%	-43.64%		-48.01%		-40.05%	
Severe	-4.907***	0.765	-1.863***	0.395	-2.459***	0.383
%	-12.04%		-10.51%		-13.43%	
Post-covid	3.714***	0.778	2.270***	0.397	1.018**	0.399
%	9.11%		12.81%		5.56%	
Adjusted R^2	0.861		0.766		0.883	
	Occupancy rate		Room rate		Hotel capacity	
Initial	-0.232***	0.006	-0.496***	0.036	-0.859***	0.375
%	-37.03%		-13.37%		-0.37%	
Alert	-0.256***	0.008	0.098*	0.058	-2.126***	0.510
%	-40.75%		2.65%		-0.91%	
Severe	-0.089***	0.008	0.530***	0.050	-2.674***	0.590
%	-14.11%		14.29%		-1.15%	
Post-covid	-0.008	0.008	0.731***	0.045	-3.308***	0.754
%	-1.34%		19.70%		-1.42%	
Adjusted R^2	0.560		0.848		0.994	

Note: The percentage change (%) is calculated relative to the mean of the outcome variable in the pre-COVID period, which is reported in Table 1. All models control for weather variables, year, month, and hotel fixed effects. Standard errors are clustered in hotels. The sample size (N*T) is 13,890. ***, **, * indicate significance at 1%, 5% and 10%, respectively.

The results show significant revenue declines during the Initial, Level Three Alert, and Severe periods, with the largest drops occurring in the Initial period. Total revenue, room revenue, and F&B revenue decreased by NT$13.71 million, NT$8.33 million, and NT$4.40 million, respectively, during this period. Compared to pre-COVID levels, these show reductions of 33.7 percent, 46.9 percent, and 23.9 percent.

By comparison, the post-COVID period shows signs of recovery. Sales value, room, and F&B revenue grew by 9.1 percent, 12.8 percent, and 5.6 percent, respectively, compared to pre-pandemic levels. This suggests that government support measures and a rebound in domestic tourism helped drive the recovery (Rickards, 2024; Tourism Bureau Taiwan, 2024). Occupancy rates followed a similar trend, dropping sharply by 37 percent, 40.1 percent, and 14 percent during the Initial, Level Three Alert, and Severe periods, respectively, before returning closer to pre-COVID levels in the post-COVID phase. Room rates, however, followed a different course: after an initial 13.4 percent decline during the Initial period, rates gradually increased, reaching a 19.7 percent rise in the post-COVID period. During the Alert period, room rates increased by 2.65% (=0.098/3.7*100) compared to the pre-COVID-19 period. The results indicate that hotels deliberately adjusted pricing strategies to maximize revenue during the recovery phase.[3]

4.2. Impacts on Hotel Employment, Service Quality, and Guest Visits

Table 3 shows the COVID-19's influence on hotel employment and service quality. Employment levels dropped significantly throughout all pandemic stages, with the room department experiencing the largest declines. These reductions continued into the post-COVID period, indicating possible long-term structural changes in the industry. Compared to pre-COVID levels, total employment decreased by 7.9 percent, 17.1 percent, 13.1 percent, and 8.7 percent during the Initial, Level Three Alert, Severe, and post-COVID periods, respectively. Service quality also declined and did not fully recover in the post-COVID phase. Overall service quality, room service quality, and F&B service quality fell by 8.1 percent, 8.1 percent, and 10.5 percent, respectively, reflecting the difficulties hotels faced in maintaining service standards amid staff reductions and ongoing operational challenges and disturbances.

Table 3. Results of the impacts of Covid-19 on the number of employees and service quality.

Variables	All employees		Room department employees		F&B department employees	
	Coef.	S.E	Coef.	S.E	Coef.	S.E
Initial	-18.427***	1.014	-6.176***	0.354	-8.891***	0.591
%	-7.92%		-15.16%		-8.58%	
Alert	-39.685***	1.641	-12.861***	0.560	-18.652***	0.915
%	-17.05%		-31.56%		-17.99%	
Severe	-30.581***	1.711	-9.592***	0.582	-14.537***	0.965
%	-13.14%		-23.54%		-14.02%	
Post-covid	-20.350***	1.838	-5.237***	0.627	-11.089***	1.068
%	-8.74%		-12.85%		-10.70%	
Adjusted R^2	0.965		0.929		0.963	
	Overall service quality		Room service quality		F&B service quality	
Initial	-0.071***	0.005	-0.023***	0.002	-0.035***	0.003
%	-7.20%		-8.06%		-8.25%	
Alert	-0.146***	0.007	-0.049***	0.002	-0.071***	0.004
%	-14.79%		-16.77%		-16.79%	
Severe	-0.116***	0.007	-0.038***	0.003	-0.056***	0.004
%	-11.75%		-13.08%		-13.26%	
Post-covid	-0.080***	0.008	-0.023***	0.003	-0.044***	0.005
%	-8.09%		-8.07%		-10.50%	
Adjusted R^2	0.931		0.848		0.927	

Note: The percentage change (%) is calculated relative to the mean of the outcome variable in the pre-COVID period, which is reported in Table 1. All models control for weather variables, year, month, and hotel fixed effects. Standard errors are clustered in hotels. The sample size (N*T) is 13,890. *** indicates significance at 1%.

[3] The value 3.7 in the denominator represents the mean room rate in the pre-COVID period (see Table 1).

Table 4 shows the impact on guest visits. Mobility restrictions during the pandemic led to significant drops in guest numbers, with total visits decreasing by 31.7 percent, 49 percent, and 16.2 percent during the Initial, Level Three Alert, and Severe periods, respectively. In the post-COVID era, group guest visits recovered substantially, indicating that government promotional and subsidy programs played a major role in the sector's recovery (Tourism Bureau Taiwan, 2024).

Table 4. Results of Covid-19 impacts on the number of hotel guests.

Variable	All guests		Domestic guests		International guests	
	Coef.	S.E	Coef.	S.E	Coef.	S.E
Initial	-2.670***	0.150	1.105***	0.093	-3.776***	0.120
%	-31.74%		29.94%		-79.96%	
Alert	-4.123***	0.150	-0.247**	0.120	-3.875***	0.121
%	-49.00%		-6.70%		-82.07%	
Severe	-1.361***	0.166	1.382***	0.132	-2.743***	0.120
%	-16.17%		37.44%		-58.09%	
Post-covid	-0.223	0.149	0.387***	0.105	-0.611***	0.123
%	-2.65%		10.50%		-12.93%	
Adjusted R^2	0.713		0.727		0.685	
	FITs		Group guests			
Initial	-1.594***	0.133	-1.076***	0.061		
%	-29.50%		-35.76%			
Alert	-2.869***	0.122	-1.253***	0.077		
%	-53.10%		-41.65%			
Severe	-0.919***	0.146	-0.441***	0.082		
%	-17.01%		-14.67%			
Post-covid	-0.405***	0.126	0.182*	0.094		
%	-7.49%		6.04%			
Adjusted R^2	0.663		0.648			

Note: The percentage change (%) is calculated relative to the mean of the outcome variable in the pre-COVID period, which is reported in Table 1. All models control for weather variables, year, month, and hotel fixed effects. Standard errors are clustered in hotels. The sample size (N*T) is 13,890. ***, **, * indicate significance at 1%, 5% and 10%, respectively.

4.3. Recovery Trajectory in the Post-COVID-19 Period

Figure 3 depicts the dynamic rebound trajectory of the hotel industry during the post-COVID period, estimated using an event study framework. The results indicate a gradual recovery across key business performance indicators, with total revenue rebounding steadily, primarily driven by growth in room revenue and supported by higher room rates.

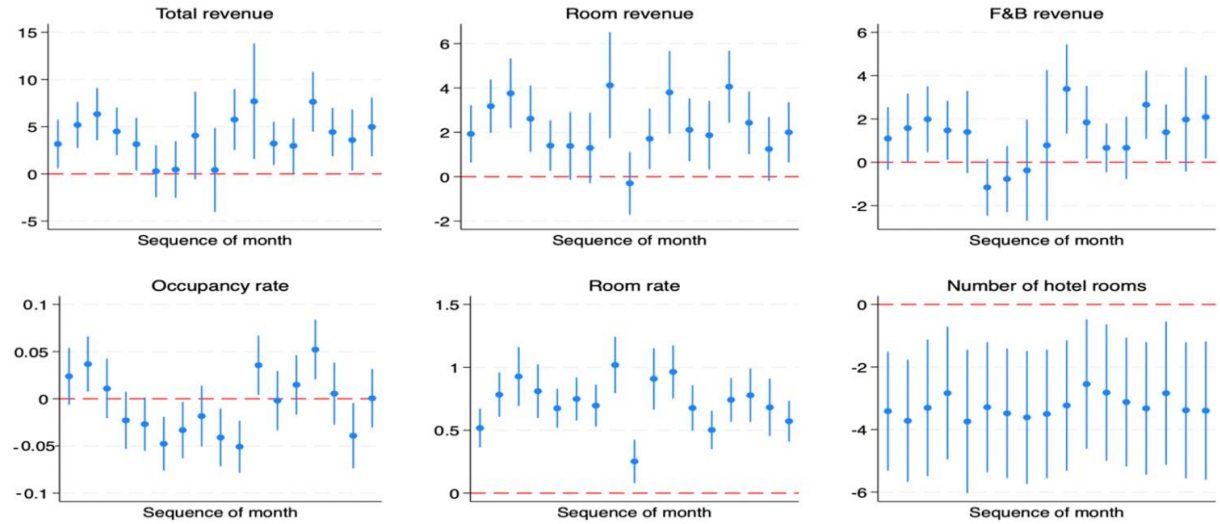

Figure 3. Estimation results of the dynamic effects in the post-COVID period.

Note: The 95% confidence intervals are reported. Each bin indicates one month during the post-COVID period (from May 2023 to September 2024). The reference group is the average value of the pre-COVID period.

Operational capacity remained somewhat limited due to strategic supply-side adjustments to match changing demand. These findings suggest that the recovery process was influenced by broader market trends and hotel-specific management strategies, such as pricing optimization and capacity adjustments.

4.4. Heterogeneous Impacts by Hotel Type and Location

Table 5 analyzes the effects on hotel performance by hotel features, such as quality (five-star versus non-five-star) and location (urban versus rural). The results indicate that five-star hotels saw larger revenue drops during the pandemic but experienced a moderate post-COVID recovery of 5.6 percent. Conversely, non-five-star hotels showed a stronger rebound, with total revenue increasing by 28 percent, driven by significant growth in room revenue (30.3 percent) and F&B revenue (21 percent). Urban hotels faced more challenges during the pandemic than rural ones. However, rural hotels posted higher revenue growth after the pandemic, with total and room revenues rising by 15.7 percent and 20.3 percent, respectively. These results emphasize how location-specific factors, especially dependence on domestic tourism, influence different recovery patterns across the hotel sector.

Table 5. Results of the heterogeneity analysis by type of hotels.

Variable	5-star hotels		non-5-star hotels		Downtown		Countryside	
	Coef.	S.E	Coef.	S.E	Coef.	S.E	Coef.	S.E
Panel A. Total revenue								
Initial	-20.296 ***	0.929	-4.751***	0.373	-19.575***	0.717	0.881	0.660
%	-33.80%		-31.99%		-42.35%		3.56%	
Alert	-26.262***	1.342	-5.512 ***	0.619	-23.288***	1.112	-5.180***	1.083
%	-43.74%		-37.11%		-50.39%		-20.90%	
Severe	-8.694***	1.210	0.275	0.569	-9.351***	0.935	5.600***	0.940
%	-14.48%		1.85%		-20.23%		22.60%	
Post-covid	3.358***	1.245	4.166***	0.548	2.335**	0.963	3.899***	0.953
%	5.59%		28.05%		5.05%		15.74%	
Adjusted R^2	0.841		0.804		0.873		0.814	
Panel B. Room revenue								
Initial	-12.064***	0.520	-3.237***	0.229	-11.676***	0.388	0.286	0.451
%	-47.58%		-43.27%		-61.61%		2.02%	
Alert	-12.604***	0.673	-2.576***	0.307	-11.196***	0.525	-2.220***	0.691
%	-49.71%		-34.44%		-59.08%		-15.69%	
Severe	-3.419***	0.632	0.233	0.291	-4.609***	0.451	4.756***	0.632
%	-13.48%		3.11%		-24.32%		33.62%	
Post-covid	2.241***	0.635	2.264***	0.294	1.530***	0.461	2.878***	0.633
%	8.84%		30.26%		8.08%		20.34%	
Adjusted R^2	0.728		0.732		0.789		0.781	
Panel C. F&B revenue								
Initial	-6.587***	0.424	-1.402***	0.177	-6.190***	0.342	-0.181	0.241
%	-18.99%		-19.02%		-22.70%		-1.71%	
Alert	-10.717***	0.640	-2.450***	0.321	-9.470***	0.551	-2.578***	0.375
%	-30.90%		-33.23%		-34.73%		-24.25%	
Severe	-4.157***	0.595	-0.111	0.320	-3.640***	0.492	0.225	0.339
%	-11.98%		-1.51%		-13.35%		2.12%	
Post-covid	0.652	0.631	1.549***	0.307	0.563	0.520	0.513	0.339
%	1.88%		21.01%		2.06%		4.82%	
Adjusted R^2	0.875		0.793		0.886		0.813	
N*T	8,045		5,935		10,299		3,681	

Note: The percentage change (%) is calculated relative to the mean of the outcome variable in the pre-COVID period, which is reported in Table 1. All models control for weather variables, year, month, and hotel fixed effects. Standard errors are clustered in hotels. *** and ** indicate significance at 1% and 5%, respectively.

4.5. Simulation Analysis: Returning to pre-COVID Employment and Guest Visit Levels

Given the significant drops in hotel employment and guest visits after COVID-19, an important question is how hotel performance would change if employment or guest numbers returned to pre-pandemic levels. To explore this,

we conducted a simulation analysis. In the first model, employment levels were added as a control variable in the regressions of business outcomes. This allows the estimated coefficients to represent the hypothetical effects of different COVID-19 phases while keeping employment fixed at pre-pandemic levels. In the second model, guest visits replaced employment as a control variable, reflecting potential impacts if guest visits returned to pre-pandemic levels. Table 6 shows the simulation results. Column (1) repeats the baseline estimates from Table 2, while Columns (2) to (4) show results when employment, guest visits, or both are included as controls. The analysis indicates that total revenue in the post-COVID period could rise by 17.8 percent if employment returns to pre-pandemic levels. Restoring guest visits alone would lead to a 10.5 percent increase in revenue. The effects were especially strong for room revenue; for instance, returning employment levels to pre-pandemic levels would boost room revenue and F&B revenue by 21.3 percent and 14.3 percent, respectively.

Table 6. Simulation results if employment or guests in the post-covid period are set to the pre-covid period level.

Variable	(1) Baseline		(2) Only guests loss		(3) Only employees loss		(4) Neither loss	
	Coef.	S.E	Coef.	S.E	Coef.	S.E	Coef.	S.E
Panel A. Total revenue								
Post-covid	3.714***	0.778	7.251***	0.705	4.294***	0.661	6.821**	0.602
%	9.11%		17.79%		10.54%		16.74%	
Adjusted R^2	0.861		0.883		0.902		0.914	
Panel B. Room revenue								
Post-covid	2.270***	0.397	3.768***	0.369	2.599***	0.312	3.518***	0.294
%	12.81%		21.26%		14.66%		19.85%	
Adjusted R^2	0.766		0.799		0.851		0.866	
Panel C. F&B revenue								
Post-covid	1.018**	0.399	2.626***	0.372	1.220***	0.376	2.478***	0.352
%	5.56%		14.34%		6.66%		13.54%	
Adjusted R^2	0.883		0.897		0.900		0.909	

Note: The percentage change (%) is calculated relative to the mean of the outcome variable in the pre-COVID period, which is reported in Table 1. In Model (1), we control for weather variables, year, month, and hotel fixed effects. In Models (2)-(4), we additionally control for the number of employees and guests, respectively. Standard errors are clustered in hotels. The sample size is 13,890. *** and ** indicate significance at 1% and 5%, respectively.

5. CONCLUSION AND MANAGERIAL IMPLICATION

This study examines how the COVID-19 pandemic impacts the hotel industry, emphasizing the critical role of employment in the recovery process. We find that workforce levels declined sharply during the pandemic and have remained below pre-COVID-19 levels throughout the post-COVID-19 recovery. This ongoing labor shortage aligns with the theory of labor market rigidity, which posits that wages and employment respond more slowly than economic conditions, leading to extended unemployment during recessions and slow job growth during recoveries (Drechsler, 2004; Forteza & Rama, 2006). Our findings provide empirical evidence of labor market rigidity in Taiwan's tourist hotel industry after COVID-19. Simulation analyses show that restoring hotel employment to pre-COVID levels could boost industry revenue by up to 17.8 percent, while increasing guest visits alone would lead to only a 10.5 percent revenue recovery. This disparity emphasizes the importance of employee stability and availability in maintaining operational performance and revenue, even when external demand remains limited.

Our heterogeneity analysis reveals significant variation in recovery progressions across different hotel types and locations. Rural and non-five-star hotels experienced faster recoveries than luxury and urban hotels, aligning with dynamic capabilities theory, which suggests that firms with stronger adaptive skills can respond more effectively to external disruptions (Marco-Lajara et al., 2022). Non-five-star and rural hotels, being more flexible and closely connected to domestic markets, were able to capitalize on the surge in domestic tourism amid international travel restrictions. Conversely, luxury and urban hotels, which rely heavily on international guests, faced greater difficulties in adjusting operations to serve domestic markets and travelers. These outcomes also align with contingency theory,

suggesting that smaller, rural hotels can adjust more quickly to changing market conditions because of their managerial flexibility, smaller size, and simpler business models.

The results further suggest that increasing guest visits alone is not enough to restore overall industry performance. A coordinated recovery strategy that simultaneously addresses workforce shortages and boosts demand is crucial for a strong, sustainable rebound. Previous research has shown that COVID-19 significantly changed hotel operations (Chan, Gao, & McGinley, 2021). In line with this literature, our study finds that hotels increased room rates during the post-COVID period, likely in response to decreased guest numbers. Although pricing adjustments helped recover revenue, they may also impact consumer welfare, indicating a trade-off between revenue recovery and buyer satisfaction.

The findings of this paper have implications for hotel managers and decision-makers. Rehiring and retaining staff are crucial for maintaining service quality and driving revenue growth. Hotels that invest in a well-trained, sufficiently staffed workforce are more likely to restore operational capacity and stay competitive in a recovering market. Furthermore, boosting demand requires a comprehensive strategy that includes innovative marketing tactics to rebuild traveler confidence, personalized travel packages, loyalty programs, and flexible pricing to attract customers in a price-sensitive market. The key lesson from this study is the importance of flexibility and adaptability in hotel industry operations. The pandemic has stressed the need for contingency planning, revenue diversification, and digital adoption. Technologies, including contactless check-in systems, dynamic pricing, and customer relationship management platforms, can increase operational efficiency and the guest experience. Long-term recovery also relies on investments in sustainability and institutional resilience. Workforce cross-training can enhance labor flexibility, while digital transformation boosts efficiency and customer engagement. Aligning business strategies with social objectives including public health, safety, and sustainability can build buyer trust and loyalty, supporting long-term resilience and success in the post-pandemic landscape environment.

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APPENDIX

Table A1. Full estimation results of the revenue equations.

Variables	Total revenue		Rental revenue		F&B revenue	
	Coef.	S.E	Coef.	S.E	Coef.	S.E
Initial	-13.714***	0.581	-8.326***	0.326	-4.391***	0.265
Alert	-17.787***	0.879	-8.510***	0.435	-7.331***	0.421
Severe	-4.907***	0.765	-1.863***	0.395	-2.459***	0.383
Post-covid	3.714***	0.778	2.270***	0.397	1.018**	0.399
Precipitation	-0.007***	0.002	-0.002***	0.001	-0.004***	0.001
Preciptation^2	0.000	0.000	0.000	0.000	0.000**	0.000
Wind speed	0.725	0.737	0.113	0.389	0.390	0.361
Wind speed^2	-0.354***	0.082	-0.154***	0.042	-0.160***	0.038
Temperature	-0.456	0.404	-0.380*	0.210	0.083	0.201
Temperature^2	-0.005	0.009	0.002	0.005	-0.009**	0.004
Constant	54.498***	5.336	25.793 ***	2.728	21.765***	2.697
Year FE	Yes		Yes		Yes	
Month FE	Yes		Yes		Yes	
Hotel FE	Yes		Yes		Yes	
Adjusted R^2	0.861		0.766		0.883	
N*T	13,980		13,980		13,980	

Note: ***,**,* indicate statistical significance at the 1%, 5% and 10% level, respectively. Standard errors are clustered in hotels.

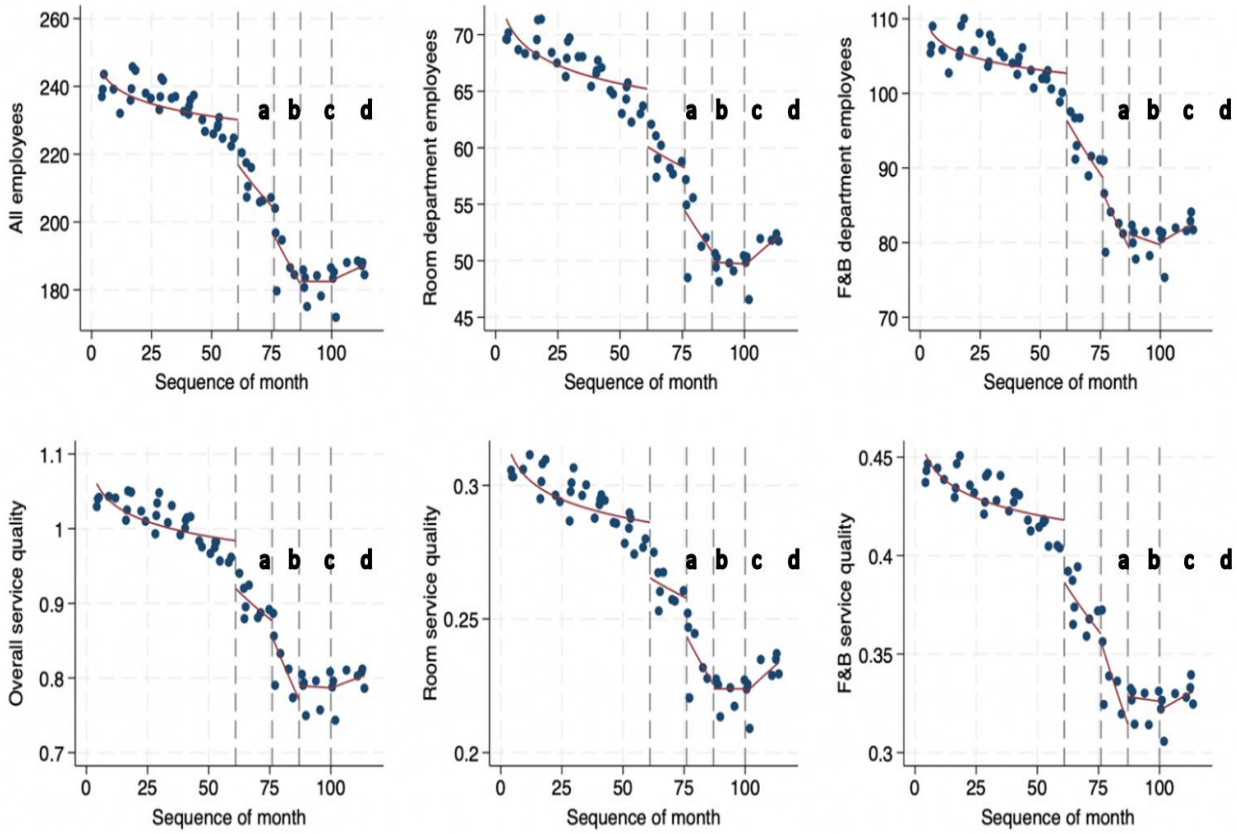

Figure A1. Sample statistics of the number of employees and service quality.

Note: a, b, c, and d indicate the beginning of four periods during and after the pandemic. a is for initial period. b indicates (level 3) alert. c represents severe period. And, d is for post-COVID era.

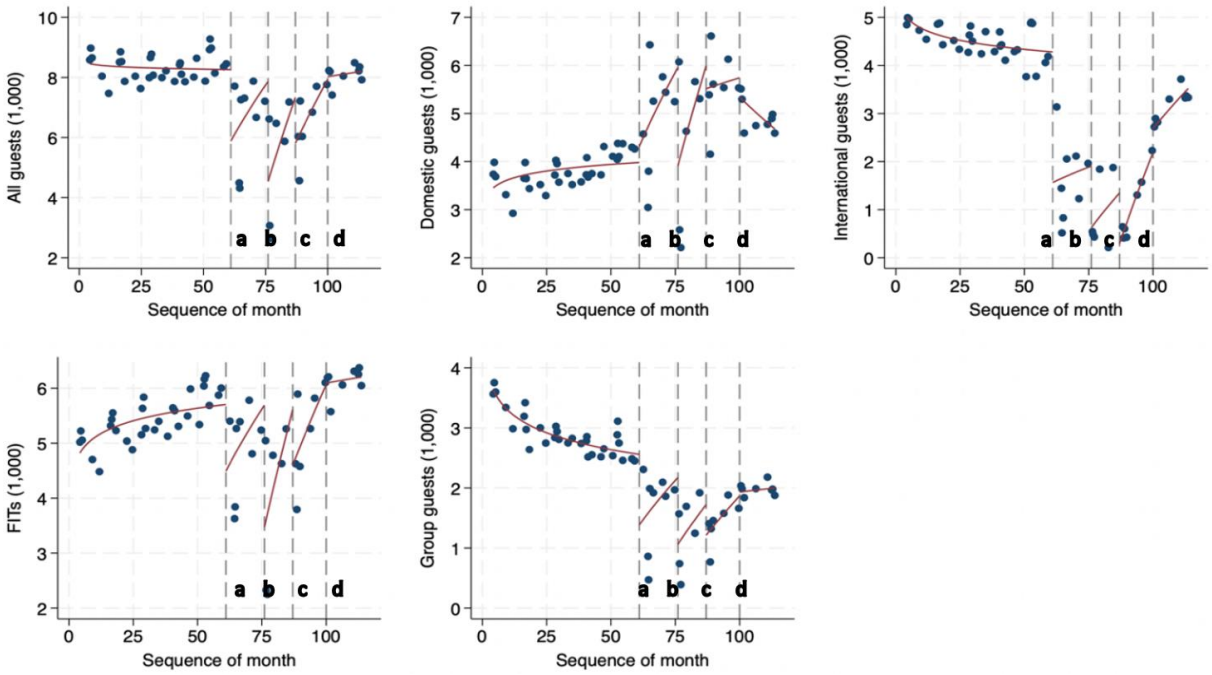

Figure A2. Sample statistics of the number of hotel guests.

Note: a, b, c, and d indicate the beginning of four periods during and after the pandemic. a is for initial period, b indicates alert, c represents severe period, and d is for post-COVID era.