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STRUCTURAL BREAKS AND VOLATILITY PERSISTENCE IN HOTEL OCCUPANCY RATE

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ABSTRACT

Purpose: Although Singapore has been one of the most attractive destinations for international tourists over the past 20 years, little evidence exists on the dynamics of its hotel occupancy rate. Our study aims to extend this scarce literature

Design/Methodology/Approach: The present study employs time-varying volatility processes (e.g., GARCH process) and models the uncertainty associated with the hotel occupancy rate in Singapore.

Findings: The main results indicate that shocks to the occupancy rate have a long run persistence and that there are asymmetric impacts in the occupancy rate. Further analysis suggests that structural breaks emanating from extreme news or shocks exert substantial impacts on the level of uncertainty for hotel occupancy rate.

Originality/Value: Managers in the hotel industry could benefit from our findings while adopting active measures to reduce risk in tourism demand and hotel occupancy and attract more international tourists.

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QUEBRAS ESTRUTURAIS E PERSISTÊNCIA DE VOLATILIDADE NA TAXA DE OCUPAÇÃO DE HOTÉIS

RESUMO

Objetivo: Embora Cingapura tenha sido um dos destinos mais atraentes para turistas internacionais nos últimos 20 anos, existem poucas evidências sobre a dinâmica de sua taxa de ocupação hoteleira. Nosso estudo tem como objetivo ampliar essa escassa literatura

Projeto/Metodologia/Abordagem: O presente estudo emprega processos de volatilidade variável no tempo (por exemplo, processo GARCH) e modela a incerteza associada à taxa de ocupação de hotéis em Cingapura.

Conclusões: Os principais resultados indicam que os choques na taxa de ocupação têm uma persistência de longo prazo e que há impactos assimétricos na taxa de ocupação. Uma análise mais aprofundada sugere que as quebras estruturais provenientes de notícias ou choques extremos exercem impactos substanciais sobre o nível de incerteza da taxa de ocupação de hotéis.

Originalidade/valor: Os gerentes do setor hoteleiro podem se beneficiar de nossas descobertas e adotar medidas ativas para reduzir o risco na demanda turística e na ocupação hoteleira e atrair mais turistas internacionais.

Palavras-chave: Cingapura, Taxa de Ocupação Hoteleira, Incerteza, Persistência de Volatilidade, Quebras Estruturais, Modelos GARCH.

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RUPTURAS ESTRUCTURALES Y PERSISTENCIA DE LA VOLATILIDAD EN LA TASA DE OCUPACIÓN HOTELERA

RESUMEN
Objetivo: Aunque Singapur ha sido uno de los destinos más atractivos para los turistas internacionales en los últimos 20 años, existen pocos datos sobre la dinámica de su tasa de ocupación hotelera. Nuestro estudio pretende ampliar esta escasa literatura.
Diseño/Metodología/Enfoque: El presente estudio emplea procesos de volatilidad variable en el tiempo (por ejemplo, el proceso GARCH) y modela la incertidumbre asociada a la tasa de ocupación hotelera en Singapur.
Resultados: Los principales resultados indican que las perturbaciones de la tasa de ocupación tienen una persistencia a largo plazo y que existen impactos asimétricos en la tasa de ocupación. Un análisis más detallado sugiere que las rupturas estructurales derivadas de noticias o perturbaciones extremas ejercen impactos sustanciales en el nivel de incertidumbre de la tasa de ocupación hotelera.
Originalidad/Valor: Los gestores del sector hotelero podrían beneficiarse de nuestras conclusiones a la hora de adoptar medidas activas para reducir el riesgo en la demanda turística y la ocupación hotelera y atraer más turistas internacionales.

Palabras clave: Singapur, Tasa de Ocupación Hotelera, Incertidumbre, Persistencia de la Volatilidade, Rupturas Estructurales, Modelos GARCH.

1 INTRODUCTION

The tourism sector in Singapore has been remarkably effective in enticing a growing number of international tourists over the past 20 years. In March 2004, the Singaporean government launched “Uniquely Singapore” marketing campaign through Singapore Tourism Board (STB) to attract more attention from international travelers (Lee, 2008). Since then, the number of international tourists visiting this small and beautiful Southeast Asian country has increased substantially, from 7.08 million in 2005 to 18.50 million in 2018. Hence, the leisure industry in Singapore contributes significantly to the country’s economic expansion. This is also reflected in a recent report available from STB revealing that the leisure industry in Singapore contributes about 4% to its economy.

Such enormous success of the tourism industry in Singapore has been the subject of many academic studies over the years. Toh et al. (2004) employ the two-stage shift-share model to conduct a comparative analysis between the tourism demand in Singapore and that of its neighboring countries including Thailand, Malaysia, and Hong Kong. Khan et al. (2005) investigate the long- and short-run associations between trade and tourist arrivals in Singapore. Oh and Morzuch (2005) examine the performance of several Time-Series Models in predicting the tourism demand in Singapore. Furthermore, Lee (2009) documents that tourist arrivals from major sources are stationary, implying that shocks to the arrival indexes have temporary effects on the tourism demand in Singapore. Lee (2010) employs linear ARDL (auto-regressive distributed lag) bound tests and finds no evidence of long-run connections between hotel room rates and tourism demand in Singapore. Lee (2011) shows that international tourism and economic performance have positive impacts on hotel room rates in Singapore, while terrorism has a negative effect. Tan and Tan (2013) consider the Singapore's tourism markets and the role of structural breaks and indicate that most of the tourism markets exhibit convergence when several break points are taken into account, whereas Tan and Tan (2014) apply unit root tests and provide evidence that the tourist arrivals to Singapore are stationary with several break points, suggesting the effects of shocks are transitory and not permanent. Recently, Lee (2020) proposes a theoretical model associating hotel room rates to excess supply of hotel rooms using annual data from Singapore over the period 1991-2017.

While numerous papers examine different aspects of tourism in Singapore, the dynamics of hotel occupancy rate (henceforth, HOR) remains understudied. This is surprising given that the occupancy rate represents a temporally disaggregated means of monitoring the performance of individual hotels (Jeffrey et al., 2002). Accordingly, HOR allows for the detection of trends and fluctuations within the hotel industry (O'Neill, 2011). For example, during the peak seasons, hotel owners usually raise the average hotel prices considering that the demand will be high and no rooms will remain empty. During the off-seasons, on the other hand, the occupancy rate tends to be low and average room rates seem decreasing. Moreover, high occupancy rate could also be less attractive for particular groups of travelers. Mattila and O'Neill (2003) argue that a the level of satisfaction of an hotel guest during a high occupancy period can be relatively low due to the relatively higher room rate as well as the less attentive service arising from the spreading of hotel employees over the needs of a larger number of guests. On the flip side, a large number of tourists get attracted to the hotels in demand as those visitors often consider a positive link between occupancy rate and hotel's reputation. On the whole, hotel occupancy rate is an important variable that can give substantial insights into the Singaporean tourism and hospitality industry.

In this study, we extend the scant literature by modeling the uncertainty associated with the hotel occupancy rate in Singapore. To this end, we use monthly data on hotel occupancy rate and employ GRACH-based models, while accounting for asymmetry and structural breaks.

It is worth noting that significant events including natural catastrophes, geopolitical risk, terrorism, financial or health crises can lead to an uncertainty in tourism sector, which suggests the necessity to accurately model such uncertainty for the sake of formulating suitable tourism policies. Hoti et al. (2007), for example, highlights the importance of modeling uncertainty arguing that because tourism is one of the world's largest export industry, it is crucial to precisely estimate the volatility of tourism demand for the sake of making decisions that involve both public and private sectors. Further evidence from Chan et al. (2005) shows that measuring volatility in the leisure industry in a proper way is useful to managers seeking to periodically evaluate the strengths and weaknesses of their business. While modeling uncertainty has gained enormous attention in the fields of economics and finance, such investigations rarely exist in the tourism literature[1]. Our study aims to address this vacuum.

The contributions of this paper are three-fold. Firstly, to the best of our knowledge, this is the initial study to model the volatility of HOR and examine whether shocks to HOR have short- or long-run impacts on the visitors. Secondly, we investigate if structural breaks, which usually occur in time-series data due to the consequence of economic or political events (e.g., wars, recessions etc.), have any significant influence on the volatility of HOR in Singapore. This is important as that the presence of structural breaks can lead to an upward bias in the estimation of the volatility persistence (Hillebrand, 2005). Thirdly, we assess whether the impact of positive and negative shocks (i.e. good and bad news) on the volatility of HOR remain unchanged in the presence of structural breaks in the occupancy rate.

The findings of this empirical analysis could help managers and policymakers of hotel industry in Singapore to understand how the volatility of HOR, which can ultimately impact the profitability of the hotel industry. Such an understanding will be useful for the management in taking effective measures to accelerate the recovery process.

The rest of the paper proceeds as follows. Section 2 outlines the data and models. Section 3 presents and discussed the empirical results. Section 4 concludes.

2 DATA AND METHODOLOGY

2.1 DATA

We utilize monthly data on the hotel occupancy rate in Singapore from January 1995 to December 2018, yielding 288 monthly observations. The commencing date of our sample period is dictated by data availability. Data are collected from DataStream.

[1] Previous studies that consider modeling the volatility of tourism demand include Chan et al. (2005), Shareef and McAleer (2005), Kim and Wong (2006), Shareef and McAleer (2007), Shareef and McAleer (2008), Hoti et al. (2007) and Divino, McAleer (2010), Balli et al. (2015) and Dutta et al. (2021). Our study, however, differs from these articles in two major ways. First, these studies investigate the volatility of tourist arrivals, while ours examines the uncertainty in hotel occupancy rate. Second, this is among the initial studies to inspect the impact of structural breaks on the volatility of tourism demand.

Table 1 exhibits the results of two different unit root tests: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The hypothesis for these tests is that the series under study is not stationary. Conducting unit root tests is important given that the existence of unit roots introduces a spurious regression. Hence, we need to precisely detect if unit roots exist in the hotel occupancy data. The results of the unit roots tests are presented in three panels. Panel A (no intercept) shows that the HOR index is non-stationary at levels, while both Panel B (intercept only) and Panel C (intercept and trend) indicate that occupancy rate data are stationary at levels.

2.2 GARCH MODELS

Methodologically, we use the generalized autoregressive conditional heteroskedasticity (GARCH), exponential GARCH (EGARCH), and GJR-GARCH models to estimate the risk associated with hotel occupancy rate in Singapore. Now the mean equation is specified as follows:

$$\Delta HOR_t = \pi + \phi \Delta HOR_{t-1} + \varepsilon_t \qquad (1)$$

where:

ΔHOR_t is the first-order difference of hotel occupancy rate at month *t*.

The residual term ε_t is assumed to follow the Student's *t* distribution.

Notably, the AR(1) process has been selected based on the values of Akaike information criterion (AIC) and Bayesian information criterion (BIC) criteria.

Regarding the conditional variance equation, we consider the standard GARCH (1,1) model, defined as:

$$h_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}^2 \qquad (2)$$

with:

ω, α and β being the parameters of GARCH (1,1) process.

In addition, h_t^2 refers to the conditional volatility and ε_{t-1}^2 represents the effect of news or shocks.

Note that $(\alpha + \beta)$ captures the volatility persistence for hotel occupancy rate.

Furthermore, we consider asymmetric models such as the GJR-GARCH and EGARCH models to assess if positive or negative shocks (i.e., increases or decreases in the occupancy rate) have an equal effect on the conditional volatility of HOR.

The EGARCH model has the following form:

$$\ln(h_t^2) = \omega + \alpha\left|\frac{\varepsilon_{t-1}}{h_{t-1}}\right| + \gamma\frac{\varepsilon_{t-1}}{h_{t-1}} + \beta ln(h_{t-1}^2) \quad (3)$$

where: γ captures to the asymmetric parameter, and β captures the persistence of volatility.

The GJR-GARCH model is given by:

$$h_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \gamma\varepsilon_{t-1}^2 S_{t-1} + \beta h_{t-1}^2 \quad (4)$$

where:

S_{t-1} denotes a dichotomous variable that equals 1 when $\varepsilon_{t-1}$is negative and 0 otherwise.
Note that the measure of persistence in volatility is $\alpha + \beta + {}^1/_2\gamma$.

In order to determine whether the adopted models are correctly specified, we apply a number of sign bias tests, namely sign bias test, negative size bias test, and positive size bias test (Engle & Ng, 1993). These tests are applied to the residuals of a GARCH fit to the occupancy rate data.

The sign bias test is based on the following regression:

$$\epsilon_t^2 = \rho_0 + \rho_1 D_{t-1}^- + v_t \quad (5)$$

where:

D_{t-1}^- is a dichotomous variable taking the 1 if the residual $\epsilon_{t-1} < 0$ and 0 otherwise and v_t is an i.i.d. error term. If the null hypothesis $H_0\colon \rho_1 = 0$ is accepted, then the employed model is considered appropriate.

The negative size bias test, which has been used to examine whether the size of the negative shocks would have different effects on volatility, is based on the following regression:

$$\epsilon_t^2 = \rho_0 + \rho_1 D_{t-1}^{-} \epsilon_{t-1} + v_t \qquad (6)$$

The positive size bias test, which is employed to examine if the size of the positive shocks would have different effects on volatility, is based on the following regression:

$$\epsilon_t^2 = \rho_0 + \rho_1 (1 - D_{t-1}^{-}) \epsilon_{t-1} + v_t \qquad (7)$$

Negative and positive size biases exist when ρ_1 is significantly different from zero in Equations 6 and 7, respectively.

2.3 GARCH MODELS WITH STRUCTURAL BREAKS

To detect the structural breaks in the occupancy rates, the Bai and Perron (1998, 2003a, b) structural break test is used. This test is advantageous as it can identify multiple breaks in the data series rather than a single break.

Once the structural breaks are detected, we extend Equation 2 as follows

$$h_t^2 = \omega + \varphi_1 D_1 + \cdots + \varphi_n D_n + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}^2 \qquad (8)$$

where:

$D_1, \cdots, D_n$ indicate the dichotomous variables that take the value of 1during the break periods and zero otherwise. The same extension pertains to the asymmetric models in equations 3 and 4.

The application of the Bai-Perron test detects only one potential break in the occupancy data which occurs during March 2003. The possible reasons for these breaks could be SARS (Severe acute respiratory syndrome) and avian flu. When investigating the causes of structural breaks in global tourism demand, Cró and Martins (2017) also conclude that the 2003 structural break in Singapore tourism data can be explained by these diseases. Figure 1, which depicts the hotel occupancy rate index, also demonstrates that HOR decreases drastically following these viruses which broke out in Singapore during 2003.

3 RESULTS AND DISCUSSION

3.1 GARCH ESTIMATES

Table 2 shows the results of GARCH, EGARCH, and GJR-GARCH models. The parameter (β) is significant for the asymmetric models only, while the parameter (α) is significant for the GJR-GARCH model only. This suggests that a shock to the hotel occupancy rate (i.e., tourism demand) is persistent in the long run. All the models appear to be stationary, indicating that the ML Estimators for the HOR index have asymptotic properties and that the conclusions drawn from our GARCH analyses is sound. Further evidence indicates that the γ parameter is significant, implying an asymmetric effect for the HOR index. Considering the asymmetric GARCH models, we also find evidence of leverage effects, as the γ parameter takes a negative value in the EGARCH model and a positive value in the GJR-GARCH process.

Table 3 presents the values of *t*-statistics for different sign bias tests. It is evident from these results that the sign bias test is insignificant in each case confirming that the model specifications are correct. In addition, the positive size bias test is also insignificant at conventional levels. Only the negative size bias test is significant, as the corresponding coefficient is significantly different from zero. Hence size of the negative shocks could have different effects on volatility of hotel occupancy rate. Note that the negative size bias test is significant only at the 10% level, indicating that the adopted models are precisely specified.

3.2 STRUCTURAL BREAKS AND VOLATILITY PERSISTENCE

The results of volatility models accounting for the structural break are presented in Table 4. They show a lower degree of volatility persistence when structural breaks have been considered. For example, the β coefficient for the GJR-GARCH without structural changes is 0.84, whereas it decreases to 0.56 after accounting for structural breaks. Further evidence from AIC, BIC and log-likelihood values implies that GARCH models with structural breaks outperform their counterparts that ignore structural breaks. Interestingly, the effect of structural break is positive (although insignificant), suggesting that the presence of structural breaks leads to an increase in the level of occupancy rate uncertainty in the hotel industry.

3.3 IMPACT OF NEWS ON VOLATILITY

The global tourism business is sensitive to news concerning with social security, war, cataclysmic events, fear-based oppression, epidemic and political insecurity. The adverse news shocks are expected to impact worldwide as well as local tourism ecosystem. It is quite probable that the shocks arising from antagonistic news are often trailed by fluctuations in tourist arrivals in the host country. The impact of some news shocks may prevail for a longer duration, while others may promptly and impalpably vanish. Additionally, the extent to which the tourists are affected is also conditional upon the characteristic feature and severity of the news. Thus, the stream of unpleasant news endows potential negative impacts on tourism demand. It is, therefore, crucial to understand the impact of news on hotel industry volatility.

Table 5 demonstrates the effects of good and bad news on the volatility of occupancy rates. The results from the asymmetric GARCH models show that the estimates measuring the impacts of positive and negative shocks tend to increase when taking the structural changes into account. For example, in case of the GJR-GARCH model, the effect of bad news $(\alpha + \gamma)$ amounts to 0.14 when breaks are ignored and 0.17 when breaks are taken into account. The corresponding effects of good news (α) are 0.17 and 0.18 respectively. Therefore, good news has a higher impact on the conditional volatility of hotel occupancy rate than bad news of the same magnitude. It follows that ignoring structural breaks in the HOR index can lead to an overestimation of the volatility persistence and an underestimation of the news impact.

4 CONCLUSION AND POLICY IMPLICATIONS

Although Singapore has been one of the major destinations for international tourists over the years, the dynamics of its hotel occupancy rate receives little attention in earlier literature. To extend this scarce literature, the present study employs time-varying volatility processes and model the risk associated with the hotel occupancy rates in Singapore. Our results show that a shock to the hotel occupancy rate (i.e., tourism demand) is persistent in the long run and that there are asymmetric impacts in the occupancy rate index. Further analysis implies that structural breaks originating from extreme news or shocks exert substantial impacts on the level of uncertainty for hotel occupancy rate.

The findings have important implications to academics and researchers who are always in search of developing appropriate methods for forecasting tourism demand and hotel occupancy rate in major tourist destinations such as Singapore. Since modeling volatility plays a crucial role in risk management, our results will be of paramount importance to predicting uncertainties linked to the hotel occupancy rate. Managers in the hotel industry could also benefit from our findings while adopting active measures to reduce risk in tourism demand and hotel occupancy and attract more international tourists. Such policies can involve stabilizing hotel prices and enhancing tourism destinations through promotional activities (Kim et al., 2020). Policymakers could also build on our findings while reinforcing the role of Singapore as an ultimate destination for international tourists.

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APPENDICES

Table 1

Findings of stationarity tests

	ADF	PP	Decision
Panel A: No intercept			
Levels	-0.39	-0.23	Non-stationary
First differences	-19.39***	-23.82***	Stationary
Panel B: Intercept only			
Levels	-4.01***	-6.54***	Stationary
First differences	-19.35***	-23.75***	Stationary
Panel C: Intercept and Trend			
Levels	-4.65***	-7.24***	Stationary
First differences	-19.32***	-23.69***	Stationary

Note: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP).
***p < 0.01, **p < 0.05.

Table 2

GARCH estimates

Parameters/Models	GARCH		EGARCH		GJR-GARCH	
	Estimates	Standard error	Estimates	Standard error	Estimates	Standard error
ω	9.66	6.12	0.63	0.49	3.38**	1.45
α	0.15	0.11	0.14	0.15	-0.17***	0.04
β	0.38	0.36	0.75***	0.19	0.86***	0.07
γ			-0.21**	0.10	0.32***	0.08
Persistence	0.53		0.75		0.84	
Log-likelihood	-832.77		-831.08		-827.41	
AIC	5.87		5.86		5.83	
BIC	5.94		5.95		5.92	

Notes: ***p < 0.01, **p < 0.05.

Table 3

Results of sign bias tests

Models →	GARCH	EGARCH	GJR-GARCH
Sign bias	1.06	1.28	1.44
Negative size bias	-1.87*	-1.82*	-1.89*
Positive size bias	0.74	0.65	1.07

Notes: This table reports the *t*-statistics for different sign bias tests.
***p < 0.01, **p < 0.05.

Table 4

Estimates of GARCH models with structural breaks

Parameters/Models	GARCH		EGARCH		GJR-GARCH	
	Estimates	Standard error	Estimates	Standard error	Estimates	Standard error
ω	11.56*	6.27	0.77	0.47	8.67***	3.25
α	0.09	0.09	-0.02	0.14	-0.18***	0.04
β	0.32	0.34	0.74***	0.15	0.56***	0.19
γ			0.20**	0.10	0.36***	0.09
φ	972.94	2024.84	2.39	1.92	512.85	670.92
Persistence	0.41		0.74		0.56	
Log-likelihood	-831.76		-829.73		-824.38	
AIC	5.87		5.86		5.82	
BIC	5.95		5.96		5.92	

Notes: ***$p < 0.01$, **$p < 0.05$.

Table 5

Effect of news on volatility

Models →	Baseline EGARCH	Baseline GJR-GARCH	EGARCH with breaks	GJR-GARCH with breaks
Bad news	1.21	0.14	1.20	0.17
Good news	0.79	0.17	0.80	0.18

Notes: The effects of good and bad news are $|1 + \gamma|$ and $|-1 + \gamma|$ for the EGARCH model and $|\alpha|$ and $|\alpha + \gamma|$ for the GJR-GARCH process, respectively.

Figure 1

Hotel Occupancy Rate in Singapore (1995-2018)