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The Impact of Market Volatility on Hotel Efficiency in Malaysia

Does Hotel Size Matter?

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Abstract

It is often argued that small firms are more flexible than large firms. As a result, small firms perform better in volatile markets compared to large firms. The present paper explores this idea for a representative sample of private hotels in Malaysia. Specifically, the paper estimates the impact of volatility in occupancy rates on the pure technical efficiency of small versus large hotels. A slack-based non-radial efficiency measure obtained from the data envelopment analysis methodology is used. The empirical results confirm that smaller hotels are better at dealing with volatility than large hotels are. That is, there is a positive and significant impact of higher volatility on the efficiency of relatively small hotels, a negative and significant impact on the efficiency of larger hotels, and no significant impact on the efficiency of the average hotel. Higher women's ownership also helps hotels to deal with volatility. The paper discusses the policy implications of the findings.

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The Impact of Market Volatility on Hotel Efficiency in Malaysia: Does Hotel Size Matter?

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1. Introduction

Volatility in market demand characterized by erratic, diurnal, seasonal, and cyclical fluctuations in the number of visitors and occupancy rates is a key feature of the hotel industry (see Alemayehu and Tveteraas 2020, Saito and Romão 2018, Park et al. 2016, Chen and Yeh 2012, Jang 2004, and Highman and Hitch 2002). While there are some benefits from higher volatility, most studies contend that the high cost of adjusting inputs in the short run (henceforth, adjustment cost) outweighs the benefits. Studies of the manufacturing sector suggest that the adjustment cost varies, being less for small compared to large firms. As a result, smaller firms suffer less or benefit more from higher volatility. The present paper makes a first attempt at exploring this idea in the case of hotels. We estimate the impact of volatility in occupancy rates on a slack-based measure of the efficiency of hotels in Malaysia obtained using the Data Envelopment Analysis (DEA) methodology. Our results confirm that smaller hotels are less negatively (or more positively) impacted by higher volatility in occupancy rates. We also find that hotels with more women's ownership suffer less from higher volatility in occupancy rates, and those that use temporary workers suffer more.

The relationship between volatility in demand and the profitability or efficiency of hotels has been explored in several studies (Section 2.1 reviews the literature). While the evidence is somewhat mixed, most studies find that higher volatility has a negative impact on hotels' performance. Studies for other service sectors and manufacturing sectors reach a similar conclusion. The key issue here is the shape of the short-run average and marginal cost curves. The steeper the slope of the cost curves, the larger the decline in firm performance when adjusting output to match fluctuating demand. Efficiency differences have also been linked to hotel size (see Pulina et al. 2010, Pérez-Rodríguez et al. 2023, Aissa and Goaied 2016, Salman Saleh et al. 2012, Shyu and Hung 2012, Assaf and Agbola 2011), although not always in the same direction. For instance, Pulina et al. (2010) find that medium-sized hotels in Sardinia, Italy, are more efficient than small and large hotels. However, for hotels in the Canary Islands, Spain, Pérez-Rodríguez et al. (2023) find that efficiency is higher for large hotels than for small and medium hotels. De Jorge and Suárez (2014) find a U-shaped relationship between efficiency and the size of hotels in Spain.

Some studies of the manufacturing sector analyze how the shape of the short-run cost curves, and therefore the impact of volatility in demand on firm performance, varies between small and large firms (section 2.2 reviews the literature). The claim here is that production technology and the internal organization of small firms are more flexible, and therefore small firms can respond to volatility at a lower cost than large firms. In contrast, large firms have their efficiency niche in more stable markets, where economies of scale allow them to achieve a lower long-run average cost. To the best of our knowledge, the issue of how hotels of different sizes respond to volatility has not been explored. The present paper is the first to do so.

Our results show that higher volatility in occupancy rates has no significant impact on the efficiency of the average hotel (see figure 1). However, there is a sharp heterogeneity, with the impact being positive and statistically significant for the relatively small hotels and negative and significant for the relatively large hotels (see figure 2). For our final baseline specification, a one standard deviation increase in volatility in occupancy rates is associated with an increase in efficiency by 0.073 points (about 14.2 percent of the sample mean efficiency) for hotels at the 25th percentile value of size, which is significant at the 5 percent level. The corresponding change at the 75th percentile value of hotel size is a decrease in efficiency by 0.092 points (about 18.1 percent of the sample mean efficiency), significant at the 5 percent level. The result is robust to several alternative measures of efficiency, hotel size, and volatility. We also find that higher women's ownership is associated with a less adverse (or more beneficial) impact of higher volatility in occupancy rates on the efficiency of hotels. To the best of our knowledge, this is the first paper to find such a gendered effect in any industry.

The survey of hotels that we use is nationally representative of registered private hotels in Malaysia. The survey provides information on various hotel characteristics and hotels' experiences with different aspects of the business environment. We exploit this rich information to raise our confidence against the omitted variable bias problem. We also use the methodology of Oster (2019) to formally test for omitted variable bias. Nevertheless, causality-wise, our results should be treated with due caution as they are based on pure cross-sectional data.

2. Literature review and conceptual framework

2.1 *Volatility and firm performance*

Fluctuations in market demand can affect the performance of hotels significantly. Low demand during off-peak seasons results in excessive capacity (Cuccia and Rizzo 2011, Park et al. 2016) if there are fixed costs in production or a high cost of adjusting inputs such as the number of rooms (see Butters 2020) and labor (see Alemayehu and Tveteraas 2020, Park et al. 2016). Too high demand during peak seasons can also put pressure on available resources, leading to poorer quality of service and lower performance (see Parrilla et al. 2007). In an early theoretical contribution, Sheshinski and Dreze (1976) showed that, compared to stationary demand, fluctuating demand leads to a higher expected cost per unit of output. At least to some extent, the problem of fluctuating demand can be solved by using a more flexible production method or technology. However, flexible technologies are limited, and so is their efficacy in improving efficiency (see, for example, Bryson 2007, Kleinknecht et al. 2006). More importantly, flexible technologies may impose additional costs. As Mills (1984) notes, a plant certain to operate x units of output per week will surely have lower costs at that output than will a plant designed to be passably efficient from x/2 to 2x. Other theoretical (Hagspiel et al. 2016) and empirical (Mera et al. 2017, Merschmann and Thonemann 2011) studies make a similar point.

Several papers have empirically explored the relationship between hotel performance and volatility in demand. Sáez-Fernández et al. (2020) find that higher seasonality is associated with lower efficiency among hotels in the Balearic Islands, Spain. Chen and Chang (2012) find a negative impact of price instability on the profitability of hotels in Taiwan, China. Alemayehu and Tveteraas (2019) find that for 94 hotels in Norway, demand fluctuations are associated with only a partial adjustment of labor to the optimal level in the long run. Thus, they conclude that demand fluctuations can cause hotels to operate at suboptimal levels. Chen and Yeh (2012) find that more demand uncertainty is associated with a higher likelihood of failure among international tourist hotels in Taiwan, China. Saito and Romão (2018) find that seasonal variation has a non-negligible impact on the total factor productivity of hotels in Spain. Park et al. (2016) find a negative impact of more demand volatility on the labor productivity of hotels in 43 medium-sized hotels in two chains in the UK. Fernandez-Morales and Mayorga-Toledano (2008) find that for hotels in Costa del Sol in Spain, underutilization of capacity in periods of low demand coupled with fixed costs has a negative effect on productivity. Similar results are also found for other service industries (see Morikawa 2012, Baker 2004) and manufacturing (see Merschmann and Thonemann 2011).

A negative impact of higher volatility on hotels' performance is not a forgone conclusion. There are studies that either find no significant impact or a positive impact from higher volatility. For example, Jones and Siag (2009) analyze the impact of demand variability on the productivity of 45 chain hotels in the UK. The authors find no significant impact of demand variability. Ortega and Chicon (2013) also report that seasonality does not reduce labor productivity in the Spanish hospitality industry. Lado-Sestayo and Fernández-Castro (2019) find a positive impact of seasonality on the efficiency of hotels in Spain, which they attribute to cost savings when production is concentrated in a few periods of the year. Also, higher seasonality can improve productivity by allowing businesses to undertake maintenance or refurbishment work or develop new markets (see Grant et al. 1997).

2.2 *The relevance of firm size*

Several studies have explored how the cost of adjusting inputs in the short run varies across firms. Most of these studies focus on the manufacturing sector, and we are not aware of any such study for the hotel industry. The broad idea here is that the adjustment cost, as reflected in how steeply short-run marginal and average cost curves rise, depends in part on a firm's internal organization, which varies between small and large firms. It is claimed that smaller firms are more flexible (flatter short-run average and marginal cost curves) than larger firms, and so smaller firms suffer less (or benefit more) from higher volatility. Larger firms have their own efficiency niche, which is characterized by a lower long run average cost. Stigler (1939) was the first to argue that small firms have a lower cost of adjusting inputs in the short run than large firms. Das et al. (1993) argue theoretically and provide evidence that, compared to large firms, small firms have more flexible production technologies, as reflected in the flatter short-run average cost curve. This allows smaller firms to respond better to changing demand conditions. Caves and Pugel (1980) make a somewhat similar point. They argue that large firms rely more on capital-intensive methods of production that have high fixed costs. Greater reliance on capital and more specialized forms of capital reduces large firms' ability to adjust to demand fluctuations. In contrast, small firms choose more flexible production methods, which entail the use of more nonspecialized inputs and a greater reliance on variable factors of production. Mills and Schumann (1985) also argue that firm size and flexibility are inversely related within industries. According to these authors, small firms tend to have fewer decision-makers and a less complicated bureaucracy than large firms. These organizational characteristics mean that small firms can respond more quickly to changes in market conditions. Fiegenbaum and Karnani (1991) also highlight these and other organizational factors. Using data from Compustat on 3,000 companies from 83 industries, the authors find that smaller firms have greater output flexibility than large firms and that this greater output flexibility improves the performance of smaller firms. Interestingly, the authors predict that there is no significant relationship between output flexibility and the performance of the average firm, a positive relationship between the two for small firms, and a negative one for large firms. We find similar results below for the impact of market volatility on hotel efficiency. Zimmermann (1995) also develops a theoretical model and provides empirical evidence from German manufacturing industries that shows that smaller firms are more flexible. Hirsch et al. (2020) consider 2,186 firms in the EU dairy processing industry. They also find that larger firms have lower long-run average cost curves or static efficiency, while smaller firms are more flexible. Renner et al. (2014) use data on Polish agricultural farms to estimate the relationship between farm size and flexibility in production. As in the above studies, flexibility is captured by the slope of the average cost curve. This study also confirms a negative relationship between flexibility and farm size. For 58 manufacturing industries in Malaysia, Nor et al. (2007) find that variations in sales are larger for the relatively smaller firms. The authors argue that this is consistent with smaller firms responding better to unexpected demand fluctuations.

3. DEA methodology

DEA is a non-parametric method of estimating the efficiency of decision-making units (DMUs). Being non-parametric, DEA does not make any assumptions about the form of the production technology or about the distributional properties of the efficiency estimates. Throughout, we focus on the input-oriented model, where efficiency involves minimizing inputs for a given level of outputs. We do so because hotels can only control input use and not the level of demand or output. Among others, Perrigot et al. (2009) and Hernández-Guedes et al. (2024) use input-oriented, non-parametric efficiency measures. We also assume variable returns to scale (VRS) technology instead of constant returns to scale (CRS) technology. We do so because VRS is generally regarded as a more accurate representation of the true technology for the hotel industry given market imperfections, seasonality, scale effects, and heterogeneity (see Hernández-Guedes et al. 2024 for more details). Input minimization can happen when all inputs are varied in the same proportion (radial model) or in different proportions (non-radial model). The DEA literature on hotel efficiency has mainly relied on radial measures. The few studies that use a non-radial distance measure do so using the methodology of Tone (2001). Examples include Ashrafi et al. (2013), Deng et al. (2020), and Xia et al. (2018).

In the first step, DEA identifies the feasible production set. This includes all the DMUs' observed input and output vectors (production vectors), all production vectors with less (of one or more) outputs and/or more (of one or more) inputs than that of any observed DMU (free disposal assumption), and all linear combinations of feasible production vectors (convexity assumption). In the second step, the efficiency frontier is constructed, which consists of all fully efficient feasible production vectors. A production vector is fully efficient if there is no other feasible vector with the same (or higher) output that uses less of all inputs (radial) or some inputs (non-radial). In the last step, a DMU's (in)efficiency is calculated as its distance from the frontier. It captures the maximum percentage reduction in inputs when moving to the frontier without reducing the output.

DEA was first proposed as a linear programming problem by Charnes et al. (1978). The authors employed a radial distance measure and assumed CRS technology. Banker et al. (1984) also employed the radial distance measure but replaced CRS with VRS technology. Tone (2001) introduced a non-radial model that allows for disproportionate changes in inputs in estimating a DMU's distance to the frontier (slack-based measure of efficiency).

Our baseline or main efficiency measure is the input-oriented slack-based measure of Tone (2001) with VRS technology. For this measure, the efficiency level for DMU_0 using the $\mathbf{x_0}$ input vector and producing the $\mathbf{y_0}$ output vector equals φ_0 which is obtained by solving the following linear programming problem:

$$\varphi_0 = \underset{\lambda, s^-, s^+}{Min} \quad 1 - \frac{1}{m}\sum_{i=1}^{m}\frac{s^-}{x_{i0}}$$

subject to

$$x_{i0} = \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- \qquad (i = 1, \ldots\ldots, m)$$

$$y_{r0} = \sum_{j=1}^{n} y_{rj}\lambda_j - s_i^+ \qquad (r = 1, \ldots\ldots, s)$$

$$\textstyle\sum_{j=1}^{n} \lambda_j = 1 \text{ , } \lambda_j \geq 0 \ (\forall j), \ s_i^- \geq 0 \ (\forall i), \ s_i^+ \geq 0 \ (\forall i)$$

where j denotes the firm, *r* denotes the output, *i* denotes the input, s_i^- and s_i^+ are slacks in inputs (inputs excesses) and outputs (outputs shortfalls), respectively. The linear programming problem is repeated separately for each firm j =1, …., n. For any given firm, the value of φ equals the maximum percentage reduction in inputs (averaged over all inputs) that is possible by moving the concerned DMU to the frontier while maintaining its output vector.

Our main result is robust to several alternative measures of efficiency. To this end, we employ the traditional radial DEA efficiency measure due to Banker et al. (1984) assuming variable returns to scale (BCC efficiency). Next, we relax the convexity assumption (discussed above) in the Banker et al. (1984) model. This gives rise to the free disposal hull efficiency (FDH efficiency) first introduced by Deprins et al. (1984). The slack-based measure of efficiency defined above is characterized by several DMUs that are fully efficient. This reduces the model's discriminatory power in distinguishing between DMUs' efficiency. Further, the slack-based efficiency measure is susceptible to outliers because a handful of highly efficient DMUs can make all others appear highly inefficient. We address these potential shortcomings by employing the slack-based "super efficiency" measure based on the work on Tone (2002).[1] The methodology assigns different efficiency scores greater than 1 to an otherwise fully efficient DMU depending on how much its exclusion from the sample affects the efficiency frontier. A potential outlier DMU is one with a high super efficiency score. Another issue with DEA models is that they tend to overestimate the efficiency of DMUs. This happens because there may be some DMUs in the universe not included in the sample that are more efficient than all the DMUs in the sample. We correct for the upward bias (Bias corrected efficiency) using the bootstrapping methodology of Simar and Wilson (2007). We note that the bias corrected efficiency measures are currently available only for radial DEA models. Thus, the bias correction is applied to the BCC efficiency described above.

[1] Deng et al. (2020) also use this measure of efficiency for hotels in China.

4. Data source and main variables

Our data source is a firm-level survey of private firms in Malaysia conducted by the World Bank's Enterprise Surveys (ES) in 2019. The ES are nationally representative surveys of private registered manufacturing and services firms that have five or more employees. The surveys are stratified by size, sector (within manufacturing and service), and region within the country. Informal or unregistered firms and those with fewer than five employees are excluded from the sample. We focus on the sample of hotels (ISIC Rev. 3.1 industry code 5510) in the ES. Our estimations below use all the hotels surveyed by the ES for which information is available on the main variables of interest. There are 90 hotels in the baseline sample. Sampling weights provided by the ES to correct for oversampling are used throughout. In the Appendix, a formal definition of all the variables used in the regressions is provided in Table A1. Summary statistics are provided in Table A2.

Our baseline results are based on estimating the following equation:

$$\begin{aligned} Efficiency_{ir} = {} & \alpha + \beta_1 X_{ir} * Hotel\ size_{ir} + \beta_2 X_{ir} + \beta_3 Hotel\ size_{ir} \\ & + Region\ fixed\ effects_r + Baseline\ Controls_{ir} + u_{ir} \quad \ldots\ldots (1) \end{aligned}$$

where subscript i denotes the hotel, r denotes the region (city), X is volatility in occupancy rate (defined below). The key parameter of interest is β_1, which captures how the impact of volatility in occupancy rate on a hotel's efficiency varies with the size of the hotel. In the robustness checks, several interaction term controls are added to equation (1). The estimation method used is Ordinary Least Squares (OLS) with robust standard errors clustered on the region times star rating of the hotel (defined below) level. Our main efficiency measure is bounded above by 1. Hence, we also use Tobit estimation method as a robustness check.[2]

4.1 *Dependent variable*

Our dependent variable is a measure of the efficiency of hotels. As mentioned above, our main efficiency measure is the input-oriented slack-based measure of pure technical efficiency assuming VRS technology (*SBM Efficiency*). This is a non-radial measure based on the work of Tone (2001). We use one output and three inputs. The output is the total annual sales of the hotel, and the inputs are the total annual labor cost, the number of rooms in the hotel, and the total operational cost proxied by the total annual cost of electricity. Sales, labor cost, and electricity cost are for the last fiscal year. The choice of the output and inputs is driven by the existing literature and data availability. Several studies have used annual sales revenue as an output measure (see Alemayehu and Tveteraas 2020, Hernández-Guedes et al. 2024, Barros 2005, De Jorge and Suárez 2014). Likewise, the number of rooms (Barros 2005, De Jorge and Suárez 2014), labor cost (Barros 2005, Assaf and Agbola 2011, Hernández-Guedes et al. 2024), and operating expenses (see Lado-Sestayo and Fern´andez-Castro 2019, Hernández-Guedes et al. 2024), which include electricity cost, have been used as inputs in several studies. The mean value of *SBM Efficiency* is 0.51 (or 51 percent), the standard deviation is 0.21, and the range is 0.13 to 1. Thus, a typical hotel in Malaysia can reduce all its inputs (on average) by about 49 percent while maintaining its output. About 16 percent of the surveyed hotels (8.8 percent with sampling weights) are fully efficient. Figure 3 shows the distribution of *SBM Efficiency*.

[2] Both OLS and Tobit estimation methods are used in the DEA literature. We prefer the OLS method because it offers an easier estimation and interpretation for the interaction term. Estimating interaction terms in non-linear models such as Tobit is complicated (see Ai and Norton 2003).

Our main result is robust to several alternative measures of efficiency that were discussed in Section 3. These include slack-based super efficiency, bias corrected efficiency, BCC efficiency, and FDH efficiency. All the efficiency measures considered assume an input-oriented model with variable returns to scale. Outputs and inputs are as stated in the previous paragraph. Table A1 in the Appendix provides more details on these efficiency measures.

4.2 *Main explanatory variables*

Our main explanatory variables are hotel size, volatility in market demand proxied by volatility in occupancy rate experienced by a hotel in the last year, and the interaction term between the two. For hotel size, we use the log of the number of permanent full-time workers employed at the hotel at the end of the last fiscal year. For volatility, we use the information provided in the ES on the highest occupancy rate (percentage) last year, the lowest occupancy rate last year, and the average occupancy rate last year. Specifically, our volatility measure equals the difference between the highest occupancy rate and the lowest occupancy rate divided by the average occupancy rate (*Volatility in Occupancy*). Such range-based measures of a given phenomenon are typical in the related literature (see Ferrante et al. 2018, Lundtorp 2001). The mean value of *Volatility in Occupancy* equals 0.81, and the standard deviation is 0.49. The focus of the empirical exercise below is on the interaction term between hotel size and volatility in occupancy rates (henceforth, volatility). This interaction term captures how the relationship between efficiency and volatility varies with the size of the hotel.

For robustness, we show that our main results hold for alternative measures of hotel size and volatility. For hotel size, we use the log of the number of rooms. For volatility, we use the difference between the highest and lowest occupancy rates divided by the average of the two (*Volatility in Occupancy* 1).

4.3 *Control variables in the baseline model*

We use several controls to guard against the possibility of an omitted variable bias problem. The choice of controls is motivated by existing studies on the drivers of hotel efficiency and the broader literature on firm productivity, volatility in markets, and firm size. Several studies have shown that sub-national regional factors are important drivers of hotel efficiency (see, for example, Sellers-Rubio and Casada-Diaz 2018, Assaf et al. 2015, Parte-Esteban and Alberca-Oliver 2015, Assaf and Agbola 2011). Some of the region-specific factors that impact hotel efficiency may include the level of market demand and competition, the number of international tourists, destination quality, and the quality of the business environment. Other factors that have been found to impact hotel efficiency include the age of the hotel (Arbelo et al. 2018, Assaf and Agbola 2011), whether the hotel is part of a chain (Shyu and Hung 2012, Manasakis et al. 2013), the level of product market competition (De Jorge and Suárez 2014, Assaf et al. 2017), managerial autonomy (De Jorge and Suárez 2014), and the star rating of the hotel (Assaf and Agbola 2011). Studies have also found positive effects of having a website, social media presence, and e-commerce on the occupancy rates and revenues of hotels (see El-Said et al. 2022, Shuai and Wu 2011). It is likely that these factors influence hotel efficiency, although this remains to be properly explored. Diversification of hotel revenues may also affect a firm's efficiency and its ability to deal with market volatility (see, for example, Cunill et al. 2024). Further, it is natural to expect that total hotel revenues will be positively correlated with the average occupancy rate. Last, there is voluminous literature that shows that the productivity of manufacturing and service sector firms is affected by access to finance, quality of power supply (power outages), regulatory burden, and gender of the firm's manager and owners. While the importance of these factors for the efficiency of hotels has not been properly explored, it cannot be ruled out.

Based on the discussion in the previous paragraph, we use the following controls in the baseline model: a set of dummy variables indicating the city where the hotel operates (city fixed effects), a set of dummy variables indicating the star rating of the hotel (one star, two star, three star, four star, and five star), log of the age of the firm, a dummy variable equal to 1 if the hotel is part of a chain of hotels and 0 otherwise, the proportion of hotel's ownership that is with women, a dummy variable equal to 1 if the hotel reports access to finance as a major or very severe obstacle and 0 otherwise (no obstacle, minor obstacle, or moderate obstacle), average occupancy rate during the last year, number of power outages experienced by the hotel in a typical month last year, a dummy variable equal to 1 if the largest owner of the hotel is the top manager of the hotel and 0 otherwise, a dummy variable equal to 1 if the hotel has a website and 0 otherwise, two dummy variables indicating low competition and intermediate competition with high competition being the omitted category, a dummy variable equal to 1 if the hotel competes against informal or unregistered hotels and 0 otherwise, the proportion of senior manager's time that is spent in dealing with business regulations (Time tax), a dummy variable equal to 1 if the top manager of the hotel is a woman and 0 otherwise, and a dummy variable equal to 1 if the hotel is the hotel's main product or service accounts for less than 100 percent of its annual revenue/sales and 0 otherwise (Diversified).

4.4 *Non-linear controls*

We employ several additional controls as a robustness check. These controls are aimed at demonstrating that the heterogeneity between efficiency and volatility with respect to hotel size is not a mere proxy for other possible heterogeneities. To provide an example, studies have shown that hotel size has a non-linear or U-shaped relationship with efficiency (see De Jorge and Suárez 2014). Thus, we control for the square of hotel size, the square of volatility, and the interaction terms between volatility and the following variables: dummy variables for the star rating of the hotel described above (omitted category here is One star rating hotels), log of age of hotel, dummy indicating if the hotel is part of a chain, two dummy variables for low and intermediate competition (omitted category is high competition), a dummy variable equal to 1 if the hotel uses temporary workers and 0 otherwise, a dummy variable indicating if the top manager of the hotel is a woman, and the proportion of the hotel's ownership that is with women.

5. Base regression results

5.1 *Linear relationship*

Before discussing our main results, we consider the linear relationship between volatility and efficiency. The linear relationship between efficiency and volatility is positive but statistically insignificant at the 10 percent level (see Table A3 in the Appendix). This holds with or without the baseline controls included in the specification. For instance, after accounting for all the baseline controls (column 4, Table A3), a one standard deviation increase in volatility is associated with an increase in efficiency by 0.029 points (about 5.7 percent of the sample mean efficiency). To summarize, there is no economically meaningful and statistically significant linear relationship between volatility and efficiency.

5.2 *Heterogeneity in efficiency and volatility relationship*

Our main result for the heterogeneity in the volatility-efficiency relationship with respect to hotel size is provided in Table 1. The heterogeneity is captured by the interaction term between volatility and hotel size. As evident from Table 1, the interaction term between volatility and hotel size is negative and statistically significant at the 1 percent level in all the specifications. It ranges between -0.157 and -0.182. It is equal to -0.157 without any controls (column 1) and -0.182 with all the baseline controls (column 4). Regardless of the specification considered, there is a *positive* and statistically significant relationship (at the 5 percent level or less) between volatility and efficiency for hotels that are below a critical threshold size, and a *negative* and statistically significant relationship (at the 5 percent level or less) for hotels above a critical threshold size. For some hotels that are of intermediate size, there is no statistically significant relationship (at the 10 percent level or less) between efficiency and volatility. To get a sense of the magnitude, consider the final baseline specification (column 4). For this specification, a one standard deviation increase in volatility is associated with an *increase* in efficiency by 0.073 points (about 14.2 percent of the sample mean efficiency) for hotels at the 25th percentile value of size, which is significant at the 5 percent level. In contrast, the corresponding change at the 75th percentile value of hotel size is a *decrease* in efficiency by 0.092 (about 18.1 percent of the sample mean efficiency), significant at the 5 percent level. To summarize, as far as the impact on efficiency is concerned, smaller hotels are better at dealing with volatility than larger hotels.

6. Robustness

6.1 *Robustness for efficiency*

We repeat the baseline regressions above using alternative measures of pure technical efficiency as the dependent variable. The alternative efficiency measures include BCC efficiency, bias corrected efficiency, slack-based super efficiency, and FDH efficiency. For slack-based super efficiency, we separately report the results for the full sample and for the sample of firms with the potential outliers excluded.

Table 2 contains the results for the final baseline specification for each of the efficiency measures stated in the previous paragraph. Results for all the baseline specifications (as shown in Table 1) for each efficiency measure are provided in tables A4-A8 in the Appendix. As evident from these tables, the interaction term between volatility and hotel size is negative and statistically significant at the 1 percent or 5 percent level in all specifications. For each efficiency measure and regardless of the specification considered, there is a critical level of hotel size below which there is a *positive* and significant (at the 5 percent level) relationship between efficiency and volatility. Likewise, there is a critical level of hotel size above which there is a *negative* and significant (at the 5 percent level) relationship between efficiency and hotel size. There is an intermediate range of hotel size for which there is no significant (at 10 percent or less) relationship between efficiency and volatility. In short, the baseline results discussed in sub-section 4.2 for our main efficiency measure are robust to all the alternative measures of efficiency. In fact, all the robustness checks discussed below (Subsections 6.2 to 6.6) hold for all the alternative measures of efficiency listed in this sub-section.

6.2 *Robustness for hotel size*

Next, we repeat the baseline regressions using an alternative measure of hotel size, which is the log of number of the rooms in the hotel. The results are provided in Table 3. These results are like the baseline results discussed in Section 4. That is, the results show that the interaction term between volatility and the log of the number of rooms is negative and significant at the 1 percent level for all the baseline specifications. As in the baseline model, there is a critical value of the log of the number of rooms below which the relationship between efficiency and volatility is *positive* and statistically significant (at the 5 percent level or less). In contrast, there is a critical value of the log of the number of rooms above which there is a *negative* and statistically significant relationship (at the 5 percent level or less) between efficiency and volatility. There is an intermediate range of values of the log of the number of rooms for which there is no significant (at 10 percent or less) relationship between efficiency and volatility.

6.3 *Robustness for volatility measure*

Regression results using the alternative measure of volatility are provided in Table A9 in the Appendix. The interaction term between volatility and hotel size remains negative and statistically significant at the 1 percent level. This holds for all the baseline specifications. As above, there is a critical value of hotel size (log of number of workers) below which the relationship between efficiency and volatility is *positive* and statistically significant (at the 5 percent level or less). In contrast, there is a critical value of hotel size above which there is a *negative* and statistically significant relationship (at the 5 percent level or less) between efficiency and volatility. There is an intermediate hotel size range for which there is no significant (at 10 percent or less) relationship between efficiency and volatility. Consider, for example, the final specification (column 4, Table A9). For this specification, a one standard deviation *increase* in volatility is associated with an increase in efficiency by 0.06 points (or 12.6 percent of the sample mean efficiency) for hotels at the 25^{th} percentile value of hotel size. The corresponding change at the 75^{th} percentile value of hotel size is a *decrease* in efficiency by 0.11 points (or 21.6 percent of the sample mean efficiency). These changes are statistically significant at the 5 percent and 1 percent levels, respectively.

6.4 *Robustness to other heterogenous effects*

Next, we consider robustness for non-linear controls (listed in Section 4.4). The non-linear controls ensure that our volatility-hotel size interaction term is not spuriously picking up the effects of other interaction terms or heterogeneities. Regression results controlling for all the baseline controls and the non-linear controls are provided in Table 4. As evident from Table 4, our main interaction term between volatility and hotel size remains negative, economically large, and statistically significant at the 1 percent level in some specifications and the 5 percent level in others. Thus, we conclude that our main result is not a mere proxy for non-linear effects of hotel size, volatility, and several others.

6.5 *Tobit estimation*

Next, we account for the fact that our baseline efficiency measure is bounded above by 1. Thus, we use the Tobit estimation method. The results from this estimation are provided in Table A10 in the Appendix. These results are like the baseline results discussed above in that they show that the interaction term between volatility and the number of workers (logs) is negative and statistically significant at the 1 percent level. This holds for all the baseline specifications.

6.6 *Outlier treatment*

In this section, we check if our baseline results are unduly affected by outliers. Note that the outliers here are only those that show exceptionally high efficiency relative to the rest and not the ones in the statistical sense.

To detect the outliers, we follow the methodology proposed by Thanassoulis (1999). This methodology uses the super efficiency scores for the slack-based efficiency measure as described above. Starting with the full sample, all hotels with super efficiency scores above 1.1 (that is, 10 percent above the frontier efficiency score of 1) are excluded from the sample, and super efficiency scores are re-estimated for the remaining hotels. The process is repeated until all hotels have super efficiency scores of less than 1.1, or 5 percent of the sample has been excluded. Next, the highest super efficiency score from the final round is assigned to all the excluded hotels, and the excluded hotels are included in the sample.

Regression results for efficiency scores so obtained are provided in Table A11 in the Appendix. These are like the baseline results. That is, the interaction term between volatility and hotel size is negative and statistically significant at the 1 percent level in all the specifications considered. Quantitatively, the magnitude of the interaction term is roughly the same as in the baseline model. The same holds for the estimated coefficient values of volatility and hotel size. Thus, our main result is not driven by outliers.

7. Extensions

7.1 *Scale efficiency*

We check if volatility has any impact on deviations from the optimal scale size (scale efficiency) of hotels and if the impact varies by hotel size. We find a negative linear relationship between volatility and scale efficiency, which is significant and close to the 1 percent level across all the baseline specifications (see Table A12 in the Appendix). For instance, for the final baseline specification (column 4, Table A12), a one standard deviation increase in volatility leads to a decline in scale efficiency by 0.06 points, or about 10.5 percent of the sample mean scale efficiency. In Table A13 in the Appendix, we provide the results for the interaction term between volatility and hotel size, with scale efficiency as the dependent variable. The interaction term here is weak and statistically insignificant at the 10 percent level or less. Thus, there is no evidence of any differential impact of volatility on the scale efficiency of small vs. large hotels.

7.2 *Women- vs. men-owned hotels*

One issue that has not been analyzed in the related literature is how women-led hotels or firms deal with volatility relative to men-led hotels or firms. Some studies have shown that women tend to be more risk-averse than men. Thus, one may conjecture that greater volatility adversely affects the efficiency of women-led hotels more than that of men-led hotels. However, the need to balance family responsibilities and work may force women to be more flexible in their management style. As a result, women may develop a comparative advantage in markets that are more volatile. Further, women face several additional hurdles in running businesses, such as poorer access to finance, less education and job experience, less favorable social attitudes towards work outside the home, and poorer access to public infrastructure and institutions. Faced with these problems, women entrepreneurs and managers may specialize and acquire expertise in the less sought-after and less profitable niche hotels, such as the more seasonal ones. Of course, these are mere conjectures, and the issue can only be resolved empirically.

To analyze if volatility affects women- and men-led hotels differently, we use the interaction term between volatility and the proportion of the hotel that is owned by women.

Regression results for all the baseline specifications are provided in Table 5. We find that without any other controls, the interaction term between volatility and women's ownership is weak and statistically insignificant, implying no significant gendered effect of volatility on efficiency. However, the interaction term becomes more positive and is statistically significant at the 5 percent level or less once we control for the city fixed effects and for the interaction term between volatility and hotel size. Thus, conditional on city fixed effects and the volatility-hotel size interaction term, higher women's ownership is associated with a more beneficial or less harmful impact of higher volatility on hotel efficiency. For instance, for the final baseline specification and a median-sized hotel, a one standard deviation increase in volatility is associated with a decline in the efficiency of hotels fully owned by women by 0.28 points (significant at the 1 percent level). The corresponding change for hotels fully owned by men is a decline of 0.057 points (significant at the 10 percent level). We note that the results discussed here for women's ownership are distinct from women vs. men top managers. That is, they are robust to the heterogeneous effect of volatility on the efficiency of hotels with a woman vs. man top manager (details below).

7.3 *Temporary workers*

Hotels may use more temporary workers to deal with volatility (see Dräger and Marx 2017). Temporary workers can help hotels get rid of excess labor during periods of low demand and thereby improve their efficiency. However, the opposite is also possible. That is, the use of temporary workers can exacerbate the negative effects of volatility by lowering the quality of labor (see Alemayehu and Tveteraas 2020). This may happen because temporary workers accumulate less hotel-specific skills than permanent workers, and only relatively less educated and less skilled workers may agree to a temporary job. Thus, the issue can only be resolved empirically.

To this end, we use the interaction term between volatility and a dummy variable equal to 1 if the hotel used temporary workers during the last year and 0 otherwise. About 22.7 percent of the hotels used temporary workers. Regression results provided in Table 6 reveal that without any other controls, the interaction term between volatility and temporary workers dummy is negative but small and statistically insignificant (column 1). The interaction term is larger and statistically significant at the 10 percent level when we control for city fixed effects and the interaction term between volatility and hotel size (column 2). Adding the remaining baseline controls causes the interaction term between volatility and dummy for temporary workers to increase in magnitude and become significant at the 5 percent level or less (columns 3 and 4). For the final specification (column 4, Table 6) and for the median size hotel, a one standard deviation increase in volatility is associated with an *increase* in efficiency by 0.115 points (significant at the 1 percent level) for hotels that do not use temporary workers and a *decrease* in efficiency by 0.084 points (insignificant at the 10 percent level) for hotels that use temporary workers. To summarize, the use of temporary workers magnifies the negative impact of higher volatility on hotels' efficiency.

7.4 *Other heterogeneities and all heterogeneities simultaneously*

So far, we have considered heterogeneities in the efficiency-volatility nexus with respect to hotel size, women's ownership, and the use of temporary workers. In this section, we show that all these heterogeneities hold simultaneously with and without the baseline controls and the non-linear controls discussed above.

Regression results are provided in Table A14 in the Appendix. In column 1 of Table A14, we include all the interaction terms between volatility and the following variables: hotel size, women's ownership, and the dummy for the use of temporary workers. As above, the interaction term between volatility and hotel size is negative and significant. However, as above, the relationship between volatility and women's ownership and between volatility and the use of temporary workers is positive but statistically insignificant. In column 2, we include the city fixed effects as controls. As above, all three interaction terms are now significant and carry the same signs as found above. Adding the various baseline controls does not alter the results qualitatively (see column 3).

In column 4, we include the square of volatility, the square of hotel size, and interaction terms between volatility and each of the following variables: dummy for a woman vs. man top manager; (log of) age of the firm; dummy equal to 1 if the hotel is part of a chain and 0 otherwise; a dummy variable indicating that the number of competitors is between 11 and 50, and another dummy variable indicating that the number of competitors is more than 50 or "too many to count" (omitted category is between 0-10 competitors); three separate dummy variables indicting the star rating of the hotel (two-star hotels, three-star hotels, four- or five-star hotel, omitted category is one-star hotels). Regression results in column 4 show that the heterogenous impact of volatility on efficiency with respect to hotel size, women's ownership share, and use of temporary workers continues to hold as above. Further, we find no evidence that any of the other heterogeneities considered are significant except with respect to the star rating of the hotel and whether the hotel is part of a chain.

8. Endogeneity checks

8.1 *Oster test*

Above, we found that the heterogeneity in the efficiency-volatility nexus with respect to hotel size is robust to several controls. However, it is still possible that omitted or unobserved factors may be driving the heterogeneity. We employ the test proposed by Oster (2019) to assess how serious the omitted variable bias problem is. This test is based on the idea that, under certain assumptions, we can use selection on observables to identify the likely bias from the selection on the unobservables (omitted variables). There are two ways in which the Oster test can be used, and we employ both. First, it can be used to infer the degree of unobserved selection that would need to exist to reduce the impact of the variable of interest (the interaction term between volatility and hotel size in our case) on the dependent variable to zero. This is the δ value. A value greater than 1, signifies that the unobservables would need to be more important than the observables to explain away the impact of the variable of interest. The higher the value of δ, the less likely it is that the result is driven by omitted variable bias. An important issue in this test is the choice of maximum R^2. Oster (2019) recommends a maximum R^2 value that is 1.3 times as high as the R^2 from the underlying regression. We follow this recommendation. The second use of the Oster test is to provide a lower bound for the coefficient of interest after accounting for the selection on the unobservables (the estimated omitted variable bias). This is known as the β value. Using this method, our goal below is to bound the estimates based on the assumption that selection on unobservables is, at worst, equal to selection on observables (δ=1).

We apply the Oster test to the interaction term between volatility and hotel size in the final baseline estimation provided in column 4 of Table 1. The Oster test yields a δ value of 7.86. This is much higher than the minimum value of 1, which is typically considered high enough to rule out any serious omitted variable bias problem. Thus, it is highly unlikely that our estimate of the interaction term between volatility and hotel size suffers from any serious omitted variable bias problem.

Similarly, the Oster test yields a β value of -0.195 for the interaction term between volatility and hotel size. This is slightly bigger (in absolute terms) than the OLS estimate of -0.182 (column 4, Table 1), implying that omitted variable bias, if any, weakens our main result. Bootstrapped standard errors from 5,000 repetitions show that the β value of -0.195 is statistically significant at close to the 1 percent level. Thus, our main result of a larger positive impact of volatility on the efficiency of small hotels than on large hotels easily passes the Oster test.

9. Conclusion

The impact of volatility in occupancy rates on the efficiency of hotels in Malaysia is examined. It is found that the impact varies sharply between hotels of different sizes. Hotels above a critical threshold level of size experience a significant reduction in efficiency due to higher volatility. In contrast, hotels below a critical threshold size level experience a significant increase in efficiency due to higher volatility. For hotels of intermediate size, there is no significant impact of volatility on efficiency. These results are robust to different measures of efficiency, hotel size, and volatility. They are also robust to outlier tests and endogeneity checks based on the methodology of Oster (2019). We also uncover other heterogeneities in the volatility and efficiency relationship with respect to the gender composition of hotel owners and the use of temporary workers.

The findings above are important for policy makers. First, they indicate that policies to mitigate the adverse effects of volatility should not be indiscriminately applied but targeted to hotels according to their size. Second, our findings suggest that another policy option for addressing volatility related effects is to encourage relatively small hotels to enter the more volatile hotel segments. Large hotels may be encouraged in the more stable market segments. Third, closing gender gaps is a key objective in many developing countries. Our results indicate that encouraging women in more volatile markets may be a viable option for narrowing the gender gap while at the same time increasing the overall efficiency of the hotel industry. Fourth, many countries have implemented policies encouraging small and medium-size enterprises (SMEs), arguably because SMEs create more jobs and promote a more equitable distribution of income. Our results inform the cost-benefit analysis of such policies for the hotel industry. Last, promoting temporary workers in markets where demand is highly volatile may be counterproductive as far as the efficiency of hotels is concerned.

Several issues remain to be analyzed. First, data limitations did not allow us to explore the mechanisms by which volatility affects small and large hotels. This is an important avenue for future research, as it will improve our understanding of how volatility impacts efficiency and highlight the policy options best suited to ameliorate the problem posed by volatility. Second, it will be interesting to check if the results discussed above hold in countries other than Malaysia and in other service sectors like health care, transportation, and tourism. Third, identifying niche products where women have a comparative advantage over men is important for closing gender gaps in incomes. Our results show that women entrepreneurs may have a comparative advantage in more volatile markets. This needs to be properly explored not just for hotels, but also for other services and manufacturing industries. Fourth, it is natural that hotels would adjust their investments, scale of operation, management style, and marketing strategy to volatility. It will be interesting to explore how these adjustments affect the relationship between volatility and hotel efficiency and profits. We hope that the present paper encourages research in these and other related areas.

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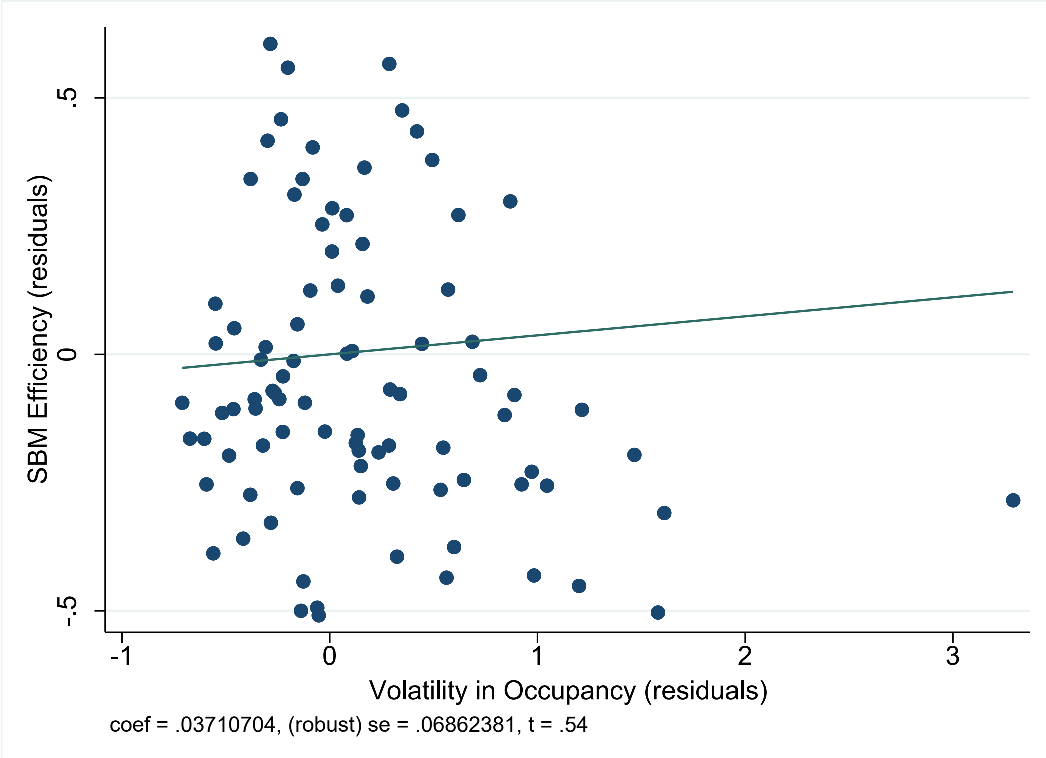
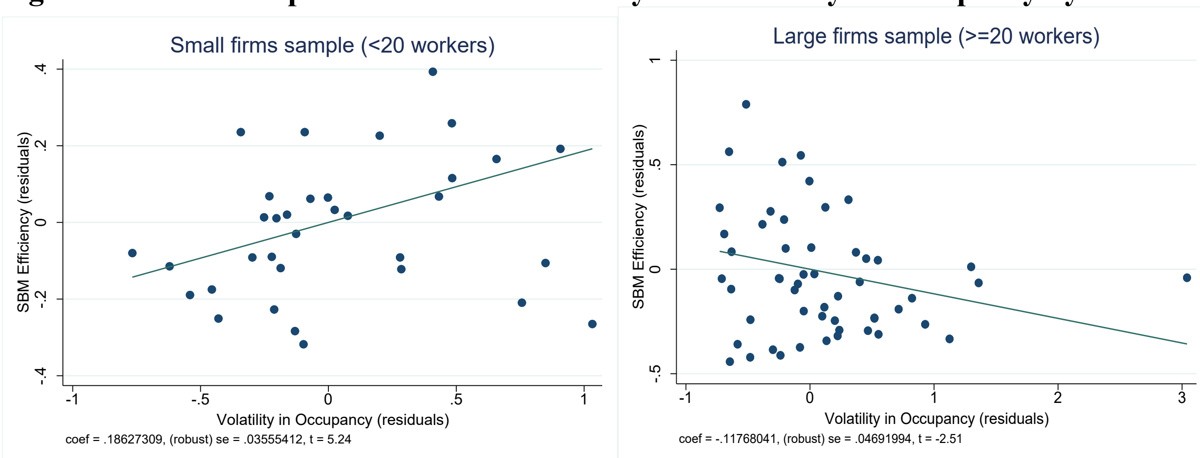
Figure 1: Linear relationship between SBM Efficiency and Volatility in Occupancy



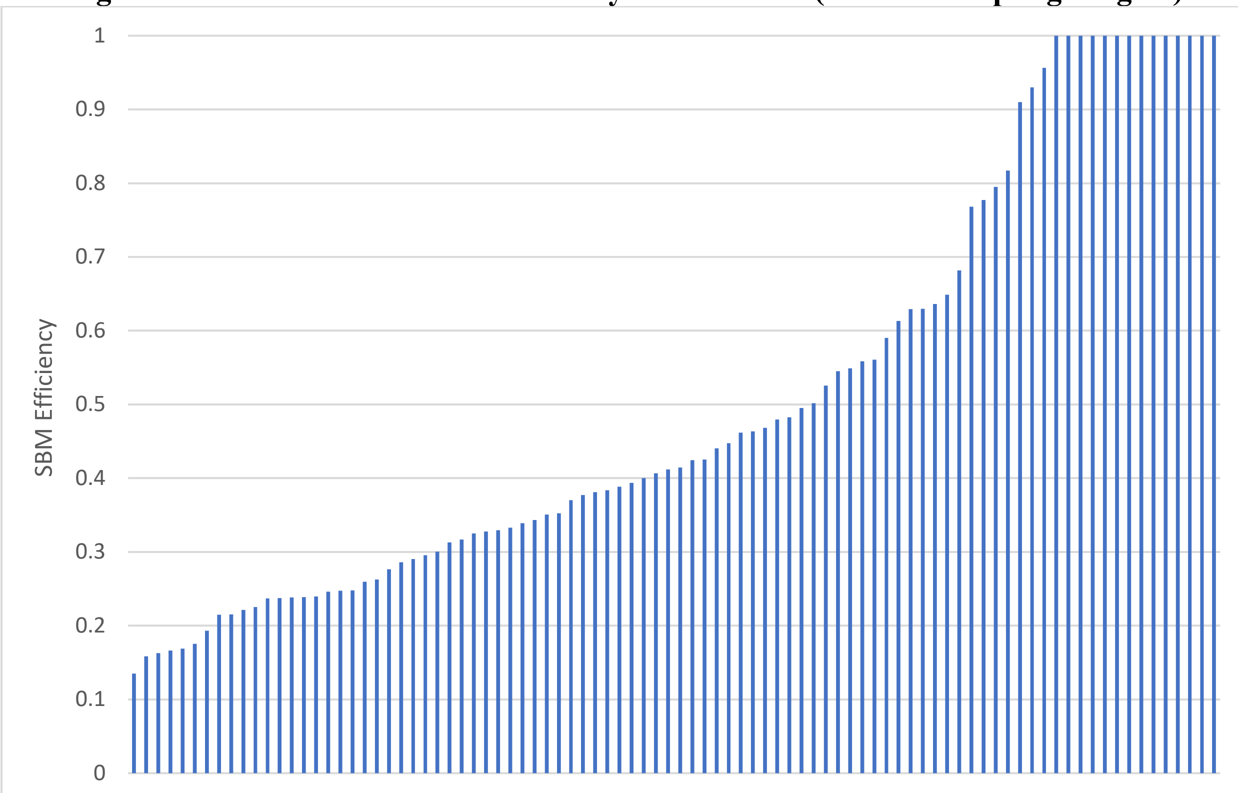
Note: The figure is a partial scatter plot of residuals obtained after controlling for region dummies (city fixed effects), dummy variables for the star-rating of the hotel (2-star, 3-star, and 4- or 5-star rating), hotel size (log of number of workers). The line of fit shown is not statistically significant at the 10 percent level or less.
Source: Authors' own calculations based on ES data for hotels in Malaysia in 2019.

Figure 2: Relationship between SBM Efficiency and Volatility in Occupancy by hotel size



Note: The figures are a partial scatter plot of residuals estimated separately for the sample of hotels with less than 20 full-time permanent workers and for the rest. These figures are obtained after controlling for region dummies (city fixed effects), dummy variables for the star-rating of the hotel (2-star, 3-star, and 4- or 5-star rating), and hotel size (log of number of workers). The lines of fit shown are statistically significant at less than the 5 percent level.
Source: Authors' own calculations based on ES data for hotels in Malaysia in 2019.

Figure 3: Distribution of SBM Efficiency across hotels (without sampling weights)



Note: SBM Efficiency is shown for each hotel in the baseline sample.
Source: Authors' own calculations based on ES data for hotels in Malaysia in 2019.

Table 1: Heterogeneity with respect to hotel size				
Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers (logs)	-0.157***	-0.180***	-0.155***	-0.182***
	(0.049)	(0.051)	(0.049)	(0.053)
Volatility in Occupancy	0.464***	0.493***	0.444***	0.548***
	(0.127)	(0.116)	(0.122)	(0.157)
Number of workers (logs)	0.107*	0.115*	0.132*	0.118
	(0.058)	(0.065)	(0.068)	(0.069)
Central region Y:1 N:0		0.005	-0.043	0.040
		(0.024)	(0.042)	(0.080)
Eastern region Y:1 N:0		0.210***	0.221***	0.241***
		(0.046)	(0.057)	(0.072)
Northern region Y:1 N:0		0.012	0.074	0.046
		(0.039)	(0.064)	(0.113)
Sabah & Sarawak Y:1 N:0		0.146*	0.115	0.155**
		(0.071)	(0.069)	(0.069)
Age of hotel (logs)			0.023	0.066
			(0.049)	(0.040)
Part of a chain Y:1 N:0			-0.154	-0.101
			(0.109)	(0.064)
Women's ownership (proportion)			-0.071	-0.077
			(0.130)	(0.189)
Finance major obstacle Y:1 N:0			0.015	-0.006
			(0.121)	(0.101)
Occupancy rate			0.117	0.138
			(0.186)	(0.192)
Number of power outages			-0.002	-0.013
			(0.020)	(0.023)
Largest owner is manager Y:1 N:0			-0.048	0.002
			(0.055)	(0.055)
Website Y:1 N:0			-0.141*	-0.065
			(0.079)	(0.096)
Low competition Y:1 N:0			0.017	0.025
			(0.041)	(0.064)
Intermediate competition Y:1 N:0			-0.000	0.042
			(0.093)	(0.103)
Two-star hotel Y:1 N:0				-0.118*
				(0.065)
Three-star hotel Y:1 N:0				0.019
				(0.060)
Four- or five-star hotel Y:1 N:0				0.110
				(0.114)

Informal competition Y:1 N:0				-0.000
				(0.087)
Time tax (proportion)				-0.096
				(0.133)
Woman top manager Y:1 N:0				0.017
				(0.063)
Diversified Y:1 N:0				-0.044
				(0.066)
Constant	0.168	0.115	0.097	-0.083
	(0.149)	(0.151)	(0.210)	(0.275)
Number of observations	90	90	90	86
Adjusted R-squared	0.143	0.253	0.285	0.343

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table 2: Alternative efficiency measures					
	(1)	(2)	(3)	(4)	(5)
Dependent variable: Pure technical efficiency	**Super efficiency**	**Super efficiency (outliers dropped)**	**BCC efficiency**	**Bias corrected efficiency**	**FDH efficiency**
Volatility in Occupancy*Number of workers (logs)	-0.270***	-0.164**	-0.175***	-0.079**	-0.102**
	(0.085)	(0.063)	(0.057)	(0.029)	(0.038)
Volatility in Occupancy	0.783***	0.495**	0.539***	0.211**	0.310***
	(0.231)	(0.190)	(0.165)	(0.082)	(0.107)
Number of workers (logs)	0.209**	0.110	0.078	0.009	0.115***
	(0.096)	(0.083)	(0.078)	(0.040)	(0.039)
Central region Y:1 N:0	0.025	0.044	0.103	0.067*	0.098
	(0.096)	(0.089)	(0.077)	(0.036)	(0.062)
Eastern region Y:1 N:0	0.262***	0.278***	0.216***	0.057	0.082
	(0.090)	(0.065)	(0.071)	(0.047)	(0.068)
Northern region Y:1 N:0	-0.096	0.063	0.023	-0.014	0.180*
	(0.192)	(0.136)	(0.103)	(0.047)	(0.094)
Sabah & Sarawak Y:1 N:0	0.072	0.152*	0.143*	0.070*	0.139*
	(0.114)	(0.080)	(0.070)	(0.034)	(0.074)
Age of firm (logs)	0.023	0.081*	0.072	0.023	0.034
	(0.039)	(0.045)	(0.043)	(0.022)	(0.037)
Part of a chain Y:1 N:0	0.013	-0.148*	-0.056	-0.010	-0.116
	(0.171)	(0.082)	(0.071)	(0.043)	(0.078)
Women's ownership (proportion)	-0.062	-0.106	0.010	0.029	0.250**
	(0.264)	(0.202)	(0.206)	(0.122)	(0.104)
Finance major obstacle Y:1 N:0	-0.049	-0.023	0.046	0.024	0.031
	(0.102)	(0.104)	(0.115)	(0.055)	(0.056)
Occupancy rate	0.141	0.102	0.144	0.029	0.226
	(0.335)	(0.216)	(0.172)	(0.090)	(0.144)
Number of power outages	-0.002	-0.021	-0.015	-0.004	0.006
	(0.033)	(0.024)	(0.022)	(0.011)	(0.008)
Largest owner is manager Y:1 N:0	-0.045	0.017	-0.055	0.002	-0.008
	(0.074)	(0.068)	(0.053)	(0.032)	(0.053)
Website Y:1 N:0	-0.083	-0.055	-0.069	-0.024	-0.054
	(0.112)	(0.104)	(0.107)	(0.050)	(0.057)
Low competition Y:1 N:0	0.010	0.008	0.007	-0.014	-0.121**
	(0.118)	(0.069)	(0.059)	(0.024)	(0.049)
Intermediate competition Y:1 N:0	0.074	0.021	0.048	0.026	0.027
	(0.099)	(0.105)	(0.101)	(0.056)	(0.099)
Two-star hotel Y:1 N:0	-0.104	-0.108	-0.078	-0.013	-0.012
	(0.071)	(0.072)	(0.063)	(0.026)	(0.054)
Three-star hotel Y:1 N:0	0.027	0.024	0.051	0.040	-0.104*

	(0.075)	(0.065)	(0.059)	(0.030)	(0.053)
Four- or five-star hotel Y:1 N:0	0.322	0.084	0.141	0.101	0.041
	(0.245)	(0.122)	(0.105)	(0.065)	(0.083)
Informal competition Y:1 N:0	-0.042	0.018	-0.001	-0.008	0.075*
	(0.106)	(0.098)	(0.094)	(0.047)	(0.038)
Time tax (proportion)	-0.150	-0.150	0.052	0.060	0.240**
	(0.194)	(0.148)	(0.111)	(0.054)	(0.112)
Woman top manager Y:1 N:0	0.049	0.022	0.021	-0.009	-0.067
	(0.069)	(0.068)	(0.067)	(0.039)	(0.042)
Diversified Y:1 N:0	-0.093	-0.061	-0.062	-0.066	-0.158***
	(0.141)	(0.077)	(0.070)	(0.043)	(0.049)
Constant	-0.131	-0.070	0.073	0.593***	0.326*
	(0.332)	(0.313)	(0.275)	(0.139)	(0.158)
Number of observations	86	83	86	86	86
Adjusted R-squared	0.112	0.290	0.334	0.227	0.359

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table 3: Number of rooms as the measure of hotel size				
Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of rooms (logs)	-0.248***	-0.284***	-0.264***	-0.295***
	(0.085)	(0.080)	(0.075)	(0.078)
Volatility in Occupancy	1.017***	1.129***	1.082***	1.255***
	(0.340)	(0.301)	(0.291)	(0.328)
Number of rooms (logs)	0.107	0.139	0.161*	0.140*
	(0.097)	(0.093)	(0.086)	(0.075)
Central region Y:1 N:0		0.015	-0.016	0.069
		(0.026)	(0.035)	(0.071)
Eastern region Y:1 N:0		0.194***	0.219***	0.214**
		(0.044)	(0.062)	(0.082)
Northern region Y:1 N:0		0.027	0.107*	0.077
		(0.036)	(0.057)	(0.078)
Sabah & Sarawak Y:1 N:0		0.173***	0.167***	0.191***
		(0.059)	(0.058)	(0.054)
Age of hotel (logs)			0.027	0.060
			(0.047)	(0.038)
Part of a chain Y:1 N:0			-0.146	-0.088
			(0.117)	(0.062)
Women's ownership (proportion)			0.010	-0.030
			(0.125)	(0.142)
Finance major obstacle Y:1 N:0			0.022	-0.010
			(0.123)	(0.106)
Occupancy rate			0.192	0.176
			(0.162)	(0.201)
Number of power outages			0.001	-0.007
			(0.021)	(0.022)
Largest owner is manager Y:1 N:0			-0.059	-0.011
			(0.057)	(0.056)
Website Y:1 N:0			-0.111	-0.038
			(0.075)	(0.083)
Low competition Y:1 N:0			0.018	0.030
			(0.035)	(0.055)
Intermediate competition Y:1 N:0			-0.062	-0.055
			(0.080)	(0.103)
Two-star hotel Y:1 N:0				-0.108**
				(0.049)
Three-star hotel Y:1 N:0				0.045
				(0.044)
Four- or five-star hotel Y:1 N:0				0.151**
				(0.072)
Informal competition Y:1 N:0				-0.038

				(0.079)
Time tax (proportion)				-0.015
				(0.158)
Woman top manager Y:1 N:0				0.044
				(0.050)
Diversified Y:1 N:0				-0.020
				(0.070)
Constant	0.033	-0.138	-0.297	-0.407
	(0.389)	(0.358)	(0.391)	(0.402)
Number of observations	90	90	90	86
Adjusted R-squared	0.243	0.350	0.360	0.440

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table 4: Non-linear controls

Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**
Volatility in Occupancy*Number of workers (logs)	-0.190***	-0.105***	-0.157**
	(0.050)	(0.025)	(0.056)
Volatility in Occupancy	0.535***	0.580***	0.866***
	(0.143)	(0.201)	(0.212)
Number of workers (logs)	0.113	-0.560***	-0.374
	(0.070)	(0.123)	(0.218)
Central region Y:1 N:0	0.013	-0.027	-0.005
	(0.086)	(0.064)	(0.108)
Eastern region Y:1 N:0	0.240***	0.216***	0.255***
	(0.070)	(0.061)	(0.087)
Northern region Y:1 N:0	0.021	0.108	0.141
	(0.116)	(0.093)	(0.130)
Sabah & Sarawak Y:1 N:0	0.122	0.161**	0.187*
	(0.074)	(0.070)	(0.090)
Age of hotel (logs)	0.069*	0.065	0.088
	(0.037)	(0.054)	(0.061)
Part of a chain Y:1 N:0	-0.170**	-0.291***	-0.338***
	(0.063)	(0.096)	(0.114)
Women's ownership (proportion)	-0.646**	-0.528	-0.290
	(0.283)	(0.318)	(0.340)
Finance major obstacle Y:1 N:0	0.013	0.089	0.080
	(0.096)	(0.057)	(0.067)
Occupancy rate	0.118	0.303	0.339
	(0.195)	(0.223)	(0.228)
Number of power outages	-0.010	0.006	-0.001
	(0.023)	(0.017)	(0.021)
Largest owner is manager Y:1 N:0	0.016	0.066	0.012
	(0.048)	(0.050)	(0.046)
Website Y:1 N:0	-0.062	-0.080	-0.110
	(0.097)	(0.082)	(0.085)
Low competition Y:1 N:0	0.020	0.004	-0.019
	(0.060)	(0.057)	(0.132)
Intermediate competition Y:1 N:0	0.064	0.049	0.449
	(0.104)	(0.076)	(0.391)
Two-star hotel Y:1 N:0	-0.104	-0.022	0.176
	(0.064)	(0.064)	(0.107)
Three-star hotel Y:1 N:0	-0.006	0.004	0.049
	(0.060)	(0.047)	(0.117)
Four- or five-star hotel Y:1 N:0	0.147	0.003	0.062
	(0.116)	(0.082)	(0.204)
Informal competition Y:1 N:0	0.023	0.071	0.096

	(0.079)	(0.049)	(0.060)
Time tax (proportion)	-0.166	-0.188*	-0.001
	(0.134)	(0.093)	(0.097)
Woman top manager Y:1 N:0	0.175	0.211*	0.102
	(0.118)	(0.118)	(0.118)
Diversified Y:1 N:0	-0.050	-0.102*	-0.162**
	(0.058)	(0.049)	(0.067)
Volatility in Occupancy*Women's ownership (proportion)	0.564***	0.616***	0.444*
	(0.157)	(0.206)	(0.243)
Volatility in Occupancy*Woman top manager Y:1 N:0	-0.158	-0.192*	-0.115
	(0.107)	(0.103)	(0.108)
Square of Volatility in Occupancy		-0.126***	-0.117**
		(0.043)	(0.049)
Square of Number of workers (logs)		0.096***	0.071**
		(0.016)	(0.030)
Volatility in Occupancy*Age of firm (logs)		-0.014	-0.007
		(0.070)	(0.083)
Volatility in Occupancy*Part of a chain Y:1 N:0		0.092	0.182**
		(0.094)	(0.085)
Volatility in Occupancy*Temporary workers Y:1 N:0			-0.371**
			(0.142)
Temporary workers Y:1 N:0			0.324*
			(0.171)
Volatility in Occupancy*Low competition Y:1 N:0			-0.072
			(0.158)
Volatility in Occupancy*Intermediate competition Y:1 N:0			-0.319
			(0.286)
Volatility in Occupancy*Two-star hotel Y:1 N:0			-0.235**
			(0.098)
Volatility in Occupancy*Three-star hotel Y:1 N:0			-0.066
			(0.153)
Volatility in Occupancy*Four- or five-star hotel Y:1 N:0			0.058
			(0.265)
Constant	-0.039	0.729**	0.285
	(0.243)	(0.281)	(0.405)
Number of observations	86	86	83
Adjusted R-squared	0.391	0.552	0.553

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table 5: Gendered effects of volatility				
Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Women's ownership (proportion)	-0.079	0.299**	0.420**	0.456**
	(0.093)	(0.137)	(0.155)	(0.193)
Volatility in Occupancy	0.071	0.510***	0.475***	0.540***
	(0.059)	(0.114)	(0.117)	(0.146)
Women's ownership (proportion)	-0.105	-0.411*	-0.465**	-0.521*
	(0.179)	(0.206)	(0.186)	(0.294)
Volatility in Occupancy*Number of workers (logs)		-0.199***	-0.186***	-0.203***
		(0.053)	(0.051)	(0.048)
Number of workers (logs)		0.133**	0.158**	0.135*
		(0.061)	(0.064)	(0.066)
Central region Y:1 N:0		0.004	-0.059	0.005
		(0.022)	(0.044)	(0.084)
Eastern region Y:1 N:0		0.215***	0.217***	0.224***
		(0.040)	(0.053)	(0.073)
Northern region Y:1 N:0		0.019	0.080	0.024
		(0.039)	(0.056)	(0.121)
Sabah & Sarawak Y:1 N:0		0.160*	0.116	0.136*
		(0.078)	(0.068)	(0.072)
Age of hotel (logs)			0.032	0.078*
			(0.046)	(0.040)
Part of a chain Y:1 N:0			-0.195*	-0.157**
			(0.105)	(0.061)
Finance major obstacle Y:1 N:0			0.007	-0.010
			(0.123)	(0.097)
Occupancy rate			0.086	0.103
			(0.184)	(0.192)
Number of power outages			0.003	-0.009
			(0.022)	(0.023)
Largest owner is manager Y:1 N:0			-0.032	0.022
			(0.058)	(0.051)
Website Y:1 N:0			-0.150*	-0.080
			(0.076)	(0.094)
Low competition Y:1 N:0			0.007	0.014
			(0.037)	(0.058)
Intermediate competition Y:1 N:0			-0.008	0.054
			(0.096)	(0.105)
Two-star hotel Y:1 N:0				-0.106
				(0.062)

Three-star hotel Y:1 N:0				-0.003
				(0.065)
Four- or five-star hotel Y:1 N:0				0.141
				(0.115)
Informal competition Y:1 N:0				0.023
				(0.078)
Time tax (proportion)				-0.136
				(0.132)
Woman top manager Y:1 N:0				0.038
				(0.058)
Diversified Y:1 N:0				-0.049
				(0.061)
Constant	0.465***	0.104	0.075	-0.067
	(0.063)	(0.138)	(0.188)	(0.246)
Number of observations	90	90	90	86
Adjusted R-squared	0.013	0.268	0.322	0.386

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table 6: Use of temporary workers				
Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Temporary workers Y:1 N:0	-0.001	-0.234*	-0.280**	-0.408***
	(0.197)	(0.121)	(0.129)	(0.125)
Volatility in Occupancy	0.080	0.567***	0.541***	0.584***
	(0.056)	(0.124)	(0.127)	(0.110)
Temporary workers Y:1 N:0	0.076	0.253**	0.317**	0.479***
	(0.175)	(0.114)	(0.138)	(0.123)
Volatility in Occupancy*Number of workers (logs)		-0.187***	-0.156***	-0.167***
		(0.046)	(0.043)	(0.035)
Number of workers (logs)		0.119**	0.123**	0.111**
		(0.053)	(0.054)	(0.042)
Central region Y:1 N:0		-0.042	-0.088	-0.050
		(0.044)	(0.058)	(0.110)
Eastern region Y:1 N:0		0.227***	0.253***	0.251**
		(0.067)	(0.072)	(0.090)
Northern region Y:1 N:0		0.018	0.111	0.089
		(0.047)	(0.075)	(0.150)
Sabah & Sarawak Y:1 N:0		0.151*	0.133	0.131
		(0.086)	(0.081)	(0.087)
Age of hotel (logs)			0.027	0.098***
			(0.041)	(0.034)
Part of a chain Y:1 N:0			-0.179*	-0.178*
			(0.092)	(0.094)
Women's ownership (proportion)			0.067	0.199
			(0.121)	(0.156)
Finance major obstacle Y:1 N:0			0.019	0.026
			(0.073)	(0.047)
Occupancy rate			0.308*	0.292*
			(0.153)	(0.169)
Number of power outages			-0.007	-0.024
			(0.019)	(0.023)
Largest owner is manager Y:1 N:0			-0.047	0.002
			(0.051)	(0.056)
Website Y:1 N:0			-0.141*	-0.109
			(0.075)	(0.078)
Low competition Y:1 N:0			0.015	-0.015
			(0.055)	(0.069)
Intermediate competition Y:1 N:0			-0.005	0.033
			(0.102)	(0.100)
Two-star hotel Y:1 N:0				-0.077
				(0.061)

Three-star hotel Y:1 N:0				-0.024
				(0.058)
Four- or five-star hotel Y:1 N:0				0.155
				(0.110)
Informal competition Y:1 N:0				0.084
				(0.055)
Time tax (proportion)				-0.047
				(0.118)
Woman top manager Y:1 N:0				-0.044
				(0.072)
Diversified Y:1 N:0				-0.152***
				(0.049)
Constant	0.423***	0.041	-0.126	-0.261
	(0.067)	(0.142)	(0.230)	(0.230)
Number of observations	87	87	87	83
Adjusted R-squared	0.009	0.306	0.364	0.489

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Appendix

Table A1: Description of variables	
Variable	**Description**
SBM Efficiency	Slack-based input-oriented non-radial pure technical efficiency obtained using the Data Envelopment Analysis (DEA). The methodology is based on the work of Tone (2001). The estimation assumes variable returns to scale and a single output and three inputs. The output is total annual sales of the hotel during the last complete fiscal year. Inputs are total labor cost incurred by the hotel during the last complete fiscal year, total cost of electricity incurred by the hotel during the last complete fiscal year, and total number of rooms at the hotel at the end of the last complete fiscal year. Stata "dea_sbm" program was used to compute the efficiency scores. Higher values of the variable imply that the hotel is closer to the efficiency frontier and therefore more efficient. Source: Authors' own calculations based on data from Enterprise Surveys, World Bank. Data available at: www.etnerprisesurveys.org
Super efficiency	Slack-based input-oriented non-radial pure technical efficiency based on the methodology in Tone (2002). The estimation assumes variable returns to scale and a single output and three inputs. The output is total annual sales of the hotel during the last complete fiscal year. Inputs are total labor cost incurred by the hotel during the last complete fiscal year, total cost of electricity incurred by the hotel during the last complete fiscal year, and total number of rooms at the hotel at the end of the last complete fiscal year. Stata "dea_supersbm" program was used to compute the efficiency scores. Higher values of the variable imply higher efficiency. Source: Authors' own calculations based on data from Enterprise Surveys, World Bank. Data available at: www.etnerprisesurveys.org
BCC efficiency	Input-oriented radial pure technical efficiency obtained using the Data Envelopment Analysis (DEA). The methodology is based on the work

	of Banker et al. (1984). The estimation assumes variable returns to scale and a single output and three inputs. The output is total annual sales of the hotel during the last complete fiscal year. Inputs are total labor cost incurred by the hotel during the last complete fiscal year, total cost of electricity incurred by the hotel during the last complete fiscal year, and total number of rooms at the hotel at the end of the last complete fiscal year. Stata's "dea" program was used to compute the efficiency scores. Higher values of the variable imply that the hotel is closer to the efficiency frontier and therefore more efficient. Source: Authors' own calculations based on data from Enterprise Surveys, World Bank. Data available at: www.etnerprisesurveys.org
Bias corrected efficiency	Bias corrected input-oriented radial pure technical efficiency obtained using the Data Envelopment Analysis (DEA) and based on the work of Simar and Wilson (2007). The estimation assumes variable returns to scale and a single output and three inputs. The bias correction is applied to BCC efficiency as described above and using bootstrapping method. The bootstrapping is done using 2,000 repetitions. The Shephard measure of inefficiency is first obtained. This ranges between 0 and 8. The Shephard measure is normalized so that it ranges between 0 and 1 and higher values imply higher efficiency. The normalization is done using the following formula: 8 minus Bias corrected Shephard inefficiency and divided by 8. Stata's "simarwilson" program was used to compute the efficiency scores. Source: Authors' own calculations based on data from Enterprise Surveys, World Bank. Data available at: www.etnerprisesurveys.org
FDH efficiency	Non-parametric efficiency measure based on the work of Deprins et al. (1984). It is obtained by removing the convexity assumption from the BDD efficiency measure described above. The measure is computed assuming variable returns to scale and input-oriented technology. Stata's "orderalpha" program is used to

	compute the efficiency scores. Inputs and output are the same as in the BCC efficiency or SBM Efficiency described above. Source: Authors' own calculations based on data from Enterprise Surveys, World Bank. Data available at: www.etnerprisesurveys.org
Volatility in Occupancy	Highest occupancy rate for the hotel during the last complete fiscal year minus the lowest occupancy rate of the hotel during the last complete fiscal year and divided by the average occupancy rate of the hotel during the last complete fiscal year. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Volatility in Occupancy 1	Highest occupancy rate for the hotel during the last complete fiscal year minus the lowest occupancy rate of the hotel during the last complete fiscal year and divided by the average of the highest and lowest occupancy rate of the hotel during the last complete fiscal year. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Number of workers (logs)	Log of number of permanent full-time workers employed at the hotel at the end of the last complete fiscal year plus the number of full-time seasonal or temporary workers employed during the last complete fiscal year. Temporary workers is adjusted for the average duration of employment (number of months) worked. Permanent, full-time workers are defined as all workers that work for a term of one or more fiscal years and/or have a guaranteed renewal of their employment and that work a full shift. Full-time seasonal or temporary workers are all short-term, that is for less than a year, workers with no guarantee of renewal of employment and work full-time. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Central region Y:1 N:0	Dummy variable equal to 1 if the hotel is in the Central (sampling) region and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Eastern region Y:1 N:0	Dummy variable equal to 1 if the hotel is in the Eastern (sampling) region and 0 otherwise. Source: Enterprise Surveys, World Bank

	www.enterprisesurveys.org
Northern region Y:1 N:0	Dummy variable equal to 1 if the hotel is in the Northern (sampling) region and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Sabah & Sarawak Y:1 N:0	Dummy variable equal to 1 if the hotel is in the Sabah & Sarawak (sampling) region and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Southern region Y:1 N:0	Dummy variable equal to 1 if the hotel is in the Southern (sampling) region and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Age of hotel (logs)	Log of age of the hotel. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Part of a chain Y:1 N:0	Dummy variable equal to 1 if the hotel is part of a chain or network and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Women's ownership (proportion)	Proportion of the hotel that is owned by women. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Finance major obstacle Y:1 N:0	Dummy variable equal to 1 if the hotel reports access to finance as a major or very severe obstacle and 0 if it reports no obstacle, minor obstacle, or moderate obstacle. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Occupancy rate	Average occupancy rate of the hotel during the last complete fiscal year. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Number of power outages	Number of power outages experienced by the hotel in a typical month over the last complete fiscal year. The variable equals 0 if there was no power outage. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Largest owner is manager Y:1 N:0	Dummy variable equal to 1 if the largest owner of the hotel is also the top manager of the hotel and 0 otherwise.

	Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Website Y:1 N:0	Dummy variable equal to 1 if the hotel has a website or social media page and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Low competition Y:1 N:0	Dummy variable equal to 1 if the number of competitors of the hotel is between 0 and 10 and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Intermediate competition Y:1 N:0	Dummy variable equal to 1 if the number of competitors of the hotel is between 11 and 50 and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
High competition Y:1 N:0	Dummy variable equal to 1 if the number of competitors of the hotel is between is more than 50 of "too many to count" as reported by the hotel and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
One-star hotel Y:1 N:0	Dummy variable equal to 1 if the star rating of the hotel at the end of the last complete fiscal year is One star and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Two-star hotel Y:1 N:0	Dummy variable equal to 1 if the star rating of the hotel at the end of the last complete fiscal year is Two star and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Three-star hotel Y:1 N:0	Dummy variable equal to 1 if the star rating of the hotel at the end of the last complete fiscal year is Three star and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Four- or five-star hotel Y:1 N:0	Dummy variable equal to 1 if the star rating of the hotel at the end of the last complete fiscal year is Four or Five star and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Informal competition Y:1 N:0	Dummy variable equal to 1 if the hotel competes against unregistered or informal hotels and 0 otherwise. Source: Enterprise Surveys, World Bank

	www.enterprisesurveys.org
Time tax (proportion)	Proportion of the hotel's senior management's time that is spent dealing with requirements imposed by government regulations. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Woman top manager Y:1 N:0	Dummy variable equal to 1 if the top manager of the hotel is a woman and 0 otherwise. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Diversified Y:1 N:0	Dummy variable equal to 1 if the percentage of its total sales that comes from its main product or service is less than 100 percent and 0 otherwise. Sales here are for the last complete fiscal year. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Temporary workers Y:1 N:0	Dummy variable equal to 1 if the hotel used full-time seasonal or temporary workers at any time during the last complete fiscal year and 0 otherwise. Full-time seasonal or temporary workers are all short-term, that is for less than a year, workers with no guarantee of renewal of employment and work full-time. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org
Number of rooms (logs)	Log of the total number of rooms at the hotel at the end of the last complete fiscal year. Source: Enterprise Surveys, World Bank www.enterprisesurveys.org

Table A2: Summary statistics					
	Mean	**Standard**	**Minimum**	**Maximum**	**Observations**
SBM Efficiency	0.509	0.213	0.135	1	90
Super efficiency	0.530	0.322	0.135	3.972	90
BCC efficiency	0.59	0.217	0.16	1	90
FDH efficiency	0.849	0.165	0.25	1	90
Bias corrected efficiency	0.705	0.116	0.089	0.848	90
Scale efficiency	0.569	0.252	0.053	1	90
Volatility in Occupancy	0.807	0.489	0.143	3.68	90
Volatility in Occupancy 1	0.222	0.122	0.038	0.5	90
Number of workers (logs)	2.578	1.006	1.609	6.215	90
Number of rooms (logs)	3.925	0.78	2.565	6.936	90
Central region Y:1 N:0	0.384	0.489	0	1	90
Eastern region Y:1 N:0	0.148	0.357	0	1	90
Northern region Y:1 N:0	0.094	0.293	0	1	90
Sabah & Sarawak Y:1 N:0	0.167	0.375	0	1	90
Southern region Y:1 N:0	0.207	0.407	0	1	90
Age of firm (logs)	2.148	0.694	0	3.761	90
Part of a chain Y:1 N:0	0.095	0.295	0	1	90
Women's ownership (proportion)	0.081	0.178	0	1	90
Finance major obstacle Y:1 N:0	0.079	0.271	0	1	90
Occupancy rate	0.626	0.171	0.1	1	90
Number of power outages	0.341	1.339	0	15	90
Largest owner is manager Y:1 N:0	0.84	0.368	0	1	90
Website Y:1 N:0	0.613	0.49	0	1	90
Low competition Y:1 N:0	0.235	0.427	0	1	90
Intermediate competition Y:1 N:0	0.034	0.182	0	1	90
Two-star hotel Y:1 N:0	0.381	0.488	0	1	90
Three-star hotel Y:1 N:0	0.168	0.376	0	1	90
Four- or five-star hotel Y:1 N:0	0.048	0.215	0	1	90
Informal competition Y:1 N:0	0.373	0.486	0	1	88
Time tax (proportion)	0.088	0.178	0	1	88
Woman top manager Y:1 N:0	0.323	0.47	0	1	90
Diversified Y:1 N:0	0.481	0.502	0	1	90
Temporary workers Y:1 N:0	0.279	0.451	0	1	87

Table A3: Linear relationship				
Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy	0.064	0.035	0.055	0.059
	(0.056)	(0.077)	(0.039)	(0.055)
Central region Y:1 N:0		0.043	-0.006	0.003
		(0.056)	(0.064)	(0.098)
Eastern region Y:1 N:0		0.205***	0.212***	0.147
		(0.061)	(0.053)	(0.091)
Northern region Y:1 N:0		0.044***	0.146*	-0.028
		(0.015)	(0.084)	(0.158)
Sabah & Sarawak Y:1 N:0		0.127*	0.115	0.088
		(0.072)	(0.070)	(0.082)
Age of hotel (logs)			0.072	0.114
			(0.074)	(0.069)
Part of a chain Y:1 N:0			-0.140	-0.094
			(0.115)	(0.101)
Women's ownership (proportion)			-0.113	-0.204
			(0.121)	(0.222)
Finance major obstacle Y:1 N:0			0.032	0.028
			(0.121)	(0.122)
Occupancy rate			0.229	0.133
			(0.212)	(0.220)
Number of power outages			-0.003	-0.013
			(0.017)	(0.018)
Largest owner is manager Y:1 N:0			-0.054	0.026
			(0.073)	(0.060)
Website Y:1 N:0			-0.164**	-0.133
			(0.069)	(0.085)
Low competition Y:1 N:0			-0.020	-0.003
			(0.052)	(0.067)
Intermediate competition Y:1 N:0			-0.004	0.047
			(0.113)	(0.123)
Two-star hotel Y:1 N:0				-0.066
				(0.077)
Three-star hotel Y:1 N:0				0.008
				(0.071)
Four- or five-star hotel Y:1 N:0				0.070
				(0.103)
Informal competition Y:1 N:0				0.051
				(0.081)
Time tax (proportion)				0.019
				(0.154)

Woman top manager Y:1 N:0				0.069
				(0.067)
Diversified Y:1 N:0				-0.039
				(0.064)
Constant	0.457***	0.408***	0.275	0.172
	(0.059)	(0.044)	(0.213)	(0.243)
Number of observations	90	90	90	86
Adjusted R-squared	0.011	0.067	0.175	0.197

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A4: Super efficiency				
Dependent variable: Super efficiency (Slack-based)	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers (logs)	-0.207*** (0.068)	-0.240*** (0.073)	-0.233*** (0.078)	-0.270*** (0.085)
Volatility in Occupancy	0.577***	0.640***	0.638***	0.783***
	(0.164)	(0.176)	(0.200)	(0.231)
Number of workers (logs)	0.181**	0.203**	0.240**	0.209**
	(0.081)	(0.090)	(0.091)	(0.096)
Central region Y:1 N:0		-0.052	-0.099	0.025
		(0.067)	(0.080)	(0.096)
Eastern region Y:1 N:0		0.217***	0.217**	0.262***
		(0.067)	(0.088)	(0.090)
Northern region Y:1 N:0		-0.088	-0.103	-0.096
		(0.099)	(0.177)	(0.192)
Sabah & Sarawak Y:1 N:0		0.078	0.036	0.072
		(0.097)	(0.102)	(0.114)
Age of hotel (logs)			-0.021	0.023
			(0.061)	(0.039)
Part of a chain Y:1 N:0			-0.035	0.013
			(0.178)	(0.171)
Women's ownership (proportion)			-0.098	-0.062
			(0.171)	(0.264)
Finance major obstacle Y:1 N:0			-0.014	-0.049
			(0.133)	(0.102)
Occupancy rate			0.135	0.141
			(0.263)	(0.335)
Number of power outages			0.014	-0.002
			(0.032)	(0.033)
Largest owner is manager Y:1 N:0			-0.105	-0.045
			(0.094)	(0.074)
Website Y:1 N:0			-0.177*	-0.083
			(0.099)	(0.112)
Low competition Y:1 N:0			0.034	0.010
			(0.055)	(0.118)
Intermediate competition Y:1 N:0			0.032	0.074
			(0.118)	(0.099)
Two-star hotel Y:1 N:0				-0.104
				(0.071)
Three-star hotel Y:1 N:0				0.027
				(0.075)
Four- or five-star hotel Y:1 N:0				0.322
				(0.245)

Informal competition Y:1 N:0				-0.042
				(0.106)
Time tax (proportion)				-0.150
				(0.194)
Woman top manager Y:1 N:0				0.049
				(0.069)
Diversified Y:1 N:0				-0.093
				(0.141)
Constant	0.009	-0.048	0.025	-0.131
	(0.191)	(0.182)	(0.267)	(0.332)
Number of observations	90	90	90	86
Adjusted R-squared	0.095	0.147	0.111	0.112

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A5: Super efficiency (with outliers excluded from the sample)				
Dependent variable: Super efficiency (Slack-based)	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers (logs)	-0.155**	-0.178***	-0.140**	-0.164**
	(0.058)	(0.062)	(0.057)	(0.063)
Volatility in Occupancy	0.461***	0.484***	0.406***	0.495**
	(0.148)	(0.140)	(0.140)	(0.190)
Number of workers (logs)	0.104	0.112	0.117	0.110
	(0.071)	(0.080)	(0.081)	(0.083)
Central region Y:1 N:0		0.017	-0.025	0.044
		(0.028)	(0.046)	(0.089)
Eastern region Y:1 N:0		0.238***	0.268***	0.278***
		(0.045)	(0.046)	(0.065)
Northern region Y:1 N:0		0.024	0.130	0.063
		(0.052)	(0.080)	(0.136)
Sabah & Sarawak Y:1 N:0		0.156**	0.133*	0.152*
		(0.074)	(0.076)	(0.080)
Age of hotel (logs)			0.043	0.081*
			(0.053)	(0.045)
Part of a chain Y:1 N:0			-0.218*	-0.148*
			(0.122)	(0.082)
Women's ownership (proportion)			-0.071	-0.106
			(0.141)	(0.202)
Finance major obstacle Y:1 N:0			-0.009	-0.023
			(0.119)	(0.104)
Occupancy rate			0.119	0.102
			(0.192)	(0.216)
Number of power outages			-0.016	-0.021
			(0.021)	(0.024)
Largest owner is manager Y:1 N:0			-0.047	0.017
			(0.060)	(0.068)
Website Y:1 N:0			-0.131	-0.055
			(0.081)	(0.104)
Low competition Y:1 N:0			0.001	0.008
			(0.043)	(0.069)
Intermediate competition Y:1 N:0			-0.018	0.021
			(0.087)	(0.105)
Two-star hotel Y:1 N:0				-0.108
				(0.072)
Three-star hotel Y:1 N:0				0.024
				(0.065)
Four- or five-star hotel Y:1 N:0				0.084
				(0.122)

Informal competition Y:1 N:0				0.018
				(0.098)
Time tax (proportion)				-0.150
				(0.148)
Woman top manager Y:1 N:0				0.022
				(0.068)
Diversified Y:1 N:0				-0.061
				(0.077)
Constant	0.180	0.118	0.081	-0.070
	(0.179)	(0.184)	(0.224)	(0.313)
Number of observations	86	86	86	83
Adjusted R-squared	0.116	0.221	0.264	0.290

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A6: BCC model (VRS)				
Dependent variable: BCC (VRS) efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers (logs)	-0.165***	-0.182***	-0.159***	-0.175***
	(0.048)	(0.048)	(0.049)	(0.057)
Volatility in Occupancy	0.510***	0.519***	0.478***	0.539***
	(0.112)	(0.104)	(0.114)	(0.165)
Number of workers (logs)	0.093	0.099	0.098	0.078
	(0.060)	(0.062)	(0.070)	(0.078)
Central region Y:1 N:0		0.040	0.011	0.103
		(0.029)	(0.041)	(0.077)
Eastern region Y:1 N:0		0.202***	0.220***	0.216***
		(0.039)	(0.045)	(0.071)
Northern region Y:1 N:0		0.006	0.060	0.023
		(0.038)	(0.058)	(0.103)
Sabah & Sarawak Y:1 N:0		0.135*	0.105	0.143*
		(0.077)	(0.072)	(0.070)
Age of hotel (logs)			0.028	0.072
			(0.050)	(0.043)
Part of a chain Y:1 N:0			-0.116	-0.056
			(0.105)	(0.071)
Women's ownership (proportion)			0.023	0.010
			(0.169)	(0.206)
Finance major obstacle Y:1 N:0			0.060	0.046
			(0.122)	(0.115)
Occupancy rate			0.190	0.144
			(0.161)	(0.172)
Number of power outages			-0.006	-0.015
			(0.021)	(0.022)
Largest owner is manager Y:1 N:0			-0.112*	-0.055
			(0.056)	(0.053)
Website Y:1 N:0			-0.132	-0.069
			(0.085)	(0.107)
Low competition Y:1 N:0			0.020	0.007
			(0.038)	(0.059)
Intermediate competition Y:1 N:0			0.037	0.048
			(0.090)	(0.101)
Two-star hotel Y:1 N:0				-0.078
				(0.063)
Three-star hotel Y:1 N:0				0.051
				(0.059)
Four- or five-star hotel Y:1 N:0				0.141
				(0.105)

Informal competition Y:1 N:0				-0.001
				(0.094)
Time tax (proportion)				0.052
				(0.111)
Woman top manager Y:1 N:0				0.021
				(0.067)
Diversified Y:1 N:0				-0.062
				(0.070)
Constant	0.267*	0.209	0.205	0.073
	(0.149)	(0.144)	(0.192)	(0.275)
Number of observations	90	90	90	86
Adjusted R-squared	0.194	0.264	0.298	0.334

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A7: Bias corrected efficiency				
Dependent variable: Bias corrected efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers (logs)	-0.069**	-0.076***	-0.069**	-0.079**
	(0.025)	(0.024)	(0.025)	(0.029)
Volatility in Occupancy	0.187***	0.193***	0.184***	0.211**
	(0.053)	(0.052)	(0.055)	(0.082)
Number of workers (logs)	0.005	0.009	0.013	0.009
	(0.031)	(0.030)	(0.034)	(0.040)
Central region Y:1 N:0		0.012	0.005	0.067*
		(0.021)	(0.024)	(0.036)
Eastern region Y:1 N:0		0.044*	0.052	0.057
		(0.025)	(0.033)	(0.047)
Northern region Y:1 N:0		-0.030	-0.007	-0.014
		(0.019)	(0.032)	(0.047)
Sabah & Sarawak Y:1 N:0		0.058*	0.051	0.070*
		(0.031)	(0.034)	(0.034)
Age of hotel (logs)			0.002	0.023
			(0.023)	(0.022)
Part of a chain Y:1 N:0			-0.042	-0.010
			(0.051)	(0.043)
Women's ownership (proportion)			0.001	0.029
			(0.108)	(0.122)
Finance major obstacle Y:1 N:0			0.028	0.024
			(0.057)	(0.055)
Occupancy rate			0.102	0.029
			(0.075)	(0.090)
Number of power outages			-0.002	-0.004
			(0.011)	(0.011)
Largest owner is manager Y:1 N:0			-0.033	0.002
			(0.029)	(0.032)
Website Y:1 N:0			-0.054	-0.024
			(0.038)	(0.050)
Low competition Y:1 N:0			0.016	-0.014
			(0.020)	(0.024)
Intermediate competition Y:1 N:0			0.049	0.026
			(0.050)	(0.056)
Two-star hotel Y:1 N:0				-0.013
				(0.026)
Three-star hotel Y:1 N:0				0.040
				(0.030)
Four- or five-star hotel Y:1 N:0				0.101
				(0.065)
Informal competition Y:1 N:0				-0.008

				(0.047)
Time tax (proportion)				0.060
				(0.054)
Woman top manager Y:1 N:0				-0.009
				(0.039)
Diversified Y:1 N:0				-0.066
				(0.043)
Constant	0.677***	0.658***	0.633***	0.593***
	(0.071)	(0.070)	(0.087)	(0.139)
Number of observations	90	90	90	86
Adjusted R2	0.226	0.238	0.207	0.227

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A8: Free Disposal Hull (FDH) efficiency				
Dependent variable: Free Disposal Hull efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of	-0.107***	-0.121***	-0.096**	-0.102**
workers (logs)	(0.028)	(0.033)	(0.036)	(0.038)
Volatility in Occupancy	0.345***	0.377***	0.361***	0.310***
	(0.085)	(0.093)	(0.096)	(0.107)
Number of workers (logs)	0.097***	0.098***	0.073**	0.115***
	(0.032)	(0.030)	(0.034)	(0.039)
Central region Y:1 N:0		-0.055	0.014	0.098
		(0.063)	(0.042)	(0.062)
Eastern region Y:1 N:0		0.045	0.094	0.082
		(0.083)	(0.072)	(0.068)
Northern region Y:1 N:0		0.034	0.164*	0.180*
		(0.064)	(0.081)	(0.094)
Sabah & Sarawak Y:1 N:0		0.043	0.106	0.139*
		(0.078)	(0.063)	(0.074)
Age of hotel (logs)			-0.003	0.034
			(0.037)	(0.037)
Part of a chain Y:1 N:0			-0.102	-0.116
			(0.070)	(0.078)
Women's ownership (proportion)			0.147	0.250**
			(0.122)	(0.104)
Finance major obstacle Y:1 N:0			0.007	0.031
			(0.050)	(0.056)
Occupancy rate			0.463***	0.226
			(0.137)	(0.144)
Number of power outages			0.007	0.006
			(0.007)	(0.008)
Largest owner is manager Y:1 N:0			-0.019	-0.008
			(0.046)	(0.053)
Website Y:1 N:0			-0.036	-0.054
			(0.048)	(0.057)
Low competition Y:1 N:0			-0.036	-0.121**
			(0.041)	(0.049)
Intermediate competition Y:1 N:0			0.064	0.027
			(0.088)	(0.099)
Two-star hotel Y:1 N:0				-0.012
				(0.054)
Three-star hotel Y:1 N:0				-0.104*
				(0.053)
Four- or five-star hotel Y:1 N:0				0.041
				(0.083)

Informal competition Y:1 N:0				0.075*
				(0.038)
Time tax (proportion)				0.240**
				(0.112)
Woman top manager Y:1 N:0				-0.067
				(0.042)
Diversified Y:1 N:0				-0.158***
				(0.049)
Constant	0.535***	0.536***	0.264*	0.326*
	(0.125)	(0.094)	(0.134)	(0.158)
Number of observations	90	90	90	86
Adjusted R-squared	0.133	0.162	0.218	0.359

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A9: Alternative measure of volatility in occupancy				
Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy 1* Number of workers (logs)	-0.645***	-0.781***	-0.670***	-0.783***
	(0.223)	(0.227)	(0.205)	(0.193)
Volatility in Occupancy 1	1.889***	2.086***	1.911***	2.245***
	(0.519)	(0.500)	(0.533)	(0.586)
Number of workers (logs)	0.118*	0.134*	0.147**	0.134*
	(0.061)	(0.067)	(0.069)	(0.065)
Central region Y:1 N:0		0.007	-0.035	0.036
		(0.019)	(0.040)	(0.074)
Eastern region Y:1 N:0		0.214***	0.220***	0.239***
		(0.044)	(0.054)	(0.070)
Northern region Y:1 N:0		-0.016	0.063	0.014
		(0.043)	(0.061)	(0.114)
Sabah & Sarawak Y:1 N:0		0.141**	0.119*	0.153**
		(0.066)	(0.062)	(0.066)
Age of hotel (logs)			0.024	0.066*
			(0.048)	(0.038)
Part of a chain Y:1 N:0			-0.151	-0.095
			(0.106)	(0.062)
Women's ownership (proportion)			-0.074	-0.091
			(0.126)	(0.192)
Finance major obstacle Y:1 N:0			0.017	-0.000
			(0.119)	(0.100)
Occupancy rate			0.171	0.173
			(0.165)	(0.198)
Number of power outages			0.004	-0.005
			(0.021)	(0.025)
Largest owner is manager Y:1 N:0			-0.049	0.005
			(0.051)	(0.050)
Website Y:1 N:0			-0.147*	-0.074
			(0.084)	(0.094)
Low competition Y:1 N:0			0.017	0.028
			(0.040)	(0.066)
Intermediate competition Y:1 N:0			-0.011	0.042
			(0.102)	(0.106)
Two-star hotel Y:1 N:0				-0.109*
				(0.062)
Three-star hotel Y:1 N:0				0.016
				(0.054)
Four- or five-star hotel Y:1 N:0				0.107

				(0.108)
Informal competition Y:1 N:0				-0.007
				(0.086)
Time tax (proportion)				-0.127
				(0.108)
Woman top manager Y:1 N:0				0.028
				(0.064)
Diversified Y:1 N:0				-0.036
				(0.067)
Constant	0.132	0.064	0.008	-0.141
	(0.144)	(0.153)	(0.226)	(0.270)
Number of observations	90	90	90	86
Adjusted R-squared	0.148	0.262	0.308	0.362

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A10: Tobit estimation				
Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers (logs)	-0.147**	-0.196***	-0.193***	-0.193***
	(0.069)	(0.057)	(0.055)	(0.049)
Volatility in Occupancy	0.388*	0.491***	0.506***	0.576***
	(0.199)	(0.128)	(0.120)	(0.144)
Number of workers (logs)	0.062	0.102	0.176**	0.132**
	(0.089)	(0.071)	(0.080)	(0.066)
Central region Y:1 N:0		-0.002	-0.094	0.038
		(0.047)	(0.066)	(0.081)
Eastern region Y:1 N:0		0.230***	0.207***	0.255***
		(0.068)	(0.077)	(0.082)
Northern region Y:1 N:0		-0.018	-0.053	0.046
		(0.111)	(0.092)	(0.110)
Sabah & Sarawak Y:1 N:0		0.278***	0.151**	0.159**
		(0.067)	(0.060)	(0.076)
Age of hotel (logs)			-0.038*	0.071**
			(0.023)	(0.036)
Part of a chain Y:1 N:0			-0.091	-0.113
			(0.098)	(0.084)
Women's ownership (proportion)			-0.123	-0.103
			(0.132)	(0.185)
Finance major obstacle Y:1 N:0			0.089	-0.019
			(0.108)	(0.075)
Occupancy rate			-0.070	0.130
			(0.203)	(0.169)
Number of power outages			0.001	-0.014
			(0.017)	(0.017)
Largest owner is manager Y:1 N:0			0.009	0.001
			(0.061)	(0.066)
Website Y:1 N:0			-0.157***	-0.068
			(0.047)	(0.068)
Low competition Y:1 N:0			0.030	0.035
			(0.055)	(0.067)
Intermediate competition Y:1 N:0			-0.020	0.042
			(0.055)	(0.087)
Two-star hotel Y:1 N:0				-0.136*
				(0.076)
Three-star hotel Y:1 N:0				0.016
				(0.068)
Four- or five-star hotel Y:1 N:0				0.096
				(0.126)

Informal competition Y:1 N:0				0.005
				(0.070)
Time tax (proportion)				-0.107
				(0.103)
Woman top manager Y:1 N:0				0.021
				(0.059)
Diversified Y:1 N:0				-0.044
				(0.059)
Constant	0.384	0.185	0.250	-0.113
	(0.261)	(0.165)	(0.195)	(0.228)
Number of observations	98	98	98	86
Adjusted R-squared	0.484	2.099	2.961	4.090

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A11: Outlier test based on the slack-based super efficiency measure				
Dependent variable: Super efficiency (Slack-based)	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers	-0.163***	-0.187***	-0.160***	-0.190***
(logs)	(0.053)	(0.055)	(0.052)	(0.056)
Volatility in Occupancy	0.477***	0.506***	0.454***	0.569***
	(0.135)	(0.124)	(0.129)	(0.167)
Number of workers (logs)	0.117*	0.126*	0.143*	0.129*
	(0.064)	(0.070)	(0.073)	(0.074)
Central region Y:1 N:0		0.007	-0.042	0.044
		(0.025)	(0.045)	(0.085)
Eastern region Y:1 N:0		0.227***	0.240***	0.265***
		(0.047)	(0.060)	(0.074)
Northern region Y:1 N:0		0.006	0.075	0.051
		(0.043)	(0.072)	(0.123)
Sabah & Sarawak Y:1 N:0		0.145*	0.111	0.153*
		(0.071)	(0.071)	(0.075)
Age of hotel (logs)			0.027	0.069
			(0.052)	(0.042)
Part of a chain Y:1 N:0			-0.168	-0.115
			(0.119)	(0.070)
Women's ownership (proportion)			-0.074	-0.080
			(0.138)	(0.203)
Finance major obstacle Y:1 N:0			0.002	-0.022
			(0.124)	(0.105)
Occupancy rate			0.120	0.147
			(0.200)	(0.211)
Number of power outages			-0.002	-0.014
			(0.022)	(0.024)
Largest owner is manager Y:1 N:0			-0.053	-0.001
			(0.060)	(0.063)
Website Y:1 N:0			-0.145*	-0.064
			(0.084)	(0.101)
Low competition Y:1 N:0			0.015	0.025
			(0.043)	(0.067)
Intermediate competition Y:1 N:0			-0.005	0.040
			(0.097)	(0.110)
Two-star hotel Y:1 N:0				-0.124*
				(0.068)
Three-star hotel Y:1 N:0				0.023
				(0.063)
Four- or five-star hotel Y:1 N:0				0.115

				(0.122)
Informal competition Y:1 N:0				-0.003
				(0.092)
Time tax (proportion)				-0.114
				(0.143)
Woman top manager Y:1 N:0				0.019
				(0.067)
Diversified Y:1 N:0				-0.045
				(0.071)
Constant	0.151	0.093	0.072	-0.115
	(0.162)	(0.163)	(0.228)	(0.300)
Number of observations	90	90	90	86
Adjusted R-squared	0.132	0.240	0.267	0.322

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A12: Scale efficiency (linear impact)				
Dependent variable: Scale efficiency (SBM)	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy	-0.186**	-0.209***	-0.145***	-0.122**
	(0.066)	(0.059)	(0.044)	(0.050)
Central region Y:1 N:0		0.061	0.221***	0.118
		(0.062)	(0.053)	(0.073)
Eastern region Y:1 N:0		0.084	0.073	0.051
		(0.093)	(0.052)	(0.063)
Northern region Y:1 N:0		0.120*	0.204*	0.247**
		(0.067)	(0.100)	(0.110)
Sabah & Sarawak Y:1 N:0		0.161*	0.260***	0.161**
		(0.079)	(0.055)	(0.077)
Age of hotel (logs)			0.008	-0.084*
			(0.032)	(0.041)
Part of a chain Y:1 N:0			0.061	-0.055
			(0.071)	(0.094)
Women's ownership (proportion)			-0.071	-0.200
			(0.143)	(0.220)
Finance major obstacle Y:1 N:0			0.005	-0.058
			(0.122)	(0.084)
Occupancy rate			0.333*	0.282
			(0.175)	(0.233)
Number of power outages			0.025	0.016
			(0.015)	(0.012)
Largest owner is manager Y:1 N:0			0.104	0.099
			(0.073)	(0.074)
Website Y:1 N:0			0.235***	0.189**
			(0.054)	(0.069)
Low competition Y:1 N:0			-0.087	-0.037
			(0.051)	(0.068)
Intermediate competition Y:1 N:0			-0.045	-0.063
			(0.152)	(0.181)
Two-star hotel Y:1 N:0				0.090**
				(0.039)
Three-star hotel Y:1 N:0				0.219***
				(0.067)
Four- or five-star hotel Y:1 N:0				0.265**
				(0.115)
Informal competition Y:1 N:0				-0.005
				(0.056)
Time tax (proportion)				-0.067
				(0.083)

Woman top manager Y:1 N:0				0.083
				(0.084)
Diversified Y:1 N:0				0.045
				(0.081)
Constant	0.720***	0.664***	0.085	0.292
	(0.062)	(0.039)	(0.134)	(0.188)
Number of observations	90	90	90	86
Adjusted R-squared	0.120	0.121	0.369	0.395

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A13: Scale efficiency (heterogeneity results)				
Dependent variable: Scale efficiency (SBM)	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers (logs)	0.031	0.032	0.032	0.063
	(0.038)	(0.042)	(0.046)	(0.044)
Volatility in Occupancy	-0.205**	-0.219**	-0.195*	-0.310***
	(0.090)	(0.100)	(0.110)	(0.104)
Number of workers (logs)	0.136***	0.137***	0.149***	0.139**
	(0.024)	(0.033)	(0.051)	(0.058)
Central region Y:1 N:0		0.046**	0.128***	0.049
		(0.021)	(0.044)	(0.061)
Eastern region Y:1 N:0		0.041	0.056	-0.003
		(0.045)	(0.036)	(0.058)
Northern region Y:1 N:0		-0.017	0.082	0.083
		(0.058)	(0.078)	(0.075)
Sabah & Sarawak Y:1 N:0		0.042	0.154**	0.087
		(0.080)	(0.069)	(0.051)
Age of hotel (logs)			-0.061	-0.118***
			(0.039)	(0.034)
Part of a chain Y:1 N:0			-0.063	-0.106
			(0.065)	(0.082)
Women's ownership (proportion)			-0.153	-0.245
			(0.120)	(0.185)
Finance major obstacle Y:1 N:0			-0.050	-0.039
			(0.090)	(0.067)
Occupancy rate			0.100	-0.026
			(0.169)	(0.223)
Number of power outages			0.024*	0.025**
			(0.013)	(0.009)
Largest owner is manager Y:1 N:0			0.180**	0.153***
			(0.076)	(0.054)
Website Y:1 N:0			0.122***	0.061
			(0.042)	(0.057)
Low competition Y:1 N:0			-0.091*	-0.093
			(0.045)	(0.056)
Intermediate competition Y:1 N:0			-0.084	-0.128
			(0.075)	(0.083)
Two-star hotel Y:1 N:0				0.129**
				(0.054)
Three-star hotel Y:1 N:0				0.088
				(0.057)
Four- or five-star hotel Y:1 N:0				-0.040
				(0.110)
Informal competition Y:1 N:0				0.024
				(0.057)

Time tax (proportion)				0.096
				(0.107)
Woman top manager Y:1 N:0				0.061
				(0.067)
Diversified Y:1 N:0				-0.003
				(0.060)
Constant	0.322***	0.301***	0.070	0.365*
	(0.071)	(0.081)	(0.129)	(0.189)
Number of observations	90	90	90	86
Adjusted R-squared	0.503	0.488	0.620	0.633

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.

Table A14: All heterogeneities simultaneously				
Dependent variable: SBM Efficiency	**(1)**	**(2)**	**(3)**	**(4)**
Volatility in Occupancy*Number of workers	-0.170***	-0.204***	-0.184***	-0.157**
(logs)	(0.044)	(0.049)	(0.036)	(0.056)
Volatility in Occupancy	0.494***	0.575***	0.584***	0.866***
	(0.124)	(0.123)	(0.113)	(0.212)
Number of workers (logs)	0.126**	0.134**	0.120***	-0.374
	(0.053)	(0.051)	(0.042)	(0.218)
Volatility in Occupancy*Women's ownership	0.191	0.280**	0.273*	0.444*
(proportion)	(0.133)	(0.126)	(0.140)	(0.243)
Women's ownership (proportion)	-0.298	-0.381**	-0.103	-0.290
	(0.267)	(0.176)	(0.214)	(0.340)
Volatility in Occupancy*Temporary workers	0.051	-0.202*	-0.367***	-0.371**
Y:1 N:0	(0.116)	(0.108)	(0.117)	(0.142)
Temporary workers Y:1 N:0	0.036	0.216**	0.437***	0.324*
	(0.126)	(0.100)	(0.120)	(0.171)
Central region Y:1 N:0		-0.024	-0.039	-0.005
		(0.039)	(0.111)	(0.108)
Eastern region Y:1 N:0		0.241***	0.256**	0.255***
		(0.057)	(0.091)	(0.087)
Northern region Y:1 N:0		0.037	0.096	0.141
		(0.048)	(0.152)	(0.130)
Sabah & Sarawak Y:1 N:0		0.176*	0.142	0.187*
		(0.094)	(0.089)	(0.090)
Age of hotel (logs)			0.102***	0.088
			(0.034)	(0.061)
Part of a chain Y:1 N:0			-0.199**	-0.338***
			(0.095)	(0.114)
Finance major obstacle Y:1 N:0			0.021	0.080
			(0.049)	(0.067)
Occupancy rate			0.267	0.339
			(0.171)	(0.228)
Number of power outages			-0.021	-0.001
			(0.023)	(0.021)
Largest owner is manager Y:1 N:0			0.011	0.012
			(0.051)	(0.046)
Website Y:1 N:0			-0.101	-0.110
			(0.079)	(0.085)
Low competition Y:1 N:0			-0.029	-0.019
			(0.067)	(0.132)
Intermediate competition Y:1 N:0			0.031	0.449

			(0.101)	(0.391)
Two-star hotel Y:1 N:0			-0.074	0.176
			(0.060)	(0.107)
Three-star hotel Y:1 N:0			-0.029	0.049
			(0.056)	(0.117)
Four- or five-star hotel Y:1 N:0			0.178	0.062
			(0.111)	(0.204)
Informal competition Y:1 N:0			0.090	0.096
			(0.056)	(0.060)
Time tax (proportion)			-0.072	-0.001
			(0.125)	(0.097)
Woman top manager Y:1 N:0			-0.037	0.102
			(0.072)	(0.118)
Diversified Y:1 N:0			-0.151***	-0.162**
			(0.048)	(0.067)
Volatility in Occupancy*Woman top manager Y:1 N:0				-0.115
				(0.108)
Square of Volatility in Occupancy				-0.117**
				(0.049)
Square of Number of workers (logs)				0.071**
				(0.030)
Volatility in Occupancy*Age of hotel (logs)				-0.007
				(0.083)
Volatility in Occupancy*Part of a chain Y:1 N:0				0.182**
				(0.085)
Volatility in Occupancy*Low competition Y:1 N:0				-0.072
				(0.158)
Volatility in Occupancy*Intermediate competition Y:1 N:0				-0.319
				(0.286)
Volatility in Occupancy*Two-star hotel Y:1 N:0				-0.235**
				(0.098)
Volatility in Occupancy*Three-star hotel Y:1 N:0				-0.066
				(0.153)
Volatility in Occupancy*Four- or five-star hotel Y:1 N:0				0.058
				(0.265)
Constant	0.113	0.030	-0.258	0.285
	(0.168)	(0.134)	(0.223)	(0.405)
Number of observations	87	87	83	83
Adjusted R-squared	0.144	0.309	0.498	0.553

Standard errors in brackets. All standard errors are Huber-White robust and clustered at the Region-Star Rating level.