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Phanin KHRUEATHAI,
Akarapong UNTONG,
Mingsarn KAOSA-ARD,
Renato Andrin VILLANO

MEASURING OPERATION EFFICIENCY OF THAI HOTELS INDUSTRY: EVIDENCE FROM META-FRONTIER ANALYSIS

Abstract

This paper utilizes a unique hotel-level dataset to examine operational efficiency and technology gap in Thailand's hotels. This paper classifies the hotels in Thailand into five groups with distinctive levels of operational technologies. A meta-frontier analysis is applied to evaluate the operational efficiency scores of the hotels in same groups and between groups. The result show that, the hotels in the five groups differ in the use they make of input operational efficiency. Meanwhile, the mean efficiency of the hotels with room rate between 300–900 baht per night and total revenue lower than 1 million baht per year is particularly low. This study suggests to transferring knowledge about operational management from the hotels with higher operational efficiency to the hotels that had low operational efficiency. This might help to improve operational efficiency and competitiveness in long run.

Khrueathai Phanin, Faculty of Management Science, Uttaradit Rajabhat University, Thailand.
Untong Akarapong, Student of Tourism and Environmental Economics, The University of the Balearic Islands, Spain.
Kaosa-ard Mingsarn, Public Policy Studies Institute Chiang Mai University, Thailand.
Villano Renato Andrin, School of Business, Economics and Public Policy, University of New England, Armidale, NSW Australia.

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1. Introduction

The operational efficiency of the hotel industry in Thailand has been extensively analyzed using advanced efficiency methods such as DEA (Data Envelopment Analysis) and SFA (Stochastic Frontier Analysis) (Akarapong, 2004; Mingsarn and Akarapong, 2005; Akarapong and Mingsarn, 2009). However, these methods assume homogenous technology and the same environmental characteristics, making the results not strictly comparable across different groups of hotels (Assaf, Barros and Josiassen, 2009). To assess more accurately the impact of different technologies and environmental characteristics, this study applies the concept of meta-frontier analysis developed by Rao, O'Donnell and Battese (2003) and O'Donnell, Rao and Battese (2007) to estimate the envelope of possible frontiers that might arise from the heterogeneity between groups of hotels.

Moreover, most of previous studies of hotel efficiency focused on the estimation of managerial or operational efficiencies by using a limited data set and restrictive functional form. They also assumed that technologies are similar across hotels and indusial environment. But in fact, the different groups of hotel use a differenct managerial or operation technology. Such as the foreign investment hotels had to use the standard managerial technology from the hotels chain while the local hotels didn't have these and manage the hotel on their own. In order to examine the patterns and differences in performance in these different categories of hotels, the purpose of this paper is to estimate the operational efficiencies of the Thai's hotel industry using Cobb-Douglas functional form, a larger data set and a methodology that would be similar to the hotel environment and technology across different groups of hotels.

The main objective of this study is to use meta-frontier analysis to assess the operating efficiency of five different hotel types in Thailand. There are 1) foreign investment 2) room rate more than 900 baht per night (or more than 30 US$ per night) 3) room rate less than 300 baht per night (or less than 10 US$ per night) 4) room rate between 300–900 baht per night (or between 10–30 US$ per night) and 5) total revenue less than 1 million baht per year (less than 300 thousand US$) and room rate between 300–900 baht per night and total revenue more than 1 million baht per year. The study focuses on the potential of different types of ownership to raise operating efficiency through foreign investment. In addition, the question of whether higher room rates price are more productive than lower rates is analyzed. Greater productivity gains are expected at higher levels of cooperation at large hotels because they should open up a broader range of opportunities to improve operational efficiency.

The paper is organized as follow. Section 2 contains method of analysis, and is followed by the results and discussion in section 3. In section 4, concluding comments are presented.

2. Method of analysis

2.1. Analytical Framework

Operational efficiency is an important factor in managerial business. The estimation of technical efficiency represents to the ability of competitiveness (Hwang and Chang, 2003). Relative efficiency (Farrell, 1957) has been extended and modified to Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Both approaches are popular in the efficiency literature, however; DEA has some restrictions such as inability to take into account error term in the output and stochastic element of production, no assumption about distribution efficiency, No significant test of the technical efficiency (Barros, 2006; Barros and Dieke, 2008). On the other hand, the advantage of the stochastic frontier approach is that it allows for random disturbances, such as the effect of quality of inputs, and measurement errors in the output variables (Barros, 2006; Barros and Dieke, 2008). According to these advantages, this study used the stochastic frontier (SFA) approach with emphasis on the parametric model, and then calculated the efficiency scores for individual hotel units.

2.1.1. Stochastic Frontier Analysis (SFA)

The stochastic frontier framework in this study is a parametric specification of econometric models to estimate the production frontier and measure efficiency scores. The basic stochastic frontier production function is defined as:

$$Y_i = f(X_i, \beta) \exp(\varepsilon_i) \qquad (1)$$

where Y_i is the output of i-th (i = 1, 2, ..., N) firm; X_i is the corresponding matrix of inputs; β is the vector of parameters to be estimated; and ε_i is the error term that consists of two independent elements, V_i and U_i, such that $\varepsilon_i \equiv V_i - U_i$. The V_is are assumed to be symmetric, identically and independently distributed errors that represent random variations in output, as a result of factors outside the control of the decision-making unit, as well as the effects of measurement error in the output variable, variables excluded from the model and statistical noise. They are assumed to be normally distributed with mean zero and variance σ^2_v $[V_i \sim N(0,\sigma_V^2)]$. The U_is are non-negative random variables that represent the stochastic shortfall of outputs from the most efficient production. U_i is defined by truncation of the normal distribution with mean $U_i = \delta_0 + \sum^J_{j=1} \delta_j Z_{ji}$ and variance σ^2_U, where Z_{ji} is the value of the j-th explanatory variable associated with the technical inefficiency effect of firm i; and δ_0 and δ_j are unknown parameters to be estimated (Battese and Coelli, 1995). The maximum likelihood method is used to estimate the parameters of both the stochastic frontier model and the inefficiency effects model. The variance parameter of the likelihood function is estimated in terms of $\sigma^2 \equiv \sigma^2_V + \sigma^2_U$ and $\gamma \equiv \sigma^2_U \diagup \sigma^2$. The technical efficiency of a firm can be defined by the ratio of the observed output to the corresponding stochastic frontier output by

$$TE_i = \frac{Y_i}{f(X_i;\beta)\exp(V_i)} = \exp(U_i). \quad (2)$$

2.1.2. Meta-frontier Approach

The meta-frontier production is a production function that covers individual frontier of groups. A graph of the meta-frontier function is presented in figure 1. Several studies are used to estimate technical efficiency in different regions, environmental, and technologies of agricultural production. To begin with the stochastic meta-frontier framework was done by Battese and Rao (2002), Battese, Rao and O'Donnell (2004), and O'Donnell, Rao and Battese (2008). Then, Villano, Fleming and Fleming (2008) proposed that other studies, such as latent class model (Greene, 2004), and state-contingent frontier (O'Donnell and Griffiths, 2006) still have biased estimators of the parameters of the frontier and technical inefficiency because the results reveal that lack of success in accounting for environmental variables. Therefore, meta-frontier analysis was used to estimate the technology gap ratio and estimate parameters of frontier and technical inefficiencies.

From figure 1, the estimation of the standard stochastic frontier model for R different groups within the industry defined as:

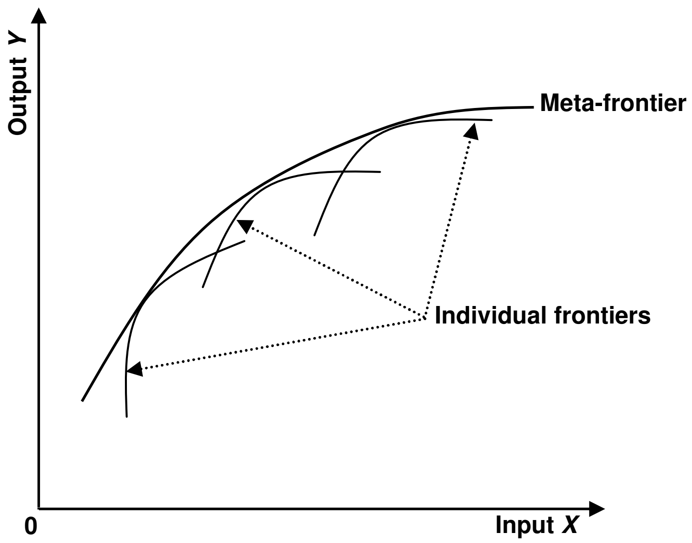
$$Y_{i(j)} = f(X_{i(j)}, \beta_{(j)}) e^{v_{i(j)} - u_{i(j)}} \quad (3)$$

$$i = 1, 2, \ldots, N_j, \quad t = 1, 2, \ldots, T, \quad j = 1, 2, \ldots, R,$$

Suppose that, for the j th group, there are sample date on N_j firms that produce one product from the various inputs.

Figure 1

Meta-frontier and Individual Frontiers



Source: (Battese *et al.*, 2004)

Where $Y_{i(j)}$ is the output for the i th firm for the j th group.

$X_{i(j)}$ is a vector of values of functions of the input used by the i th firm for the j th group.

$\beta_{(j)}$ is the parameter vector associated with the x-variables for the stochastic frontier for the j th group involved.

$v_{i(j)}$ is statistical noise assumed to be independently and identically distributed as $N(0,\delta^2_{v(j)})$ random variables.

$u_{i(j)}$ is non-negative random variables assumed to account for technical inefficiency in production and assumed to be independently distributed as truncations at zero of the $N(\mu_{i(j)},\delta^2_{(j)})$ distribution, where $\mu_{i(j)}$ is some appropriate inefficiency model, defined by Battese and Coelli (1992) and (1995).

In simplified version, the model is presented as:

$$Y_i = f\left(X_i,\beta_{(j)}\right) e^{v_{i(j)}-u_{i(j)}} \equiv e^{X_i\beta_{(j)}+v_{i(j)}-u_{i(j)}} \qquad (4)$$

Assumed that exponent of frontier production function is linear in the parameter vector, $\beta_{(j)}$, so that X_i is a vector of function of the input for the *i* th firm.

The meta-frontier production function model is expressed by

$$Y_i^* = f\left(X_i, \beta^*\right) = e^{X_i \beta^*}, \quad i = 1, 2, \ldots, N. \qquad (5)$$

Where β^* is the vector of parameters for the meta-frontier function such that:

$$X_i\beta^* \geq X_i\beta_{(j)}, \quad j = 1, 2, \ldots, J. \qquad (6)$$

Equation 6, the meta-frontier production function is solved the optimization problem by Battese, Rao and O'Donnell (2004). The optimization problem is defined as:

$$Min\ \beta \sum_{i=1}^{N} \left[\ln f\left(X_i, \beta^*\right) - \ln f\left(X_i, \beta_{(j)}\right) \right]$$

s.t. $$\ln f\left(X_i, \beta^*\right) \geq \ln f\left(X_i, \beta_{(j)}\right) \qquad (7)$$

where $\beta_{(j)}$ is the estimated coefficient vector associated with the group-*j* stochastic frontier

The observed output defined by the stochastic frontier for the *j* th group in equation 4 and it is alternatively expressed in term of the meta-frontier function in equation 5, such that:

$$Y_i = e^{-U_{i(j)}} * \frac{f\left(X_i, \beta_{(j)}\right)}{f\left(X_i, \beta^*\right)} * f\left(X_i, \beta^*\right) e^{V_{i(j)}} \qquad (8)$$

where the first term on the right-hand side of equation 10.6 is the same as technical efficiency relative to stochastic frontier for the *j* th group (Battese, Rao and Prasado, 2002).

$$TE_{i(j)} = \frac{Y_{i(j)}}{f\left(X_{i(j)}, \beta_{(j)}\right) e^{V_{i(j)}}} = e^{-U_{i(j)}} \qquad (9)$$

The second term on the right-hand side of equation 9 is the technology gap ratio (TGR) (Battese, Rao and Prasado, 2002) or the metatechnology ratio (MTRs) (O'Donnell et al, 2007) or environment-technology gap ratio (ETGR) (Villano, Fleming and Fleming, 2008), which is expressed as:

$$TGR = ETGR = \frac{f\left(X_i, \beta_{(j)}\right)}{f\left(X_i, \beta^*\right)} \qquad (10)$$

The TGR or ETGR measure the ratio of the output for the frontier production function for *j* th group relative to the potential output that is defined by the meta-frontier function, given the observed input (Battese, Rao and Prasado,

2002) and (Battese, Rao and O'Donnell, 2004). The TGR or MTR or ETGR has values between zero and one.

The technical efficiency of *i* th firm, relative to the meta-frontier, is denoted by TE_i^*, is defined in a similar way to equation 9, TE_i^* can be expressed as:

$$TE^* = \frac{Y_i}{f\left(X_i, \beta^*\right) e^{v_{i(j)}}} \qquad (11)$$

From equation 11, it is the ratio of the observed output relative to the last term on the right-hand side of equation 6, which is the meta-frontier output, adjusts for the corresponding random error.

Equation 8, 9, 10 and 11 imply that an alternative expression for the technical efficiency relative to the meta-frontier can be expressed by

$$TE^* = \frac{Y_i}{f\left(X_i, \beta^*\right) e^{v_{i(j)}}} = e^{-U_{i(j)}} * \frac{f\left(X_i, \beta_{(j)}\right)}{f\left(X_i, \beta^*\right)}$$

$$TE^* = TE_i * TGR \qquad (12)$$

O'Donnell, Rao and Battese (2008) presented the extensions to the basic meta-frontier framework, such as multiple-output; technological change (Coelli *et al.*, 2005); time-invariant inefficiency effects can be found in (O'Donnell, Rao and Battese, 2008); alternative orientations and identifying groups (Orea and Kumbhakar, 2004) and (O'Donnell and Griffiths, 2006).

2.2. Analytical Framework

2.2.1. The Empirical Model

The stochastic frontier analysis model defined by equation 1 and 2. They were estimated assuming the Cobb-Douglas functional form. The inputs are defined as the number of rooms, room rate per night, number of employees, operational expenses and assets. The output is total revenue. The specification of the functional form is defined by

$$\ln (Y_i)_{(k)} = \beta_{0(k)} + \beta_{1(k)} \ln(X_{1i(k)}) + \beta_{2(k)} \ln(X_{2i(k)}) + \beta_{3(k)} \ln(X_{3i(k)}) + $$
$$+ \beta_{4(k)} \ln(X_{4i(k)}) + \beta_{5(k)} \ln(X_{5i(k)}) + V_{i(k)} + U_{i(k)} \qquad (13)$$

Where Y_i is total revenue (in baht);

X_{1i} is the number of rooms (in room);

X_{2i} is room rate per night (in baht);

X_{3i} is the number of employees (in person);

X_{4i} is operational expenses (in baht);

X_{5i} is assets (in baht);

$\beta_0 - \beta_5$ are unknown parameters to be estimated;

k is 5 groups of the hotel groups.

The $V_{i(k)}$ are assumed to be independently and identically distributed with mean zero and variance, $\sigma_{Vi(k)}^2$; and the us are technical efficiency effects that are assumed to be half-normal and independently distributed such that $U_{i(k)}$ is defined by the truncation at zero of the normal distribution with known variance, $\sigma_{Ui(k)}^2$.

The inputs are implied inputs in that they are measured as costs, assuming all groups faced the same input prices and no changes occurred in input prices during the period when the survey was undertaken. Similarly, outputs are implied outputs in that they are measured as revenue assuming all groups faced the same output prices.

The technical inefficiency model is defined following Battese and Coelli (1995) as:

$$U_{i(k)} = \delta_{0(k)} + \delta_{1(k)} Z_{1i(k)} + \delta_{2(k)} Z_{2i(k)} + \delta_3 Z_{3i(k)} \qquad (14)$$

Where Z_{1i} is ratio of workers per room;

Z_{2i} is period of operation;

Z_{3i} is ratio of foreign guest;

$\delta_0 - \delta_3$ are unknown parameters to be estimated.

Many variables were tested for inclusion in the inefficiency model. They are discussed in this section and reasons are given for the expected direction of their relations with the level of operational efficiency of hotel industry in Thailand. The coefficient of the ratio of workers per room is expected to be positive because lower number of workers should have lower cost of labour. The other inefficiency variables, the signs on the coefficients of period of operation are expected to be negative because longer period of operation should have accumulated more revenues. Finally, the coefficient of ratio of foreign guest is expected to have a negative sign because a higher number of foreign guests would help the hotels to manage more effectively. If firms can control the quality of service, they can better control service prices.

2.2.2. Variables

The study uses 1,799 samples of hotels and guesthouses from the 2008 Survey Database of the National Statistical Office, Thailand. The statistics for input and output variables in the operating efficiency of hotel are reported in Table 1. We divided the hotels into five groups by considering the impact of different technologies: (foreign investment, room rate more than 900 baht per night, room rate less than 300 baht per night, room rate between 300–900 baht per night and total revenue less than 1 million baht per year and room rate between 300–900 baht per night and total revenue more than 1 million baht per year).

Table 1

Summary Statistics for Data on the hotels of Thailand

Variables	Units	Min	Max	Mean	SD
Total					
• Total revenues	Million baht	0.0098	2,148.69	20.49	97.11
• Total rooms	room	2	760	62	84
• Room rate	baht/night	60	54,893	707	1,816
• Employees	person	1	859	38	89
• Operational expenses	Million baht	0.0044	1,444.70	10.86	62.39
• Assets	Million baht	0.0010	5,493.44	54.14	255.85
1. Foreign investment					
• Total revenues	Million baht	0.22	2,148.69	299.76	422.73
• Total rooms	room	7	734	239	197
• Room rate	baht/night	129	19,086	3,470	3,696
• Employees	person	4	859	246	251
• Operational expenses	Million baht	0.06	1,444.70	173.34	281.58
• Assets	Million baht	0.002	5,493.44	629.93	1,245.27
2. Room rate more than 900 baht per night					
• Total revenues	Million baht	0.10	1,161.35	72,41	126.12
• Total rooms	room	2	760	145	136
• Room rate	baht/night	905	54,893	2,483	4,166
• Employees	person	2	713	135	145
• Operational expenses	Million baht	0.043	956	37.47	85.85
• Assets	Million baht	0.002	2,127.54	172.05	299.71
3. Room rate less than 300 baht per night					
• Total revenues	Million baht	0.010	19.32	0.98	1.43
• Total rooms	room	4	316	29	26
• Room rate	baht/night	60	299	206	56
• Employees	person	1	101	7	8
• Operational expenses	Million baht	0.040	8.75	0.37	0.64
• Assets	Million baht	0.001	219.24	9.74	17.40
4. Room rate between 300–900 baht per night and total revenue less than 1 million baht per year					
• Total revenues	Million baht	0.035	0.99	0.52	0.25
• Total rooms	room	2	72	18	11
• Room rate	baht/night	300	889	415	131

Variables	Units	Min	Max	Mean	SD
• Employees	person	1	16	5	3
• Operational expenses	Million baht	0.0067	1.01	0.22	0.16
• Assets	Million baht	0.0020	68.15	8.42	9.68
5. Room rate between 300–900 baht per night and total revenue more than 1 million baht per year					
• Total revenues	Million baht	1.00	148.43	8.55	14.59
• Total rooms	room	3	456	73	57
• Room rate	baht/night	300	900	493	158
• Employees	person	2	431	34	45
• Operational expenses	Million baht	0.047	56.32	3.91	7.14
• Assets	Million baht	0.001	915.38	31.99	69.38

Source: the National Statistical Office 2009.

2.3. The empirical finding

The stochastic frontier analysis-group and stochastic frontier analysis-pool estimates were obtained using FRONTIER 4.1 (Coelli, 1996) in order to formulate the technical efficiency (TE) effects model (Battese and Coelli, 1995). The stochastic frontier analysis /meta-frontier estimates were obtained using SHAZAM.

2.3.1. Hypothesis Testing

A likelihood-ratio (LR) test, for the group's stochastic frontier model is the same for all the operational efficiency of the hotel industry in Thailand. For testing of the null hypothesis, we can decide that it would be a good reason or not for estimating the efficiency level of firms to a meta-frontier operational function.

Following Battese, Rao and O'Donnell (2004), we test the null hypothesis by calculating LR statistic. The LR statistic is defined by:

$$\lambda = -2\{\ln[L(H_0)/L(H_1)]\} = 2\{\ln[L(H_0)] - \ln[L(H_1)]\} \quad (15)$$

where In $[L(H_0)]$ is the value of the log likelihood function for the stochastic frontier estimated by pooling the data for all groups.

In $[L(H_1)]$ is the sum of the value of the log likelihood function for the 5 groups operational function.

2.3.2. The Estimation of the meta-frontier function

The operational efficiency is computed using three approaches. First, a standard operation stochastic frontier (like production) was employed using pooled cross-section data. Second, group stochastic frontier functions were estimated. Finally, meta-frontier analysis was used given differences in operation environments and technologies between the five groups of hotels studied. The gamma parameters are significant for the five groups, suggesting the presence of operational inefficiency, and the LR test = 134.34, with a *p*-value of 0.00 (using a Chi-square distribution with 52 degrees of freedom). Therefore, the null hypothesis that different groups have the same stochastic frontier models can be rejected. All inputs are associated with total revenues and the high ratio of foreigner guests improves in operation efficiency (Table 2).

The estimates of the parameters of the inefficiency effects model are presented in Table 2. Estimates of the coefficients of the variables explaining differences in group efficiency provide interesting results. First, the coefficient of the variable denoting the ratio of foreign guest is significant at the 1 and 5 per cent level and has both negative and positive coefficients for all groups of hotels. This result indicates that a higher number of foreign guests is ssociated with greater operational efficiency in large hotels (group 1 and 2). It was initially surprising to find that the number of years of operation has a positive association with operational inefficiency in small hotels (group 3 and 4). On the other hand, the longer-operated hotels tend to be more efficient in only large hotels (group 1). Finally, the ratio of workers per room has positive association with operational inefficiency. This result suggests that the higher the number of workers, the lower the level of efficiency in only large hotels (group 1).

Estimated operational efficiencies with respect to the group frontiers and the meta-frontier, together with estimated MTRs, are presented in Table 3. Hotels differ in operational efficiency, MTRs, and the use they make of inputs. The value of MTRs ranges from 0.56 to 0.86, which explains that on average, hotels in Thailand operate between 56–86 percent of the potential total revenue given the technology available to the industry as a whole. As expected, estimated operational efficiencies are lower and dispersed in the meta-frontier model. The average MTR were found to be significantly different for five groups[1]. However, the meta-frontier analysis provides a more consistent and homogenous efficiency comparison. Mean MTRs vary considerably between hotels and across groups whereas mean operational efficiency with respect to the pooled frontier are reasonably similar across groups but differ in the operational efficiency with respect to group frontiers. Hotels with the lowest total revenue and room rate per night have the lowest (Group 4) MTR (0.56) due to a lack of operating technology, few foreigners, and their small size that precludes labour-saving technologies.

[1] We test the sampling distribution of the difference means by using a *t* test. The value of the test statistic is 3.56, which falls in the rejection region, thus, we reject H_0.

Table 2

Estimates for parameters of the stochastic frontier model.

Variables	Group 1	Group 2	Group 3	Group 4	Group 5	Pooled frontier	Meta-frontier
Frontier model							
Constant	5.196*** (0.980)	4.956*** (0.480)	5.327*** (0.382)	8.588*** (0.683)	6.679*** (0.993)	4.994*** (0.118)	5.421
Total rooms (rooms)	0.220 (0.217)	0.192 (0.732)	0.272*** (0.045)	0.076 (0.052)	0.034 (0.213)	0.149*** (0.027)	0.074
Room rate (baht per night)	0.169* (0.128)	0.193*** (0.072)	0.117** (0.066)	-0.140* (0.089)	0.170 (0.366)	0.163*** (0.033)	0.124
Employees (persons)	0.218 (0.227)	0.285*** (0.072)	0.308*** (0.043)	0.410*** (0.059)	0.406* (0.294)	0.403*** (0.014)	0.429
Operational expenses (baht)	0.561*** (0.103)	0.530*** (0.029)	0.504*** (0.025)	0.362*** (0.033)	0.424* (0.218)	0.517*** (0.045)	0.548
Assets (baht)	0.003 (0.023)	0.015** (0.009)	0.004 (0.008)	0.022* (0.017)	0.015 (0.028)	0.008* (0.006)	0.017
Inefficiency effect model							-
Constant	0.968 (0.766)	0.577*** (0.149)	-9.992*** (3.558)	-11.035*** (7.281)	0.090** (0.039)	0.101*** (0.036)	-
Ratio of workers per room (%)	1.115* (0.701)	-0.121 (0.116)	-1.864 (1.198)	-1.254 (1.744)	0.016 (0.113)	0.034 (0.032)	-
Period of operation (day)	-0.127* (0.097)	0.004 (0.004)	0.076*** (0.030)	0.102* (0.069)	0.002 (0.006)	0.0008 (0.0015)	-
Ratio of foreign guest (%)	-0.033* (0.022)	-0.083*** (0.001)	0.014** (0.008)	0.045** (0.026)	0.002** (0.001)	-0.0018*** (0.0004)	-
Variance parameter							-
Sigma-squared	0.895* (0.593)	0.190** (0.017)	2.080*** (0.612)	2.459* (1.545)	0.200*** (0.021)	0.243*** (0.008)	-
Gamma	0.802*** (0.179)	0.302*** (0.083)	0.902*** (0.029)	0.957*** (0.030)	0.00004*** (0.00001)	0.000007*** (0.000003)	-
Log-L	-34.47	-116.19	-494.34	-131.60	-363.38	-1274.32	-

Note : *** denote significance at the 1% level. ** denote significance at the 5% level. * denote significance at the 10% level.
: The numbers in parentheses are standard errors.

Source: Author’s calculation.

Table 3

Estimates of Technical efficiency (TEs) and Technology Gap Ratios (MTRs)

Groups	Min	Max	Mean	SD
Total				
• Pool frontier	0.6464	0.9999	0.9074	0.0473
• Group frontier	0.1742	0.9999	0.8376	0.0995
• Technology gap ratio (MTR)	0.3526	1.0000	0.6417	0.1066
• Meta-frontier	0.1109	0.9966	0.5354	0.1016
1. Foreign investment (group 1)				
• Pool frontier	0.8295	0.9999	0.9722	0.0463
• Group frontier	0.2372	0.9300	0.7822	0.1408
• Technology gap ratio (MTR)	0.6353	1.0000	0.8371	0.0969
• Meta-frontier	0.1660	0.9109	0.6543	0.1379
2. Room rate more than 900 baht per night (group 2)				
• Pool frontier	0.6464	0.9999	0.9381	0.0585
• Group frontier	0.4116	0.9719	0.7634	0.1304
• Technology gap ratio (MTR)	0.5041	1.0000	0.7149	0.0908
• Meta-frontier	0.3554	0.8537	0.5415	0.0966
3. Room rate less than 300 baht per night (group 3)				
• Pool frontier	0.8312	0.9999	0.8952	0.0392
• Group frontier	0.1742	0.9406	0.8208	0.0743
• Technology gap ratio (MTR)	0.4365	0.8621	0.6543	0.0605
• Meta-frontier	0.1109	0.7496	0.5367	0.0671
4. Room rate between 300–900 baht per night and total revenue less than 1 million baht per year (group 4)				
• Pool frontier	0.8490	0.9999	0.9027	0.0370
• Group frontier	0.2109	0.9315	0.7988	0.1106
• Technology gap ratio (MTR)	0.3721	0.9600	0.5620	0.0979
• Meta-frontier	0.1260	0.7977	0.4475	0.0948
5. Room rate between 300–900 baht per night and total revenue more than 1 million baht per year (group 5)				
• Pool frontier	0.7945	0.9999	0.9062	0.0457
• Group frontier	0.7622	0.9999	0.9061	0.0489
• Technology gap ratio (MTR)	0.3526	1.0000	0.6173	0.1169
• Meta-frontier	0.3126	0.9966	0.5592	0.1107

Source: Author's calculation.

In terms of the relationship between efficiency and hotel classification, the efficiency of foreign investment hotels is higher than domestic investment hotels (0.83) and they can earn revenue from the other sources of income, such as entertainment activities, food and beverage. Meanwhile, the MTRs of groups 1, 2, 3 and 5 are lower than group 4, and group 4 has the lowest MTRs. Group 4 has the lowest average MTR ratio hence its average efficiency is reduced from 37.21 percent when compared relative to the frontier within group to 10.66 percent when compared to the meta-frontier.

2.4. Conclusion

This paper has provided some interesting results on the operational efficiency of the hotel industry in Thailand. The meta-frontier analysis is used to develop the traditional frontier analysis because this model enables the calculation of comparable operational efficiency for firms operating under different technologies or locations.

The meat-frontier analysis divides the operational efficiency into two parts: 1) operational efficiency respect to the sub-group; and 2) operational efficiency respect to the meta-frontier by considering the technology gap ratio. Paper shows how group frontier and the meta-frontier can be estimated using a Cobb-Douglas functional form. An empirical example used cross-sectional data of statistics for input and output variables in the operating efficiency of 1,799 hotels. We divide the hotel into five groups.

The finding of the study is that, hotels in the five groups differ in the use they make of input operational efficiency and technology gap ratio (MTRs). Mean MTRs vary substantially between hotels and across groups whereas mean operational efficiency are reasonably similar across groups but differ in the extent of variation among hotels within each group. The mean value of operational efficiency for the pooled frontier, group frontier and meta-frontier models across all groups are 0. 90, 0.83 and 0.53 respectively. Group frontiers show that the mean value of MTR varies from 0.56 in hotels with room rate between 300–900 baht per night and total revenue less than 1 million baht per year to 0.83 in hotels with foreign investment. The low MTR is attributable to a lack of operation management.

The results suggest that transferring knowledge and knowledge management about operation management from higher operational efficiency of hotels to lower operational efficiency of hotels needs to be organized. For example, quality standards from foreign investment would be to improve operational efficiency in small-sized hotels. Furthermore, specific policy initiatives designed to assist hotels groups could be implemented through the difference in technologies. For example, foreign investment hotels should focus on allocate labour efficiency that should be replaced by modern technologies whereas domestic investment hotels or hotels which earn revenue from only one source of income (room rate) could intend to achieve efficiency in asset management. The policies towards small hotels might need to be different from large hotels that enable the government to establish appropriate policies for several types of Thailand hotels.

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