The Demands Prediction and Developmental Potentialities of the Tourism Industry Based on the Grey Forecasting and DEA Models

Thi-Tra-Giang Ta [1*]

Recive 2023,09,02 ***Accept 2023,10,18***

Abstract

In the recent years, tourism industry is growing extremely strong at the almost countries in the world. In this research, the Grey forecasting models (GM(1,1), Grey Verhulst and DGM(1,1)) and DEA models (Mamlquist and super-SBM) were used to predict and analyze the demands and developmental potentialities of the travel field in four next years from 2023 to 2026. Furthermore, these methods were also adopted for forecasting and dissect the data of the decision making units (DMUs), then which DMUs would be known to grow well in the future. Basing on the research models for the analysis and estimation, we obtain that the travel industry is growing at almost countries from 2019 to 2022. However, the activity effect of the travel business is not so high. So operation productivity of business is forecasted more effects and profits of the stage from 2019 to 2022. It contributes significantly in the world economy. Otherwise, from the analysis results, we can know the travel ability and having the efficient solutions for the business activities and development potentialities of tourism industry in the next years. Moreover, this research provides the data sheet for the corporation to study and investigate about the travel field. The development of tourism industry creates the jobs, income for people and contributing generally to the growth of the global economy.

Keywords: *Grey model, tourism industry, DEA, Mamlquist, super-SBM.*

[1]. *Faculty of Industrial Systems, Ha Noi University of Industry, No 298, Cau Dien Street, Bac Tu Liem District, Hanoi City, Vietnam*
(Corresponding author) *

Introduction

Travel and tourism, one of the world's largest industries, outperformed the global economy in 2019 and grew faster than many other notable industries such as manufacturing, financial services, communications and retail. According to the World Travel & Tourism Council's (WTTC) economic research, in 2019, Travel & Tourism grew its total contribution to GDP by 3% to US$6.6 trillion in GDP and increased its number of jobs by five million to 260 million. All countries need to realize that the potential for developing their economies through Travel & Tourism can take place alongside their needs for border security. Concerted action from countries like India, China, the UK, US and Russia would start a domino effect of removing these constraints worldwide. This study focuses on evaluating the efficiency of the biggest global travel companies. It is a crucial part of global economic to help other researchers have information about ranking and whole performance evaluation of companies.

Travel and tourism is an important economic activity in most countries around the world. In addition to the generation of foreign exchange earnings tourism also alleviates the balance of payments problems, creates employment and contributes significantly towards the increase of income, savings, investment and economic growth.

Another contribution of tourism analyses to economics is the impetus provided by tourism to analyses of those areas of overlap between other social sciences and the more narrow concerns of materialistic economics .

Furthermore, in some countries, special tourism taxes have been imposed to raise government revenue. As well as its direct economic impact, the sector has significant indirect and induced impacts.

The tourism industry has emerged as one of the leading service industries in the global economy, as well as in the United States economy in recent decades. Economic flows, generated by international tourism, have become vital factors in economic growth and international economic relations in many countries. The tourism industry is one of the largest industries in the United States. Tourism today has become an important segment of India economy contributing substantially to sustainable development of the country. The tourism industry contributed a total about 124.8 billion U.S. dollars to GDP in India in 2022. This accounted for approximately 6% of India's total GDP. The industry directly provided about 23.5 million jobs in that year.

In 1957, Farrell introduced a nonparametric method to evaluate technical efficiency. His input oriented model is related to the Mahler (1939) inequality, which states that the normalized cost function is less than or equal to the input distance function. Charnes, Cooper and Rhodes (1978) proposed a CCR model based on the Farrell efficiency to measure the overall efficiency.

Data Envelopment Analysis (DEA) is related new "data oriented" approach to evaluate the performance of a group of entities that are called Decision Making Units (DMUs). It converts multi-inputs into multi-outputs. Since DEA model was first introduced in 1978, researchers have quickly recognized that it is an excellent and easily used methodology for performance evaluations. For instance, Zhu (2003) provides a number of DEA spreadsheet models that can be used in performance evaluation and benchmarking.

Grey System theory was initiated in 1982. The theory has become quite popular with its ability to deal with the systems that have partially unknown parameters. As a superiority to conventional statistical models, grey models require only a limited amount of data to estimate the behavior of unknown systems (Deng, 1989). The Grey system theory has been developed rapidly and caught the attention of many researchers. The concept of the grey system theory has been wide and successfully in several fields such as rainfall prediction, industry, business and geological systems studies, environmental studies, decision making, etc.

Methodology

2.1. Super - efficiency model (Super-SBM-Oriented)

Super-SBM that developed on "Slacks-based measure of efficiency" (SBM) [18] is used in this research. In that having n DMUs with the input and output matrices $X = (x_{ij}) \in R^{m\times n}$ and $Y = (y_{ij}) \in R^{s\times n}$, respectively λ is a non-negative vector in R^n. The vectors $S^- \in R^m$ and $S^+ \in R^s$ indicate that the input excess and the output shortfall, respectively.

Let an optimal solution for SBM be$(p^*, \lambda^*, s^{-*}, s^{+*})$. A DMU (x_0, y_0) is SBM-efficient, if$p^* = 1$. This condition is equivalent to $S^{-*} = 0$ and$S^{+*} = 0$, no input excesses and no output shortfalls in any optimal solution. And the SBM return the efficiency result between 0 and 1.

If the DMU (x_0, y_0) is SBM-efficient,$p^* = 1$, super SBM model is as follows:

$$min\,\delta = \frac{\frac{1}{m}\sum_{i=1}^{m}\overline{x_i}/x_{i0}}{\frac{1}{s}\sum_{r=1}^{s}\overline{y_r}/y_{r0}} \qquad (1)$$

Where S. t $\overline{x} \geq \sum_{j=1,\neq 0}^{n}\lambda_j\, x_j,\ \overline{y} \leq \sum_{j=1,\neq 0}^{n}\lambda_j\, x_j,$ $\bar{y} \geq x_0\ and\ \bar{y} \leq y_0, \bar{y}\,\bar{y} \geq y_0,\ \ \lambda \geq 0.$

2.2. Malmquist productivity index

The Malmquist index evaluates the efficiency change of a DMU between two time periods, Malmquist Productivity Index was described by R. Fare in 1994. It is defined as the result of the 'Catch-up' and 'Frontier-shift' terms. The catch-up term has other name is efficiency change because that is related to the amount of effort to improve the efficiency of each DMU. While the frontier-shift term reflects the change in the efficient frontier of a DMU between the two time periods t_1 and t_2.

We now employ the following notation for the efficiency score of the DMU $(x_0, y_o)^{t1}$ measured by the frontier technology t_2:

$\delta^{t2}((x_0, y_0)^{t1})$, ($t_1$=1, 2 and t_2=1, 2)

Using this notation, the 'catch-up' effect can be expressed as:

$$Catch - up = \frac{\delta^{t2}((x_0,y_0)^{t2})}{\delta^{t1}((x_0,y_0)^{t1})} \qquad (2)$$

The frontier- shift effects is expressed as:

$$Frontier - shift = \left[\frac{\delta^{t1}((x_0,y_0)^{t1})}{\delta^{t2}((x_0,y_0)^{t1})} \times \frac{\delta^{t1}((x_0,y_0)^{t2})}{\delta^{t2}((x_0,y_0)^{t2})}\right]^{1/2} \qquad (3)$$

The Malmquist index (MI) is obtained as the product of Catch-up and Frontier-shift, it can be presents as bellows:

Malmquist index = (Catch-up) × (Frontier-shift) = C × F.

This equation of MI can be described as:

$$MI = \left[\frac{\delta^{t1}((x_0,y_0)^{t2})}{\delta^{t1}((x_0,y_0)^{t1})} \times \frac{\delta^{t2}((x_0,y_0)^{t2})}{\delta^{t2}((x_0,y_0)^{t1})}\right]^{1/2} \qquad (4)$$

If MI > 1 that means the progress made in the total factor productivity of the DMU_o from period t_1 to t_2, while MI = 1 and MI < 1 show, the status quo and decay in the total factor productivity.

2.3. Grey system theory

This study applies Grey forecasting models to creating forecasting data and all of these are based on GM (1,1), and all above subjects are called Grey forecasting. The theory of three models GM(1,1), Grey Verhulst and DGM(1,1) has been introduced in some papers

3. Results and discussions

3.1. Collect the DMUs.

The tourism is the second-fastest growing filed globally, with 3.9 percent per annum over the past ten years. According to statistic, the direct and total economic impact of travel and tourism on the global economy from 2019 to 2022. Take a look at this list of the top tourism companies in the world, listed by their prominence with corporate logos when available. This list of major tourism companies includes the largest and most profitable tourism businesses, corporations, agencies, vendors and firms in the world. After doing the survey of travel industry, my study finds out 31 companies which are in the list top 50 travel companies worldwide based on their market share.

3.2. Choose the most suitable Grey forecasting model

The researcher used three Grey forecasting models to study, evaluate and compare the results obtained. Then given the most appropriate prediction model.
As discussed in Chapter 3 of the study, the researcher used three Grey forecasting models to study, evaluate and compare the results obtained. Then given the most appropriate prediction model.
Figure 1 below shows the actual total revenue of DMU12 from 2019 to 2022 with the results obtained by Grey (1,1), Verhulst and DGM (1,1). Looking at the figure, we can see that the results of the DGM model (1,1) are close to the actual situation.

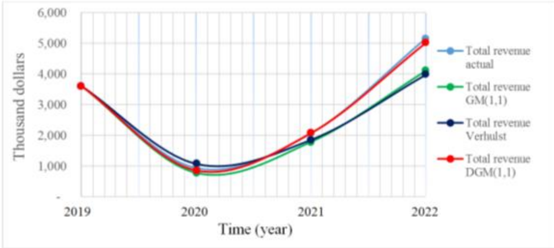
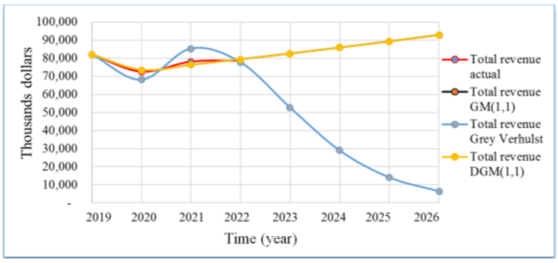


Figure 1. Comparison between Grey models and actual data of DUM12

Figure 2 below shows the from 2019 to 2022 with the results obtained by Grey (1,1), Verhulst and DGM (1,1). Looking at the figure, we can see that the results of the DGM model (1,1) are close to the actual situation. We can see the average MAPE of Verhulst is 174.86009%, it is fail. Because average MAPE less than 10% is considered good. The average MAPE of Grey (1,1) and DGM(1,1) are 5.84092% and 0.084169354%. So, result of DGM (1,1) is the best qualified. Therefore, DGM (1,1) is chosen to be the most appropriate Grey forecasting model to predicting data from 2023 to 2026.

Figure 2. Comparison between Grey models and actual data of DUM12



The Pearson product-moment correlation coefficient (or Pearson correlation coefficient, for short) is a measure of a linear association between two variables and is denoted by *r*. The Pearson correlation coefficient, *r*, can take a range of values from +1 to -1. A value of 0 indicates that there is no association between the two variables. A value greater than 0 indicates a positive association; that is, as the value of one variable increases, so does the value of the other variable. A value less than 0 indicates a negative association; that is, as the value of one variable increases, the value of the other variable decreases.

The formula of the Pearson correlation coefficient (r) is:

The formula of the Pearson correlation coefficient (r) is:

$$r = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{n}}{\sqrt{(\sum X^2 - \frac{(\sum X)^2}{n})(\sum Y^2 - \frac{(\sum Y)^2}{n})}} \quad (5)$$

Table 1. Correlation of input and output data in 2019

	Cost and Expenses	Total Assets	Total stockholder's equity	Total revenues	Operating income	Net income
Cost and Expenses	1	0.707191	0.633652	0.986639	0.838219	0.707767
Total Assets	0.707191	1	0.734145	0.748574	0.827578	0.724185
Total stockholder's equity	0.633652	0.7341454	1	0.687813	0.867971	0.804863
Total revenues	0.986639	0.7485737	0.687813	1	0.890418	0.743579
Operating income	0.838219	0.8275782	0.867971	0.890418	1	0.811193
Net income	0.707767	0.7241851	0.804863	0.743579	0.811193	1

Combining with the following results (Table 1), we can see the results of the respective correlation coefficient score is very high. The linear relationship between input and output factors is strong. Therefore, the researcher chooses the input and output variables at the beginning is appropriate.

3.4. Ranking Super-SBM

Table 2. Scores and rankings of all 31 DMUs from 2019-2022

No.	DMU	2019	2020		2021	2022	No.	DMU	2019	2020	2021	2022
1	DMU1	19	29		29	29	17	DMU17	20	22	19	22
2	DMU2	11	16		4	2	18	DMU18	3	4	6	3
3	DMU3	8	5		8	8	19	DMU19	9	18	18	23
4	DMU4	22	24		26	24	20	DMU20	7	7	9	6
5	DMU5	12	10		10	16	21	DMU21	2	1	1	1
6	DMU6	12	10		10	10	22	DMU22	6	6	2	7
7	DMU7	15	9		20	20	23	DMU23	10	17	15	15
8	DMU8	25	25		25	27	24	DMU24	31	30	30	30
9	DMU9	23	23		28	25	25	DMU25	5	2	7	5
10	DMU10	28	27		22	18	26	DMU26	4	3	3	4
11	DMU11	30	26		24	26	27	DMU27	17	10	27	13
12	DMU12	29	15		10	10	28	DMU28	18	19	17	17
13	DMU13	27	28		23	21	29	DMU29	26	31	31	31
14	DMU14	16	8		5	14	30	DMU30	12	10	10	28
15	DMU15	1	10		10	10	31	DMU31	21	20	21	19
16	DMU16	24	21		16	9						

The researcher used super- SBM to rank of 31 DMUs based on their scores (table 2). Thereby, we can see DMU 21's business performance is the best, it is always in the top 1 or top 2. The score of DMU26 is also very good (in the top 3 or 4). The business operation of DMU18 and DMU25 in period of 2019-2022 is quite good (in the top 7). In this stage, four these DMUs operate well and stable. In the future, they continue to develop if there are the better business strategies. Having the slowest scores are DMU24 and DMU29. Two DMUs usually rank in the last two positions, it means they aren't operating well. Then, to operating well this two DMUs need the effective business strategies and strict management.

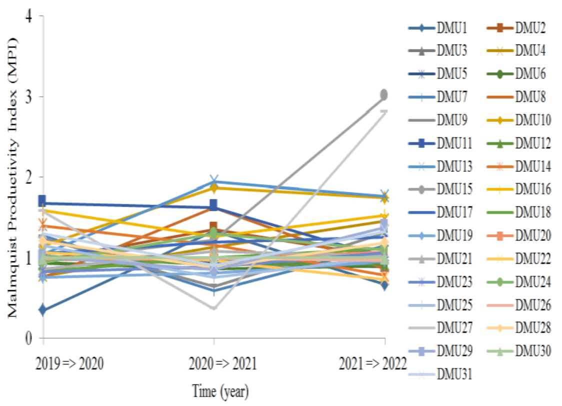
And one group include DMU2, DMU3, DMU14, DMU15 and DMU22 perform at an average performance, which is likely to be more efficient or weak depending on the strategy of the managers.

3.5. Performance Efficiency

The Malmquist Productivity Index (MPI) suggests a convenient way of measuring the productivity change of a given unit between two consequent time periods. This is important parameter for performance evaluation of DMUs. This study applies the Malmquist Productivity Index to assess the productivity changes of the top 31 travel companies in the world.

As shown in Figure 3, we can see an improvement in the productivity of 31 DMUs as to how. In the period from 2019 to 2022, only DMU15 has significant improvement in productivity for four consecutive years. DMU4 also has progress but not as effective as DMU15. The performance of the DMU16 is also quite high in the early stages but then goes back down. Especially DMU11, its productivity has been strongly regressed for 4 consecutive years, it means that the operating of company is not effective.

Figure 3. Productivity index (MPI) change over the period of 2019-2022



After reviewing and analyzing the results above, we have an overview of all 31 DMUs. Most of the DMUs do not have a good performance improvement, there are changes, but they are not too different and not noticeable. This shows that the business activities of these tourism companies are not highly effective in the period from 2019 to 2022. The strategies, policies, management as well as technologies that companies are applying are not really effective. But according to predict in the next time from 2023 to 2026, travel companies are much more efficient, profitable. Therefore, in the future, these travel companies need to offer more optimal solutions for the company to operate more efficiently, contributing to the development of tourism in the world.

Conclusions

This study is performed to rank about evaluation of the largest and most well-known travel companies in the world for the period from 2019 to 2022. At the same time, it predicts the viability of public companies in the period from 2023 to 2026. The operation productivity of business is forecasted more effects and profits of the stage from 2023 to 2026. It contributes significantly in the world economy.

This research shows the main results as following:

Research, investigate and consider important factors effect on the efficiency operation, then apply the data analysis methods to handle these factors, and apply the Grey forecasting models to predict the data of enterprise for the future, which can predict future growth potential of the company.

Super-SBM and Mamlquist productivity index models are combined to rank and analyze the operational performance of company, through the indicators about efficiency change, technology change and productivity index change.

It contributes an important part to measuring the performance of the tourism industry today. Based on this article, managers will show up with the most appropriate strategies for a company to operate more effectively, or the researchers will show up with measures and theories to develop the industry.

References

- C. Lim. (1997). Review of international tourism demand models. *Annals of Tourism Research*, 24(4), 835–849.

- R. Weston. (1983). The ubiquity of room taxes. *Tourism Management*, 4(3): 194-198.
- P.K. Mishra, H.B. Rout and S.S. Mohapatra. (2011). Causality between Tourism and Economic Growth: Empirical Evidence from India. *European Journal of Social Sciences*, 18(4): 518-527.
- E.M. Ekanayake and M. Halkides. (2012). Inbound international tourism to the United States: A panel data analysis. *International journal of management and marketing research*, 5(3): 15-27.
- Y. Chen and J Zhu. (2003). DEA Models for Identifying Critical Performance Measures. *Ann Oper Res*, 124(1-4): 225-244.
- E. Kayacan, O. Kaynak and B. Ulutas. (2010). Grey system theory- based models in time series prediction. *Expert Systems with Application*, Vol. 37, pp. 1784-1789.
- J. Lan and H. Cheng. (1999). The grey system and prediction of geological and mineral resources. *Mathematical Geology*, Vol.24, No. 6, pp. 653-662.
- Y. H. Lin, C. C. Chiu, Y. J. Lin and P. C. Lee. (2013). Rainfall prediction using innovative grey model with the dynamic index. *Journal of Marine Science Technology*, Vol. 21, No. 1, pp. 63-75.
- Y.Luo and X. Che. (2013). Improvement and application of initial value of non-equidistant GM (1,1) Model. *International Journal of Computer Science Issues*, Vol. 10, No. 2, pp. 113-118.
- A.Mohammadi, L. Moradi, A. Talebnejad and A. Nadaf. (2011). The use of grey system theory in predicting the road traffic accident in Fars province in Iran. *Australian Journal of Business Management Research*, Vol. 9, pp. 18-23.
- R. Fare, S. Grosskopf, M. Norris and Z. Y. Zhang. (1994). Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries. *The American Economic Review*, pp 66-83.
- J. Zhu. (2014). Quantitative Models for Performance Evaluation and Benchmarking,Data Envelopment Analysis with Spreadsheets. *Third edition*, vol. 213.
- W. Niu, Z. Zhai, G. Wang, J. Cheng and Y. Guo. (2011). Adaptive multivariable grey prediction model. *Journal of Information Computer Science*, Vol. 8, No. 10, pp. 1801-1808.
- Miencha Haron, J. A. Arul Chellakumar.(2012).Efficiency Performance of Manufacturing Companies in Kenya: Evaluation and Policies. *International Journal of Management and Business Research,* Vol. 2, Issue 3, Pages 233-242 (2012).
- Shallu Sehgal, Suparn Kumar Sharma. (2011). Total Factor Productivity of Manufacturing Sector in India: A Regional Analysis for the State of Haryana. *International Journal of Management and Business Research*, Vol. 1, Issue 4, Pages 241-256.