

Application of DEA Model to Evaluate the Performance of Logistics Enterprises in Vietnam

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Abstract—*Nowadays, logistics has become one of the most important economic sectors in Vietnam. The objective of this paper is to evaluate the operation performance of thirteen logistics and transport companies. The slack based model and Malmquist productivity index in Data envelopment analysis are implemented to rank and evaluate the average efficiency change from the period of 2014 to 2017. The empirical results show that almost DMUs growth in productivity change based on technical efficiency change and not to change in technology. Thus, Vietnam logistics industry needs to improve more in technology to reach their business efficiency.*

Keywords— *Malmquist productivity index; Slack based model; Data envelopment analysis; Logistics.*

I. INTRODUCTION

Logistics service sector is one of the top growing and stable of Vietnam in recent years. The good performance of the logistics sector accounts for 15-20% of GDP in Vietnam [1]. According to the World bank's 2018 logistics performance index, Vietnam ranking 39th among 160 countries. Thus, logistics performance is particularly important for Vietnam economy. However, high cost and poor synchronization are problems to the Vietnam logistic industry which affects to Vietnam's competitiveness and potentially worsening the economy [2]. Moreover, most of the Vietnam logistics networks lack integration and operate on small scale without the use of modern equipment or systems [3]. According to [4] good performance, logistics can play an important role in reducing cost of doing business, aiming at strengthening Vietnam trade competitiveness. Thereby, in order to reduce costs and improve the competitiveness of the logistics sector. Vietnam logistics industry needs to be changed to meet the development needs of the market and the economy. Thus, evaluating the performance of Vietnam's logistics companies is very important to help investors and policy makers have an overview about reality of Vietnam logistics industry. In the context of evaluating logistics performance, performance measurement includes not only the internal procedures but also requires an understanding of the performance of other member firms in the logistics industry.

A large number of studies have evaluated the performance of logistics companies by using Data envelopment analysis (DEA) [5-10], Rashidi & Cullinane [11] applied Data envelopment analysis for evaluating the sustainability of national logistics performance. The result showed that logistics industries of the United States, the Netherlands, Norway and Australia are found to be top performers under both approaches, while that of Greece, Korea, Italy and Portugal are found to be poor performers under both. Marchet

et al. [12] implemented DEA approach to assess efficiency and innovation in the third party logistics (3PL) industry. The result allowed that thirteen 3PL. The results allowed identifying 13 3PL providers as efficiency leaders and 6 as leaders from both the efficiency and the innovation side. Chandraprakaikul and Suebpongsakorn [13] used Malmquist productivity index (MPI) to evaluate the operation performances of 55 Thai logistics companies from 2007 to 2010. The study contributes to find Thai logistics companies weaknesses in order to improve their logistics efficiency. Zhang et.al [14] proposed Malmquist index to measure the total-factor carbon emission performance of the Chinese transportation industry. The empirical results pointed out that the total-factor carbon emission performance of the Chinese transportation industry as a whole decreased by 32.8% over the period. Pires and Fernandes [15] used Malmquist index to indicate the airlines' capital structure changes from 2001 to 2002. Chu and Wu [16] applied the slack-based model (SBM) for efficiency evaluation of transportation systems in the 30 provincial regions in China. Hamdan and Rogers [17] implemented SBM model to determine the efficiency of third party logistics operations. The result presented company's performance and provide significant insights for managers to support their expected performance. Bajec and Tuljak [18] evaluated the efficiency of logistics service providers considering undesirable performance criteria by using SBM model. Wang et.al [18] integrated super slack based model (super SBM) and Malmquist index for evaluating and selecting Green logistics providers for sustainable development. The empirical result provided the useful information for green logistics providers in order to improve financial performance as well as environmental activities.

Hence, the purpose of this study is to evaluate the performance of Vietnam logistics industry by integrating the slack-based model (SBM) and Malmquist productivity index (MPI) in Data development analysis (DEA) to help investors select the suitable partner to create more benefits, reduce risks and aid decision making for management. The paper also demonstrates the importance of relevant productivity and performance measures to logistics, both operationally and strategically. The result of this study also provides the information to policy makers in order to improve Vietnam logistics industry performance.

II. PROPOSED METHODOLOGY

This study implemented SBM model and MPI to measure the efficiency in Vietnam logistics industry. To get credible and equitable data, this research selects 13 logistics and

transport companies. The framework is proposed in four stages as below.

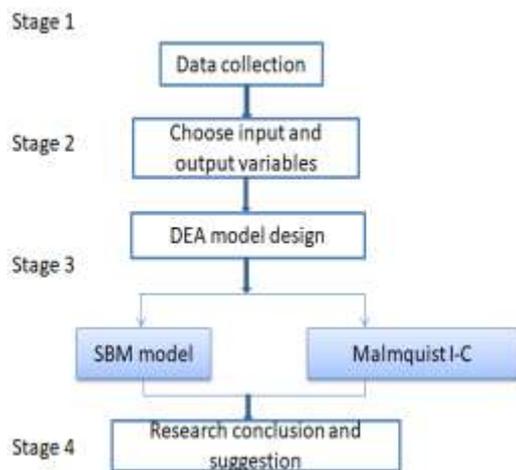


Figure 1: Flow chart of proposed method

Stage 1: Collect the data of logistics and transport companies. This study chooses 13 logistics and transport companies in as decision making units (DMUs) in Table 1.

Stage 2: Choose input and output variables. According to [19, 20, 21], it is important for using financial criteria to evaluate the company’s operation efficiency and successfully competing in the market, especially in logistics industry. Thus, this study selects financial criteria for input and output variables. The financial data for this study was collected from Vietnam stock change market from 2014- 2017. Based on previous study, the study selected three input factors are total assets, total operating expense, total liabilities and two out factors are total equity and net income.

Stage 3: DEA model design
 Firstly, the author uses the SBM model which provided by Tone [22] for ranking and measuring the efficiency of 13 selected companies during 2014-2017. Then, the operation efficiency overall productivity efficiency, technology efficiency and technical efficiency are evaluated based on Malmquist productivity index.

Stage 4: Research conclusion and suggestion
 Based on the SBM scores and MBI index, the study gives the conclusion and suggestion.

TABLE 1: Logistics and transport companies list

DMUs	Full English name of companies	Stock name
DMU1	Vinalink Logistics Corporation	VNL
DMU2	Vinalines Logistics Vietnam	VLG
DMU3	Gemadep Corporation	GMD
DMU4	Vinafco	VFC
DMU5	Vietfracht	VFR
DMU6	Hatien Transco	HTV
DMU7	Sea & Air Freight International	SFI
DMU8	Vinafreight	VNF
DMU9	Tancang Logistics	TCL
DMU10	Vietnam Airlines JSC	HVN
DMU11	Railway Construction Corporation	RCC
DMU12	Viet Nam Ocean Shipping	VOS
DMU13	Petrolimex Joint Stock Tanker	PJT

III. RESEARCH RESULTS

A. Performance Ranking: Slack Based Model “SBM”

To evaluate the operation process of 13 DMUs, the research proposes the SBM model in DEA to determine and ranking the performance of DMUs. It can be found out from Table 2 that the VNL, VLG has the highest score of 1 for 2014, 2015, 2016 and 2017 respectively. PJT attend first ranking in 2015-2017, third ranking in 2014, fourth ranking in 2014 and 2017 is TCL. That means these companies have good performance. In contrast, RCC, SFI and HVN need to improve business performance.

TABLE 2: Efficiency rank and score of DMUs (2014-2017)

DMUs	2014		2015		2016		2017	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
VNL	1.00	1	1	1	1	1	1	1
VLG	1.00	1	1	1	1	1	1	1
PJT	0.37	3	1	1	1	1	1	1
TCL	0.35	4	1	1	1	1	0.86	4
VFR	0.34	5	0.67	5	0.69	5	0.71	5
HTV	0.34	6	0.49	6	0.59	6	0.67	6
VNF	0.33	7	0.48	7	0.55	7	0.59	7
GMD	0.33	8	0.41	8	0.50	8	0.55	8
VFC	0.31	9	0.40	9	0.42	9	0.38	9
VOS	0.26	10	0.36	10	0.34	10	0.31	10
RCC	0.18	11	0.31	11	0.28	11	0.25	11
SFI	0.17	12	0.22	12	0.22	12	0.24	12
HVN	0.16	13	0.18	13	0.20	13	0.22	13

B- Total Factor Productivity Index (TFPT)

Table 3 shows changes of total factor productivity index over time. From 2014 to 2015, almost DMUs presented that productivity loss and RCC had the lowest score while VLG, GMD, HTV, SFI, VNF and TCL showed productivity growth. From 2015 to 2016, almost logistics and transport companies had productivity growth except for HTV, SFI and VOS. From 2016 to 2017, there are seven companies with MPI larger than 1 including VNL, GMD, VFC, VFR, HVN, VOS and PJT, which indicated that these companies had productivity growth in this period.

TABLE 3: Annual productivity change (MPI) from 2014-2017

Malmquist	2014=>2015	2015=>2016	2016=>2017	Average
VNL	0.60	1.05	1.13	0.75
VLG	2.50	1.14	0.77	1.47
GMD	1.00	1.18	1.22	1.13
VFC	0.90	1.12	1.12	1.05
VFR	0.76	1.11	1.19	1.02
HTV	1.61	0.75	0.79	1.05
SFI	1.46	0.97	0.97	1.13
VNF	1.11	1.01	0.91	1.01
TCL	1.21	1.08	0.98	1.09
HVN	0.99	1.23	1.16	1.13
RCC	0.59	1.10	0.99	0.89
VOS	0.81	0.70	1.22	0.91
PJT	0.76	1.08	1.34	1.06
Average	1.10	1.04	1.06	1.05
Max	2.50	1.23	1.34	1.47
Min	0.59	0.70	0.77	0.75
SD	0.58	0.16	0.17	0.17

However, for the whole period of 2014 to 2017, average Malmquist index of VLG (score of 1.47) had the highest productivity growth while VNL (score of 0.75) had the lowest score in productivity change. The others DMUs such as GMD, VFC, HVN and VOS show continuous improvement in the past 4 years.

C. Technological Change (TECHCH)

Technological change (frontier shift) is the consequence of innovation. This is the adoption of the best practice in logistics and transport companies. Figure 2 shows that the average value of all DMUs in technological change (= 1.09) in the period of 2016 - 2017 are higher than the two last periods (with the average score of 0.99 and 0.64). However, for the whole period of 2014 to 2017, there are only three companies including VLG, VNF and HVN had the average score larger than 1. This indicates that innovation improved in this period for these companies and there was investment in new technologies. Regarding the VNL (score of 0.94), VFC (score of 0.88), HTV (score of 0.80), SFI (score of 0.87), TCL (score of 0.88), RCC (score of 0.81), PJT (score of 0.88), GMD (score of 0.81) VFR (score of 0.87) and VOS (score of 0.94) were showing a slow movement in terms of technological change.

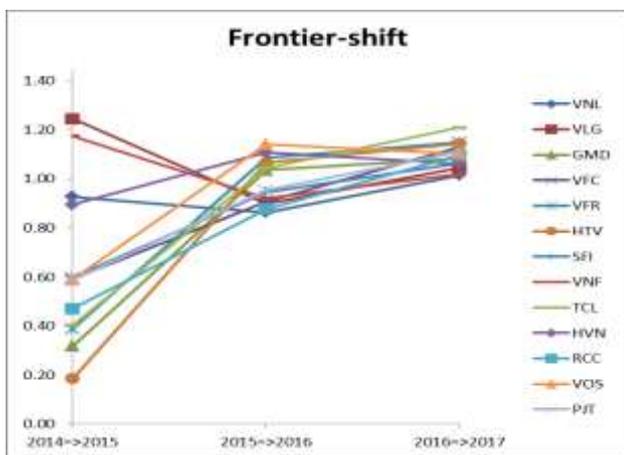


Figure 2: Technological change of DMUs from 2014-2017.

D- Technical Efficiency Change (TECI) or “catch-up”

The improvement in technical efficiency (score larger than 1), which means an improvement in management skills and improvement in quality. Figure 3 shows the changes of technical change index over time. According the results of “catch-up” effect or technical efficiency change for the whole period of 2014 to 2017, the average score of almost DMUs are larger than 1 except for VNL (score of 0.80) and VNF (score of 0.98). Thus, VNL and VNF need to learn more from advanced logistics companies, improve their operation management in order to gain a competitive advantage.

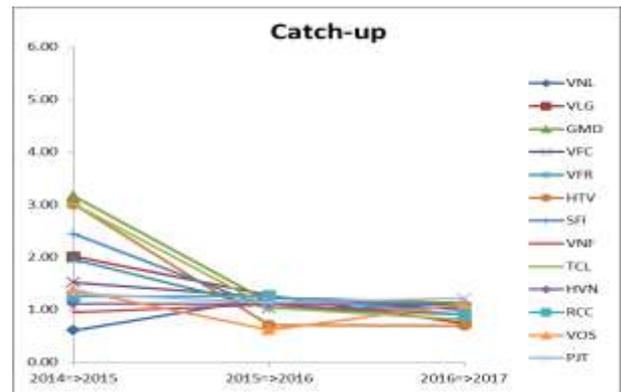


Figure 3: Technical efficiency change over the period 2014-2017

IV. CONCLUSIONS

This study integrated SBM model and Malmquist productivity index to evaluate the operation performance for Vietnam logistics industry. The results show the variation in productivity, technological change and technical efficiency change. The finding of the study is that most logistics companies increased in technological change in the period of 2016 -2017 compared with 2015- 2016 and 2014-2015, which means that these companies have improved in technology. In terms of a whole period, most DMUs only have a slight change. In the period of 2016-2017 compared with 2014-2015, most logistics companies decreased in technical efficiency change, which means that these DMUs need to improve in management and quality. However, for the whole period of 2014-2017, most DMUs presented efficiency in technical change. In summary, the indices of almost companies for the period of 2014-2017 show growths in productivity but they are based on technical efficiency change and not to change in technological. Thus, Vietnam logistics companies need to invest more in technology to achieve business efficiency and contribute to increased competitiveness with other countries in the region.

Through evaluating the operation performance of Vietnam logistics industry by using financial criteria, this research gives helpful information to investors in order to choose the right partners to improve business performance. These results also give a clear picture to help Vietnam policy makers understand Vietnam logistics industry status. According to that Vietnam policy makers can make some solutions to gain logistics industry competitive advantage.

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