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ICLIE 2021 VIETNAM

Van Lang University - Faculty of Commerce

PROCEEDINGS OF INTERNATIONAL CONFERENCE ON LOGISTICS AND INDUSTRIAL ENGINEERING 2021

SOCIAL SCIENCES PUBLISHING HOUSE

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FOREWORDS

The International Conference on Logistics and Industrial Engineering (ICLIE) is an international forum for leading researchers, educators, software developers, and practitioners to discuss current issues, share ideas and experiences on the latest development in the field of Industrial System Engineering, Logistics and Supply Chain Management, and Management Science.

The theme of ICLIE 2021 is: "Industrial Engineering and Supply Chain Management in the Global Business Environment". Nowadays, as the world is becoming heavily integrated, supply chains are becoming more vulnerable to disruptions such as pandemics and natural disasters. Furthermore, the mounting pressure of environmental and socio-economic problems is becoming more apparent. As a result, the aim of the conference is to seek for unfolding new business development opportunities through , Logistics and Supply Chain Management in the global environment.

There are 150 papers submitted to the conference. After being reviewed by experts, 70 papers were accepted to be presented at the conference sections and published in the Proceeding of ICLIE 2021 in English version following in **Interested topics**, but not limited to:

- Sustainable and Green Products
- Design and Performance Optimization of Renewable Energy Systems (Wind, Solar, Wave, Hydro power, etc.)
- Sustainable Industrial Processes
- International Collaborations in Logistics Education and Training.
- Business & Economics.
- Business Ethics
- Business Intelligence
- Business Information Systems
- Business Performance Management
- Business Statistics
- International Commerce
- Smart Logistics and Green Mobility
- Closed Loop Supply Chains
- Green Sourcing and Procurement
- Reverse Manufacturing and Logistics
- Logistics for Healthcare Systems
- Sustainability in Logistics and Supply Chains
- Novel Automation, Information and Data Architectures on the Design of Logistics Systems and Supply Chains
- Intelligent Transportation and Distribution Systems: Theory and Application Models
- Automation and Informatics for Intelligent Transportation Systems
- Port, Supply Chain and Warehouse of The Future
- Distribution Strategies & Packing Management
- Logistics Planning and Control
- Optimization of Logistics & SCM Systems
- Inventory Management

- Decision Support Systems for Logistics & SCM
- E-logistics, E-supply chain, Last Mile Delivery Problems
- IoTs Applications in SCM
- Operation Research/ Optimization
- Modelling, Simulation in Supply chains and Industrial Systems
- Scheduling in Manufacturing & service systems
- Smart City
- And other related topics in the field of Business and Commerce, Industrial Engineering, Management Science, Logistics, and Supply Chain Management

The ICLIE 2021 is held in Ho Chi Minh City, Vietnam; hosted by **Van Lang University (VLU) in collaboration with Ho Chi Minh City University of Technology (HCMUT).**

The Organization Committe appriciates the enthusiastic participation of researchers, policy makers, industry experts, practitioners, and students from all over the country. In addition, we also would like to give a big thanks to the contribution of VLU and HCMUT to the success of the conference.

Again, the The ICLIE 2021 gratefully acknowledges the support from all of you.

On behalf of the Organization Commitee of the International Conference on Logistics and Industrial Engineering 2021.

Conference Organizing Committee

AN APPLICATION OF DATA ENVELOPMENT ANALYSIS TO EVALUATE THE PROFITABILITY AND MARKETABILITY EFFICIENCY OF PHARMACEUTICAL COMPANIES IN VIETNAM

Xuan-Huynh Nguyen[1], Quoc-Tuan Nguyen[2], and Thi-Kim-Lien Nguyen[3]*

[1] *Hanoi School of Business & Management, Vietnam National University, Hanoi 100000, Vietnam*

[2] *Faculty of Tourism, Hoa Binh University, Hanoi 100000, Vietnam*

[3] *Scientific Research-International Cooperation, Thanh Dong University, Hai Duong 171967, Vietnam*

Abstract. The pharmaceutical industry is an essential aspect of human life around the world because it researches and provides medicine. In this study, we investigate the performance of the pharmaceutical industry in Vietnam through the negative Malmquist model in Data Envelopment Analysis (DEA). This study applies the Malmquist model with the presence of negative values in DEA to evaluate the effectiveness of listed Vietnamese pharmaceutical companies from Q1/2019 to Q2/2020. The empirical results showed efficiency in a two-stage model, inclusive of business performance and market performance, through the negative Malmquist Index as it changes from time-to-time. The analysis results revealed that in the first stage, inputs such as operating costs and equity were those factors most directly influencing business performance; whereas, in the second stage, output values in the first stage were the input values for stage two, which were the factors most directly affecting market efficiency. The research results, thus, gave a performance overview of each pharmaceutical company in each period. Moreover, the research also informed the solution to improve overall efficiency in the phases where good efficiency did not occur

Keywords: Data Envelopment Analysis – DEA; Negative Malmquist model; efficiency; pharmaceutical industry

1. Introduction

The development of the pharmaceutical industry has always been an important factor in the human therapeutic process because humans have used drugs to treat illness and disease for more than 3000 years (David, 2016). The function of a pharmaceutical company is to research, develop, market, and distribute drugs. Although the global pharmaceutical industry was found in China about 1100 BCE (Leung, 2006), at the end of 19 century, it was actually established and developed sharply. From the earlier of 2020 to now, the pharmaceutical companies over the world are facing the impact of COVID-19, the pandemic has reduced the number of novel late-stage assets (Elmhirst & Urquhart, 2020). In recent years, the pharmaceutical industry in Vietnam has experienced rapid development. The COVID-19 pandemic has negatively impacted both the domestic and international pharmaceutical industry continuously since early 2020. To gain an overview of development in the pharmaceutical industry in Vietnam, both before and after the pandemic, this study utilized the negative Malmquist model in DEA to provide an overall evaluation of business activities and marketability for twelve pharmaceutical companies listed on the Vietnamese Stock Market since the beginning of 2019 to the end of Q2/2020. The purpose of this study is to evaluate the efficiency of pharmaceutical companies in Vietnam from 2019 to the end of Q2/2020, the collected data was analysed in two stages. Stage one analyzed the early input variables, including total assets, operating costs, and equity to provide output variables which are net revenue from sales and service providers to indicate business efficiency. The second stage was to analyzed market performance using output values available from stage one as input variables to capture output variables such as earnings per share and book-value of shares. The empirical results found out the business efficiency and market efficiency of each pharmaceutical company in each period.

Data envelopment analysis (DEA) has been a useful tool since it includes many models, such as the efficiency Slacks-Based Model (SBM), higher efficiency model (Super-SBM), etc. DEA is a non-parametric method used in economics and operational research to calculate levels of efficiency. It helps to provide a measure for the efficiency of a specific Decision-Making Unit (DMU). Results of the analysis provide benchmarks to select efficiency methods in the production and business process. The first traditional model was brought about by Charnes, Cooper, and Rhodes (1978) (Charnes, Cooper, & Rhodes, 1978) and became known as the CCR model. Since that time, many researchers built and developed newer models with diverse resolution for variables. This included the undesirable outputs model (Seiford & Zhu, 2002) developed to simultaneously deal with desired output variables and unwanted output variables. In the early stages of development, the DEA model could only give the maximum efficiency score of 1. Tone (2002), however, has produced the basic theory of unlimited efficiency scores in which scores are calculated based on available input and output variables. Another common feature of DEA is its use of a non-parametric method and a linear program.

The Malmquist model introduced by Cave, Christensen, and Diewert (1982) shows the change in efficiency over time. Fare, Grosskopf, Norris, and Zhang (1992) further developed it and included it in DEA. The Malmquist model offers technical efficiency for each period, combined with high efficiency, to give an unlimited maximum score. The Malmquist model delivers values based on technical changes and technical efficiency. According to Aghayi, Tavana, and Maleki, (2019), technical change and technical efficiency change is the sum of the factors that change efficiency and are measured by the Malmquist Index (MI). MI helps to identify past unit operations and to offer a new direction in the future. In addition, the Malmquist model was developed to solve negative values (Ghasem, Shabnam, & Simin, 2014). With these characteristics, many researchers have chosen the negative Malmquist model to measure the performance in various fields such as banking (Maria & Emmanuel, 2010), economics (Esmaeili & Malkhalifeh, 2017), industry (Naser, Hadi, & Ali, 2018), and environmental engineering (An, Wu, Li, Xiong, & Chen, 2019). The negative Malmquist model, as well as the data inclusion method, have been utilized by researchers in different fields to measure the structured performance in that industry using selected input and output variables. It should be noted, however, depending on the profession involved, the research goals, the number of variables, and types of variables are selected accordingly to meet particular needs.

In the early stages of formation, the Malmquist model can only work utilizing positive values, but in the following research efforts, it has developed and resolved the presence of negative values in the original data. Therefore, this study used the negative Malmquist model in DEA to deal with the presence of negative data and measure the performance of pharmaceutical companies in Vietnam. This paper introduces the negative Malmquist model in DEA to work with negative values based on previous research carried out by Esmaeili and Malkhalifeh (2017). Previous models set out to evaluate efficiency were only able to calculate positive values and eliminate the negative values. The strength of this method, thus, is to provide a comprehensive view and insight into the pharmaceutical industry in Vietnam in recent periods regardless of valuation. The research results reflect the current situation of Vietnam's pharmaceutical industry. Each company can re-examine its relative advantages and disadvantages and draw future development directions. In addition, the research reveals a detailed evaluation in each phase based on the Malmquist model through two stages: efficiency in business and marketability efficiency.

The rest of the study is arranged in four sections as follows. Section 1 overviewed the pharmaceutical industry, data envelopment analysis, and the negative Malmquist model. Section 2 showed the data source, proposal research, and formula equations of the negative Malmquist model. Section 3 conducted the analysis results of business efficiency and market efficiency. Section 4 summarized the main results which were figured out.

2. Materials and method

2.1. Data collection

Based on the given research objectives and models, data obtained from 12 pharmaceutical companies listed on the Vietnam stock market since the beginning of 2019 to the end of Q2 2020 was collected from website: https://vietstock.vn/ (Vietstock, 2020). The list of pharmaceutical companies is shown in Table 1.

Table 1. List of 12 pharmaceutical companies in Vietnam

Symbol	Company names
DBD	Binh Dinh Pharmaceutical - Medical Equipment Joint Stock Company
DCL	Cuu Long Pharmaceutical Joint Stock Company
DHG	Hau Giang Pharmaceutical Joint Stock Company
DMC	Domesco Medical Import-Export Joint Stock Company
DP3	Central Pharmaceutical Joint Stock Company 3
IMP	Imexpharm Pharmaceutical Joint Stock Company
OPC	OPC Pharmaceutical Joint Stock Company
PME	Pymepharco JSC
PPP	Phong Phu Pharmaceutical Joint Stock Company
SPM	SPM JSC
TRA	Traphaco JSC
VDP	Central Pharmaceutical Joint Stock Company VIDIPHA

With the research objectives and principles of MI in the DEA method, the input and output variables from the financial reports were selected particularly.

Total assets (TAS): The total amount of assets includes tangible and intangible which are owned by the pharmaceutical company.

Operating expenses (OES): The operating expenses are rent, equipment, inventory cost, marketing, payroll, insurance, step costs, and funds.

Owner’s equity (QEY): The owner’s equity is the owner’s investment in the business.

Net revenue (NRE): The net revenue is the sale of a pharmaceutical company when this value is returned from the selling operation.

Profit after tax (PAT): The profit after tax is the earnings of a business when the total revenue deducts all income taxes.

Earnings-per-share (EPS): The earnings-per-share of a pharmaceutical company is a part of net profit, excluding extraordinary items or discontinued operations, or on a diluted basis.

Book value per share (BVPS): The book value per share is the ratio of equity available to common shareholders.

2.2. Proposal research

The proposal research of pharmaceutical company is drawn in the Figure 1.

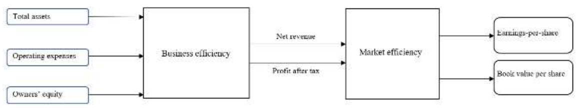

Figure 1. Proposal research

Figure 1 showed that the research is divided into two stages. In the first stage which evaluated business performance, the selected input variables included: Total assets, operating expenses, and owners' equity; the output variables included: Net revenue and profit after tax, these factors were used to measure the performance of the business process. In the second stage of market efficiency, the selected input variables were given as the output variables in stage one, including net revenue and profit after tax; the output variables included earnings-per-share and book value per share, the market efficiency of each pharmaceutical company in each period was conducted.

With the appearance of negative data in the outputs of stage 1 and inputs of stage 2, the negative Malmquist model in DEA is used to measure the efficiency of business process and market process. Each score of these pharmaceutical companies in each stage and each period is calculated based on the historical data.

2.3. Malmquist model

The Malmquist model is used to measure the performance of DMU's during successive periods, it evaluates the efficiency change over time with the positive data (Tone, 2016). In the previous time, Saitech group provided DEA-Solver-PRO versions without dealing with the negative data, the current version – DEA-Solver-PRO provided the fifteen version in which solves with the negative data. Tohidi, Razavyan, and Tohidnia, (2014) introduced the presence of the negative data in DEA. Thus, this paper used the Malmquist model with negative data to provide an analysis of the efficiency of pharmaceutical companies located in Vietnam in recent times. There scores are calculated according to the negative Malmquist model in DEA. The negative Malmquist model, thus, evaluates the value by the ratio of total output to total input in each period. Each DMU is set with input and output variables as x^t, y^t respectively. The distance between set points is given as D. The MI score at each point is listed as $D_0^t(x_0^t, y_0^t)$, $D_0^{t+1}(x_0^t, y_0^t)$, $D_0^t(x_0^{t+1}, y_0^{t+1})$, and $D_0^{t+1}(x_0^{t+1}, y_0^{t+1})$.

Catch-up efficiency is calculated by:

$$Catch-up = \frac{D_o^{t+1}(x_o^t, y_o^t)}{D_o^t(x_o^t, y_o^t)} \quad (1)$$

Frontier-shift (FS) efficiency is conducted by:

$$FS = \left[\frac{D_o^t(x_o^{t+1}, y_o^{t+1})}{D_o^{t+1}(x_o^{t+1}, y_o^{t+1})} \times \frac{D_o^t(x_o^t, y_o^t)}{D_o^{t+1}(x_o^t, y_o^t)} \right]^{1/2} \quad (2)$$

To combine equation (1) and (2), the equation of Malmquist model is formulated as follows:

$$Malmquist = \left[\frac{D_0^t(x_0^{t+1}, y_0^{t+1})}{D_0^t(x_0^t, y_0^t)} \times \frac{D_0^{t+1}(x_0^{t+1}, y_0^{t+1})}{D_0^{t+1}(x_0^t, y_0^t)} \right]^{1/2} \quad (3)$$

Table 2. Data description of 12 farmaceutical companies

Indicator	Time	TAS	OES	QEY	NRE	PAT	EPS	BVPS
Max	Q1/2019	4,234,594	212,046	3,017,944	767,191	135,174	11,454	54,499
Min		146,760	5,297	96,948	30,503	-2,688	62	12,119
Average		1,456,267	69,665	1,054,342	264,883	36,092	3,854	28,110
SD		1,001,251	56,255	762,470	185,872	36,385	2,894	11,563
Max	Q2/2019	4,335,180	286,430	3,054,381	975,823	172,919	11212	54,570
Min		148,516	5,825	98,146	40,740	-2,479	-9	12,268
Average		1,476,260	84,254	1,044,543	305,557	40,144	3,827	27,120
SD		1,034,583	83,148	761,771	239,123	46,389	2,850	10,569
Max	Q3/2019	3,927,167	266,665	3,173,706	874,357	117,477	9,902	54,679
Min		150,497	6,035	102,489	39,283	1,776	138	11,647

Indicator	Time	TAS	OES	QEY	NRE	PAT	EPS	BVPS
Average		1,474,775	82,987	1,079,628	299,006	36,102	3,752	27,954
SD		947,490	69,860	792,013	211,626	32,386	2,545	10,800
Max	Q4/2019	4,146,819	358,361	3,377,551	1,279,383	203,845	10,421	55,001
Min		157,942	7,372	106,058	41,003	4,023	680	12,052
Average		1,516,127	97,259	1,113,238	382,436	54,245	3,932	28,476
SD		995,719	97,060	846,072	318,246	54,851	2,503	10,889
Max	Q1/2020	4,194,259	260,661	3,529,584	858,456	176,970	10,084	55,159
Min		153,036	6,617	107,784	29,584	1,949	690	12,248
Average		1,511,905	85,137	1,150,654	298,124	41,458	3,974	29,265
SD		1,005,530	69,052	883,260	210,975	45,680	2,401	10,978
Max	Q2/2020	4,297,132	254,312	3,192,212	820,292	185,736	9,921	54,307
Min		151,521	5,965	103,330	27,465	749	673	11,742
Average		1,537,704	69,351	1,104,389	275,395	45,197	4,047	27,711
SD		1,027,219	69,060	798,849	204,948	47,284	2,352	10,516

Table 3. Business efficiency

DMUs	Q1/2019	Q2/2019	Q3/2019	Q4/2019	Q1/2020	Q2/2020	Average
DBD	0.9140	0.9704	0.9528	1.3165	1.1808	0.9458	1.0467
DCL	0.5557	0.5859	0.5799	1.9289	0.6372	0.6382	0.8210
DHG	1.0000	1.0821	1.0386	1.1792	1.1939	1.1939	1.1146
DMC	1.2808	1.7241	1.5631	1.5244	1.2072	1.7609	1.5101
DP3	1.5711	3.7661	1.4931	0.8602	1.3671	2.3611	1.9031
IMP	0.6520	0.6947	0.7416	1.1078	0.7213	0.8557	0.7955
OPC	1.0413	1.1311	1.1532	0.9477	1.1129	0.8504	1.0394
PME	0.8402	1.0092	0.8886	2.0625	1.0308	0.9086	1.1233
PPP	3.8429	3.1953	4.2150	3.9778	3.6439	3.4550	3.7216
SPM	0.5915	0.4904	0.6503	0.6717	0.4562	0.5220	0.5637
TRA	1.1250	1.3591	0.9577	1.5082	1.0935	1.3586	1.2337
VDP	1.2207	1.2164	1.1711	1.1974	1.1364	0.9470	1.1482

Table 4. Market efficiency

DMUs	Q1/2019	Q2/2019	Q3/2019	Q4/2019	Q1/2020	Q2/2020	Average
DBD	0.2058	0.1790	0.1876	0.1549	0.1448	0.1994	0.1786
DCL	8.4701	4.0826	0.4006	0.1110	0.6143	0.4582	2.3561
DHG	0.0803	0.0654	0.0848	0.0550	0.0779	0.0829	0.0744
DMC	0.2749	0.2347	0.2352	0.2152	0.3587	0.2950	0.2689
DP3	1.0000	1.0261	1.1152	1.4598	1.4598	2.0378	1.3498
IMP	0.2355	0.2489	0.2169	0.1567	0.2168	0.2017	0.2127
OPC	0.2923	0.2760	0.2872	0.3449	0.3034	0.4434	0.3245
PME	0.1477	0.1250	0.1340	0.1150	0.2162	0.2744	0.1687
PPP	2.5674	1.7048	1.7184	1.5905	4.0381	2.7170	2.3894
SPM	1.0000	1.0000	1.0000	0.8724	0.3005	1.2068	0.8966
TRA	0.1922	0.2515	0.2254	0.1388	0.1954	0.2105	0.2023
VDP	0.6272	0.8359	0.5231	0.4758	0.5877	0.7144	0.6273

Table 5. Difference between business performance

DMUs	Q1/2019	Q2/2019	Q3/2019	Q4/2019	Q1/2020	Q2/2020	Average
DBD	0.7082	0.7914	0.7652	1.1616	1.0360	0.7465	0.8681
DCL	-7.9143	-3.4968	0.1793	1.8179	0.0229	0.1800	-1.5352
DHG	0.9197	1.0167	0.9538	1.1242	1.1160	1.1110	1.0402
DMC	1.0059	1.4895	1.3280	1.3092	0.8486	1.4659	1.2412
DP3	0.5711	2.7401	0.3779	-0.5996	-0.0928	0.3232	0.5533
IMP	0.4165	0.4459	0.5247	0.9512	0.5045	0.6540	0.5828
MKV	0.7490	0.8551	0.8660	0.6028	0.8095	0.4070	0.7149
OPC	0.6924	0.8842	0.7546	1.9475	0.8145	0.6342	0.9546
PME	1.2755	1.4905	2.4966	2.3873	-0.3943	0.7380	1.3323
PPP	-0.4085	-0.5096	-0.3497	-0.2007	0.1558	-0.6848	-0.3329
TRA	0.9327	1.1076	0.7323	1.3694	0.8982	1.1482	1.0314
VDP	0.5935	0.3805	0.6480	0.7216	0.5487	0.2327	0.5208

Assigning values to the input and output variables with the presence of negative values such as $x_i^{\min}, y_i^{\min}$ $(i = 1, K, m)$, respectively. MI is calculated as follows:

$$\min_{\theta,\lambda} \theta = D^{\min}(x_i^{\min}, y_i^{\min}) \tag{4}$$

In which

$$\begin{aligned}
&x_i^{\min} = Min(x_{i1}^1, x_{i2}^1, K, x_{i1}^T, K, x_{in}^T)\\
&i = 1, K, m)\\
&x_i^{\min} \geq 0, x_i^{\min} = 0 / x_i^{\min} < 0, x_i^{\min} \times 1.1\\
&y_i^{\min} = Min(y_{i1}^1, y_{i2}^1, K, y_{i1}^T, K, y_{in}^T)\\
&i = 1, K, m\\
&y_i^{\min} \geq 0, y_i^{\min} = 0 / y_i^{\min} < 0, y_i^{\min} \times 1.1
\end{aligned} \tag{5}$$

Narjes and Alireza (2014) showed that results indicating an increase in efficiency are shown as greater than 1. On the other hand, results whose values are less than 1 imply a marked reduction in efficiency, these inefficient companies should have a solution to increase the efficiency.

3. Results and discussions

In the study, data from the 12 pharmaceutical companies listed on the stock market in Vietnam since early 2019 to the end of Q2/2020 was used in the analysis. Table 2 summarizes the variables used in efficiency analysis.

According to Table 1, the statistical data revealed the presence of negative values including PAT of Q1 and Q2 in 2019 and EPS of Q2/2019. As the normal models in DEA, these values must remove, however, based on the characteristics of the Malmquist Model which allows for negative values, the annual efficiency of each pharmaceutical company was still able to be calculated. Before going into the data calculation method, the initial values need to be checked for correlation to ensure a relationship between the variables according to the principles in DEA.

Correlative relationships between variables must always range between -1 and +1. Based on the results of the analysis, the correlation coefficient between the variables in stage one range between 0.7696 and 1, indicating a relatively good correlation in the business performance stage. In the second stage of market return efficiency, the variables are correlated from – 0.2225 to 1. Despite not indicating good results, these correlation values are still within an acceptable range to indicate efficiency. Therefore, all the input and output data in the two analysis stages are suitable for an application to the Malmquist model wherever negative values appear.

For any unit operating in business or production, the first stage of enterprise always involves capital investment, followed by profits with interest from sales after a period of sustained operations. To provide concrete results regarding the business efficiency of the pharmaceutical industry in Vietnam, the study used both input and output variables by applying the technical model to calculate the scores, as shown in Table 3.

The business performance results described 12 pharmaceutical companies in Vietnam, as shown in Table 1, showed considerable fluctuations across different operating periods. Analysis revealed that three of the companies: DHG, DMC, and PPP always maintained business efficiency from early 2019, where the scores in each period were above 1 and the average value of all six quarters for each of the companies is 1.1146; 1,5104 and 3.7216, respectively. SPM, meanwhile, had the lowest performance for all six quarters, with scores below 1 and an average score of 0.5637. Other companies have fluctuating scores in each quarter, which indicated both efficient and inefficient periods. DCL and IMP, with average scores below 1, did not achieve the efficiency score, possessing the results of 0.8210 and 0.7955, respectively. During the same period, the remaining pharmaceutical companies had ineffective periods, but their average scores were still above 1. The results, thus, implied that the SPM pharmaceutical company has the worst comparative business performance.

Based on the scores of these pharmaceutical companies in the business activities, their positions in this stage were determined as shown in Figure 2. PPP was considered as the best company when it always held the first position in 5 periods except for 2019/Q2. DP3 tried to best to rank the first position in Q2/2019, but it has been down sharply in Q4/2019, and then kept stable within two earlier quarters of 2020. DMC only ranked the second position in Q3/2019, it owns the third and fourth positions with four periods and one period, respectively. PME had a unique period with the second position, remaining periods ranked the eighth and ninth position. DBD, DHG, OPC, TRA, and VDP ranked in the middle position from fourth to tenth. DCL only ranked the third position in Q4/2019, other periods had the eleventh and twelfth positions. SPM was the worst company that always stayed at the eleventh and twelfth position from Q1/2019 to Q2/2020.

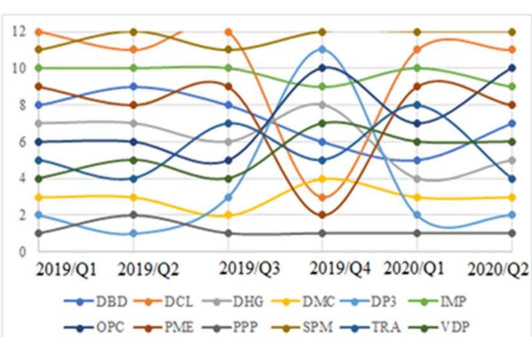

Figure 2. Ranking the business activities

In stage 1, efficient and inefficient scores and the ranking of each pharmaceutical company in each quarter from the beginning of 2019 to the end of Q2/2020 regarding business performance were determined. In stage 2, market efficiency was based on the input variables taken from the output variables in stage one and based on the output index. The paper calculated market efficiency based on the Malmquist model, as shown in Table 4.

The results of market efficiency research showed that there are only two pharmaceutical companies, DP3 and PPP, that achieved effective results during all six quarters examined, and they had average scores of over 1, with 1.3498 and 2.3894, respectively. In contrast, up to eight pharmaceutical companies, including DBD, DHG, DMC, IMP, OPC, PME, TRA, and VDP, did not have any efficient operational periods and their average scores were all lower than a value of one, their average scores were 0.1786; 0.0744; 0.2689; 0.2127; 0.3245; 0.1687, 0.2023, and 0.6273, respectively. The other two companies, DCL and SPM, have both efficient and inefficient periods. Whereas SPM had an efficient average score of only 0.8966, and two inefficient and four efficient periods; although DCL experienced a period of inefficiency, the average score is still above 1 (2.3561), it had two efficient and four inefficient periods. Based on the average score, PME was considered as the worst company with the lowest average score (0.1687), and PPP was determined the best company with the highest average score as 2.3894.

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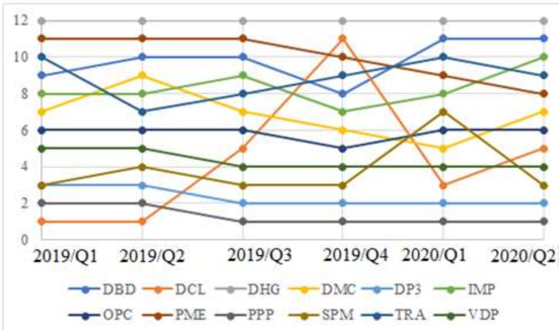

Figure 3. Ranking the market activities

As same as the first stage, the position of each pharmaceutical company in the market activities was determined based on the score of the market activities in Table 4. Figure 3 described the continual variation of 12 pharmaceutical companies in each period. PPP ranked the second position in Q1 and Q2 of 2019, and then it tried the best to hold the first position in the remaining periods. DP3 was similar to PPP when this company owned the third position in Q1 and Q2 of 2019 and the second position in the remaining periods. DCL had excellent quarters with the first position in Q1 and Q2 of 2019; however, it was down sharply, especially in Q4/2019 with the eleventh position. DHG was defined as the worst company when it always held the final position the whole time. The remaining companies had consecutive variations in each period.

There are clear differences between the business performance and market performance of each pharmaceutical company during each quarter. Based on the business performance scores provided in Table 3, as well as the market performance scores in Table 4, the difference between the two stages was calculated using formula (4). The detailed results are given in Table 5.

$$D = HQKD - HQTT \quad (6)$$

Where D is the difference score; HQKD is business efficiency; HQTT is the market efficiency.

Table 5 showed that most pharmaceutical companies have higher business performance scores than market performance scores, except for a few cases with higher market performance scores, DCL in Q1 and Q2 of 2019; DP3 in Q4 of 2019 and Q1 of 2020; PME in Q1 of 2020; PPP in most quarters except Q1 of 2020. Average scores for DCL and PPP, whose business efficiency scores are lower than market efficiency, are -1.5352, and -0.3329, respectively. According to the analysis, only PPP achieved effective scores throughout the entire period in both stages of business efficiency and market performance with average scores for each period all above a value of 1.

Based on the empirical results shown and DEA, one suggestion is to increase the score during inefficient periods, to increase output variables, and to decrease input variables. In the first stage, input values for inefficient units need to reduce excess in input variables, such as total assets, operating costs, and equity. Obviously, further effort needs to be made to achieve better business results. In the second stage, during relative periods of market inefficiency, companies need to exhibit an effective strategy to increase earnings per share and market value per share.

4. Conclusion

Input and output variables of pharmaceutical companies related to business performance and market performance were identified and analyzed in this research. The paper studied twelve pharmaceutical companies listed on the Vietnam stock market during the period from early 2019 to the end of Q2/2020. Results provide a detailed account of efficiency in business activities and business marketing for each pharmaceutical company, in every quarter, thus determining efficient and inefficient operational periods. Final results reveal, that of all twelve pharmaceutical companies, MKV achieved the best efficiency throughout the whole assessed period, thus, obtaining optimum efficiency in the marketplace.

Research results also show that many companies experienced periods of ineffective business and diminished market efficiency. These values offered insights into the inefficient operational period of each company. It is, therefore, advisable that a reassessment takes place of the input and output variables. This must be done to better strategize and to find a suitable solution for improving future efficiency levels. If during the business performance evaluation process, there are adjustments to reduce input variables and increase output variables, the value will be improved significantly. For the market assessment process, the output variables need to follow a strategy and deliberate policies to improve.

Although the study indicated the performance of pharmaceutical companies in Vietnam for both business and market processes, it still has limitations. First, the study only demanded the pharmaceutical industry in Vietnam, the further research should compare with the pharmaceutical industry of other countries. Second, the research measured the efficiency of 12 pharmaceutical companies in the previous time, the further study can utilize the forecasting model such as GM (1,1) model, Holt-winters methods to have a foreseen observation.

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