Assessment of Performance Management of European Freight Transportation Industry

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***Abstract*—Nowadays, freight transportation has great contribution to the development of foreign trade since it can high profit to each logistics company. Therefore, optimizing performance to get the best profit of these companies is crucial. This paper collects data from financial reports of logistic companies in European nations from 2011 to 2013, and uses DEA method to figure out key factors impacting on performance in order to propose solutions for the companies. After analyzing, there are significant rises in the numbers of Catch-up, Frontier and Malmquist, which indicate that the profits of the companies increase. The results indicate that good investment in technique brings a low-cost transportation system as well as better service quality to customers. In short, this research can help logistics companies plan strategies in the future and enhance the competitiveness to the rivals in global economic volatility.**

Keywords: Freight transportation industry, Data envelopment analysis (DEA), Logistics, Europe.

I. INTRODUCTION

In this global competition era, the trade exchange between various countries has played an important role in the development of a company in which the smooth transport process is a decisive factor to success. This is because transportation is an important activity and the most visible of the work oflogistics. In other words, the activity that physically connects the business to its supply chain partners, such as suppliers and customers, is a major influence on the customer's satisfaction, and it impacts the cost of products and services.

Nowadays, the majority of firms pay highly attention to transportation management, and this management can be a boost or a barrier to the development of each individual company. Transport investments link the relationship between producers and consumers with the aim of creating more productive division.One of the biggest difficulties that the businesses commonly face with is high cost in terms of equipment investment, transportation, and fuel resources. Another difficulty is that the last output of a transportation company, such as income revenue and relative costs, has to be evaluated in order to give the proposed business plan for the following year.So, what are the criteria commonly used to perform the operation evaluation of businesses? Dealing with these questions, the authors have been motivated to conduct this topic with the aim of helping the transportation companies have the better overview of the measure of performances and implementing of forecasting, and thereby it can help businesses to improve their competitiveness in the international market. Thus, this research mainly focuses on solving:To establish an assessment model to measure the performance of the freight transport in European industry. By using Malmquist productivity index (MPI), we can estimate the productivity change in the European transportation industry.

II. LITERATURE REVIEW

A. *Definition Performance Measurement*

Performance management (PM)mean a process which is designed to improve organizational, group and individual performance and which is owned and driven by line managers [3].Meanwhile,performance management is recognized as being an important part of the manufacturing strategy literature [9]. Nowadays, performance management is evolving at a considerable rate to combat new organizational realities; owing to the fight for industrial supremacy, the concept of performance, as it is measured and evaluated, is undergoing a transformation in modern business organizations or business operation in-group.

B. *Components of Performance Measurement*

A decade ago the performance management literature was often content with trying to represent the processes defined by the three factors: labeled measurement, analysis and response. As time has passed, more complex frameworks and systems have evolved, so that today the entire figure is almost encompassed. Performance managementtoday has moved towards examining the organization as a whole, and impacting to a greater extent upon strategy. Inter-organizational performance management systems will have an impact outside the organization-in the external environment-the final frontier of performance management. In the coming years there will be a significant increase at the inter-organizational performance management level, whereby supply chain performance management and more particularly extended enterprise performance management concepts will be examined in greater detail to assess the performance.

C. Evaluation of performance management

DEA is a nonparametric programming technique used to treat problems of multiple inputs and outputs associated with multiple DMUs [10].Thus, we propose a performance evaluation methodology based on DEA, which can incorporate multiple inputs and outputs in multiple stages and results in a single relative efficiency measure. Since the conventional DEA models are found to be ineffective in measuring the performance of various transportable related functions, many multi-stage DEA models have been developed to accommodate various indirect processes and their contribution to corporate performance from 2011 to 2013.

III. RELATED RESEARCHES ABOUT DEA

We propose a performance evaluation methodology based on DEA, which can incorporate multiple inputs and outputs in multiple stages and results in a single relative efficiency measure. Since the conventional DEA models are found to be ineffective in measuring the performance of various supply chain related functions, many multi-stage DEA models have been developed to accommodate various indirect processes and their contribution to corporate performance [11]

DEA offers an innovative approach to the problem of objectively assigning weights to compare the efficiency of the subunits of a transportation organization validly. Since the first papers applying DEA to public transportation were published in 1992, the procedure has become increasingly popular for comparing transit organizations with each other [12]. However, DEA has not been used to compare subunits within a given transit organization. Herein, we demonstrate the use of DEA for comparing a set of subunits that each performs the same activity within their parent transportation agency. Similar analyses have been conducted to compare the performance of organizational subunits such as freight companies and retail outlets.

In this paper, performance evaluation methodology based on DEA has been proposed as non-parametric technique to measure the relative efficiency of firms, which can incorporate multiple inputs and outputs in multiple stages and results in a single relative efficiency measure. The DEA - based MPI has proven to be a very useful tool for measuring the productivity changes of DMUs in the past several decades. Beside DEA also developed as an excellent method for analyzing performance and modeling organizations and operational processes, particularly when market prices are unavailable.

IV. METHODOLOGY

A. Collecting the data of transportation companies

The European's transportation industry includes new logistics in sea route, and trucking in roadway. This study, the companies were selected which demanded includes as *DMU* providing logistic service. In our research, we deleted the incomplete data which lack some information such as: ones don't have the data of shipping logistic and trucking and total 23 companies of The European transportation industry were chosen to be our *DMU*s as empirical samples.

B. Analysis stage DEA

The main reason that motivated the choice of DEA in this study is the fact that the technique to measure the relative efficiency of transportation companies. In this study, DEA was an approach to measuring the relative efficiency of a set of DMUs with multiple inputs and multiple outputs using mathematical programming.DEA also could be applied to panel data to measure the productivity changes between two or more periods of activities fulfilled by a specific set of DMU. DEA has been recognized as an excellent method for analyzing performance and modeling organizations and operational processes, particularly when market prices are unavailable [7]. The DEA-based MPI has proven to be a very useful tool for measuring the productivity changes of DMUs in the past several decades.

Productivity measurement was a part of important research topic DEA. Approach productivity measurement in DEA was the Malmquist productivity index (MPI) [5], which was named after Malmquist to give ideas for the MPI. In addition, another scholars assumed that the Malmquist calculates the relative performance of a DMU at different periods of time using the technology of base period [7].

C. Malmquist productivity index (MPI)

In this research, we$y_j^t = (y_{1j}^t, \ldots, y_{sj}^t)$adopted theorem's [7] and selected *nDMU*s, each DMU_j $(j=1,2,\ldots,n)$ produces a vector of outputs by using a vector of inputs $x_j^t = (x_{1j}^t, \ldots, x_{mj}^t)$at each time period t, t=1,…, T. Charnes et al (1978) could be the CCR DEA model as:

$$\theta_0^t(x_0^t, y_0^t) = min_{\theta_0, \lambda_j}\theta_0$$

$$s.t\sum_{j=1}^{n} \lambda_j x_j^t \leq \theta_0 x_0 \quad (1)$$

$$\sum_{j=1}^{n} \lambda_j x_j^t \geq y_0^t, \lambda_j \geq 0, j = 1, \ldots, n$$

Where$x_0^t = (x_{10}^1, \ldots, x_{m0}^t)andy_0^t = (y_{10}^1, \ldots, y_{s0}^t)$means input and output vectors ofDMU_0among others. Theorem (1) shows input-oriented, because it acknowledges the possible redial reductions of all inputs are fixed at companies current levels.

The Malmquist productivity index is defined asPI_0

$$PI_0 = \left[\frac{\theta_0^t(x_0^t, y_0^t)}{\theta_0^t(x_0^{t+1}, y_0^{t+1})} \frac{\theta_0^{t+1}(x_0^t, y_0^t)}{\theta_0^{t+1}(x_0^{t+1}, y_0^{t+1})}\right]^{\frac{1}{2}} \quad (2)$$

PI_0Measures the productivity change between periods *t* and *t*+1. Productivity declines ifPI_0>1, remains unchanged if PI_0 =1 and improves if PI_0<1. Notes that $PI_0$are expressed by the radial efficiency scores obtained from several input-oriented DEA model. Therefore, this PI_0 is called input-oriented radial Malmquist productivity index.

The following modification ofPI_0 makes it possible to measure the change technical efficiency and the movement of EPF in term of a specific:DMU_0

$$PI_0 = \frac{\theta_0^t(x_0^t,y_0^t)}{\theta_0^{t+1}(x_0^{t+1},y_0^{t+1})}\left[\frac{\theta_0^{t+1}(x_0^{t+1},y_0^{t+1})}{\theta_0^{t}(x_0^{t+1},y_0^{t+1})}\,\frac{\theta_0^{t+1}(x_0^{t},y_0^{t})}{\theta_0^{t+1}\theta_0^{t}(x_0^{t},y_0^{t})}\right]^{\frac{1}{2}} \quad (3)$$

The firm term on the right-hand side measures the magnitude of technical efficiency change between period$t$ and$t$+1. Obviously, accordingly as technical efficiency improves remains or declines. The second term measures the shift in the EPF between periods$t$and$t$+1

$$\frac{\theta_0^t(x_0^t,y_0^t)}{\theta_0^{t+1}(x_0^{t+1},y_0^{t+1})} = 1 \quad (4)$$

D. Research Procedure

This paper used DEA as the foundation and conjures up a set of systematic assessment models. The working procedure in this study is mainly collecting the information of proceeding the European transportation industry data and also collecting all connected documents as this study draft action plan as referenced. Firstly, we must choice the proper input and output variables while using DEA methods. The authors consider the organizational goals and the European freight transportation industry of innovation, according to previous studies, the indicator selected as input measure includes: Cost of goods sold, selling, general and administrative [11], equity [13] and total current [10] Secondly, Based on previous researches, the selected output indicators are: Gross profit, Operating Income [6], Net Income [4]. This study adopted the following indicators as output variables: Y1: Net income, Y2: Gross profit, Y3: Operation income

E. Computational results

Transportation companies productivity changes: The Malmquist productivity index (MPI) and its decomposition.In order to understand the trend of the transportation Industry in European's 23 companies from 2012 to 2014, this study analyzed changes in productivity during four-year period for each company.

1) Components of the Malmquist productivity index: Catch-up efficiency change.

We began by presenting the results of change values for transportation efficiency, following by a measure of productivity growth. The change in efficiency was called "catch-up efficiency change". The annual catch-up efficiency change index for each lab was shown in Table 1.

TABLE I. OVERALL CHANGE VALUES FOR CATCH-UP EFFICIENCY CHANGE.

Catch-up	2010=>2011	2011=>2012	2012=>2013	Average
DMU1	1.0039	0.9998	1.0124	1.0054
DMU2	1.1008	1.072	0.7784	0.9837
DMU3	1	1	1	1
DMU4	0.9994	1.0106	1	1.0033
DMU5	1.91	0.8657	0.5356	1.1038
DMU6	1	1	1	1
DMU7	0.9694	1.1931	0.7515	0.9714
DMU8	0.9924	1.2574	0.6435	0.9644
DMU9	0.3327	1.0727	0.7184	0.7079
DMU10	1	1	1	1
DMU11	1	0.9798	0.9968	0.9922
DMU12	1	1	1	1
DMU13	1.413	1.6534	0.9084	1.3249
DMU14	0.9639	1.4015	0.7551	1.0401
DMU15	0.9993	1.0976	1.3789	1.1586
DMU16	1.4891	1.0957	1.4793	1.3547
DMU17	0.9786	0.9693	0.718	0.8887
DMU18	1.0993	0.998	0.9505	1.0159
DMU19	1.1399	0.8982	0.8602	0.9661
DMU20	1.0582	0.7524	0.9478	0.9195
DMU21	0.7647	0.9711	1.0471	0.9276
DMU22	1.1854	1.1718	0.7731	1.0435
DMU23	1.0743	0.8742	1.1338	1.0274
Average	1.0641	1.058	0.9299	1.0174
Max	1.91	1.6534	1.4793	1.3547
Min	0.3327	0.7524	0.5356	0.7079
SD	0.2804	0.1884	0.2172	0.1311

The change in technical efficiency defined as the diffusion of best-practice technology in the management of the activity and is attributed to investment planning, technical experience, and management and organization in the freight transportation company. According to the table 4.5, between 2010 and 2013, the average rise in the Catch-up criteria stood at 1.0174, a slight increase of 1.74 % in the Malmquist index. This is because the Malmquist index of Catch-up criteria rose by 6.4% from 2010 to 2011. In other words, transportation companies have focused more on the technical efficiency in terms of freight transportation as long as the economy crisis recovered. This figure continued to increase by 5.8% between 2011 and 2012, but fell back by 7% in the year 2013. It is also noticeable that in the period of 3 years (2010-2013), 14 out of 23 companies (DMU1, DMU3, DMU4, DMU5, DMU6, DMU10, DMU12, DMU13, DMU14, DMU15, DMU16, DMU18, DMU22, DMU23) had the Mamlquist index which was higher than 1. Of these 14 companies, DMU 16 accounted for the highest number of Malmquist index (1.3547), accounting to a rise of 35.47%. This caused the growth of Malmquist index of Catch-up criteria in this period.

2) Components of the Malmquist productivity index: Frontier-shift

The next diagram Change values for Transportation level shows the trend of the change index frontier-shift or innovation effect. The annual frontier efficiency index for each company was shown in Table 2.

TABLE II.CHANGE VALUES FOR THE FRONTIER-SHIFT

Frontier	2010=>2011	2011=>2012	2012=>2013	Average
DMU1	1.0347	0.7841	1.3022	1.0403
DMU2	0.982	0.8013	1.4566	1.0799
DMU3	1.1024	0.5587	2.0796	1.2469
DMU4	0.8752	1.4911	0.1648	0.8437
DMU5	1.0247	0.7664	1.9845	1.2585
DMU6	1.094	0.9949	1.0598	1.0495
DMU7	1.0616	0.8385	1.484	1.1281
DMU8	1.084	0.6902	1.5951	1.1231
DMU9	1.9341	1.0029	1.3409	1.5616
DMU10	0.8115	0.6848	0.8854	0.7939
DMU11	1.0454	1.0029	0.932	0.9934
DMU12	1	1.0964	1	1.0321
DMU13	0.9901	0.883	1.1457	1.0063
DMU14	1.0614	0.7408	1.2967	1.033
DMU15	0.7335	0.7997	1.0017	0.845
DMU16	1.0195	1.2405	1.0206	1.0935
DMU17	1.0894	1.0298	1.1355	1.0849
DMU18	1.016	1.128	0.9595	1.0345
DMU19	0.7156	1.2727	1.1476	1.0453
DMU20	0.9829	1.3909	1.0773	1.1504
DMU21	0.9698	1.0121	1.1364	1.0394
DMU22	0.8778	0.9383	1.278	1.0314
DMU23	0.9746	1.1352	1.0663	1.0587
Average	1.0209	0.9688	1.1978	1.0684
Max	1.9341	1.4911	2.0796	1.5616
Min	0.7156	0.5587	0.1648	0.7939
SD	0.2266	0.2365	0.3823	0.1535

The appliance of advanced technologies is one of the primary factors, which determine the European transport company's existence. Thus, transport companies should focus on equipment and new technologies. As for the Table 1, the average increase in the Malmquist index of transport companies was 1.0684 from 2010 to 2013. In other words, there was a marginal rise of 6.84% in the Malmquist index over this period. The reason for it would be that the Malmquist index went up by 2.09% (2010-2011), and by 19.78% (2011-2013), but fell by 3.12% between 2011 and 2012.

From 2012 to 2013, 19 out of 23 companies (DMU1, DMU2, DMU3, DMU5, DMU6, DMU7, DMU8, DMU9, DMU12, DMU13, DMU14, DMU16, DMU17, DMU18, DMU19, DMU20, DMU21, DMU22, DMU23) had the Malmquist index of Frontier-shift higher than 1. Of these 19 companies, the highest Malmquist index was seen in the company DMU9, at 1.5616, comprising a rise of 56.16%. In contrast, the companies that had Malmquist index of frontier-shift lower than 1, were DMU4, DMU10, DMU11 and DMU15, with DMU making up the lowest Malmquist index (0.7939). These differences can reveal that some companies had not yet concerned about the frontier-shift, and there were not investment in new technologies (methodologies, procedures and techniques) and the commensurate skills upgrades related to it.

3) Productivity changes: The Malmquist productivity index and its decomposition

TABLE III. PRODUCTIVITY CHANGES: THE MALMQUIST PRODUCTIVITY INDEX AND ITS DECOMPOSITION

Malmquist	2010=>2011	2011=>2012	2012=>2013	Average
DMU1	1.0387	0.7841	1.3022	1.0417
DMU2	1.081	0.8589	1.1338	1.0246
DMU3	1.1024	0.5587	1.998	1.2197
DMU4	0.9752	1.9111	0.9648	1.2837
DMU5	1.9367	0.6635	1.5165	1.3722
DMU6	1.094	0.9949	1.0598	1.0495
DMU7	1.0292	1.0004	1.1153	1.0483
DMU8	1.0758	0.8679	1.0264	0.99
DMU9	0.7788	1.0759	0.9633	0.9393
DMU10	0.8115	0.6848	0.8854	0.7939
DMU11	1.0454	1.0029	0.932	0.9934
DMU12	1	1.0964	1	1.0321
DMU13	1.3991	1.46	1.0408	1.3
DMU14	1.0231	1.0382	0.9791	1.0135
DMU15	0.7335	0.7997	1.0017	0.845
DMU16	1.0195	1.2405	1.0206	1.0935
DMU17	1.0661	0.9982	0.8153	0.9599
DMU18	1.1169	1.128	0.9119	1.0523
DMU19	0.8157	1.1432	0.9871	0.982
DMU20	1.0401	1.0465	1.021	1.0359
DMU21	0.7417	0.9828	1.1899	0.9715
DMU22	1.0406	1.0995	0.9881	1.0427
DMU23	1.047	0.9924	1.2089	1.0828
Average	1.044	1.0186	1.0896	1.2173
Max	1.9367	1.9111	1.998	1.3722
Min	0.7335	0.5587	0.8153	0.7939
SD	0.244	0.2771	0.2477	0.135

Table 3 displays the calculated annual productivity changes in the European logistics and shipping industry, as represented by the Malmquist out-based productivity in DEA. As noted earlier, a greater-than-one Malmquist productivity index denotes the improvement in the performance of transportable management in the European Industrial.

Between 2010 and 2013, we can see that the Malmquist Productivity of the years 2011, 2012 and 2013 rose by 4.4%, 1.86% and 8.96% respectively, leading to the rise of 21.73% in the Malmquist Productivity. Of the 23 companies, 15 companies had the Malmquist index larger than 1, and the Malmquist index of the other 8 companies was smaller than 1. DMU5 accounted for the highest growth, at 37.22%, and DMU10 amounted to the lowest fall, at 20.61%.

During the period 2011-2012, DMU 18 had the highest productivity growth in transportation goods over the period 2011-2012, on the other hand, DMU 18 considered a decrease of 11.69% in 2012-2013. This means, these companies declined production in transportation goods. The number of transportation goods in the EU continues to increase 1.11% against these previous years. Additionally, the index of DMU 21 went up slightly in the transportation goods from 2010 to 2013. In the first period, DMU 21 had lowest index in transportation goods, which was 24.11%. In 2012-2013, this index improved gradually 20.71%. This point suggested that these companies increased production in transportation goods.

Overall, the average frontier change range of the transportation companies from 104.4% to 101.86%. Average MPI production transportation increased 92.7% from 2012 to 2013, then this index improved 108.96% the highest efficiency declined over the whole period from 2012 to 2013.

V. CONCLUSIONS

This study proposed a framework combined with DEA to evaluate the performance of European transportation companies in period 2010-2013. The authors estimate the operation circumstance of these companies in future in order to find the best performance management.

The operational performance analysis of MPI as shown in this work including operational performance productivity changes, provide meaningful implications performance management. They are useful benchmarking tool to examine the relative firm progress among competitors. In this study, from collected data applied to DEA model, we explained the operational efficiency index of each company as well as the development or change in technique, which is used in goods transport. Author analyzed efficiency of 23 European transportation companies, and then estimated the operational efficiency of each company in two specific periods 2010-2013.

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