

## **Financial Statement Analysis and Activity-Based Costing Analysis for Shipping Industry: A Data Envelopment Analysis Approach**

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**Abstract:** Ratio analysis is a commonly used analytical tool for verifying the performance of a firm. Easy computed ratios explain their wide appeal although interpretation is problematic, especially when two or more ratios provide conflicting signals. This paper built a method to measure inefficient companies in shipping industry through identifying the waste and causes. However, shipping industry needs much resource and cost-down to maintain operation efficiency. Activity-Based Costing (ABC) is an information system developed in the 1980s to overcome some limitations in traditional cost accounting and enhance its usefulness to operation management. Data envelopment analysis (DEA) is a handful method for evaluating DMU's activities. An overall operation management without ABC cannot reveal specific activity areas. Therefore, this paper combines and integrates two separated but widely used models for measuring costs and efficiency performance. The results show that a better operation management of the shipping industry, including product planning and design, quality management and control, process design and improvement, and work force management, could achieve cost reduction and improve efficiency while integrated DEA, financial statement analysis and ABC analysis.

**Key words:** operation efficiency, data envelopment analysis (DEA), activity-based costing (ABC), financial statement analysis.

## 1. INTRODUCTION

Ratio analysis is a commonly used analytical tool for verifying the performance of a firm. Finance and accounting texts devote a section to ratio analysis as a summary of accumulated knowledge necessary for the preparation of financial statements that are designed to report the performance of the entities to the stakeholders. This situation has also happened in the shipping industry. Because the service-specifics of shipping industry are capital-intensive, high debt, high financial risk, unsteady income, and highly affected by oil price and exchange rate, and so on. A good ratio analysis management is critical for successful business. However, during the late 1970s and early 1980s, the methodology of ratio analysis was considered suspect, especially by the advocates of the strong form of the efficient market hypothesis. While ratios are easy to compute, which in part explains their wide appeal, their interpretation is problematic, especially when two or more ratios provide conflicting signals.

Accordingly, financial statement analysis is a main concern of this study. This paper combines and integrates two management tools for measuring costs and performance of business units: activity-based costing (ABC) and data envelopment analysis (DEA). DEA provides a powerful, systematic tool for analyzing data generated by ABC, facilitating the statement transparency by measurement units.

ABC determines cost drivers as activity measures to allocate overhead costs more accurately than traditional cost systems. In contrast, activity-based management is not only concerned with allocating overhead costs more precisely but also tries to identify and improve inefficient activities. ABC systems are generally very expensive to implement, and many organization managers later question whether the investment was worth-while. By adding DEA to their arsenal, managers acquire a system for activity-based management that provides them with detailed quantitative performance benchmarks for individual parts of their firms or divisions—benchmarks that facilitate decision making. DEA provides each DMU with an efficiency score that has to be viewed as its relative efficiency in the set of all DMUs involved in the benchmarking. Accordingly, we combines and integrates two management tools for measuring costs and performance of business units: activity-based costing (ABC) and data envelopment analysis (DEA). Coupled with ABC, DEA becomes a scalpel that can be used to reduce waste in specific area and product line, rather than a shovel used bluntly and clumsily on organizations as a whole. The efficiency frontier facilitates firms cost reduction, change in product mix and new product development. Combination with ABC, DEA can help firms search cost drivers and resources drivers in order to reduce waste in different areas and specific product lines.

However, in the wake of the stock market crash of 1987, the level of faith in the informational efficiency of the market waned, and ratio analysis again seemed to gain ground in academic literature. Shipping industry faced with a dramatic financial crisis affected by cargo cut-down in the world in 2007. In this paper, we argue that DEA can complement traditional ratio analysis with ABC especially if the goal is to provide information regarding the operating and technical efficiency of the firm. This paper has three objects of study:

- Financial statement analysis could integrated multiple financial ratio through DEA methodology and improve past incomparable with common basis.
- In the past, ABC helps firm look for inefficiency activities, but it can impute a concise value to give the improvement information. This paper conducted DEA method to fill this gap.
- DEA method is only a goal-programming methodology. DEA is easy to be doubted about the inputs and outputs chosen. We adopt the inputs and outputs through ABC and financial statement analysis to fill this gap.

The rest of the paper is structured as follows. The next section articulates the relationship between DEA and traditional ratio analysis. In the following section the general DEA model is established and processed. The fourth section shows performance management of integration ABC with DEA for shipping industry. The last section provides some conclusions and suggestion.

## **2. LITERATURE REVIEW**

### **2.1 Financial Statement Analysis: a DEA Approach**

Financial statement analysis has traditionally been performed using a set of ratios to highlight the relative performance of a firm as compared to its industry. The number of ratios that can be computed on the basis of financial data is constrained only by the imagination of the analyst. However, only a subset of the potentially infinite number of ratios can be meaningfully interpreted. Two problems with the traditional financial statements analysis are the one ratio at a time approach and the subjective choice of specific ratios to assess the overall health of a firm. So, we propose a more integrative model incorporating much of the information contained in financial ratios.

Financial statements are a summary of the operating, financing, and investment activities of a firm over a period of time. So financial statements are supposed to contain enough information to help investors and creditors make an informed decision about investing or lending money to the company. Financial statement analysis is the ultimate key that will help investors and creditors gain enough insight into the company to make an informed decision about the company. Furthermore, financial statement analysis is also used by management to

make decisions about the firm in a more informed manner; financial statement analysis helps identify a firm's strengths and weaknesses so that management can take advantage of a firm's strengths and make plans to counter weaknesses.

Currently, the Generally Accepted Accounting Principles (GAAP) in the USA mandate that only earnings per share (EPS) related ratios is reported in the financial statements. However, consider many other ratios. Two problems with the traditional financial statements analysis are the one ratio at a time approach and the subjective choice of specific ratios to assess the overall situation of a firm. So, this paper proposes a more integrative model incorporating much of the information contained in financial ratios. DEA can be applied to performance evaluation by converting financial performance indicators to their technical efficiency equivalents. One such approach is to decompose Return on Equity (ROE) by the DuPont model. ROE, measuring the relationship of net income to common equity, can be decomposed as follows:

$$ROE = \frac{NI}{S} \times \frac{S}{A} \times \frac{A}{E} \quad (1)$$

where profit margin= net income (NI)/sales (S); asset turnovers=sales (S)/total assets (A); equity multiplier= total assets (A)/common equity (E). This decomposition facilitates the examination of ROE in terms of a measure of profitability ( profit margin), level of assets required to generate sales (asset turnovers), and the financing leverage (equity multiplier). As such, ROE encompasses measures of sales, net income, total assets, and common equity. The components given above (sales, net income, total assets, and common equity) define important dimensions of the technical efficiency of a revenue-producing organization. That is, sales, total assets, and common equity can be minimized as inputs, and net income can be maximized as an output. This view identifies a technically efficient firm as using a minimum of resources yet producing a maximum of net income.

In this way, financial ratios, commonly used to assess the financial performances of a firm, are systematically incorporated into an operational definition of efficiency; revenues are maximized subject to the constraints from employing long-term (assets and equity) and short-term (costs) resources.

## **2.2 Activities-based Costing Analysis: a DEA Approach**

Mabberly(1992) found that ABC tends to focus on longer term improvements in the delivery of activities that enable the institution to move toward its corporate goals through the monitoring of productivity, capacity utilization, efficiency and effectiveness. ABC focused on

activities, not responsibilities, and so is seen as less threatening to the managers of the various functions under review. Cooper and Kaplan (1992) concurred that many companies do not have an explicit game plan for making the transition from generating information in the ABC analysis stages to having line managers make decisions in an action stage. What emerges from the above question is the need for a model to ABC, one that converts cost data into performance measures. The basis of any performance management system should be the key performance indicators. DEA is just such a model that could solve above shortcoming. Data generated by ABC systems are ideal for enabling DEA analysis. The merge of ABC with DEA enables activity-based management by providing performance-benchmarking indicators along with a set of diagnostics for identifying problems and inefficiencies.

Charnes, Cooper, and Rhodes (1978) were the pioneer to propose the DEA methodology as an evaluation tool for decision units. DEA has been applied successfully as a performance evaluation tool in many fields including manufacturing, school, banks, pharmacies, small business development centers, and nursing home chains. Cooper, Seiford and Tone (1999) provided a comprehensive text with models, applications, references and DEA-Solver software

We employed a mathematical planning model (CCR model) to measure the efficiency frontier based on the concept of Pareto optimum. The basic idea of DEA is to identify the most efficient decision-making unit (DMU) among all DMUs. The most efficient DMU is called a Pareto-optimal unit and is considered the standard for comparison for all other DMUs. That is to say, a single firm is considered DEA Pareto efficient if it cannot increase any output or reduce any input without reducing other output or increasing other input. An efficient firm can enjoy efficiency scores of unity, while an inefficiency firm receives DEA scores of less than unity.

Efficiency is the ratio of the weighted sum of a firm to the weighted sum of inputs. The efficiency of any firm is computed as the maximum of a ratio of weighted firms to weighted inputs, subject to the condition that similar ratios, using the same weights, for all other firms under consideration, are less than or equal to one. Here, we denote the maximum efficiency as  $E_k$ ,  $Y_{kj}$  as the  $j$ th output of the  $k$ th DMU and  $X_{ki}$  as the  $i$ th input of the  $k$ th DMU. If a DMU employs  $p$  input to produce  $q$  output, the score of  $k$ th DMU,  $E_k$ , is a solution from the fractional linear programming problem):

$$Max E_k = \frac{\sum_{j=1}^q U_j Y_{kj}}{\sum_{i=1}^p V_i X_{ki}}$$

$$\begin{aligned}
 & s.t. \frac{\sum_{j=1}^q U_j Y_{rj}}{\sum_{i=1}^p V_i X_{ri}} \leq 1 \\
 & i=1,2,\dots,p; \quad j=1,2,\dots,q; \quad r=1,2,\dots,k,\dots,R \\
 & U_j, V_i \geq \varepsilon > 0 \quad \forall i, j
 \end{aligned}$$

Where  $U_j$  and  $V_i$  are the variable weights in the  $j$ th output and the  $i$ th input, respectively. The former model can be reformulated by adding  $\sum_{r=1}^R \lambda_r = 1$  to the problem, which provides valuable information about the cost benefits:

$$\begin{aligned}
 Min \quad TE &= \theta - \varepsilon \left( \sum_{i=1}^p S_{ki}^- + \sum_{j=1}^q S_{kj}^+ \right) \\
 s.t. \quad \sum_{r=1}^R \lambda_r X_{ri} - \theta X_{ki} + S_{ki}^- &= 0 \\
 \sum_{r=1}^R \lambda_r Y_{rj} - S_{kj}^+ &= Y_{rj} \\
 \sum_{r=1}^R \lambda_r &= 1 \\
 \lambda_r \geq 0, \quad S_{ki}^- \geq 0, \quad S_{kj}^+ \geq 0, \quad \forall i, j, k, r
 \end{aligned}$$

Where  $\theta$  is the efficiency score and  $\varepsilon$  is a non-archimedean quantity which is very minute. We can calculate the relative efficiency score from the above model and further estimate the targeted value for each output/input of each shipping companies.

### 3. RESEARCH METHDOLOGY

ABC and Financial statement analysis plus DEA are almost an obvious marriage. Indeed, in its early years, linear programming (of which DEA is a variant) was sometimes referred to as activity analysis (Dorman *et al.*, 1958). DEA Algorithm could examine whether individual units are obtaining the most output out of their given inputs for each individual activity or profit center. Together ABC and Financial statement analysis provide a two-dimensional portrayal of a business across individual operating units and individual inputs and outputs.

The clearer picture from ABC systems led naturally to activity-based management (ABM). ABM enables the organization to accomplish its outcomes with fewer demands on

organizational resources; that is, the organization achieves the same outcomes at a lower total cost. ABM accomplishes its objective through two complementary applications: operational and strategic ABM (see Figure 1). Operational ABM—doing things right—works to enhance efficiency, lower costs, and enhances asset turnovers. Operational ABM can increase the capacity of resources (equipment and people) by reducing machine downtime, improving operation activities and processes, and increasing the efficiency of the organization’s resources. The benefits from operational ABM can be measured by reduced costs, higher revenues (through better resource utilization), and cost avoidance.

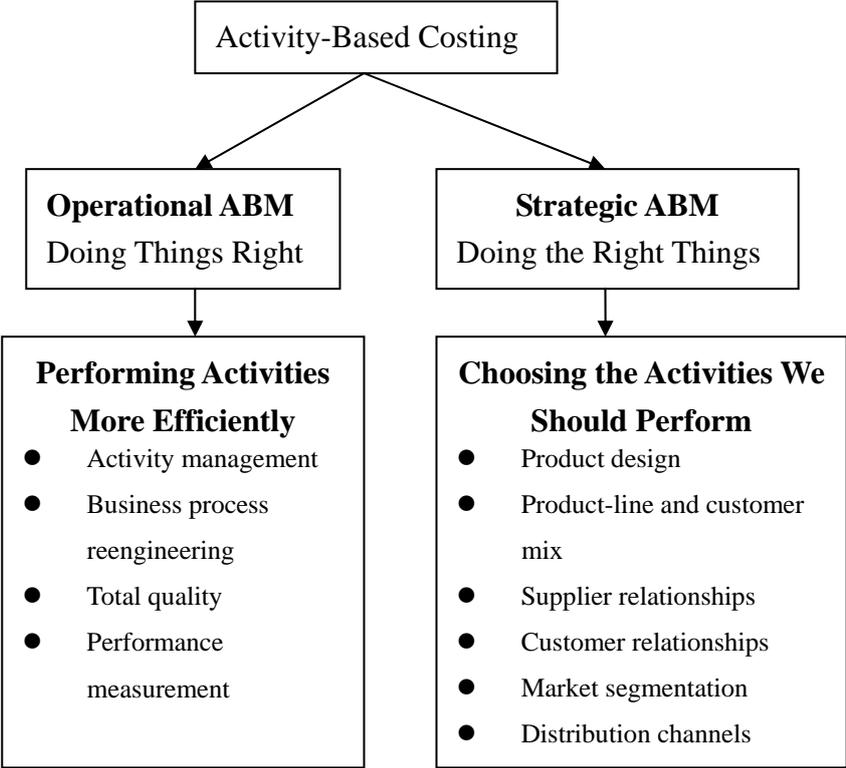


Figure 1. Using ABM for Operational Improvements and Strategic Decisions (adapted from Kaplan and Cooper; 1998, p. 4)

Strategic ABM—doing the right things—attempts to alter the demand for activities to increase profitability while assuming, as a first approximation, that activity efficiency remains constant. Strategic ABM encompasses shifting the mix of demand for activities away from such unprofitable applications by reducing the cost driver quantities demanded by unprofitable activities. Managers can then shift the activity mix toward more profitable uses. They can also use ABC information to choose suppliers that are low-cost, not just low-price. Strategic ABM also encompasses decisions about product design and development where perhaps the biggest opportunity for cost reduction exists.

Concisely, activity-based cost accounting (ABC) breaks cost estimation into four separate stages: (1) identifying activities, (2) assigning resource costs to activities, (3) identifying outputs, (4) linking activity costs to outputs. It differs from traditional cost accounting, which assigns cost directly to output (Cooper and Kaplan, 1992). Generally, the performance management decision-making process has been defined to constitute decision responsibility in five major areas: Product planning and design, quality management and control, process design and improvement, inventory management and work force management (Schoreder, 2000). Because the characteristics of shipping industry are intangible product and non-stored, we ignore the inventory management. In this paper, we develop operation function and cost reduction for shipping industry of Taiwan from above four major areas.

Ratio analysis helps to show whether the firm's position has been improving or deteriorating relative to its own past or other firms in the industry or industry averages. By benchmarking the firm's financials against its own peers or industry averages, management can identify the relative strengths and weaknesses of the firm and plan better for the future. Benchmarking will also help investors and creditors better understand the relative position of a firm in the industry and make investment/lending decisions in a more informed manner. In this paper, we illustrate the use of data envelopment analysis, an operations research technique, to analyze financial statements of firms by benchmarking financial ratios of a firm against its peers as well as against the industry averages. We use the shipping industry as an example in this study to conduct our analysis and show the advantages of data envelopment analysis in benchmarking a firm. Data envelopment analysis also helps identify the areas in which a firm has strengths relative to competition as well as the areas in which the firm is weak relative to competition. Furthermore, data envelopment analysis also lays the areas in which a firm needs improvement relative to its peers and by how much improvement is needed in each of those areas.

The focus of this paper is to implement a system for internal benchmarking that would compare inefficient firms with relatively efficient ones. From the outset, we ran out project not as a consultancy model, aimed primarily at providing externally generated advice, recommendations, and reports, but rather as a practitioner model, aimed at providing an internal tool managers could understand well enough to use themselves. This paper tackles the project in four major areas by integration with financial statement analysis and activities-based costing analysis with data envelopment analysis: Service planning and design, quality management and control, capacity and investment management and work force management.

## **4. EMPIRICAL RESULTS**

This paper designs and implements an operational system by integrating financial statement analysis, ABC with DEA at shipping firms. The objective of our ABC-Plus-DEA project is to provide firms and area managers with an operational tool that could diagnose underutilized resources not readily visible with existing accounting tools. DEA of the efficiency of each firm in converting inputs into outputs yields valuable information on best-practice firms. To make best comparison meaningful, it is necessary to compare each firm with other firms that are similar to it in some sense with regard to business environment, mix of activities, and size. Hence, Kantor and Maital (1999) conducted a cluster analysis on the finance bank's branches, dividing them into similar groups, with each group internally homogeneous. This paper utilizes this service groups to application with DEA, financial statement analysis and ABC for shipping industry.

### **4.1 Service Planning and Design**

An ABC/M system can provide useful insight into service design decisions. Traditionally, cost accounting's allocation that based on machine hours or direct labor hours does not provide a clear picture of the true allocation of resources. Banker et al. (1990) conducted a research that product costs thus become distorted, leading to a biased analysis of design for manufacturability, product profitability, outsourcing, and make or buy decisions.

Service design should be a group process with input from marketing, finance and operations. Unfortunately, each of these groups tends to look at design from their individual perspectives. ABC helps the process of synthesizing these different perspectives by identifying specific cost drivers. Once this driver is recognized, service designs can be modified with the goal of reducing or eliminating unnecessary setup changes, thus lowering the cost. Financial managers could choose relative and meaningful inputs and outputs through DEA method and realize how to make better performance. About service planning and design, we examine the cost drivers of shipping industry through ABC methods; the average time in transit and frequency of sailing chosen as DEA inputs in order to attain timeliness of service. In order to obtain well financial performance, through financial statement analysis, this paper choose fixed assets turnovers ratio as output. So these attributes could be chosen as input and output from DEA analysis. The result of analysis can offer managers to know how to improve bad conditions and better the sailing route planning and design.

## **4.2 Quality Management and Control**

The ABC/M can play a well trade-off role in the quality control and cost reduction. Because it includes non-value added activities in the costs, ABC/M can provide the information that allows a firm to determine what impact each project would have, and therefore a means to determine which ones to pursue first. Without this insight into prioritization, a firm can pursue several low impact improvement projects at great cost and little gain, while overlooking other projects that might have a tremendous impact.

ABC/M information can also play a role in quantifying the costs of quality. What are the costs of quality? There are four categories: (i) prevention (i.e. costs of activities performed to prevent errors from occurring); (ii) appraisal (i.e. costs of inspection such as determining if the product conforms to standards); (iii) internal failure (i.e. the costs of correcting errors before they reach the final customer, such as scrap, rework and change orders); and (iv) external failure (i.e. costs associated with errors that reach the final customer, such as correcting the error, handling complaints.) Many of these quality costs can be categorized as non-value added costs that would not have been identified with traditional cost accounting (Schneider, 1992).

The services of shipping industries are focus on rapid responses, timeliness, and freight on good condition. They could utilize ABC to reduce unessential cost and obtain the best quality management and control. There are many non-valued activities on cost accumulation. We could realize how to make better service through DEA analysis. This paper chooses RFID cost and document handling cost as inputs of DEA. In order to attain high Quality Management and Control, we choose assets turnovers ratio as output of DEA. ABC/M simplifies the determination of quality costs by revealing such activities and their costs, which can be used in detecting and correcting activities if applying DEA analysis.

## **4.3 Capacity and Investment Management**

ABC/M systems help firms understand the link between increasing owner's profit and minimizing unused capacities. With an ABC/M system, these costs are isolated and measured in three parts: idle, non-productive, and productive. The capacity of shipping industry is related with buy or rent decision for shipping companies. If cargos demand increase, shipping companies may rent ships instead of buy ships to make more profits. Because firms must achieve a high return on investment through investment management, they must make a finance decision deliberately. In order to choose better investment project, ABC/M systems can improve the accuracy of cost data to help in prioritizing quality improvement projects,

they can provide information to help assess capacity decisions. Through DEA analysis, managers can realize how to choose the valuable investment project. So the attributes about ability to provide specialized equipment or service arrangements when required, cleanliness and condition of containers, quality and availability of handling equipment and adequacy of storage facilities. This paper chooses containers investment and handling costs as input of DEA. In order to attain maximum investment profits, we choose returns on equity (ROE) as output of DEA.

#### **4.4 Work Force Management**

Turney (1993) conducted a research that the ABC process can have a significant impact on a firm's employees, particularly in areas of employee empowerment and accountability, roles and responsibilities, and performance measures. ABC starts with identifying activities that are performed in a firm. An excellent starting point for gathering ABC information is the front-line employee. (Gupta, M.; Galloway, K., 2003)

With ABC system, performance measures can be described in meaningful terms. An employee becomes aware of how his activities contribute to the firm's financial performance. In order to attain useful evaluation results, we could know not only how employees are currently contributing, but also how employees might improve his performance to increase that contribution through DEA analysis. Integration ABC with DEA can be used establish benchmarks, which can be used as a basis for performance evaluation. Through DEA analysis, we can rank the business units and select the inefficiency units to close in order to obtain more revenue and cut-off cost.

#### **4.5 DEA Analysis**

Through financial statement analysis and ABC, ABC could find cost drivers to reduce inefficiency activities. These cost drivers include average time in transit, frequency of sailing, RFID cost, document handling cost, and containers investment/handling costs. This paper link financial statement analysis and chosen the substitute variable as input item of DEA. Operating expenses could stand for average time in transit and frequency of sailing. Fixed assets could stand for RFID cost and container investment. Receivable turnover in days could stand for document handling cost. So this paper had chosen operating expenses, fixed assets and receivable turnover in days as inputs of DEA. Financial statement analysis could view firm's profitability and return on investment. Three outputs, fixed assets turnovers ratio, assets turnovers ratio, and returns on equity (ROE) are utilized as outputs of DEA. So we chose 14 open market shipping companies as DMUs and collected the data of two input variables and two output variables from TEJ (Taiwan Economics Journal) database in 2007.

This paper applies DEA to fourteen Taiwanese open-market shipping companies: First Steamship, EVERGREEN, Sincere Navigation, U-Ming, EVERGREEN INTERNATIONAL, TaJung, YML, TZE SHIN, Chinese Maritime Transport (CMT), China Container Terminal (CCT), EMIC, WAN HAI, TAIWAN NAVIGATION, and SHIH WEI NAVIGATION for evaluation. The 14 issued shipping firms' data list on Table 1.

**Table 1 14 shipping firms' data regarding ABC and financial statement analysis**

<b>Open-market shipping firms</b>	operating expenses	fixed assets	receivable turnover in days	fixed assets turnovers ratio	assets turnovers ratio	returns on equity (%)
First Steamship	99,628	978,309	2.16	0.3	0.06	24.37
EVERGREEN	2,507,373	10,785,775	14.34	2.73	0.32	16.35
Sincere Navigation	91,564	969,822	8.36	125.47	10.13	30.09
U-Ming	169,133	1,261,325	55.98	1.76	0.07	40.03
EVERGREEN INTERNATIONAL	170,528	9,419,610	33.24	0.5	0.21	4.6
TaJung	4,219,596	8,118,971	65.29	0.72	0.55	-6.15
YML	2,102,064	17,594,143	10.85	6.49	1.3	12.91
TZE SHIN	97,049	560,313	33.12	1.85	0.21	4.61
CMT	204,682	421,703	37.9	4.3	0.17	45.11
CCT	82,867	3,050,947	40.1	0.47	0.36	10.57
EMIC	1,063,480	3,313,269	50.55	2.85	0.44	9.8
WAN HAI	2,017,490	10,430,001	3.86	5.68	0.99	19.95
TAIWAN NAVIGATION	164,854	1,149,603	7.93	2.05	0.26	22.48
SHIH WEI NAVIGATION	110,952	265,204	21.27	1.04	0.04	29.57

The estimated efficiencies for the 14 issued shipping firms in Taiwan, along with their rank orders and rating results are shown in Table 2. As explained before, these efficiencies were computed for each DMUs after taking into consideration the inputs and outputs of all 14 issued firms in the set. Hence these efficiencies are relative ratings implication. Moreover, the high rating firms (whose efficiency = 1) were used as the benchmarking. Therefore, these rating results represent relative-to-best efficiencies.

**Table 2 Shipping firm's DEA efficiency and ranking results**

Open-market shipping firms	DEA Efficiency	rank
First Steamship	0.251982	10
EVERGREEN	0.117633	14
Sincere Navigation	1	1
U-Ming	0.472423	6
EVERGREEN INTERNATIONAL	1	1
TaJung	0.118848	13
YML	0.12964	12
TZE SHIN	0.449175	7
CMT	0.233512	11
CCT	0.269939	8
EMIC	1	1
WAN HAI	0.260567	9
TAIWAN NAVIGATION	1	1
SHIH WEI NAVIGATION	1	1

Now, with such results, we can examine DEA efficiency. To begin with, there are five shipping firms, as Sincere Navigation, EVERGREEN INTERNATIONAL, EMIC, TAIWAN NAVIGATION and SHIH WEI NAVIGATION firms which have higher efficiency value, where its DEA efficiency value is 1.00. This demonstrates these shipping firms paid more attention on quality Management and Control and service planning and design if using ABC and financial statement analysis. These high efficiency firms are mostly tramp shipping companies. The last inefficiency firms most focus on liner shipping firms, such as EVERGREEN, YML, WAN HAI. Although EVERGREEN and YML are top no. 4 and no. 14 of carriers in the world in 2007, the liner shipping firms spend most inefficiency activities: average transit time, handling document cost and RFID cost. These firms could view the cost driver through ABC method to improve profitability. In quality management and service planning and design aspect, inefficiency firms could reduce operating expenses through re-arrange transit route and e-learning system to avoid unnecessary cost and expenses.

## 5. CONCLUSIONS AND DISCUSSION

ABC and financial statement analysis provide concrete recommendations for improving efficiency according to various types of outputs if using the DEA computation. This paper

presented an actual application of ABC, financial statement analysis with DEA analysis in the shipping industry. DEA is an interesting and useful method for evaluating the shipping industry. The most important advantage of DEA for benchmarking activities is that it is able to identify low activities on the basis of aggregate activity information. But DEA cannot find spotting weaknesses in specific activity areas without ABC and financial statement analysis. The results show five shipping firms, as Sincere Navigation, EVERGREEN INTERNATIONAL, EMIC, TAIWAN NAVIGATION and SHIH WEI NAVIGATION firms which have higher efficiency value. These high efficiency firms are mostly tramp shipping companies and could carry out benchmarking within a firm's specific reference group. The last inefficiency firms most focus on liner shipping firms, such as EVERGREEN and YML. The two liner shipping firms are top no.4 and 14 carriers in the world in 2007, but they had wasted much resource in operating activities. Their management board should re-arrange operation activities through ABC method and sensitivities of financial statement analysis. If it can avoid inefficiency activities, it can improve profitability in the future. The further research could find which activities cut-down could increase more return on investment. Lin *et al.* (2005) showed that the sensitivity of earnings per share for shipping companies is a good tool for managers to increase the profit.

So the combination of ABC, financial statement analysis and DEA provide concrete recommendations for improving efficiency according to various types of outputs. The results of this paper show that a better performance management, including service planning and design, quality management and control, process design and improvement and work force management could achieve cost reduction and improvement efficiency if implemented DEA. This paper combined ABC and DEA with financial statement analysis, so that we could carry out benchmarking within a firm's specific reference group (with which it shares many common features) if we considered the application of financial statement analysis.

#### **ACKNOWLEDGEMENTS**

This work was supported by National Science Council, Taiwan, ROC under grant NSC 97-2410-H-231-010-SSS. The authors would like to thank anonymous reviewers for their helpful comments on this paper.

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