

*Full Length Research Paper*

# Analysis of debt-paying ability for a shipping industry in Taiwan

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The debt financing market is an integral part of the global financial system. A company partially financed by debt faces bankruptcy danger. Although financial statement analysis covers more ratio approaches to viewing a firm's liquidity, leverage, asset activity, profitability and performance, it cannot integrate a diverse ratio to analyze firm's debt-paying ability. This paper employs data envelopment analysis to evaluate debt-paying ability of the shipping industry in Taiwan. After verifying all available financial information, the current study chooses a total of fourteen shipping open-market firms for analysis. The estimated results show that five shipping firms have relatively high debt-paying ability. This paper compares DEA rating results with the Taiwan Rating Company (TRC)'s ratings to increase the contribution. Empirical results show that EVERGREEN pays more attention than other shipping firms to reducing default risks and creating revenue competency.

**Key words:** Debt-paying ability, data envelopment analysis (DEA), default risks.

## INTRODUCTION

A company partially financed by debt faces bankruptcy danger. Bankruptcy danger takes place when a debt payment is due and the company does not have sufficient cash on hand. The important determinants of corporate debt financing choices are identified as follows: amount of fixed assets, firm size, growth opportunities, risk, profitability and tax debt shield (Opler and Titman, 1994; Rajan and Zingales, 1995; Booth et al., 2001 and Gonenc, 2003). The debt financing market is an integral part of the global financial system. Several international finance literatures (Fridson, 1989; Fabozzi and Cheung, 1990; Altman, 1992) examine corporate debt credit analysis; however, no explicit model is made with regard to analyzing corporate debt-paying ability. Industrial corporate bonds have been assigned quality ratings since the early 1900s. Several international private organizations (such as Moody and S&P) have been assigning ratings to a portion of new bonds issued each year. Besides the limited scope of these bond ratings, some industry executives and investors alike have not

had complete confidence in the effectiveness of such bond ratings. Thus, many experts have expressed a need for an impartial and reliable ratings model that might provide useful information for investors and managers.

Although a financial statement analysis covers more ratio approaches to viewing a firm's liquidity, leverage, asset activity, profitability, and performance, it cannot integrate the diverse ratio to analyze firm's debt-paying ability. Data envelopment analysis fills this gap. Considering debt-issue circumstances, the main purpose of bond ratings is to reach an effective evaluation as to the ability and legal obligations of an issuer to make timely payments of principal and interest on a security over the life of the instrument. A bond rating is also designed to rank, within a consistent framework, the relative risk of each debt issue and issuer. When an issuer and each debt issue value bond pricing, a bond rating is also the major determinant for corporate managers on the pricing spread of bond offerings (Grammenos and Arkoulis, 2003). In arriving at an issuer's rating, international rating organizations typically stress examining specific circumstances of each issuer and each debt issue. The risk to timely payment is calculated by measuring issuer's ability to generate cash in the

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future. Of particular concern is management's ability to sustain cash generation in the face of adverse and ever-changing circumstances in today's business environment. Generally, the greater the predictability of an issuer's cash flow, the higher the issuer's ratings. Cash flow, which is crucial from the default risk point of view, is computed by means of primary variables, with a feedback effect.

A geographically diversified shipping industry operating in several countries may have the opportunity to use more debt than other industries. The reason is that the shipping industry is able to diversify its cash flows and, therefore has potentially less fluctuation in profits and lower bankruptcy risk. Other higher debt financing factors of the shipping industry are liquidity and hedging. To reduce firm's default risk and protect investors' rights and interests, building a clear-cut analysis model of debt-paying ability is of great urgency to help the shipping industry improve financial profitability, but to also help investors make more reliable investment decisions.

## LITERATURE REVIEW

The finance literature revisits that some determinants have consistent effects on firm's debt-paying ability. The fluctuation in operating profits is one affected determinant used to measure bankruptcy risk. A firm with a high level of bankruptcy risk is not expected to have a high level of debt. The uncertainty of operating profits is related to the variable demand for debt-paying ability. In times of prosperity, we can expect a high level of operating profits and in these circumstances debt-paying ability should be favorable. Low demand indicates a poor economy, and debt-paying ability will most likely be poor. Another determinant is the adverse relationship between profitability and debt ratio. Myers and Majluf (1984) explain this relationship by the pecking-order theory that highlights the low level of debt financing and lower debt ratio of high debt-paying ability firms.

The other determinant of debt-paying ability is the effectiveness level of tangible fixed assets. A high level of tangible fixed assets creates more collateral for a firm, helping a firm to raise more debt. Booth et al. (2001) argue that the relationship between tangible fixed assets and debt financing is related to the maturity structure of debt. In this case, efficient tangible fixed assets turnover may help firms increase long-term debt-paying ability. Another determinant is the firm's liquidity (the ability to convert to cash). Liquidity is explained as the company's ability to pay its current liabilities as they fall due. Examining a firm's liquidity by comparing current assets with current liabilities indicates short-term debt-paying ability of the entity. Several comparisons such as working capital, current ratio, acid-test ratio and cash ratio determine this ability.

A number of previous studies have related bond ratings

to default frequency. Several literatures indicate that some relationship exists between bond ratings and historical records of bond default (Harold, 1938; Hickman, 1958; Atkinson and Simpson, 1967; Altman, 1990). This study also examines firm's debt-paying ability through the bond ratings system. Taiwan has two noted bond ratings organizations: the Taiwan Economic Journal (TEJ) and the Taiwan Ratings Company (TRC). The ratings criteria are based on qualification factors and quantification factors. Qualification factors include a company's norm, record of past interest payment, management competency and morality, market share, range of prosperity, industry vision and payment method. Quantification factors are reflected by solvency and operational conditions of the issuer, profitability, debt-paying analysis and asset efficiency. However, these bond ratings procedures are somewhat complicated, unclear, and somewhat incredible to many investors and issuers. Therefore, this paper constructs a clear, logical and comprehensible procedure to revisit firm's debt-paying ability.

Previous literature typically uses related financial indicators to measure debt-paying ability in the shipping industry, often leading to a problematic weight assignment for each indicator. The financial ratio method is an appropriate method when firms use a single input or generate a single output. However, as with many firms, employing various inputs to provide a variety of services (outputs) is necessary. Which ratio evaluators select becomes an issue when a great number of related financial indicators are involved. One type of solution is to aggregate the average among all indicators to integrate a single measurement. The DEA approach can be particularly applied to solve the above-mentioned weight assignment dilemma. This approach draws on a mathematical programming method to generate a set of weights for each indicator. While considering how to improve debt-paying ability, the DEA approach also ranks efficiency scores of individual firms.

Other literatures (Goh and Ederington, 1999; Dichev and Piotroski, 2001) argue that improving debt-paying ability has positive relations on stock profitability and performance. This paper also focuses on relative comparisons of debt-paying ability of entities and bond ratings results. Finally, this work examines the positive relationship of bond ratings and stock investment performance and profitability from past literature. Debt-paying ability analysis affects investor or creditor decisions and can be an improvement indicator for operational performance. Thus, this paper builds a clear and plausible debt-paying ability analysis model for applying data envelopment analysis.

## METHODOLOGY

Many literatures revisit firm's debt-paying ability using a multiple regression model, discrimination analysis, or probit model. Only

DEA methodology solves the financial ratio indicator to employ various inputs to provide a variety of services (outputs). The DEA also solves the weight assignment dilemma and draws on a mathematical programming method to generate a set of weights for each indicator.

Charnes et al. (1978) first proposed 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, academic institutions, banks, pharmaceutical firms, small business development centers, and nursing home chains. The present study applies this method to analyze the shipping industry debt-paying ability. The DEA is a non-parametric approach for evaluating relative efficiency of decision-making units (DMUs) using multiple inputs to produce multiple outputs. 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, a single firm is considered DEA Pareto efficient if it cannot increase any output or reduce any input without reducing other output or increasing any other input. A good debt-paying ability firm enjoys higher efficient scores, while a bad debt-paying ability firm receives DEA scores less than other units.

Four models are included in DEA analysis, as the CCR, BCC, Additive, and Slacks-based Measure (SBM) model (Cooper et al., 2000). Though the other three models cannot solve invariant units and negative input or output problems, this study employs the SBM model to measure the shipping industry debt-paying ability. The SBM model yields the same efficiency value when distances are measured in either kilometers or miles and have the following important properties: The measure is invariant with respect to the unit of measurement of each input and output item, and the measure is monotone decreasing in each input and output slack.

To estimate the efficiency of a DMU  $(x_0, y_0)$ , we formulate the following fractional program in  $\lambda, S^-, S^+$  and  $\rho$ :

$$\rho_o = \text{Min} \frac{1 - \frac{1}{m} \sum_{i=1}^m S_i^- / x_{io}}{1 + \frac{1}{s} \sum_{r=1}^s S_r^+ / y_{ro}}$$

$$s.t. \quad x_{io} = \sum_{j=1}^n x_{ij} \lambda_j + S_i^-, \quad i = 1, 2, \dots, m;$$

$$y_{ro} = \sum_{j=1}^n y_{rj} \lambda_j - S_r^+, \quad r = 1, 2, \dots, s;$$

$$S_i^- \geq 0, i = 1, 2, \dots, m; S_r^+ \geq 0, r = 1, 2, \dots, s$$

It is readily verifies that the objective function value  $\rho$  satisfies invariant units because the numerator and denominator are measured in the same units for every item in the objective of the

above equation. Furthermore, we have  $0 \leq \rho \leq 1$ , and the SBM model can be transformed into the program below by introducing a positive scalar variable  $k$ .

$$k, S^-, S^+, \text{ and } A:$$

$$\rho_o = \text{Min} \quad k - \frac{1}{m} \sum_{i=1}^m S_i^- / x_{io}$$

$$s.t. \quad 1 = t + \frac{1}{s} \sum_{r=1}^s S_r^+ / y_{ro}$$

$$kx_{io} = \sum_{j=1}^n A_j x_{ij} + S_i^-, \quad i = 1, 2, \dots, m;$$

$$ky_{ro} = \sum_{j=1}^n y_{rj} - S_r^+, \quad r = 1, 2, \dots, s;$$

$$A_j = k\lambda_j \geq 0, j = 1, 2, \dots, n; S_i^- = ks_i^- \geq 0, i = 1, 2, \dots, m;$$

$$S_r^+ = ks_r^+ \geq 0, r = 1, 2, \dots, s; k > 0$$

This paper follows bond ratings criteria of the Taiwan Economic Journal (TEJ), including qualification factors and quantification factors. Since qualification factors are difficult to obtain and measure, this study chooses quantification factors to serve as measurement indicators. Following the financial literature, quantification factors include firm's operating profits, debt ratio, fixed asset efficiency, and liquidity. According to financial statement analysis, without enough earnings, a corporation cannot produce enough revenue to pay back long-term liabilities. Moreover, long-term debt-paying ability has a positive relationship with operating profits. With a sound capital structure, a corporation will have a lower debt ratio, representing lower default risk. Long-term liabilities make use of long-term assets (fixed assets). Generally, fixed assets turnover is used to measure how well a corporation creates sales and profits, especially shipping industry have a high percentage of ships for the fixed assets. Liquidity represents a firm's ability to accommodate decreases in its liabilities and its ability to fund increases in its assets. A firm has adequate liquidity when it can obtain sufficient funds either by decreasing liabilities or by converting its liquid assets promptly into cash at a reasonable cost. This paper selects two input variables: fixed assets and debt ratio. Considering the direct relationship between input variables and output variables, the current work chooses fixed assets turnover and current ratio as output items.

Fixed assets are tangible long-term assets used for continuing business operation. They represent a place to operate (especially operational ships) and the equipment to produce, sell, deliver, and service the company's service. They are therefore also called operating assets or, sometimes, tangible assets, long-lived assets, or plant assets. Debt ratio shows the proportion of the company financed by creditors in comparison with that financed by stockholders. Fixed assets turnover is computed by dividing net sales by average fixed assets; the current ratio is computed by dividing current assets by current liabilities.

## EMPIRICAL ANALYSIS

Unlike regression, DEA does not impose any particular functional form on the data, creating a more flexible piecewise linear function. Therefore DEA is a good tool to evaluate enterprises' performances. In this study, there is a DMU in one company. The empirical results serve as a valuable diagnostic tool for observing the efficiency score of each individual unit, and for providing direction in managerial auditing through slack analysis.

The shipping industry has capital-intensive, high debt ratio, high financial risk, unsteady income, and is highly

**Table 1.** Input/output variables of Taiwan's 14 open-market shipping companies.

Shipping firms	Input		Output	
	Fixed assets (Thousands dollars)	Debt ratio (%)	Fixed assets turnover (%)	Current ratio (%)
First Steamship	996,361	30.52	0.05	68.68
EVERGREEN	9,648,175	32.61	3.78	91.53
Sincere navigation	1,089,768	9.45	68.71	113.37
U-Ming	1,424,057	16.23	1.56	104.31
EVERGREEN international	9,588,340	14.13	0.45	268.86
TAJUNG	8,372,264	45.44	0.67	109.35
YML	15,363,071	48.10	5.99	152.69
TZE SHIN	582,421	54.30	1.80	136.00
CMT	402,021	37.01	3.75	39.16
CCT	3,004,671	62.82	0.46	179.29
EMIC	2,576,569	17.57	4.40	319.46
WAN HAI	12,164,440	44.96	4.20	276.00
Taiwan navigation	806,412	23.29	2.81	212.25
SHIH WEI Navigation	275,100	20.94	1.31	131.13

**Table 2.** Shipping firm's debt-paying ability and rating results of firms using DEA.

Open-market shipping firms	DEA efficiency	Rank	TRC rating
First Steamship	0.251982	10	twBB
EVERGREEN	0.117633	14	twB
Sincere Navigation	1	1	twAA
U-Ming	0.472423	6	twBBB
EVERGREEN international	1	1	twAA
TaJung	0.118848	13	twB
YML	0.12964	12	twB
TZE SHIN	0.449175	7	twBBB
CMT	0.233512	11	twBB
CCT	0.269939	8	twBB
EMIC	1	1	twAA
WAN HAI	0.260567	9	twBB
Taiwan navigation	1	1	twA
SHIH WEI navigation	1	1	twA

affected by oil price and exchange rate. Evaluating debt-paying ability is therefore a very important criterion for investors and managers. After financial crisis happened, shipping industry faced transportation loading shortage in 2008. The current study chooses fourteen open-market shipping companies as DMUs and collects the data of two input variables and two output variables from the 2008 TEJ (Taiwan Economics Journal) database. This paper applies DEA to evaluate 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. Table 1

shows input and output variables of the fourteen companies.

This table represents Taiwan shipping firm's financial conditions. Most shipping firms have higher debt ratio, especially liner shipping (YML and WAN HAI) firms and container transportation (CCT and TaJung) firms. Tramp shipping firms have lower debt ratio, respectively. Because liner shipping and container transportation firms are capital-intensive, high in debt, with high financial risk, unsteady in income, and highly affected by oil prices and exchange rates, these firms possess a bad capital structure. From a fixed assets efficiency perspective, Sincere Navigation has the highest fixed assets turnover and utilizes its fewer fixed assets to create more operating revenue. Financially, the current ratio displays

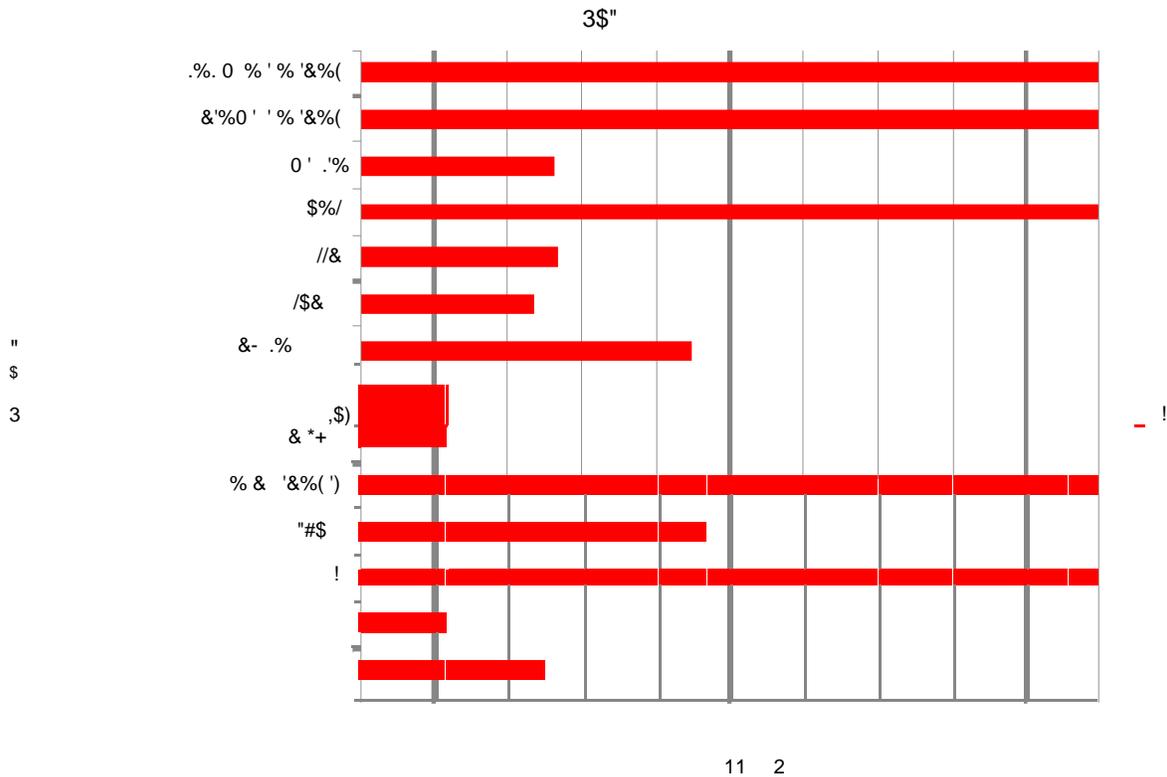


Figure 1. The efficiency graph for shipping firms.

Table 3. Sensitivity analysis of debt-paying ability for EVERGREEN.

Variable name	Estimated weight	Value measured	Value if efficient	Slack
Fixed assets turnover	0.0008	3.78(%)	3.78(%)	0
Current ratio	0.0012	91.53(%)	91.53(%)	0
Fixed assets	5.1823	\$ 9,648,175(thousands)	\$ 8,903,369 (thousands)	\$ 744,805 (thousands)
Debt ratio	0.0153	32.61(%)	5.16(%)	27.45(%)

firm's liquidity. The current ratio of most shipping firms is greater than one. Furthermore, EMIC has the best liquidity condition compared to the others. Table 2 shows the comparison between DEA efficiency and rating results in the first analysis, using four variables (2 outputs and 2 inputs) in DEA.

Table 2 shows estimated efficiencies for the fourteen issued shipping firms in Taiwan, along with their rank orders and rating results. These efficiencies were computed for each DMU after considering the inputs and outputs of all fourteen issued firms in the set. Hence these efficiencies imply relative ratings. Moreover, this investigation uses high rating firms (whose efficiency = 1) for benchmarking. These rating results therefore represent relative-to- best efficiencies. From the table 2 representation, this work observes that the DEA computation results are consistent with rating results from the Taiwan Rating Company. This result represents that

investors and decision managers could employ this easy and understandable tool (DEA) to verify all desired financial information and bond ratings.

Using these results enables examining DEA efficiency. To begin, five shipping firms, Sincere Navigation, EVERGREEN INTERNATIONAL, EMIC, TAIWAN NAVIGATION and SHIH WEI NAVIGATION have higher efficiency value and rating results in 2008 (shown as Figure 1), where rating efficiency value is 1.00. This demonstrates that these shipping firms paid more attention to reducing default risks and creating revenue competency. These high debt-paying ability firms are mostly tramp shipping companies. Fixed assets turnover and current ratio account for significant high debt-paying ability. However, EVERGREEN, despite its worldwide class shipping status, has a negative debt-paying ability rating efficiency value of 0.1176 in 2008. Such results illustrate that EVERGREEN must pay more attention to

improving its debt conditions progressively.

Sensitivity analysis takes a closer look at each of the inefficient firms at each firm level. For example, Table 3 shows sensitivity analysis results for EVERGREEN. This table shows the amount of slack in each of the controllable input and output observations for this firm. This slack is computed by comparing the input and output of EVERGREEN with inputs and outputs of its efficient reference firms. EVERGREEN can become efficient (increase efficiency from 0.1176 to 1.00) by decreasing slack in the listed input items. Its reference sets are similar to the financial situation of Sincere Navigation and to EMIC in 1996. Table 3 shows that EVERGREEN can decrease fixed assets \$744,805(thousands) (such as transportation, stevedoring and ship facilities, etc.) and increase capital structure, decreased from 32.61 to 5.16%. This paper suggests that EVERGREEN could obtain higher debt-paying ability by reducing inefficient fixed assets.

## CONCLUSION AND SUGGESTIONS

This paper employs data envelopment analysis to evaluate debt-paying ability of the shipping industry in Taiwan. After verifying all available financial information, this investigation analyzes fourteen open-market firms. The estimated results show that five firms have relatively high debt-paying ability, with a high overall rating level. High efficiency is demonstrated by Sincere Navigation, EVERGREEN INTERNATIONAL, EMIC, TAIWAN NAVIGATION and SHIH WEI NAVIGATION firms in 2008. These empirical results also show that EVERGREEN pays more attention to reducing default risks and creating revenue competency.

This paper also compares DEA rating results with the Taiwan Rating Company (TRC)'s ratings to increase the contribution. A lower rating can effectively promote resource utilization efficiency by reducing inefficient fixed assets and debt ratio. This work also compares the data envelopment analysis results to firm's rating results by the Taiwan Rating Company as a decision reference for investors and managers. Thus, we conclude that four variables, fixed assets, debt ratio, fixed asset turnover and current ratio have higher discrimination to judge firm's ratings. We encountered some key limitations in our research. Some of the rating processes, which analysts typically review, include the following: market share and competitive position, cost structure and capital, financial flexibility, quality of management, and strategic direction. Considering these qualification factors contributes to a more complete and objective bond ratings process. The further research could attain the the bond ratings determinants and corporate debt-paying ability factors if using AHP (Analytic Hierarchy Process) technique. (Lin and Yahalom, 2009)

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