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A RISK SCORING MODEL AND APPLICATION TO MEASURING INTERNET STOCK PERFORMANCE

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This paper proposes a risk scoring model to assess the performance of 27 US companies listed online by applying Data Envelopment Analysis (DEA) and comparing with the traditional financial measure Return on Equity (ROE). The DEA evaluation process involves two processes: (1) computation of operating efficiency and effectiveness to measure a company's operating performance, and (2) measurement of the return level per unit of risk to provide guidance for their investors. The risk scoring model is useful for both investors and company managers. For investors, it yields a new stock selecting strategy. For managers, it provides a risk-adjusted performance evaluation process. Empirical results show that for the Internet industry, the effectiveness of a company is more important than operating efficiency. Investors investing in efficient online companies yield higher returns.

Keywords: Performance evaluation; risk factors; online company; data envelopment analysis (DEA); Return on Equity (ROE).

1. Introduction

In financial markets, there are many kinds of investments, with stock the most popular. When investors choose which stock to invest in, they may expect high return from investing in high performance companies. However, the greatest concern for investors is whether their investment has the potential for high returns, and whether the high performance companies will always yield high returns.

Even after the dotcom collapse, US Internet stock remains a popular investment. However, investors are still concerned about future "Internet Bubbles." Thus,

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the US Internet stock market is a useful research focus with respect to financial performance.

From an accounting perspective, the Return on Equity (ROE) ratio is an important indicator to measure the performance of a company because the goal of a company is to maximum the stockholders' equity. The DuPont model breaks return on equity (ROE) into three parts: profit margin, total asset turnover and financial leverage.[19] It enables us to identify the existence of many indicators that influence the performance of a company. Hence, multiple indicators are considered. Data Envelopment Analysis (DEA) is a performance evaluation method capable of considering multiple inputs and multiple outputs. In this research, we aim to formulate an evaluation process combining DEA method with the concept of ROE. Investors can use this as a stock selection method, and managers can use it for performance evaluation.

The remainder of the paper is organized as follows. Section 2 is the literature review for different methods in performance evaluation. Section 3 gives the basics of DEA used in this paper. Section 4 defines the evaluation process and its corresponding evaluation factors (inputs and outputs). Section 5 provides a literature survey of DEA variable selection, which will illustrate how we choose input and output variables. Section 6 presents the empirical study using the example of 27 US Internet corporations. The last section presents our conclusions and future research directions.

2. Different Methods for Performance Evaluation

Performance evaluation considers a number of attributes (or criteria) and covers multiple levels. Items chosen for evaluating performance include both quantifiable and non-quantifiable indicators. These may be mutually exclusive, related or independent of each other. In addition, the problems that are being faced are extremely complex and unpredictable. A number of techniques have been proposed. Objectivity, fairness and feasibility are crucial for performance evaluation. This study reviews seven methods applicable to the evaluation of performance. They are (1) Multivariate Statistical Analysis;[6,10] (2) Data Envelopment Analysis;[13,24] (3) Analytic Hierarchy Process;[4,16] (4) Fuzzy Set Theory;[4,9] (5) Grey Relation Analysis;[12] (6) Balanced Scorecard;[15] and (7) Financial Statement Analysis.[7] The fundamental theories of the seven methods, their advantages and disadvantages when applied to performance evaluation are described in detail below:

(1) Multivariate Statistical Analysis: Statistical methods to quantify complex issues or events and to arrange them systematically for the purpose of classification, inference, evaluation and forecast.

Strengths:

(i) It is based on traditional methods of statistics, with solid theoretical foundation.

(ii) The system is complete and could be applied in almost all areas of research.

Weaknesses:

(i) It requires a large sample size and normal distribution.
(ii) Methods not including statistical testing cannot be used systematically, which hampers further interpretation of the results.

(2) Data Envelopment Analysis: Based on the concept of Pareto Optimality. When measuring the efficiency value of DMU, only the production margin is required. The production margin would then be compared with actual production to calculate efficiency values.

Strengths:

(i) DEA could be used to handle problems with multiple inputs and outputs.
(ii) It would not be influenced by different scales.
(iii) The results of DEA evaluation on efficiency is a composite indicator, and could be used to apply the concept of total production factors in economics.
(iv) The weighted value in the DEA model is the product of mathematical calculation and hence free from human subjectivity.
(v) DEA can deal with interval data as well as ordinal data.
(vi) The results of the evaluation by DEA could provide more information on the data used, which could be used as a reference in the decision-making process.

Weaknesses:

(i) It yields the efficient frontier, which may be quite large.
(ii) If the sample size is too small, the outcome is less reliable.
(iii) There should not be too many variables.
(iv) The degree of relation between the input and output variables (indicators) is not considered.

(3) Analytic Hierarchy Process: an approach to quantify subjective estimates. Complex and non-systematic issues are treated systematically in a stepwise process, yielding weighted value of options (indicators).

Strengths:

(i) Easy to apply.
(ii) The results are subject to consistency checking.
(iii) Solid theoretical foundation and is objective.
(iv) Easier to handle qualitative problems.

Weaknesses:

(i) When there are great differences across experts, diverse results yield little value.
(ii) Fails to discuss the relation between factors (indicators).

(4) Fuzzy Set Theory: Provides an overall evaluation on events or phenomenon influenced by a number of factors, by way of building up of subordinate functions. Accordingly, the qualitative and quantitative values of the indicators would be interchangeable, and a value in real numbers would be assigned to each factor under evaluation. Priority would then be assessed.

Strengths:

(i) It can deal with a large number of uncertain problems.
(ii) Since it is a simulation of human thought and decision processing, it is compatible with human behavior.

Weaknesses:

(ii) The degree of subordination is indicated by a value between 0 and 1, so the results of evaluation would be subject to influence by the choice over subordination function.
(ii) The relation between variables (indicators) is not discussed.

(5) Grey Relation Analysis: Based on the homogeneity or heterogeneity of the trend development of factors to find out if there is Grey Relation between two indicators and the extent of this relationship.

Strengths:

(i) No rigid requirement for sample size.
(ii) Can still be applied when the distribution of data is uncertain.
(iii) Is based on data analysis, and is free from traditional subjectivity in decision making.
(iv) The method of calculation is simple and easy to apply.

Weaknesses:

(i) Cannot directly handle qualitative issues (non-quantifiable).
(ii) The criteria for choosing Grey Relation coefficient value would directly affect the final evaluation result.

(6) Balanced Scorecard: A performance evaluation system containing four components for evaluation. This is also called a strategic management system, which could help firms translate strategy into actions. The four components are finance, customer, internal process and learning and growth.

Strengths:

(i) Can integrate information, and put various key factors for the success of the organization into one report.
(ii) Avoids information overload since the indicators used for performance measurement are the key indicators.

Weaknesses: The procedure for the application of BSC is complex and time consuming.

(7) Financial Statement Analysis: People use this approach with the belief that the result of business activities of the firm would be reflected in its financial statement.

Strengths:

(i) Objective: It is the reflection of actual events.
(ii) Concrete: All data in the financial statement can be quantified.
(iii) Measurable: Since the data in the financial statement can be quantified, they are measurable.

Weaknesses:

(i) There is no criterion for selecting a ratio that is agreeable by all users.
(ii) The figures in the financial statement have been added or simplified, and could not satisfy the needs of all users.
(iii) Financial statement could not express qualitative information, such as ability, morale, potential and trust.

Each of the above seven methods can be independently applied to evaluating performance. However, none of them is perfect. There is a saying that "Whenever there is an advantage, it entails a drawback." Researchers can only choose a method to evaluate performance that has the least amount of drawbacks for that study's particular situation. In contrast to other approaches such as AHP, Multivariate Statistical Analysis and Grey Relation Analysis, DEA requires little assumption about a functional form among variables. No prior information on weight assigned to input/output variables is required. Thus, DEA provides a very good tool for objectively gauging the DMU performance. DEA has been widely used to yield new insights into activities (and entities) previously evaluated from other methods such as TOPSIS and fuzzy methods.[23,24]

3. Basics of Data Envelopment Analysis

DEA is a non-parametric approach to build an efficiency frontier to measure relative efficiency for a set of homogeneous decision-making units (DMUs) between multiple inputs and outputs. The theory of DEA can be traced back to Farrell,[8] who proposed using production frontier to evaluate the technical efficiency. He divides efficiency into overall efficiency (or economic efficiency), technical efficiency, and allocative efficiency (AE). Overall efficiency (OE) is composed of technical efficiency (TE) and allocative efficiency. Technical efficiency shows that the maximum products that factories can produce while giving the specific inputs. Allocative efficiency shows that given the specific price and product technology the inputs enterprises should put into. If we multiply economic efficiency by allocative efficiency, we get technical efficiency. That is:

$$\text{OE} = \text{AE} \times \text{TE}$$

This is the efficiency measuring model that Farrell proposed in 1957. There are two major DEA models extended by Charnes, Cooper, Rhodes and Banker. One is

the CCR model proposed by Charnes, Cooper and Rhodes,[5] and the other is the BCC model proposed by Banker, Charnes and Cooper.[1]

The CCR model assumes constant return to scale (CRS). Since the CCR model was presented, DEA has been widely approved as an analytical tool for performance evaluation. The CCR model was extended by Banker, Charnes and Cooper[1] to include variable returns to scale (VRS), and this model is referred to as the BCC model. And until now, these two models have been the main types of DEA.

The CCR model is input-oriented, and the BCC is output-oriented. In this research, the output-oriented BCC model is adopted because the variable returns to scale assumption is more realistic, and the goal of companies is to maximize their outputs.

$$\begin{aligned}
&\min h_s = \sum_{j=1}^{m} V_j X_{js} + D_s \\
&\text{subject to } \sum_{k=1}^{p} U_k Y_{ks} = 1 \\
&\qquad \sum_{k=1}^{p} U_k Y_{ki} - \sum_{j=1}^{m} V_j X_{ji} - D_i \le 0, \quad i = 1, 2, \ldots, n
\end{aligned}$$

$V_j \ge 0, j = 1, 2, \ldots, m; U_k \ge 0, k = 1, 2, \ldots, p.$

D_i is a constant and we can use D_i as the index of the return scale of the DMU. The standard is as follows:

$D_i > 0 \rightarrow$ DMU is under decreasing returns to scale
$D_i = 0 \rightarrow$ DMU is under constant returns to scale
$D_i < 0 \rightarrow$ DMU is under increasing returns to scale.

Using duality theory and the slack variable to transform the equation, we get:

$$\begin{aligned}
&\max H_s + \varepsilon \left\{ \sum_{j=1}^{m} SV_{js}^{-} + \sum_{k=1}^{p} SV_{ks}^{+} \right\} \\
&\text{subject to } H_s Y_{ks} - \sum_{i=1}^{n} Y_{ki} \lambda_i + SV_{ks}^{+} = 0 \\
&\qquad X_{js} - \sum_{i=1}^{n} X_{ji} \lambda_i - SV_{js}^{-} = 0 \\
&\qquad \sum_{i=1}^{n} \lambda_i = 1
\end{aligned}$$

$\lambda_i \ge 0, i = 1, 2, \ldots, n; SV_{js}^{-} \ge 0, j = 1, 2, \ldots, m; SV_{ks}^{+} \ge 0, k = 1, 2, \ldots, p.$

We can see that compared with CCR model, the BCC model adds the constraint of $\sum_{i=1}^{n} \lambda_i = 1$, to make sure the production frontier will be raised to the origin.

4. The Proposed Approach

DEA can deal with multiple inputs and outputs simultaneously, and DEA models are broadly used in many fields. DEA is believed to be one of the most commonly used approaches to measure company performance in the financial industry. In this section, we propose a model to combine DEA models with a financial analysis tool to evaluate efficiency of online companies.

Financial ratio analysis has been the standard technique used in economics to examine business and managerial performances.[21] Due to its simplicity and ease of understanding, the analytical ratio measure has been widely applied in many areas such as in financial investment and insurance industries. Two of the most preferred analytical ratios are Return on Equity (ROE) and Return on Assets (ROA), both providing insight into a financial institution that allows management to make strategic decisions that can dramatically affect its structure and profitability. ROA is defined as the ratio of Net Income divided by Total Assets and estimates how efficient we are at earning returns per dollar of assets. ROA has been merged into DEA to evaluate efficiency and effectiveness of an organization.[13] ROE is calculated by dividing Net Income by average Equity and identify how efficiently we use our invested capital. Companies that boast a high ROE with little or no debt are able to grow without large capital expenditures, allowing the owners of the business to withdrawal cash and reinvest it elsewhere. ROE is just as comprehensive and could be the better indicator than ROA in terms of identifies a firm's profitability and potential growth, i.e. the potential risk that a firm can takes. Moreover, from the accounting perspective, when we use the ROA ratio to measure company performance, the ROE ratio has to be used simultaneously to see whether the high ROE ratio is coming from the financial leverage, or if company ROA is high. So in this research, we use the ROE ratio to make the evaluation process more complete.

$$\text{ROA} = \frac{\textit{Net Income}}{\textit{Assets}}$$

$$\text{ROE} = \frac{\textit{Net Income}}{\textit{Equity}}$$

Many investors fail to realize, however, that two companies can have the same return on equity, yet one can be a much better business. The DuPont model provides a tool to decompose ROE into three elements in the calculation of ROE; the net profit margin, asset turnover, and the equity multiplier. By examining each input individually, we can discover the sources of a company's return on equity and compare it to its competitors.

Using the DuPont model, ROE ratio can be decomposed into:

$$\begin{aligned}\text{ROE} &= \frac{\textit{Net Income}}{\textit{Sales}} \times \frac{\textit{Sales}}{\textit{Assets}} \times \frac{\textit{Assets}}{\textit{Equity}} \\ &\quad \text{(Effectiveness) (Efficiency) (Equity multiple)} \\ &= \text{ROA} \times \text{Equity multiple.}\end{aligned}$$

Asset turnover (efficiency) is used to measure the ability of the firm and can be deemed as the operational efficiency of a company. Profit margin (effectiveness) is used to diagnose the effectiveness of a company. It measures not only the competitiveness of the product but the expense control ability of a company.

The equity multiple can be used to understand the capital structure of a company, and companies can use financial leverage to control their capital structure. So investors should take higher risk to gain higher return. Hence, we use the concept of ROE to test whether investing in companies with high financial performance can get high returns or not, because it is important to think of return and risk simultaneously when choosing an investment target.

Based on the concept of measuring firm performance by efficiency and effectiveness, this research adopts the two-stage DEA model[14] to evaluate the performance of online companies. The two-stage DEA approach is shown as follow.

The risk scoring model is depicted in Fig. 2, to include two sub-processes. In contrast to Fig. 1, Fig. 2 introduces another process to understand whether investing in companies with high financial performance can get high returns or not.

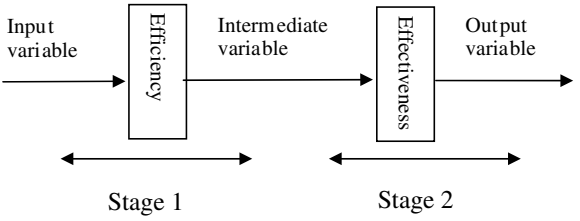

Fig. 1. Two-stage DEA model.

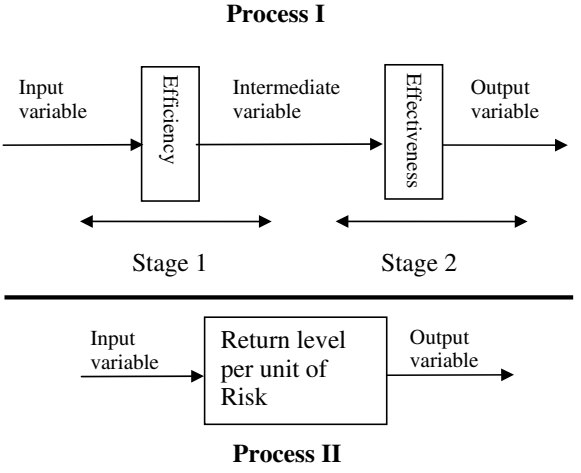

Fig. 2. Proposed evaluation process.

These two processes can be used to evaluate the company from both enterprise (company performance) and investor (the returns per unit of risk available) perspectives; hence this evaluation process can give investors and managers more accurate criteria to make decisions.

5. Variable Selection

In order to measure DMU efficiency, the selection of the input variables and output variables is very important. In the Internet industry, existing literature defines a good set of variables to measure online company performance to include both financial data and non-financial data.

Some criteria are set up in order to facilitate the input and output selections as follows:

(1) The variables adopted by the paper measuring Internet industry using the DEA approach can be considered.
(2) There are limited papers measuring Internet industry performance using the DEA approach, so a two-stage DEA approach will be used for measuring operating efficiency and effectiveness.
(3) For measuring the investing risk, there is only one paper using DEA approach to measure the relationship between return and risk. Hence, the variables adopted by that paper have been considered.
(4) All the variables must conform to the ROE concept.

We based our variable selection on existing literature in Table 1 where various financial measures are employed to evaluate the efficiency of a financial institution.

In evaluation process 1, we choose operating expense, employees, total assets, revenue, gross profit, EPS and net income as the main variables to measure the performance of online companies based on the literature review and suggestions by experts. In order to measure efficiency, we used total assets, total equity and operating expense as input variables to measure how much money they can earn (revenue) and how many profits (gross profit) they can generate. Total assets was chosen as an input because it is the sum of intangible asset, current asset, and fixed asset. And the intangible asset which is shown in the balance sheet as a result of a merger or takeover is hard to measure.[3] The variable of operating expense was chosen as an input because many Internet companies do not report the number of marketing expense or R&D expense. In order to measure effectiveness, we used revenue and gross profits as input variables to see how well companies controlled their expenses to generate money (net income) and how much income was shared with stockholders (EPS).

In evaluation process 2, we choose Beta, book value to market value (BV/MV) and rate of return as the main variables to measure how much return a company can generate given the same risk. Beta was chosen as an input because investing

Table 1. Input and output variables.

Authors	Efficiency Inputs	Efficiency Outputs	Effectiveness Inputs	Effectiveness Outputs	Invest Risk Inputs	Invest Risk Outputs
Seiford & Zhu (1999)[20]	Employee Total assets Equity	Revenue Profit	Revenue Profit	Market value EPS Stock price		
Wu *et al.* (2006)[23]	Employee, Assets, other expenses	Deposits, Revenue, Profits				
Gulser & Ilhan (2001)[11]					Beta Sharpe index Treynor index Market capitalization Book value/ market value Earings/ price	Rate of return
Luo (2003)[18]	Employee, Total assets, Equity	Revenue Profit	Revenue, Profit	Market value, EPS, Stock price		
Barua *et al.* (2004)[2]	IT Capital, NIT capital, Labor, Number of years in business	Sales, Gross margin				
Carlos *et al.* (2005)[3]	Number of employees, Total assets, Total operating expenses	Revenues, Unique visitors				
Tsai *et al.* (2006)[22]	Total assets, CAPEX, Employee number	Revenue, EBITDA, Operating profit				
Lo & Lu (2006)[17]	Employee, Total assets Equity,	Revenue Profit	Revenue, Profit	Market value, EPS, Stock price		

risk can divide into systematic risk and non-systematic risk. For investors, the non-systematic risk can be dispersed by diversification effect. So, if systematic risk is the only concern, then the beta coefficient is better to measure the risk. BV/MV was chosen as an input because it is also a common used ratio to measure investing risk.

6. Empirical Study

6.1. *The sample*

The sample for this study includes listed online companies in the United States. There are 127 listed online companies in NASDAQ categories, and they are grouped into three categories: Internet service providers, Internet information providers, and Internet Software and Services providers. Data used for DEA computation are subject to some requirements. For example, data cannot be negative: Data must be from the same accounting period. Therefore, we only chose 27 listed online companies. Data was collected from Yahoo! Finance (http://finance.yahoo.com/) and EDGAR Online (http://edgar.brand.edgar-online.com/default.aspx) for 2006.

6.2. *The DEA result*

The DEA efficiency scores are a percentage value which varies between 0% and 100%. If the efficiency score is equal to 100%, then the score is the best efficiency and hence the unit is the most efficient unit.

The DEA result for evaluation process 1 is shown in Table 2.

We can see that 10 out of 27 listed online companies, namely, "GOOG", "TZOO", "JCOM", "AMZN", "UNTD", "DTAS", "ADAM", "EGOV", "EBAY", and "RATE" are BCC-efficient on operating efficiency. There are 6 out of 27 listed online companies, namely, "ADAM", "ORCC", "JCOM", "PCLN", "GOOG", and "YHOO" are BCC-efficient on effectiveness.

Moreover, of the ten companies that are BCC-efficient on operating efficiency, seven companies are not BCC-efficient on effectiveness. These are "TZOO", "AMZN", "UNTD", "DTAS", "EGOV", "EBAY", and "RATE". These seven companies can use their resources to generate profits very well; however, they cannot use their profits to generate income very well. This is because when comparing to the companies that are BCC-efficient on both dimensions, these seven companies do not control their expenses well, or they issue more stock so that EPS becomes diluted.

On the other hand, of the 6 companies BCC-efficient on effectiveness, three companies are not BCC-efficient on operating efficiency. They are "ORCC", "PCLN", and "YHOO". These companies can use their profits to generate income very well; however, they cannot use their resources to generate profits very well. This may be because when comparing with the companies with BCC-efficient on both dimensions, these companies spend more costs on their products, or the sales volumes or

Table 2. BCC-efficient scores on performance.

Company Name	Stock Code	Operating Efficiency Score	Effectiveness Score
Google, Inc.	GOOG	100	100
A.D.A.M. Inc.	ADAM	100	100
j2 Global Communications Inc.	JCOM	100	100
eBay Inc.	EBAY	100	65.88
Bankrate, Inc.	RATE	100	64.24
Travelzoo, Inc.	TZOO	100	50.54
Digitas, Inc.	DTAS	100	40.03
NIC Inc.	EGOV	100	35.16
United Online, Inc.	UNTD	100	34.96
Amazon. com, Inc.	AMZN	100	30.44
Varsity Group, Inc.	VSTY	99.03	93.39
Citrix Systems, Inc.	CTXS	93.81	56.05
Sabre Holdings Corporation	YHOO	91.64	100
Websense, Inc.	WBSN	90.67	76.26
Aquantive, Inc.	AQNT	89.54	36.69
Digital River, Inc.	DRIV	86.64	96.26
IAC/InterActive Corp	IACI	84.27	67.88
Sabre Holdings Corporation	TSG	82.46	32.18
Sohu.com Inc.	SOHU	82.12	79.56
Priceline. Com, Inc	PCLN	81.63	100
eCollege .com	ECLG	79.94	23.92
Open Solutions, Inc.	OPEN	75.56	59.98
Sina Corporation	SINA	72.87	67.65
iPass Inc.	IPAS	71.68	20.92
Online Resources Corporation	ORCC	68.58	100
Corillian Corporation	CORI	67.17	13.37
SupportSoft Inc.	SPRT	54.22	17.19

price is lower than the market price, or their capital has mainly come from inside (stockholder's equity), but not borrowed from outside (Liabilities).

The DEA efficiency scores as a percentage value which varies between 0% and 100%. In order to see the total efficiency of each company, we time the efficiency scores of operating efficiency and effectiveness. The DEA efficiency scores are also a percentage value between 0% and 100%. It can be observed that only three companies perform best in both dimensions, showing that they are BCC-efficient in both operating efficiency and effectiveness, which are "ADAM", "GOOG" and "JCOM". These three companies can use their resources to generate profits as well as using their profits to generate income.

The DEA result for evaluation process 2 is shown in Table 3.

Table 3. BCC-efficient scores on the level of returns per unit of risk.

Company Name	Stock Code	Risk Score
j2 Global Communications, Inc.	JCOM	100
Priceline.com, Inc.	PCLN	100
Varsity Group, Inc.	VSTY	100
A.D.A.M., Inc.	ADAM	100
Online Resources Corporation	ORCC	60.89
Yahoo!, Inc.	YHOO	45.93
Google, Inc.	GOOG	42.39
Digital River, Inc.	DRIV	39.62
Sohu.com, Inc.	SOHU	37.20
Websense, Inc.	WBSN	30.88
Bankrate, Inc.	RATE	30.25
Travelzoo,, Inc.	TZOO	26.70
Amazon.com, Inc.	AMZN	24.11
Aquantive, Inc.	AQNT	23.62
Citrix Systems, Inc.	CTXS	23.27
United Online, Inc.	UNTD	22.48
Sina Corporation	SINA	22.40
eBay, Inc.	EBAY	19.20
NIC, Inc.	EGOV	18.92
Digitas, Inc.	DTAS	15.67
Sabre Holdings Corporation	TSG	15.67
Open Solutions, Inc.	OPEN	14.76
IAC/InterActiveCorp	IACI	10.94
eCollege.com	ECLG	10.24
Corillian Corporation	CORI	9.04
iPass, Inc.	IPAS	8.86
SupportSoft, Inc.	SPRT	5.02

We can see there are four out of 27 listed online companies, namely, "JCOM", "PCLN", "VSTY", and "ADAM" are BCC-efficient on investing risk. These four companies have the highest level of returns per unit of risk, which means if the investors invest in these four companies, they can expect the highest level of returns.

There is a correlation between total efficiency and investing risk. Table 4 shows the top ten and last four companies with total efficiency and risk. If investors invest in these companies with high scores in total efficiency, they can enjoy higher level of returns. Otherwise, if the investors invest in the companies with low scores in total efficiency, they will get a lower level of returns.

Moreover, through the comparison on Table 5, we can see the companies BCC-efficient on operating efficiency but not BCC-efficiency on effectiveness will perform worse in total efficiency. For example, "TZOO", "AMZN", "UNTD", "DTAS", "EGOV", "EBAY", and "RATE" are BCC-efficient on operating efficiency but their performance on effectiveness is bad, and then the total efficiency of these companies will be lower.

Table 4. Ranking of the BCC-efficient scores of total efficiency and investing risk.

Rank	Total Efficiency	Investing Risk
1	ADAM	ADAM
2	JCOM	JCOM
3	GOOG	PCLN
4	VSTY	VSTY
5	YHOO	ORCC
6	DRIV	YHOO
7	PCLN	GOOG
8	WBSN	DRIV
9	ORCC	SOHU
10	EBAY	WBSN
24	ECLG	ECLG
25	IPAS	CORI
26	SPRT	IPAS
27	CORI	SPRT

Table 5. Ranking of the BCC-efficient scores of whole model.

Rank	Operating Efficiency	Marketability	Total Efficiency	Investing Risk
1	ADAM	ADAM	ADAM	ADAM
2	JCOM	JCOM	JCOM	JCOM
3	GOOG	GOOG	GOOG	PCLN
4	AMZN	PCLN	VSTY	VSTY
5	UNTD	ORCC	YHOO	ORCC
6	DTAS	YHOO	DRIV	YHOO
7	TZOO	DRIV	PCLN	GOOG
8	EGOV	VSTY	WBSN	DRIV
9	EBAY	SOHU	ORCC	SOHU
10	RATE	WBSN	EBAY	WBSN
24	IPAS	ECLG	ECLG	ECLG
25	ORCC	IPAS	IPAS	CORI
26	CORI	SPRT	SPRT	IPAS
27	SPRT	CORI	CORI	SPRT

On the other hand, the companies BCC-efficient on effectiveness but not on operating efficiency will perform better in total efficiency than the companies with BCC-efficient on operating efficiency but not on effectiveness. For example, "ORCC", "PCLN", and "YHOO" are BCC-efficient on effectiveness, but the performance on operating efficiency is not good. However, these companies have good score in total efficiency.

So, we find out that the main dimension that influences total efficiency of a company is the effectiveness. For the Internet industry, the effectiveness of a company is more important than operating efficiency.

There are only two out of 27 listed online companies, namely "ADAM", and "JCOM" that are BCC-efficient on operating efficiency, effectiveness and investing

risk. Not only can these companies operate well, but also investors can get the highest return by investing them.

"GOOG" is BCC-efficient on operating efficiency and marketability; however, their efficiency score in investing risk is low. It means GOOG can use their resources to generate profits, as well as using their profits to generate income, but investors cannot get the high returns as expected from investing in GOOG.

On the other hand, there are three of 27 listed online companies, namely "IPAS", "CORI", and "SPRT" are BCC-inefficient on operating efficiency, effectiveness and investing risk. These companies not only operate their company inefficiently, investors also get the lowest return by investing in them.

7. Conclusions

This paper proposed a new performance measurement model combining ROE and DEA approach for both investors and managers. From empirical study, we draw the following conclusions:

(1) The main contribution of this study is to propose an accurate evaluation process combing ROE concept and the DEA model. The evaluation process not only considers the performance of a company, but also considers the return to investors as the whole performance to measure a company. For investors, this model can be used as the stock selecting strategy. Based on the relative score of each DMU, investors can easily rank the priority of the stocks. And for managers, this model can be used to be the performance measurement model. Based on the relative score of each DMU, the managers know the position where if their company and also their competitors stand, and they can know in each dimension if their companies perform well or need to be improved.
(2) Based on the research results, the main dimensional influence for a company's total efficiency is effectiveness. For the Internet industry, the company effectiveness is more important than operating efficiency in influencing performance. Hence, investors may focus on the net income and EPS when they want to measure the US Internet stock market. For managers, most of the Internet companies perform well on operating efficiency, which means the companies can use their resources to generate profit well. However, most of the Internet companies have lower efficiency scores on effectiveness. So companies should control their expenses, hence, the net income will be higher.
(3) If the investors invest in companies with high scores in operating performance, they can gain the higher level of returns. If the investors invest companies with low scores in operating performance, they can gain the lower level of returns.

As with any study, this research is not without limitations. Three limitations are noted.

(1) The DEA model cannot use negative numbers.[25,26] However, the listed online companies can have negative net income or equity. In order to compare these

listed online companies in the same basis, the companies with different financial periods are excluded. So there are only 27 companies left. The number of decision-making units (DMUs) is greater than twice of the summation of the number of input and output variables, so the sample size used in this study still complies with the requirement of DEA approach.

(2) Non-financial data are not included, which is also an important dimension to measure online companies. This is because some data cannot be measured or may be confidential.

(3) There are few previous research reports using DEA to evaluate the performance of the Internet industry, resulting in the lack of theoretical back up in the input and output variable selection.

(4) DEA can be combined with classical risk management such as value at risk[27] to develop new methodologies for optimizing risk management.[28,29]

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