Multi-disciplinary Approach to Evaluate Companies' Performances

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Abstract

Effective and objective evaluation of a company's performance based on facts is not only essential information to potential investors for wise investment decisions but also an important tool for management in strategic planning, development and deployment. This paper describes a multi-disciplinary approach which combines accounting with predictive statistics, multi-attribute utility modeling, and group decision making to compare and evaluate the performance of multiple companies. The raw data is compiled from audited financial statements from 2006 through 2008. Data was first analyzed using accounting ratios which were then used to predict future years' ratios with predictive statistics tools. These ratios became the parameters in evaluating a company's performance in term of liquidity, profitability, efficiency, solvency, and size. Multi-attribute utility modeling and group decision making methods were used to rank order the companies by overall value. To illustrate this complex multi-disciplinary approach, five of the largest companies in computer software industry: Microsoft, Oracle, CA, Intuit, and Red Hat were compared. However, this approach could be applied to evaluating any companies' performances within the same, or even across various industries simultaneously.

Keywords
Accounting, predictive statistics, multi-attributes utility model, group decision making, engineering management.

1. A Three-Stage Approach

1.1 Accounting ratios

Accounting ratios are useful to extract information from financial statements and to quantify the five most important criteria in evaluating companies' performance. The most representative accounting ratios were selected to measure liquidity, profitability, efficiency, solvency, and size.

- For liquidity, net working capital ratio measures the percentage of net working capital of the total asset. This allows one to best determine how liquid the company is.
    - Formula: Net working capital ratio = (current assets – current liabilities) / total assets.
- For profitability, profit margin measures how much out of every dollar of sales a company actually keeps in earnings. This is very useful to compare different companies regardless of their size or industries.
    - Formula: Profit margin = net income / total revenue.
- For efficiency, return on equity (ROE) measures how much profit the company is able to generate given resources provided by its stockholders. ROE tells us how efficient the management is working.
    - Formula: ROE = net income / total equity.
- For solvency, solvency ratio measures a company's ability to meet long-term obligation and therefore suggests how likely a company will continue meeting its debt obligations. As a standard, financially healthy companies have at least 20% solvency ratios.
    - Formula: Solvency ratio = after tax net profit + depreciation / (long term liabilities + short term liabilities).
- For size, market capitalization is used as this is the most common valuation method of a company. Even though it frequently fluctuates as stock price changes, the magnitude of market capitalization still generally stays constant as long as the company is not undergoing dramatic changes such as insolvency.

1.2 The first stage of the analysis

The first stage determined the accounting ratios for all five companies using data from audited financial statements from 2006 through 2008. These were readily available on Yahoo Finance website [1]. Table 1 illustrates sample results for Microsoft.

Table 1: Accounting ratios calculation for Microsoft showing derivation of ratios for Stage 2.

Microsoft					
Liquidity: Net Working Capital Ratio Calculation					
Date	Current Asset	Current liability	Net working capital	Total Asset	Ratio
6/30/2006	$49,010,000	$22,442,000	$26,568,000	$69,597,000	0.382
6/30/2007	$40,168,000	$32,074,000	$8,094,000	$63,171,000	0.128
6/30/2008	$43,242,000	$36,507,000	$6,735,000	$72,793,000	0.093
Mean	$44,140,000	$30,341,000	$13,799,000	$68,520,333	0.201
Profitability: Profit Margin Calculation					
Date	Net Income	Total Revenue	Profit Margin		
6/30/2006	$12,599,000	$44,282,000	0.285		
6/30/2007	$14,065,000	$51,122,000	0.275		
6/30/2008	$17,681,000	$60,420,000	0.293		
Mean	$14,781,667	$51,941,333	0.284		
Efficiency: Return on Equity Ratio Calculation					
Date	Net Income	Total Equity	Return on Equity		
6/30/2006	$12,599,000	$40,104,000	0.314		
6/30/2007	$14,065,000	$31,097,000	0.452		
6/30/2008	$17,681,000	$36,286,000	0.487		
Mean	$14,781,667	$35,829,000	0.418		
Solvency: Solvency Ratio Calculation					
Date	After Tax Net Income	Depreciation Expenses	Total Liabilities	Solvency Ratio	
6/30/2006	$12,599,000	$903,000	29,493,000.00	0.458	
6/30/2007	$14,065,000	$1,440,000	32,074,000.00	0.483	
6/30/2008	$17,681,000	$2,056,000	36,507,000.00	0.541	
Mean	$14,781,667	$1,466,333	32,691,333.33	0.497	
Size: Market Capitalization					
$183,940,000,000					

2. Predictive Statistics

2.1 The second stage of the analysis

The results from the first stage of the analysis were then used to predict each company's future accounting ratios over the next ten to twenty years. The data were statistically analyzed to identify the data distributions and construct

models like multiple linear regressions or even non-linear regressions to predict future ratios. In order to perform this analysis, the currently available annual data had to be analyzed as well as the quarterly or even monthly financial statements because the model improves the accuracy and reliability with added data points.

However, due to the complexity of the regression modeling and the large amount of data required, and the temporal basis of the data, a "simple moving average" method, which is a simple recursive function, was used (see Equation (1) below).

$$Ratio_{(N+1)} = (Ratio_{(N-2)} + Ratio_{(N-1)} + Ratio_{(N)})/3 \tag{1}$$

3. Multi-Attributes Utility Model (Multiplicative Case)

3.1 The third stage of the analysis

In this stage, the results from the statistical predictions were input to Keeney-Raiffa multiattribute utility functions for the comparison across companies [2]. The results from the second stage of the analysis arearranged in Table 2. The data in Table 2 were converted to descriptive statistics in Table 3.

Table 2: Data arrangement of the results from the second stage of the analysis

Company//Attributes	Liquidity	Profitability	Efficiency	Solvency	Size (Market Cap in Billion $)
Microsoft	0.153	0.285	0.447	0.508	183.94
Oracle	0.148	0.241	0.241	0.176	83.19
CA	-0.023	0.075	0.084	0.099	8.26
Intuit	0.143	0.162	0.227	0.307	7.24
Red Hat	0.272	0.171	0.092	0.099	1.82

Table 3: Descriptive statistics

Descriptive Statistics					
Min	-0.023	0.075	0.084	0.099	$ 1,820,000,000
Max	0.272	0.285	0.447	0.508	$ 183,940,000,000
Mean	0.139	0.187	0.218	0.238	$ 56,890,000,000
Standard Deviation	0.105	0.081	0.147	0.173	$ 78,574,959,115

- Next, utility functions for each of the attributes were defined. For this study, all of the attributes were monotonically increasing in utility. That is, the higher the values of the accounting ratios and market cap, the more preferred (higher utility). Assuming a risk-neutral attitude for the purposes of comparing the different companies, the general utility function for all five attributes has the form below (see equation (2)).

$$U(x) = (1/(\max - \min)) \cdot (x - \min) \tag{2}$$

- With this function in place, the raw data was converted into utility values shown in Table 4.

Table 4: Utilities

Utilities					
Company//Attributes	Liquidity	Profitability	Efficiency	Solvency	Size
Microsoft	60%	100%	100%	100%	100%
Oracle	58%	79%	43%	19%	45%
CA	0%	0%	0%	0%	4%
Intuit	56%	41%	39%	51%	3%
Red Hat	100%	46%	2%	0%	0%

- The next step was to obtain the data from decision makers to assign relative importance coefficients (called k_n) to each attribute. Rather than randomly interview people who might not know about company's performance evaluation, the values should be obtained from both internal and external users (intended audience of this work) who have at least some idea on evaluation of each company's performance. These decision makers can be categorized into five groups:
  - Group 1: Neutral decision makers. They would view liquidity, profitability, efficiency, solvency, and size being all equally important.
  - Group 2: Risk averse decision makers. They would rank the attributes as follow: Solvency > liquidity > efficiency > profitability > size for the reason that they do not want risks and solvency and liquidity to solely be associated with risk of the company's performance. Efficiency has a slight correlation to risks as the better the management team is, the higher chance the company will survive in the long run. For the last two attributes, profitability and size seem to have very little correlation to risk. However, profitability is certainly preferred to size as many potential investors and management teams would care more about the profit than the size of the company.
  - Group 3: Risk seeking decision makers. If they are risk seeking, they focus the most on profit and are willing to take risks. In contrast to risk adverse case, they would generally rank the attributes as follow: profitability > efficiency > size > liquidity > solvency.
  - Group 4: Extreme risk averse. They are similar to the risk averse group except that they put much more weight on solvency and liquidity than other three attributes.
  - Group 5: Extreme risk seeking. They are similar to risk seeking group except that they put much more weight on profitability and efficiency than other three attributes.

- In summary, for illustration one hypothetical set of relative importance coefficients for these five groups would be similar to Table 5.

Table 5: Risks attitude characterization with relative importance coefficients distribution

Group//Attributes	Liquidity	Profitability	Efficiency	Solvency	Size
1. Risk Neutral	0.3	0.3	0.3	0.3	0.3
2. Risk Averse	0.4	0.2	0.3	0.5	0.1
3. Risk Seeking	0.2	0.5	0.4	0.1	0.3
4. Extreme Risk Averse	0.7	0.2	0.3	0.8	0.1
5. Extreme Risk Seeking	0.2	0.8	0.7	0.1	0.3

- Next the master constant K for each of these groups was calculated using the formula (3).

$$1 + K = \prod_{n=1}^{N} (1 + K \cdot k_n) \qquad \text{[2] (3)}$$

- Next, for each group, the multi-attribute utilities were computed. The multiplicative model for multi-attributes utility model is shown in equation (4).

$$U(\vec{x}) = (\frac{1}{K}) \cdot \{\prod_{n=1}^{N} [1 + K \cdot k_n \cdot u_n(x_n)] - 1\} \qquad \text{[2] (4)}$$

  - With EXCEL software the multi-utility for all five groups can be computed and thus determine the ranking of each company's performance. See Table 6 for a sample result of one group. Note that for risk neutral group, it was assumed that liquidity, profitability, efficiency, solvency, and size were equally important.

Table 6: Multi attributes utility of risk neutral group

Multiplicative Model of multi-attributes utility for risk neutral group							
Company//Attributes	Liquidity	Profitability	Efficiency	Solvency	Size	Multi-attributes Utility	Ranking
Microsoft	60%	100%	100%	100%	100%	0.951	1
Oracle	58%	79%	43%	19%	45%	0.604	2
CA	0%	0%	0%	0%	4%	0.011	5
Intuit	56%	41%	39%	51%	3%	0.494	3
Red Hat	100%	46%	2%	0%	0%	0.414	4

- Summary of rankings for all five groups was provided in Table 7 below.

Table7: Summary rankings of all five groups

Company//Decision Maker's Ranking	Risk Neutral	Risk Averse	Risk Seeking	Extreme Risk Averse	Extreme Risk Seeking
Microsoft	1	1	1	1	1
Oracle	2	3	2	4	2
CA	5	5	5	5	5
Intuit	3	2	3	3	3
Red Hat	4	4	4	2	4

- To determine whether they all agreed or disagreed with the ranking, Kendall's coefficient of concordance was computed to be 0.856 (1.0 = complete agreement, 0=complete disagreement). In addition, a hypothesis test confirmed that their rankings were in agreement at the 5% significance level [3].
- Finally, the results of all five groups were aggregated to a group ranking based on different rules including Nash Bargaining, Borda, and Additive Utility [4-6]. Each of these rules has their own advantages and disadvantages.
    - Nash rule: Multiply the utilities and rank order the totals based on highest to lowest utility product.
        - Satisfy Nash's four axioms of "fairness."
        - The more decision makers there are, the more likely the product will approach zero. However, this can be re-scaled by taking n^{th} root of product without loss of generality.
    - Borda rule: Sum the ranks and rank order the total based on lowest to highest sum of the ranks.
        - Easiest to apply.
        - Insensitive to utilities that are close.
    - Additive Utility rule: Average the utilities and rank order the totals based on highest to lowest average utility.
        - Reflect subtle differences in utilities.
        - Average out the extreme utilities.
- Final results were summarized in Table 8. Note that all these three rules yielded the same results for the illustrative case and that Microsoft consistently ranked best.

Table 8: Final Result

Summary of Group Ranking			
Company--//--Group Ranking Rule	Nash	Borda	Additive Utility
Microsoft	1	1	1
Oracle	2	2	2
CA	5	5	5
Intuit	3	3	3
Red Hat	4	4	4

4. Discussion and Observations

In the predictive statistics stage, to predict the future accounting ratios more accurately, more sophisticated tools could be used such as multiple linear regression or even non-linear regression. Data from the past years such as monthly financial statements in the last ten years should also be gathered. This approach mainly focuses on quantitative analysis with a variety of effective methods and consideration of many essential factors. Further improvement will occur if it is combined with other qualitative analysis such as customer's satisfaction survey, customer perceived value method, quality management of the company, etc. To improve the analysis furthermore, more attributes could be added such as employees' retention, potential for future growth, customer's satisfaction, etc. This approach can be applied to evaluate not just companies' performances but also an industry's performance and portfolio management. On a broader scope, this paper can be a reference to motivate more multidisciplinary approaches for the future. What has been suggested and proven here is that seemingly unrelated subjects from other fields can be quite helpful and relevant to create a sound and meaningful analysis. Therefore, this dynamic approach essentially has no limit especially when creativity comes into play.

References

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