A FRONTIER ANALYSIS APPROACH TO DYNAMIC CONCEPTUAL CORPORATE COMPETITIVE MAPS

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ABSTRACT

A framework for developing conceptual corporate competitive maps by using overall company financial performance to firstly assess its position within an industrial landscape, and then identifying opportunities for competitive advantages and/or threats is presented. The methodology of *frontier analysis* or *data envelopment analysis* is used in order to measure the performance effectiveness of each firm. Insights into potential disruptive strategies and effective barrier of entries are finally provided through the visualization that the competitive map offers. This study was based on the analysis of the financial results of fifty seven Fortune500 companies for the preliminary work.

INTRODUCTION

The need for ranking and benchmarking commercial firms is a trade mark of the contemporary competitive market economy. Companies are evaluated on their performance in relation to their peers. Such approach affects every aspect of the firms' activities and behavior in the society that achieving desirable ranking took a primordial place on the firm's agenda. In parallel, several ranking schemes were elaborated by academics and industry consortia. A diverse range of methodologies are used in those ranking systems. Most of them are based on third party assessment and public perception. This paper offers a different approach by mapping such performances with the objective of identifying each firm within its competitive landscape and suggesting the dynamic strategic changes that should/may occur if firms want to improve their current situation. This paper proposal describes the model briefly, then presents the preliminary results, and concludes with a very brief discussion of the significance of those results.

THE MODEL

While several options are available for conducting an objective comparison of firms performance as a basis of a competitive mapping, this study has deliberately chosen to use the non-parametric, mathematical programming-based technique of Data Envelopment Analysis as a benchmarking model. The chosen model is also based on the economics concept of Pareto optimality, which considers a given decision making unit (DMU) to be Pareto efficient if it can yield a higher level of output compared to other DMUs, which require more input for the same results. The first formal development of DEA was proposed Charnes et al (1978) to evaluate a productivity model, based on the traditional single input/output measure of efficiency. Later developments allowed an extensive and more effective application of DEA analyses, such as studies on supply

chain management, banking, vendor selection, hospital performance, which all proved to be highly useful in making improvement decisions.

The specific benchmarking DEA model proposed herein is based on firms performance. As DEA affords the use of end of the year financial performance to assess the efficiency of those firms, The analysis was conducted on a sample population where the input (managerial decisions) and the output (financial performance/outcome) are clear. The model follows the traditional approach in DEA; ie. The objective is to assess the comparative technical efficiency of the DMUs. DEA is a technique that measures the relative efficiency of DMUs with multiple inputs and outputs with no obvious production function to aggregate the data in its entirety. It is a mathematical programming technique that constructs frontiers and measurement of efficiency relative to the constructed frontiers. In practice, it looks at a cohort and compares the productivity of individual members of that cohort against the expected aggregate productivity of the set. This helps uncover the relative efficiency of individual unit. As a benchmarking tool, DEA technique provides valuable information on the overall unit performance. It has been widely used in many areas for the purpose of developing comparative metrics.

In this study, our DMU is the individual firm, which uses inputs $x \varepsilon R^{N}_{+}$ to produce outputs $y \varepsilon R^{M}_{+}$. The resulting outcome will be used as a benchmark measure against similar DMUs deemed the be the best in a sample of $i = 1, \ldots, i$ DMUs. Given that each firm is different from each other in term of size and other managerial factors, weights w_i will be attached to each of them in order to solve the following general model:

$$\text{Min}_{v,\mu}\ v^{T}x_0/\mu^{T}y_0$$
$$\text{Subject to } v^{T}x_i/\mu^{T}y_i \geq 1,\ i=1, \ldots, i$$
$$v, \mu \geq 0$$

General data envelopment analysis model, adapted from Charnes et al, 1978

The above model was adapted to focus on firm efficiency (E). In the proposed model, E is defined as the efficiency index, which is based on the firm's financial signature (Prince, 2005). Specifically, it represents its ability to (1) utilize available resources (=input), to (2) generate values for the firm or its products (=output). Therefore, in the proposed model, E is algebreaically defined as:

E= *Value adding capability* / *Resource utilization*

It is important to note that in using E for the purpose of benchmarking through DEA model, the logic of the optimization model is to determine whether a cohort of firms can achieve the same or even more financial results as the targeted firm while requiring less resource. If better results are obtained with less resources, then the firm being assessed is judged to be relatively inefficient and ranks lower than the members of the cohort. Therefore, the objective function for the benchmarking DEA can be finally written as:

Minimize E

While the constraint function will be based on (1) input, (2) output, and (3) weight requirements. The general form of each constraint function will be written as:

output for the cohort >= Output for target firm

Input for cohort =< Input for target firm

The following types of input and output were identified for the purpose of integrating the financial signature measure into the optimization model:

Input	Output
Current ratio (CR) as a traditional measure of short-term liquidity *Cash coverage ratio* (CCR): calculated as (EBDIT+Depreciation)/Interest *Inventory turnover ratio* (ITR): calculated as the ratio of the Cost of Goods Sold and the Inventory *Capital Intensity Ratio* (CIR): calculated as the ratio of the Total Assets and Sales, and measuring the ability to generate sales from all available assets	*Revenue per share* (RPS): calculated as (Net income – Preferred Dividend + Depreciation)/Shares outstanding *Profit Margin* (PM): calculated as the ratio of Sales and Net Income *Return on Assets* (ROA): calculated as the ratio of Net Income and Sales *Return on Equity* (ROE): calculated as the ratio of Net Income and Total Equity

The final model, which is used as the engine of the mapping process is written as:

Min E

Subject to:

$$\Sigma\, w_i = 1$$
$$\Sigma\, (RPS_i)(w_i) \geq RPS_j$$
$$\Sigma\, (PM_i)(w_i) \geq PM_j$$
$$\Sigma\, (ROA_i)(w_i) \geq ROA_j$$
$$\Sigma\, (ROE_i)(w_i) \geq ROE_j$$
$$\Sigma\, (CR_i)(w_i) - (CR_j)E \leq 0$$
$$\Sigma\, (CCR_i)(w_i) - (CCR_j)E \leq 0$$
$$\Sigma\, (ITR_i)(w_i) - (ITR_j)E \leq 0$$
$$\Sigma\, (CIR_i)(w_i) - (CIR_j)E \leq 0$$

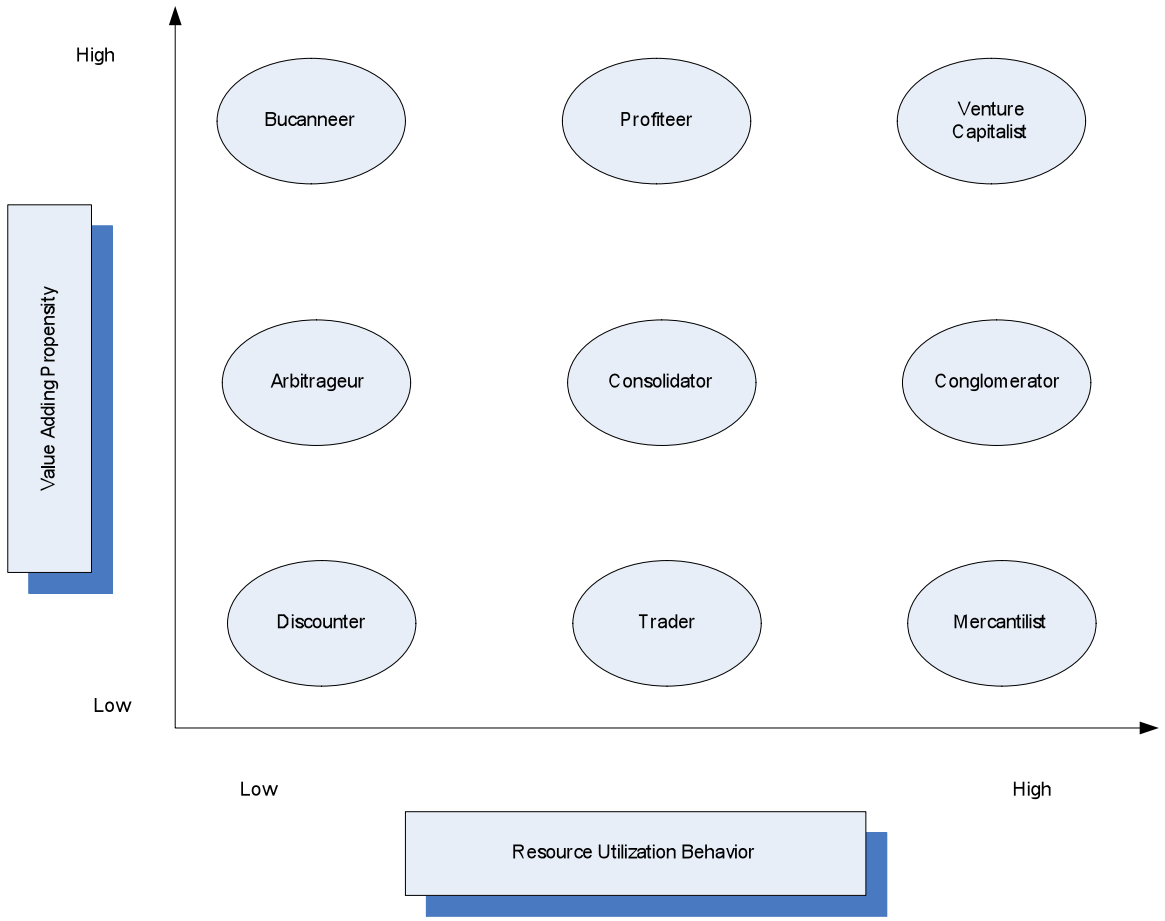
$$E, w_i \geq 0$$

Where w_i is a weight applied to the input and output of each member of the cohort, to take into accounts the difference in firm size.

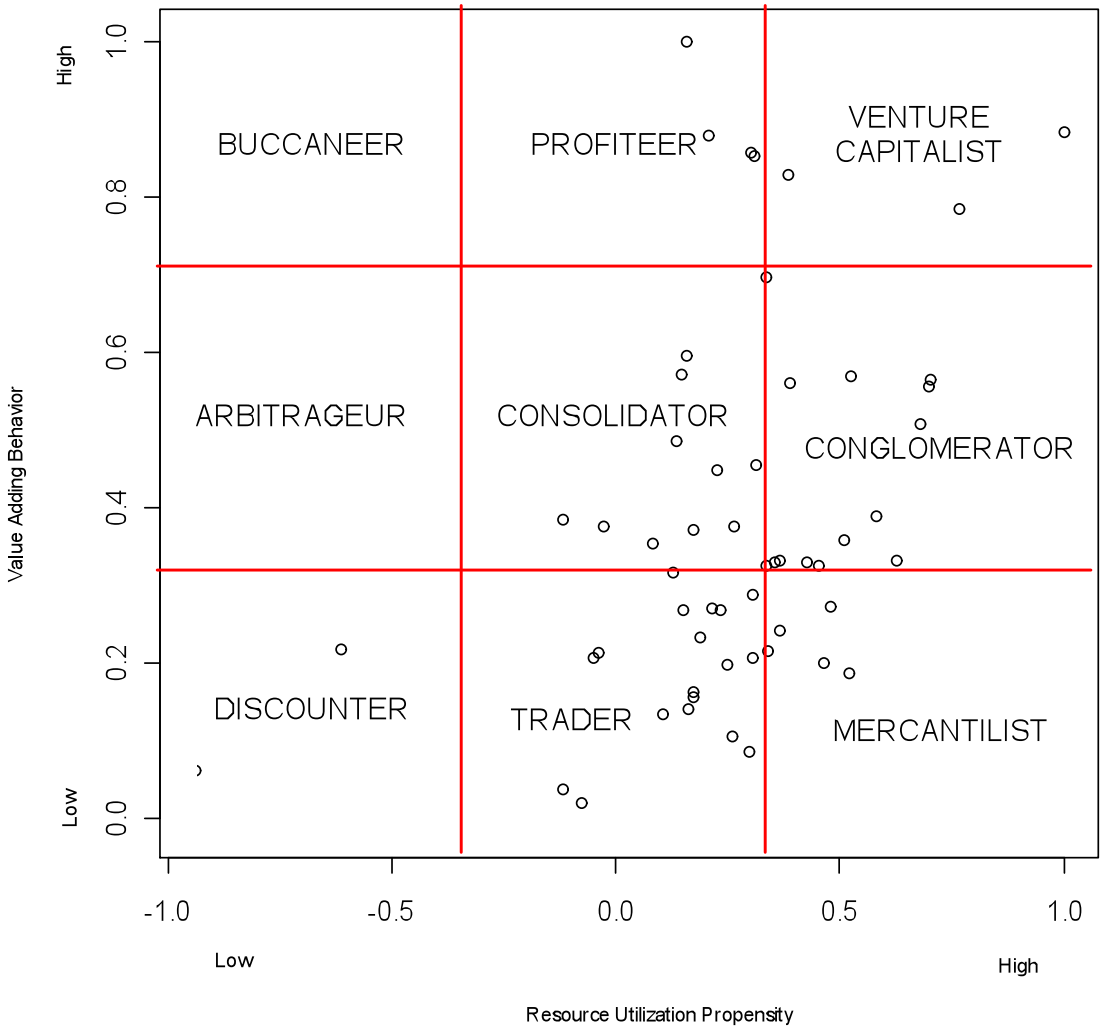
The value of E is computed for each firm while running the above model. It is then mapped into a matrix that shows how each firm's financial signature. The result is shown in the next section.

RESULTS

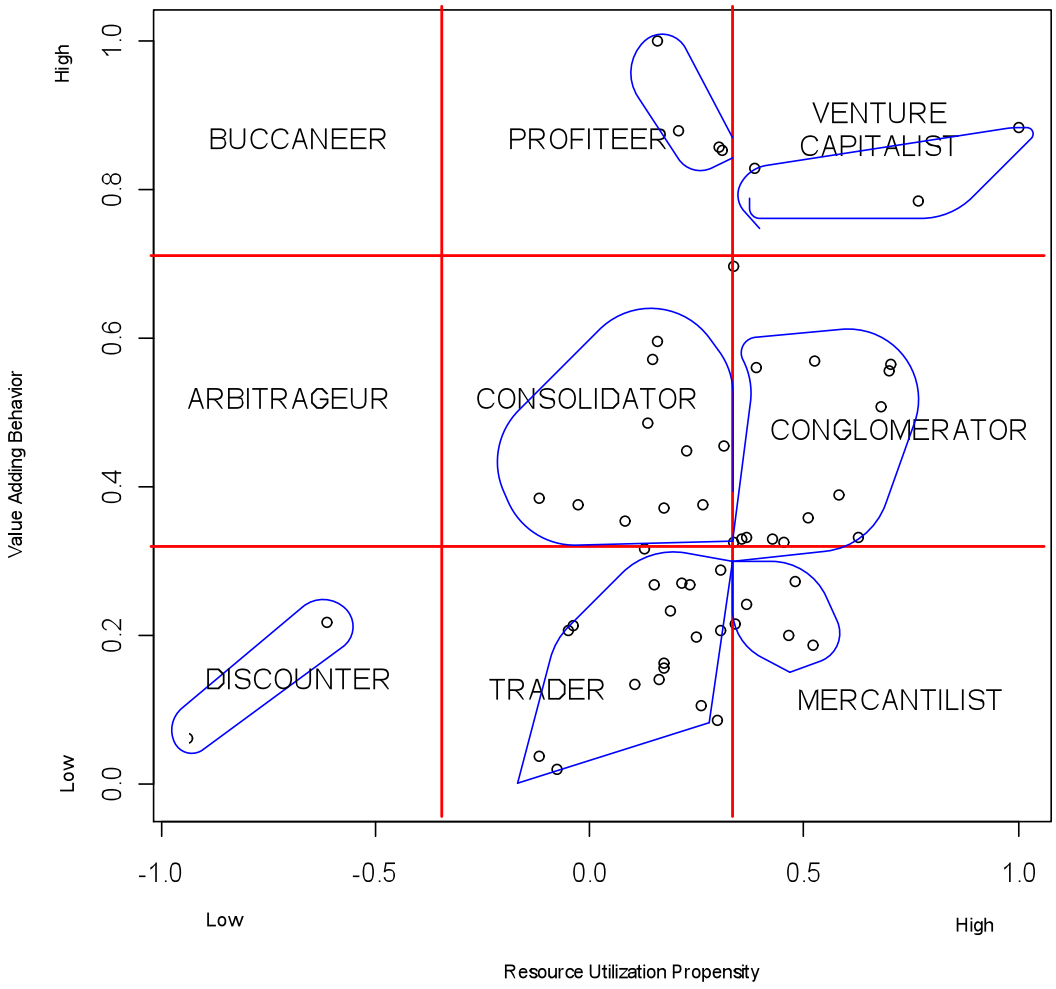
Once a performance effectiveness, or financial signature, is attributed to each firm from the value of E, it is plotted on a matrix that was developed based on the firm's resource utilization vs. value adding activities (See graph below). While resource utilization is the measure of how resources are allocated and spent, value adding is an indication of degrees at which firms improve products and services towards higher profits. These activities are ever changing, making it possible to build a dynamic mapping of the industrial landscape once a cohort of firms are mapped together. The map is however divided into nine zones that are determined based on the typology of firms as per their resource utilization and value adding as shown in the graph below:



The results are summarized in the graph below, where each dot represents a firm from the data set.



Preliminary analysis of the map shows that within each zone, firms tend to cluster within a certain area, suggesting the delimitation of frontiers. Such limits can be interpreted two ways: the barrier of entry and the limiting factors (or direction of the opportunity for disruption). The next map shows such frontiers



DISCUSSION

Firms may improve their competitive position several ways by moving from one zone to another by alteration of their products (ie. Changing their value adding behavior) or their resource utilization. Moving from one zone to another however requires firms to move out of their current frontier/limitation by disrupting it. Reading the map can therefore afford firms the opportunity to formulate their disruptive strategies by focusing on which aspect of their strategies need to be altered (product features vs. resources).

References available upon request