VALUING PRIVATE COMPANIES: A DEA APPROACH

by

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**A Thesis submitted in conformity with the requirements for the
Degree of Masters of Applied Science
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Valuing Private Companies: A DEA Approach**M.A.Sc. 2000****Burcu Anadol****Department of Mechanical and Industrial Engineering****University of Toronto****ABSTRACT**

Traditionally company valuation methods are based on discounted cash flows and liquidation values, but all have a number of known shortcomings. The application of Data Envelopment Analysis (DEA) for finding comparable firms and predicting the market values of companies is an extension of the market-based approach and replaces the traditional method where DEA is used for assessing relative efficiencies.

For the inefficient units, the DEA-Valuation analysis correctly classified the market ranges for 70% of the companies. An upper bound was predicted for the inefficient companies based on their efficient peers. Of these, 75% were below their upper bound. For the efficient peers, DEA was able to find a lower bound for their market value based on peers being compared to them 50% of the time. Although some of the ranges specified by the peers are quite wide, the method still does a relatively good job in classifying market values.

To my family

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1. INTRODUCTION

This chapter presents an overview of this thesis by providing background information on the corporate valuation field, and establishes the motivations for this research. Detailed problem definition and research objectives are presented as well as solution approaches and contributions. The chapter concludes with a summary of the organization of the remaining document.

1.1 Background

Valuation arose out of the need for appraisals of land, its management, and use. As a consequence, there have been multitudes of surveyor organizations in existence throughout history, but in the recent years, as businesses have become more complex, a new form of valuation was required. Business valuation in Canada consisted of people being trained by the provincial governments to operate in what was known as the "death duty field." This came about due to the need for additional tax revenues, and gave rise to the valuation of not only property, but of intangible, tangible and business interest items. The Canadian Association of Business Valuators was formed in 1972 to organize the different professions dealing in valuations under one umbrella organization.

The business of valuation is a multi-billion-dollar field. In 1996, \$650 billion (USD) was invested in mergers and acquisitions (M&A). This figure was double that of the peak M&A boom of the 1980s [ETTO97]. The reasons for business valuations differ, but most businesses are appraised to obtain an impartial opinion on the value of the business. Improper valuations can lead to losses adding up to hundreds, thousands, and often millions of dollars. Moreover, the range in prices that different buyers will offer is large. Often, the difference between offers may be 200 percent or more [DENN00].

Company valuation studies include the use of the asset-based approach, the discounted cash flow method and the comparable firms approaches. In comparable firms, the subject company is benchmarked relative to specific comparable companies from which useful public valuation data can be obtained. When using discounted cash flows, public companies' risk/return characteristics are analyzed, adjusted and applied to the subject company.

1.2 Motivation

The motivation for this research stems from studies in several areas of corporate finance and from applications of Data Envelopment Analysis (DEA). The importance of business valuation has received considerable attention over the past years, however, a comprehensive review of using "comparable" firms has not been considered in the present literature. For this reason, this work concentrates on finding a peer group of comparable firms using DEA; a unique application for this powerful tool.

DEA is ideal for finding comparable firms in many ways. The basic underlying methodology is a linear programming based comparison of the units under analysis, be it banks, hospital, or in this case businesses. DEA identifies best practice (efficiency frontier) units, allows multiple inputs and outputs, is non-parametric, and deterministic (does not require the specification of a functional form). DEA provides an efficiency score for each DMU (Decision Making Unit), identifies inefficient units, finds a peer group of similar companies for the units under analysis, and it projects the inefficient units to the efficient frontier (targets for improvement). It incorporates all relevant factors in a single model and no single factor is given preference (non-biased). It measures relative efficiency from the best-observed performance rather than from

averages. Also, it does not make judgments on the importance of the variables (unrestricted weights).

This paper continues the approach started by Simak [SIMA00], but differs in several respects. First, the sample includes over 400 publicly traded Canadian firms and over 40 private ones. The models for valuation differ with respect to the input/output variables, as these variables appear to be more appropriate to measure value. Simak does not carry out the actual analysis of the private companies with DEA, so this work will fill that gap. The data consisted of known SIC (Standard Industrial Classification) codes with analysis carried out only for the companies that had the same 4-digit SIC code. Further, one can propose to determine an upper bound on the market values of the inefficient companies and a lower bound for the efficient companies as determined by the lambda values (resulting from the DEA model) found from the analysis.

1.3 Problem Definition

The primary objective of this research is to value private companies using DEA. A secondary objective is to find the factors that determine market capitalization for companies and in particular, to find the firms that can be used for comparison purposes in a valuation study employing DEA. The first goal of the project is to develop a procedure for valuing public companies using DEA by finding comparable firms, hence, appropriate market value ranges, and then to validate the ranges with the known market values of the public companies. The next goal is to apply the procedures available in the public domain for valuing private companies. Some of the most pressing issues in developing a model are to determine a set of relevant inputs and outputs that serves the objective and ensuring that important variables are accounted for.

1.4 Thesis Contributions

The major contributions of this thesis are:

1. Development of appropriate valuation models for public and private companies.
2. Establishing a set of peer groups for the companies based on multiple inputs and outputs.
3. For each individual company, efficiency scores and a difference indicator are provided.
4. To gather a comprehensive data set consisting of data for 452 public companies and 49 private companies.
5. Finding a market value range for the subject (inefficient) company based on its comparative peers.
6. For the inefficient companies, establish an upper bound on their market value based on the efficient companies they are being compared with.
7. For the efficient companies, find a lower bound for their market value based on the companies being compared to them.
8. To provide an additional tool for business valuers and others to utilize in order to determine the value of a company.

1.5 Thesis Organization

The remaining chapters of this thesis are organized as follows:

- Chapter 2 provides a review of the relevant literature in the area of valuation. It identifies the different valuation methods and the shortcomings of each method, and starts to identify why data envelopment analysis may be a good tool for this application.

- Chapter 3 explains the DEA solution approach. The development of the methodology and the different DEA models are presented. The compatibility with valuation is discussed.
- Chapter 4 demonstrates the valuation model illustrating the important variables to utilize. It demonstrates how each variable was selected and why certain ones were not included.
- Chapter 5 summarizes the data acquisition process and describes the data treatment that had to be performed for the research.
- Chapter 6 presents the results of the analysis and provides a discussion of the results. An analysis of all the public companies with a SIC code in the 3600s is provided using the BCC (Banker, Charnes and Cooper) model. A complete analysis of companies having a SIC code in the 3700s and 2000s is examined including examinations of correlation's between efficiency and market value. A valuation analysis of two of the companies with all 452 companies is provided. Finally, the lessons learned from the public company valuation are used to analyze three private companies having SIC codes in the 3600s.
- Chapter 7 presents the conclusions of the work and provides recommendations for future work.

2. LITERATURE REVIEW

“In pricing an acquisition, we can always agree on the numbers. What value is tends to be more in the realm of poets than financial people” [NEED86]

Valuation of private companies is a key area of focus for accountants, lawyers, business valuers, investment bankers, and venture capitalists. The purpose of a business valuation is to find the financial worth of a company. DEA's application to measure this worth is a fairly new concept, but the multidimensional nature of corporate valuation makes it an ideal application area for DEA. This section highlights the literature related to company valuation and discusses the issues and limitations of the approaches.

The valuation concept can be dated back to the time of Napoleon and even King Henry the VIII, although, its main purpose at that time was for inheritance taxation [OVEN72]. As the business world developed, starting with the Industrial Revolution, new methodologies for valuation became necessary. Present day valuations of IPOs (Initial Public Offerings) and selling and acquiring businesses have taken centre stage in the valuation world, but there is still a significant need to value firms for estate, taxation, and divorce settlements. As there are many different applications of valuations, so are there methods to analyze them.

2.1 Value Definition

Value is the highest price a knowledgeable buyer, at arm's length, is willing to pay in an open and unrestricted market. Price and value are often used interchangeably but value generally means a willingness to sell or to buy, while price is the value at which a deal is carried out. The U.S. Internal Revenue Service defines **fair market value** as “the price at which a property would change hands between a willing buyer and a willing

seller when the former is under no compulsion to sell, with both parties having reasonable knowledge of the facts” [PRAT96].

2.1.1 Intrinsic Value

Intrinsic value of common stock is the price that is justified for a share when the primary factors of value are considered. In other words, it is the real worth of the stock, as distinguished from the current market price of the stock. It is a subjective value in the sense that the analyst must apply his or her own individual background, expertise and skills to determine it, and estimates of intrinsic value will vary from one analyst to another¹ [PRAT96].

2.2 Value Purposes

The need for business valuation may arise from a variety of circumstances and the different circumstances will require different valuations. Valuations of estate and divorce settlements are quite different than valuations for IPOs. Here is a listing of the varying needs for a valuation:

- IPOs - the company intends to sell shares to the public
- Mergers and Acquisitions (M&A)
- Selling a Business
- Estate and Gift Tax Purposes
- Re-capitalizing a Business
- ESOP (Employee Stock Ownership Plans) Valuation
- Litigation Purposes or divorce settlements

¹ From the Handbook for Financial Decision Makers, John J. Hampton, Reston VA, Publishing Co., 1979 p543-4.

2.3 Valuation Approaches

There are many different methods that can be used to assess the value of a business, but these methods can be grouped under three main approaches, namely, asset-based, income-based, and comparable firms or market value based. The two main approaches for valuation are the comparable firm approach and the income-based approach, with discounted cash flow being the most popular of the latter method. There have been articles expounding the benefits of both methods. Whether one method is used or several, each method has associated benefits and disadvantages as illustrated in Table 2-1:

Table 2-1 Valuation Approach - Advantages and Disadvantages

Approach	Advantage	Disadvantage
Comparable firms (CF)	Works best when a highly comparable group is available	There is a chance that an entire sector is under or over valued
DCF	Firmer theoretical footing	Difficult to estimate future cash flows and an appropriate discount rate
Asset-based	Looks at the underlying value of a company's assets	More relevant when a significant portion of the assets can be liquidated readily. For small, high-tech IPOs, this method has little relevance since it does not consider growth opportunities.

[BOOT00]

The purpose for the valuation may influence the method applied. Of the different value approaches the method most popular with companies is the DCF method. Booth examined a survey conducted by Mohan et al on what valuation methods large companies use and recorded the results shown in Table 2-2 (based on a scale from 1-7, where a score of 7 is the most desirable): [BOOT00]

Table 2-2 Desirability of the Different Valuation Methods

METHOD	SCORE 1-7
DCF	6.1
Market Value of Comparable	5.7
Projected Earnings	4.4
Revenue Multiples	4.1
Earnings Multiples	4.0
Book Value	3.6
Liquidation Approach	2.3

2.4 Asset Approach

This method is mainly employed on companies that are asset intensive, for example manufacturing and retail businesses. Among asset valuations, book value, replacement cost, and liquidation can determine value. One of the most basic approaches is to calculate the book value, hence the shareholders' equity. One of the problems of this method is that the assets are based on historical costs. Another method that can be used relies on established benchmarks, which are used to estimate the value of a business. For example, a small investment advisory sells for 3-4 times the current year's revenue.

Factors analyzed in asset valuation are the market value for fixed assets, leasehold improvements, owners' benefits, goodwill (intellectual property, patents, trademarks, copyrights, etc.) and inventory. The sum of these factors will give an estimate of the market value for the business.

Asset valuation is the least favoured method and considered by some to be the most difficult. Sometimes earnings have been "stored up for a number of years ...to the point at which two valuations are required, one for the operational side of the business including sufficient assets for the maintenance of earnings, and the other for what has become the investment side of the business" [OVEN59].

2.5 Discounted Cash Flow (DCF)

The DCF method calculates the expected future income stream of a company discounted back to present value, at a risk-adjusted rate. It is based on the Gordon Price Model and is mathematically represented as:

$$P = \sum \frac{D_n}{(1+k)^n}$$

Where P is the price, D_n is the dividend in year n, and k is the cost of equity or discount rate. On the other hand, the Gordon Price Model assumes constant growth so the above equation is adjusted accordingly. In this instance, g represents the growth, k and d are the same as in the above equation:

$$P_0 = \frac{d_1}{(k - g)}$$

Another way of representing DCF is to show that the DCF formulation values only the assets that give rise to the free cash flow:

$$V_0 = \sum_{t=1}^T \frac{C_t}{(1+K)^t} + \frac{V_t}{(1+K)^t}$$

Where T is the time period, C represents the free cash flow, K is the discount rate, and V_t is the terminal value.

Price Earnings Ratio/Multiple (PER) Formulation

Another variation of the Gordon Model called the Price Earnings Ratio/Multiple (PER) is based on forecasted earnings [BOOT98a]:

$$PER = \frac{(1-b)}{K-g}$$

Where b is the firm's retention rate of earnings, $(1-b)$ is the dividend payout rate, K is the discount rate and g represents growth.

2.5.1 DCF Papers

Ruback [RUBA96] prefers the DCF approach rather than the comparable firms method. He investigated the valuation of 51 highly leveraged transactions. He showed that the DCF valuation method produces more reliable estimates of market value. He examined three CAPM-based approaches to estimate discount rates that correspond to firm-level, industry-level, and market level measures of risk. All three methods performed better when compared to the comparable firms approach.

Kaplan and Ruback studied highly leveraged buyouts and re-capitalization's using the DCF approach [KAPL95]. They found that a CAPM based DCF approach has approximately the same valuation accuracy as the CF approach, using the capitalization of EBITDA².

For most companies, future earnings potential is more important than past performance, that is why calculating DCF is such an important issue in valuation. The DCF method is used predominately for companies that are not asset intensive, like the service sector. In the DCF method, certain variables and unknowns must be calculated which include: the amount of future cash flow, growth potential of the cash flow, duration of the future cash flow, risks associated with them, and the discount rate to apply to arrive at the net present value [MULL90]. Other factors to analyze include risk within the industry, quality and size of the customer base, length of time the company has been in business, and the level of technology.

² EBITDA - Earnings before interest, taxes, depreciation and amortization, also known as operating cash flow

2.5.2 Capitalization Rates

The most problematic aspect of this method is the selection of an appropriate discount rate. For private companies, the discount rates are chosen based on the perceived riskiness of the business. Risk is a part of any business. In 1776, from the *Wealth of Nations*, Adam Smith remarked that "the ordinary rate of profit always rises more or less with the risk" [BOOT98a]. A higher rate of return, or, a higher discount rate is to be employed to value the risky firm's operations. Usually, the discount rate is a percentage added to the current 90 day T-bill interest rate. For better-established businesses the discount rate may be 5-10% above the T-bill rate, and for riskier companies about 20-25%. The riskier the business the higher the discount rate. For determining an appropriate discount rate several methods can be employed; they include CAPM, WACC and analyst estimates.

2.5.2.1 CAPM

Markowitz, in 1959, analyzed the behaviour of a portfolio of securities and showed that, "unless portfolios were perfectly correlated, risk would decrease as imperfectly correlated securities were combined into portfolios" [BOOT98a]. Sharpe added to this theory, addressing the issue of covariance, highlighting the measure of risk known as a security's "beta coefficient and (it) is estimated by a simple least squares regression of the security's return against that on the market portfolio" [BOOT98a]. It was Sharpe who introduced the Capital Asset Pricing Model (CAPM), otherwise known as the market equilibrium model, which can be used to derive the required rate of return for DCF calculations. It states that the required rate is equal to the risk free rate plus

some sort of premium. It measures the risk of a security by relating the expected return on an asset to its beta:

$$K_e = R_f + (R_m - R_f)\beta$$

Where, K_e is equal to the cost of equity capital. R_f is the risk-free rate of return, R_m is the market required rate of return, and β is a measure of the systematic risk of an asset due to the co-movement with the market. If a company has a beta of one then the stock has the same volatility as the market index it is being compared to. If beta is 0.5, then the company is half as volatile, and if it is two then the company is twice as volatile. In order to estimate beta, one needs to regress the stock's price against the level of some broad market index such as the S&P 500 and the beta factor is just the slope of the regression line.

2.5.2.2 WACC

Another method to calculate the capitalization rate is to use the weighted average cost of capital (WACC); it is represented mathematically as:

$$WACC = \frac{E}{V} K_e + \frac{D}{V} K_d (1-T)$$

In the equation, K_e and $K_d (1-T)$ are the costs of equity and debt capital respectively, where the cost of debt is on an after tax basis. The weights, E/V and D/V , are the equity and debt financing proportions. WACC is the weighted average of the costs of borrowing and of selling shares. The weights are the fractions of total capital that come from the different sources. WACC is not really a separate method; it combines two or more capitalization rates to get one. It assumes that the purchase of a business can be partly financed with debt and partly with equity. It weighs the cost of capital to the cost of indebtedness.

2.5.2.3 Analyst Estimates of DCF Parameters

For the selection of the capitalization rate, valuers have information about the capitalization rates of several companies, and they try to apply these to the business under consideration. The parameters they consider in a DCF approach are the time horizon, the discount rate, and the cash flow forecasts. Most analysts choose a time horizon of less than 10 years and 55% use less than 7 years. For the discount rate, 55% of analysts used the acquiring firm's WACC, and 41% used management judgment. Also, most analysts apply industry growth trends and "expected" performance to cash flow forecasts [BOOT00].

2.5.3 Disadvantages of the DCF Method

The two major problems with the DCF procedure are the discount rate used and the estimate of future cash flows. Earnings are effected by fluctuations within a certain industry and by the state of the economy. Past earnings are no guarantee of future earnings. Underlying factors may be at play and each company should be examined thoroughly to insure the business is sound. In the case of Internet start-ups, no formula is valid. Their characteristics are such that they usually have little or no earnings, they do not have historical earnings as they have existed for only a short time, most of their value is in future growth opportunities, which are very uncertain, and their employees.

Problems manufacturing plants can have include:

- Plant may become obsolete
- Manufacturing and distribution outdated
- Products suffering due to competition or lack of sales
- Location might no longer be suitable, closeness to market
- Problems with employees

[OVEN59]

In 1959, according to a pamphlet put out by the CICA (Canadian Institute of Chartered Accountants), it was presumed that the capitalization of future profits was not widely used. Little proved that the opposite was true [LITT59]. He showed that it was the most widely used method in Canada. He quoted Mr. Justice Douglas of the United States Supreme Court, who urged caution when applying this method:

“Since its application requires a prediction as to what will occur in the future, an estimate, as distinguished from mathematical certitude, is all that can be made. That estimate must be based on an informed judgment which embraces all facts relevant to future earning capacity and hence to present worth. Including, of course, the nature and condition of the properties, the past earnings record, and all circumstances which indicate whether or not that record is a reliable criterion of future performance” [LITT59].

The risk free rate (RFR) is usually acquired from business news, but it is usually correct for only a short time period and it has to be adjusted to imitate the growth of the firm for longer time horizons. The base CAPM ignores issues such as taxation and it does not consider multiple time periods. It also does not model the real world, by ignoring transaction costs and assuming all risky assets are traded. Selecting the appropriate discount rate is a key issue in valuation. These and many other reasons make it difficult to apply the DCF approach in trying to value a company.

2.6 Problems with Accounting Ratios

There are also some problems associated with using only an accounting approach. Each company filing an annual report has to adhere to their countries' Generally Accepted Accounting Principles (GAAP). In Canada, many of the larger public

companies also, or exclusively, report according to U.S GAAP. When carrying out a complete valuation, the accounting numbers have to be adjusted for the different accounting procedures. Some accounting items to examine are whether the company accounts for inventory by LIFO or FIFO. In Canada most firms use FIFO because there is an additional 3% inventory write-off allowed for tax purposes [BOOT98]. Companies using LIFO will have decreased profits, reduced taxes but a stronger cash flow since the last item in is typically more expensive. Other issues to address include:

- Purchase or pooling of goodwill,
- Capitalization or expense items (R&D, etc.)
- Depreciation policy (accelerated, straight line, etc.)
- Off balance sheet items-pension fund liability, warranties or litigation
- Capital structure
- Discounted rate differences (risk, time value of money)

For these reasons, when conducting a full valuation it is important to adjust the income statement and the balance sheet to reflect these concerns.

2.6.1 Free Cash Flow (FCF)

Hunt [Hunt75] introduced the theory that the firm's capital expenditure (Capex), needed to sustain operations, should be subtracted from the Cash Flow from Operations (CFO) to get the true cash generating ability of the firm. The result is what is now known as Free Cash Flow (FCF). It is mathematically represented as:

$$\text{FCF} = \text{net income} + \text{non-cash items} - \text{increase Net Working Capital (NWC)} - \text{Capex}$$

Non-cash items include depreciation, goodwill, and deferred income taxes and after tax interest. FCF "captures whether or not the firm actually generated cash from its operations, after adjusting the earnings for non-cash items, the need to reinvest in NWC

and new capital expenditures to maintain the firm's operations"[BOOT00]. However, FCF's effects on asset poor companies and service organizations is an issue that has to be dealt with. In this sort of area, it is more important to address the cash dollars spent by these companies, such as for advertising, R&D, planned losses, and so on.

According to Booth [BOOT00], using FCF is one possible solution to the accounting problem. By analyzing FCF, one can get a true picture of a company's operating results, instead of the diluted view presented through the pure accounting changes used by firms.

2.7 DCF and Private Companies

How do all of these factors impact private companies? For estimating risk premiums one needs data and the data are only available in public markets. Booth [BOOT98a] examined the effect of size and transaction costs on the discount rate. He looked at the total return data on size based US portfolios going back from 1926 to 1995. This information is available from the University of Chicago's Centre for Research into Security Prices (CRSP). The data showed that smaller firms constantly outperformed larger ones. They earned close to double that of the larger firms 22.62% versus 11.41% respectively. Smaller firms performing better than CAPM predictions are referred to as the "small firm effect." Private companies are usually valued (discounted) on lower PERs than public firms are since they are considered to be riskier endeavors. Rules of thumb approximate this discount to be around 20% for private companies.

2.7.1 A Beta Coefficient for Private Companies

A beta for the DCF of a private firm is impossible to acquire but Booth [BOOT98a] suggested two alternatives, the pure play approach (PPA) and the

instrumental variables approach. The PPA “finds public companies with similar operations and use(s) their beta...(or) use(s) the broad industry classifications of the TSE or S&P market indexes” [BOOT98a]. From this he found that “a firm in the general industrial products area has a beta of 1.2 or a CAPM risk premium of 4.2-4.8%, whereas a private retailer would have a CAPM equity risk premium of 2.7-3.1%” [BOOT98a].

The instrumental variables approach, [BOOT98a], “statistically estimates the relationship between actual betas and the particular characteristics of traded firms, such as their financial structure, growth rate, dividend policy, etc.” This relationship is then used to approximate the beta for the private firm by substituting back the private firm’s financial values. For the non-traded firms, the variables act as instruments to estimate their betas as if they were traded.

The potential discount for a firm based on these findings could be 15.5 to 17%, as displayed in Table 2-3:

Table 2-3 Example of Estimating the Discount Rate

CAPM discount rate for industrial products firm with beta of 1.2	
Item	% Discount
Long Canada rate	5.5
Equities tax preferred in Canada	1
Market risk premium in Canada	3.5-4
Small firm earning since 1926	4
Non-marketability, transaction cost	1.5-2.5
TOTAL	15.5-17

[BOOT98a]

Booth extended the CAPM to include private firms, where the variables γ_1 and γ_2 are the small firm and private firm premiums. This forces the discount rates of the small firms to be higher than the larger firms:

$$K_e = R_f + (R_m - R_f) \beta + \gamma_1 + \gamma_2$$

2.8 Comparable Firms or the Market-Based Approach

The comparable firms (CF) approach or market approach as it is sometimes known, implies comparison with publicly traded companies. It is implemented by capitalizing the earnings per share (EPS) of the firm under consideration at the average or median P/E ratio of the complementary publicly traded firms. Earnings forecast, market to book, and price to sales are other factors that can be used instead of P/E ratios.

2.8.1 P/E Ratio

The P/E ratio is the relationship between the current price of a stock to its earnings. It shows the shares selling at so many times their actual or anticipated annual earnings. The P/E is calculated by dividing the current market price of common stock by the earnings per share. Investors use it to ascertain the market demand for stocks. Companies with a high P/E have greater earnings potential than low P/E stocks, but also are more volatile and somewhat riskier investments.

P/E ratios enable one share to be compared with another, they also reflect the views of thousands of investors on the quality of an issue. They indicate liquidity, earnings trend, profitability, and dividend payout along with intangible factors such as quality of management, and prospects for the industry or segment [CSI89]. To rate the P/E for a company's common shares with those of others, the companies must be comparable which usually means they must be in the same industry. P/E ratios for different industries are available in various media and industry sources, for example the TSE monthly review.

The P/E ratio is probably the most useful and widely used of all financial ratios because it is, in fact, all the other ratios combined into one figure since it represents the ultimate evaluation of a company and its shares by the investing public [CSI89].

2.8.2 P/E Ratio and Comparable Firms

Many studies examine the use of the P/E ratio for comparable firms. Boatsman and Baskin [BOAT81] compared the accuracy of two different types of P/E models. The first model finds a random company in the same industry. The second model uses a company from the same industry but with similar ten-year average growth rate for earnings. They found the accuracy of the second model to be better.

Kim reported on an article by Alford [KIM99], where Alford evaluated the accuracy of the P/E valuation method when the comparable firms are chosen by industry, firm size and earnings growth. He found that the 4-digit SIC code is the most effective in choosing comparable firms. It is also interesting to note that Alford did not find improved accuracy when size and industry membership were used together in the P/E valuation [KIM99].

Kim cited a study by De Angelo [KIM99] that demonstrated that investment bankers make extensive use of accounting data and that they depend on the CF approach. He did this by examining working papers and fairness opinions on management buyouts. He showed that underwriters base their pricing decisions on an analysis of the market price ratios, with adjustments for firm-specific differences, and determine a range of minimum and maximum offering price, then, after gathering more information they set the market price.

Ratios other than P/E can be used in conjunction with the CF approach. One can have any sort of ratio, even those that are specific to an industry, for example, market value divided by cable subscriber. Amir and Lev, cited from [KIM99], provided a valuation study of the wireless communication industry. They showed that the primary determinant of company value is the population of the franchise territory, rather than financial variables.

The value relevance of P/E and market to book (M/B) ratios has been demonstrated by empirical studies. Kim quotes two articles, one by Zerowin and the other by Liu and Ziebert [KIM99], who examined cross-sectional variability in P/E and found a significant relationship between P/E and growth, dividend payment and size.

According to Campbell “trading statistics with respect to shares of so-called comparable public companies can be, and moreover should be, a significant factor to consider” [CAMP92]. He stated that it is important to use CF where the privately held business under valuation is similar in size, business structure and business operations to one or more of the publicly traded companies.

In the U.S., the Internal Revenue Service (IRS) considers the analysis of public companies an important tool in determining the value of private companies, although this is mainly for income-tax purposes. Ruling 59-60 urges “using comparisons from quotations found in the prices at which similar companies are selling in free and open markets, including not only listed securities but also actively traded over-the-counter and unlisted securities” [OVEN59].

Morris [MORR92] reaffirmed the fact that the best multiple may come from a public market comparable. If it exists it should be given full and complete consideration.

He points out "it is difficult to depart from price, or multiple, set in the public marketplace. These public companies are one's best empirical data" [MORR92].

2.8.3 Valuing IPOs Using CF

Systematic studies on the usefulness of the CF approach have not been performed. Kim and Ritter [KIM99] come closest to filling this gap with their significant paper on IPO valuation. A detailed explanation of IPOs is discussed in a later section. Most literature recommends the use of accounting data in conjunction with comparable firm multiples when valuing IPOs. Generally, younger firms vary in terms of ratios, P/E, M/B, and price to sales, and may need further adjustments. The best way to employ P/E ratios is through the use of forecasted earnings rather than trailing earnings. Another ratio that can be used in valuations is enterprise value to sales and enterprise value to operating cash flow. Enterprise value is equal to the market value of equity plus the book value of debt minus cash. "Ratios seem more useful especially when adjusted to reflect differences between profitability and growth rates of the IPO in question and the comparable firms used" [KIM99]. However, it is difficult to forecast the future cash flow for very young companies, which is the category most IPOs fall into. That is one of the main reasons why the DCF method is imprecise, and the key advantage of the comparable firms method. The CF method is supported by academics and practitioners and widely used in case studies in business schools [KIM99].

Kim and Ritter [KIM99] use sales, earnings, operating cash flow and book value to determine value, as well as comparable firm multiples. They tested the accuracy of the comparable firms method by using two sets of comparable firms. The first set consisted of recent IPOs in the same industry and the second set was chosen by a research

boutique³. The results showed that the second set worked better than the first, and applying forecasted earnings worked better than using historical earnings. They also tested the hypothesis that young firms are harder to value by splitting the data into 'age' groups and applying the second set. They found that the "valuation errors of the comparable firm multiples are noticeably smaller for the older firms than for the younger firms, especially when using earnings" [KIM99].

The recent IPOs set consists of companies that went public not more than 12 months prior to the IPO under investigation's offer date and that has the same 4-digit SIC code. If there were more than 5 comparable firms to compare with they suggested using the 5 firms with the closest sales and ignored the rest (firm = recent IPOs). Earnings for the first year after going public typically include substantial amounts of interest income thus in the analysis EPS is used and sales numbers from prospectuses only, rather than more recent financial statements that may be skewed by interest income.

The variables they selected were offer date (cannot be more than 12 months before the offer date of the new IPO), EPS, Sales (12 month revenues prior to IPO as stated in prospectus), and book value per share (BPS) (both pre and post IPO). Another condition placed on the variables is that they must be positive. They then computed the following ratios: P/E, P/S, and M/B. The median of these market multiples is then used as the CF multiple for the company. The company's ratios are computed based on its offer price (post-issue).

CF multiples are typically higher than the multiples for the firms going public, partly because they are using market prices for the comparable firms and offer prices for the IPOs. Also, because of the short-run underpricing phenomenon (average first-day

³Company that specializes in valuing IPOs

return in the sample is 12%), one would expect the IPO multiples to be discounted by about 12% [KIM99]. The functional fixation hypothesis asserts that the market mechanically capitalizes reported EPS numbers, without adjusting for the quality and or persistence of the earnings. Friedlan et al [KIM99] suggested that the market does not fully incorporate the information content of discretionary accruals in valuing new issues, consistent with the functional fixation hypothesis.

The first model of the CF approach is surprisingly weak for the following reasons. First, because historical earnings of IPOs are transitory in nature they have little value relevance. Second, using market multiples and past data have an intrinsic limitation in that they do not reflect future growth. This leads to the third issue, which is allowing for adjustment of differences in growth and profitability. Finally, there is an element where the comparable firms may have been chosen improperly [KIM99].

A “boutique” firm, Renaissance Capital, chose the second set of comparable firms. The research boutique chose the CFs based on the major competitor firms mentioned in the prospectus of the IPO. While historical earnings contained in the prospectus are available to all market participants, practitioners also frequently use earnings forecasts for valuation purposes. In addition, Renaissance Capital did not restrict the comparable firms to the same SIC codes.

Kim and Ritter used “the geometric mean of the Renaissance Capital comparable firm P/E multiples as the explanatory variable in regressions using the three P/E ratios of the IPOs as the dependent variables” [KIM99]. The three P/E ratios, using the midpoint of the POP (preliminary offer price) for the IPO, are the last 12 months, current fiscal year’s forecast, and next year’s forecast of the EPS. Comparing the regressions, the

average prediction error falls from 55% to 43.7% to 28.5% respectively, and the percentage of firms that are valued within 15% of the actual multiple increases. Younger firm valuation using forecasted earnings works better than using historical earnings, as there is a potential growth opportunity that needs to be addressed.

They also tested the presumption that older firms will be easier to value since capitalized earnings represent more of their value than expectations about future growth rates. Consistent with that presumption, the mean absolute prediction error for the firms that are less than 10 years old at the time they go public is higher than for older firms, 31.9% and 23% respectively.

2.8.3.1 M/B Ratios

Renaissance Capital does not utilize M/B ratios. They find M/B ratios to be poor valuation metrics. They claim that M/B ratios have a disadvantage because the book value is arbitrary for IPOs since there is a large change from before the issue to after (influx of new capital from new shareholders). Rather, they recommend using enterprise value (EV) where they look at market value to sales, EV to sales and EV to operating cash flow (EBITDA) in their analysis.

To summarize Kim and Ritter [KIM99], the variation in these ratios is so large, both for public firms and IPOs, that they have only modest predictive value. Many idiosyncratic factors are not captured by industry multiples unless various adjustments for differences in growth and profitability are made. In practice, analysts place more weight on a given multiple for some industries than others. Taking this into account would probably show that CF multiples result in more accurate valuations. In practice, one starts with industry multiples and adds or subtracts adjustments of 10-20% to reflect

differences in growth rates, profitability, and quality of earnings. Investment bankers use the midpoint of the offer price range resulting in smaller prediction errors than using comparable firms. They canvas the market place for demand before setting the final issue price [KIM99].

2.8.3.2 Issues with this study

One issue with this study is the use of a maximum of 5 comparable firms and the deletion of the rest. The comparable firms approach works best with a high number of comparable firms and exclusion of firms to simplify a study may not give meaningful results. It is better to have as many comparable companies as possible.

2.8.4 Issues with the CF Approach

Three main issues with this approach are the P/E ratios employed, the use of the right multiplier for the industry, and the availability of a highly comparable group of companies. P/E ratios are dynamic and vary widely over time and among companies. The problems with P/E ratios and the right multiplier can be remedied by looking at industry trends and the broader market to forecast trends and adjust historical P/E ratios accordingly. Companies can be public and not useful for these comparisons because:

- They are not listed anywhere (traded over the counter)
- Not liquid
- Shares are priced very high (Hathaway Corp.)
- Share prices are too low because of too many shares
- Small float
- Huge stock options outstanding at low prices compared to market
- Only few very large firms are listed, private firms are one or two orders of magnitude smaller.

2.9 Private and Public Companies

In order to apply the above valuation techniques to private firms, adjustments have to be made to account for the differences that exist between public and private companies. One of the issues to keep in mind is that private companies are not as well established, and most of their value lies in their growth opportunities. Exceptions to this include Goldman Sachs and Eatons, which were both very large and well established before their respective IPOs. Private companies have less than 50 shareholders and their shares are highly concentrated, leading to liquidity risk concerns. Private companies are under no obligation to report their earnings or to produce annual reports and hence their value is often times subjective.

On the other hand, information on public companies is readily available, through financial statements, annual reports, and such. Public markets are organized places of exchange, their prices are influenced by coverage in the press and by analysts, and there is more information available about them. When compared to private firms, they are:

- Typically (but not always) larger;
- They tend to participate in more than one industry (this leads to diversified risk);
- They cover a broader geographical area;
- They have rules and regulations governing them (BOD);
- They have greater liquidity;
- They have greater access to financial resources and funding sources;
- They usually have better developed products, management teams, and strategies

2.9.1 Issues in Valuing Private Companies

When pricing privately held business interests the analyst needs to look at all available data. The important issues are:

- The nature and history of the business
- The industry's economic outlook
- Financial condition of the business
- Earnings capacity
- Intangible assets
- Market prices of stocks of corporations engaged in the same or similar businesses that have stocks actively traded in free and open markets

Other issues to examine include the reasons for the sale. Are there large capital expenditure requirements, changing market conditions, increased competition or working capital shortages? In any case, a strict review of the financial statements is necessary. Redundant assets⁴ (RA) should be separated from the operating assets and either excluded from the negotiations or sold with the proceeds distributed to the owners. Consequences of not dealing with RAs may mean that the “vendor does not receive full value when the business is sold. The purchaser may have an opportunity of disposing of the RAs and applying the net proceeds to the business, either in its operations or as a reduction of the acquisition debt incurred” [HEND88]. As well, real estate assets should be separated from operating assets. Returns on real estate may be less or more than the business return but seldom the same and therefore, may not fully be taken into account in pricing the business. Moreover, in businesses with a long history, many of their real estate assets are significantly undervalued because they were bought for much less than they are worth now and evaluating them at market is often not possible [HEND88].

Information packages must be prepared containing the qualitative and quantitative information about the private company. These are listed in Table 2-4.

Table 2-4 Information Requirements on Private Companies for Valuation

History of the company	Reasons for selling	Opportunities
Description. of current operations	Products/services	Market analysis
Summary of financial performance	Corporate profile	Competition
Key financial assumptions	Customer profile	Supplier profile
Fixed assets description	Organizational chart	Employee base

[HEND88]

2.9.2 Adjustments to Private Companies for Valuation Purposes

Wise examined the discounts that apply when valuing shares of private corporations [WISE90]. He observed factors that could affect the outcome of a valuation. This included portfolio, dis-synergy, key-men, and income tax discount. Portfolio discount deals with the fact that while the “value of each property may represent, on an individual basis, the highest price obtainable, the mix and quantity of the property may result in the bundle en bloc being less attractive to a purchaser than each one viewed individually” [WISE90]. Thus, a discount to the price has to apply. Synergy is a benefit expected from a purchase, for example, economies of scale, reduction or elimination of competition, or increase in market share. Dis-synergy discount is the opposite of this, and would account for the disadvantages that come from increasing in size, such as increased operations, management, and such. Key-men discount recognizes that there are some employees that are vital to the business, and this value, sometimes 25-45% of the price, must be discounted in arriving at the fair market value of the business. Finally, income-tax discount considers the impact on share valuation of taxes and takes into account the recapture of tax depreciation, capital gains, and tax on proceeds of intangibles.

⁴ Redundant assets are assets owned by the company that are not required in its day to day operations, examples include properties, investment in subsidiaries that are not of the core business, and investment portfolios. [HEND88]

Weaver looked at discounts caused by lack of control and lack of liquidity and marketability [WEAV98]. Perception dictates that risk is less if the investor has the right to control the business. An adjustment to the price of a business has to be made for lack of control. He quoted many studies that try to determine an appropriate amount for this rate. The important issue here is that a rate actually exists but quoting values from other studies is futile; each case is unique and must be examined individually to arrive at the discount rate. Studies included Lyons and Wilczynski [LYON89] who found the range to be 27-28%. This amount was found from premiums paid in M&A from 1968-1987. Pratt [PRAT93] studied takeovers of companies and the premium paid by the company taking over. The premium is converted to a percentage that acts as an estimate for lack of control, and is directly abstracted from actual market transactions. The discount level was found to be 26-33%. Weaver noted that it is "interesting to see this level of discount (that) exists even for SEC regulated companies where minority shareholders have more protection than with small partnerships" [WEAV98].

Lack of marketability and liquidity is concerned with the lack of a real market for the shares and the fact that investors prefer liquidity. Again, quoting many studies, one can conclude that this rate exists [but it is specific for each situation and there is no easy formula to apply. Chaffe [CHAF93] used Options Pricing Theory to find this amount. He applied a European option, which results in a lower price than using American options, and showed a minimum applicable discount. Applying the Black-Scholes Put Formula the amount is 28-41% when the marketability is constrained for 2 years. It is 32-49% using 4 years. Smaller firms with weaker earnings trade at much higher discounts than larger firms. Management Planning Inc, a valuation company, prescribed

five factors that are predictive of restricted stock discounts. The more stable/higher these variables are the lower the market discount [MERC97]:

1. Revenue
2. Recent earnings
3. Market price per share
4. Price stability
5. Earnings stability

2.10 Initial Public Offerings (IPOs)

An initial public offering is a company's first sale of stock to the public.

Companies generally issue an IPO to raise money and to increase their financial base and ability to make acquisitions. Most IPO literature recommends that to price an IPO one should initially look at and compare its operational and financial performance with that of several public companies in the same or a similar industry. In order to compare private manufacturing companies one should look at the industry as a whole, and then at the specific 4-digit SIC Code. For companies going public, the factors that influence price include the ownership retention in the business, and the risks associated with the IPOs. All this information should be applied back into and included in a complete valuation procedure.

2.10.1 Underpricing and Signaling Factors

There is an extensive amount of literature on the underpricing phenomenon of IPOs and their average first day return and the signaling factors associated with them. Signaling factors are issues such as percentage retention of stock by the original owner(s). A number of studies find that IPOs experience large increases in value during their first day of trading. Ibbotson et al [IBBO94] found an average return of 16%, while others have found 1.91% [LEVI95]. Most found that IPOs underperform by the end of

their first year or within 3 years [LEVI95]. Underpricing is due to uninformed investors and the uncertainty surrounding the true value of the issue. The underpricing can be explained by the ‘winner’s curse,’ that is, smaller less informed investors suffer winner’s curse because they receive a smaller fraction of the coveted issues and more of the unpopular issues [IBBO94]. Stoughton [STOU98] found a relation between the fraction of shares owned by large investors and company performance. He concluded that the value of a firm’s IPO is determined by its ownership structure. If larger investors buy stakes in the company, the offering price and revenues raised are higher. Firth also found a positive ownership retention signal [FIRT97]. Jain [JAIN99], on the other hand, investigated whether the performance of IPOs is improved by lead investment bank monitoring. He found that bank reputation is positively correlated with post-issue performance of IPO firms. He used a Carter and Manaster [JAIN99] study on ranking underwriters according to reputation. The “reputation proxy is based on the relative placement of underwriters in tombstone advertisements over the period of 1979-1984” [JAIN99]. It is also important to investigate if the underwriters have warrants in the company as this can influence an increase in monitoring. Warrant holders are tied to the long-term performance of the company, and will want to insure that the company is doing well.

[LJUN97] investigated the underpricing of IPOs. He found that stock market returns, the macroeconomic climate, ownership retention, and inverse offer size have a positive effect on underpricing. He also showed that German IPOs experience losses of 12% over the first three years of trading when compared with the market (exclusive of the initial underpricing return).

[KIM95] investigated the information contained in the prospectuses for new issues and found important financial variables that affect the pricing of IPOs. These variables included EPS, offer size, offer type, and industry-wide prospects. [BYRN94] found initial returns are related to firm size, method of issue, the market in which the issue is made, and the concurrent return on the market index. The average returns can be in part modeled by P/E ratios.

[SEGU97] found a higher rate of mortality for lower priced (e.g. penny stocks) stocks than for higher priced securities and that investors were not properly compensated for this risk. However, mortality is not linked to market capitalization. Market capitalization acts as a discriminatory variable for returns, volatility and liquidity. If lower offering prices signal a greater degree of lower returns, he speculated about why underwriters choose to signal this lower risk. "If an underwriter intends to make a market in an issue following an IPO, both spread and commission revenues could be enhanced by setting a lower offer price. It is at least conceivable that the increase in revenues due to a lower offer price would be sufficient in magnitude to outweigh the additional marketing costs inherent in signaling lower quality" [SEGU97].

2.10.2 Company Ownership

One other issue to note, there have been dozens of articles on the performance of companies that go public and the role of management ownership. Jensen and Meckling [JENS76] claimed that the interests of managers and other stockholders become less closely aligned as managers' stakes decrease and ownership becomes more dispersed. They documented that the ownership stake of officers declines significantly from the year previous to going public to ten years later. They also observed that the median operating

return on assets declines from the year previous to going public to the end of the first year of public trading, but thereafter, performance does not decline in ten years. However, they found that operating performance both within one year of the offering and during the first ten years of public trading is unrelated to ownership by officers.

When specifically dealing with IPOs of private companies, insiders have better information about expected values. Ownership retained by insiders is used as a signaling model where the higher the percentage of retained shares, the higher the market valuations [RITT84], [KLEI96], and [LELA77].

2.10.3 Issues with IPOs

It is important to note that there is hidden value in receiving an influx of funds/cash, either in the process of the IPO, or in a secondary offering. For example, when the company receives funds, they may now be able to attract better supplier commitments that were not possible before the addition of equity. Alternately, additional funds could change the financial risk of the company and improve its balance sheet.

2.11 Intangible Asset Valuation

Valuation is not only about fixed assets. Mullen looked at valuation of intangible assets such as brand names, trademarks, and patents [MULL90]. Intangible assets are valued just like regular assets: find the net present value of the future cash flows for the intangible assets. He suggested using the market transaction comparative method to derive multiples of sales or earnings from sales of acquisitions of similar assets, and applying these multiples, after making appropriate adjustments, to the sales or earnings of the asset to be valued.

The cost of a well-recognized brand name can add billions of dollars to a company's worth. The most recognizable name in the world, Coca-Cola, is estimated to be worth \$72 billion followed by Microsoft at \$70 billion [CBC00].

Valuation Summary

To summarize, there are many different methods to conduct a valuation, but each valuator or person who values companies is quick to point out that a combination of these methods works best. Therefore, no study is done in isolation, different methods are applied and a range of values reached, as supported by [MULL90], [FITC88], and [OVEN59].

Although the market-based approach finds comparable firms it is not a comprehensive search, the DEA-Valuation method will fill this gap.

2.12 Scope and Limitations of this Study

All these factors should be taken into account when conducting a private company valuation. However, all this information is not readily available and only applies to a complete valuation study. As well, the earnings outlook and financial conditions of the private company are not known, other than what can be interpreted from the financials. This far exceeds the scope and premises of this study. This study is intended to be a guide for valuers and should be considered as another tool they have at their disposal. Use of the DEA-CF method is to determine the best and most comparable public companies. Calculation of the market value is attempted by considering the lambda values to be a percentage, and multiplying this by the known market values in order to find unknown market values and also by inferring a market value range from the

groupings. The methodology is discussed in detail in the analysis and discussion section. Another application of this approach could be to first, find the similar companies then, instead of trying to calculate the market value, the known multiples/earnings of the public companies can be applied to the private companies. Thus one can project the earnings of the private companies using the multiples from similar public companies. Again this is information beyond the scope of this study but it is an issue to consider in a future research project. The valuation approaches examined and the analysis conducted herein are intended mainly for companies that are being acquired or sold and for IPOs. Valuation of professional practices, dentist offices, travel agencies and such, is not included in this analysis as more often than not, rules of thumb procedure is applied to these businesses.

3. DATA ENVELOPMENT ANALYSIS (DEA)

Data Envelopment Analysis (DEA) is a linear programming technique for calculating the relative performance of a population of operating entities referred to as decision-making units (DMUs). This technique considers multiple inputs and outputs of DMUs simultaneously. DEA handles multiple inputs and outputs by measuring the efficiency of a DMU as the ratio of a weighted sum of outputs to a weighted sum of inputs, subject to the constraint that the ratio is less than or equal to unity. Essentially, DEA “compares” the information available from a group of DMUs with all others in the group optimizing each individual DMU with the objective of calculating a discrete, piece-wise linear, “best practice” frontier.

The origin of DEA is from a Ph.D. dissertation done in 1978 by Rhodes [CHAR78] supervised by Cooper and Charnes. In this dissertation, Rhodes examined the efficiency of educational institutions in the New York City district with regards to their ability to improve the development of disadvantaged children. The resulting model, named CCR after the three authors, allows calculation of relative efficiencies on the units under investigation based on a constant-returns-to-scale model. The CCR model of DEA was an extension of Farrell’s single output/input technical efficiency measure [FARR57]. Following the CCR model was the introduction of the BCC model in 1984, by Banker, Charnes, and Cooper [BANK84]. The BCC model contains an added constraint of convexity, which allows DMUs to be measured on a variable-returns-to-scale basis.

In this way, DEA’s original design was to measure the relative efficiency within not-for-profit organizations. Through the years, DEA has been expanded to study the efficiency of over 50 industries including banking, fast food retail, healthcare, insurance,

credit unions, highway road maintenance, and capital budgeting projects. Over 1,300 papers have been written by academics on a wide variety of theoretical and practical advances in DEA. DEA can be considered to be a combination of economics, statistics, engineering, operations research, and management techniques.

3.1 METHODOLOGY

DEA is a form of frontier analysis that recognizes that some DMUs perform below optimum levels. In this method, each DMU is optimized against all other DMUs. That is, the linear program assigns weights to the variables so that each DMU looks the best it can. DEA constructs the efficiency frontier and calculates the efficiency score for each DMU based on its distance from the frontier. The score indicates the “proportion by which the unit can increase its outputs without consuming any more inputs, or conversely the proportion by which it can decrease its inputs and maintain its current output level” [SIMA00].

The graphical representation, refer to Figure 3-1, of the efficiency scores identifies the efficient as well as the inefficient DMUs in the observed population. The efficiency frontier, or envelopment surface, consists of the best practice DMUs. Connecting the efficient units forms the frontier and the inefficient units are enveloped within. DEA links the estimation of the technical efficiency and the production frontier. Somewhere above the efficiency frontier is the theoretical frontier. This frontier is beyond the reach of human performance, as there is always a chance for performance improvement when human labour is involved. The DMUs that are below the best practice frontier are considered to be inefficient. For each inefficient DMU, the DEA analysis identifies the sources and the levels of inefficiency for both the inputs and

outputs by comparing the inefficient unit with a single, hypothetical, reference unit formed from the linear combination of efficient units that operate under similar conditions. This comparison determines the potential improvement obtainable by the inefficient DMU.

Figure 3-1 DEA Frontier

Efficiency is typically evaluated using a ratio of output to input. The fundamental idea behind the DEA methodology is the generalization of the single-output to single-input ratio for a DMU, using a fractional linear programming technique. The efficiency of a DMU is the ratio of the weighted sum of its outputs to the weighted sum of its inputs. This allows the DEA methodology to maximize the relative efficiency score of each DMU, given that a set of assigned weights for a particular DMU is also feasible for all the other DMUs included in the analysis.

3.2 Identification of the Factors

DEA provides an analytical tool for determining effective and ineffective performance, in particular, when multiple measures of performances and various discretionary and exogenous variables are involved. The first step involving the formulation of the DEA model is to identify all relevant and significant resources that are utilized by the DMUs. These resources are generally the inputs used by the DMU to produce its outputs. The outputs are the factors, which represent and describe the amount of desirable goods or services produced by each DMU. There are also many other environmental factors or exogenous factors that may influence the formulation of the model. For any of the non-quantifiable or qualitative factors, certain proxies may be assigned and then be included in the analysis.

The general desire by management when conducting a DEA analysis is to maximize their outputs while minimizing inputs used in producing the outputs. This is a particularly important issue during the formulation of the model and the identification of the factors.

3.3 Mathematical Formulation

The Charnes et al. [CHAR94] model for DEA was formulated to maximize the efficiency of each DMU subject to the constraint that the efficiency of all DMUs be less than or equal to one. The algebraic representation of the model is as follows:

$$\begin{aligned} \max Z &= \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \\ \text{subject to } \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} &\leq 1 \quad \text{for each unit } j \\ \mu_r, v_i &\geq \varepsilon \end{aligned}$$

where μ_i = the weight given to output i
 y_{ij} = amount of output i from unit j
 v_i = the weight given to input i
 x_{ij} = amount of input i to unit j

The two most prominent models of the DEA methodology are the CCR and BCC ratio models. The CCR model is also referred to as constant returns to scale (CRS), and the BCC model is used interchangeably with the name variable returns to scale (VRS). Both of these models address managerial and economic issues and provide useful results, but the orientations are somewhat different. Within both the CCR and BCC model a decision can be made as to whether an input or output orientation is required for the analysis. This information is usually derived from the objectives given by the management or the executives of a particular organization. The formulation of the model can be oriented towards output maximization or input minimization. If a particular output level is demanded, or more specifically, if a corporation has a production standard for these DMUs, an inefficient unit can be made efficient through the reduction of its input levels while holding its output levels constant; this is referred to as an input-

oriented model. If the corporation has established amounts of input resources available to these DMUs, the inefficient units can be made efficient through increases in its outputs, while holding input resources constant; this is the output-oriented model.

Figure 3-2 represents how inefficient units are projected onto the frontier depending on whether the analysis requires input minimization or output maximization. The peers for the inefficient company C are company A and company B for input minimization and company B and company D for output maximization.

Figure 3-2 Projecting the Inefficient Unit to the Frontier

3.3.1 The CCR Ratio Model

The CCR ratio model focuses on the identification of the overall efficiency of the DMUs studied. It also identifies the sources and estimates the potential improvements available for the inefficient DMUs. It is important to note that the CCR model provides the envelopment surface that represents CRS. This assumption illustrates that any

increase in one input results in a proportional increase in at least one output or a proportional decrease in one or more inputs must hold true among all the DMUs.

3.3.1.1 CCR Input Oriented

Input-Oriented CCR Primal

$$\text{Min. } z_0 = \theta - \varepsilon \cdot \vec{1} s^- - \varepsilon \cdot \vec{1} s^-$$

$\theta, \lambda, s^+, s^-$

$$\text{s.t. } Y\lambda - s^- = Y_0$$

$$\theta X_0 - X\lambda - s^- = 0$$

$$\lambda, s^+, s^- \geq 0$$

Input-Oriented CCR Dual

$$\text{Max. } w_0 = \mu^T Y_0$$

μ, v

$$\text{s.t. } v^T X_0 = 1$$

$$\mu^T Y - v^T X \leq 0$$

$$-\mu^T \leq -\varepsilon \cdot \vec{1}$$

$$-v^T \leq -\varepsilon \cdot \vec{1}$$

3.3.1.2 CCR Output Oriented

The two approaches of CCR lead to the same envelopment surface, the only difference is how the inefficient DMU is projected to the frontier.

Output-Oriented CCR Primal

$$\text{max. } z_0 = \phi + \varepsilon \cdot \vec{1} s^+ + \varepsilon \cdot \vec{1} s^-$$

$\theta, \lambda, s^+, s^-$

$$\text{s.t. } \phi Y_0 - Y\lambda + s^- = 0$$

$$X\lambda + s^+ = X_0$$

$$\lambda, s^+, s^- \geq 0$$

Output-Oriented CCR Dual

$$\text{min } q_0 = v^T X_0$$

μ, v

$$\text{s.t. } -\mu^T Y_0 = 1$$

$$-\mu^T Y + v^T X \geq 0$$

$$\mu^T \geq \varepsilon \cdot \vec{1}$$

$$v^T \geq \varepsilon \cdot \vec{1}$$

3.3.2 BCC Ratio Model

The BCC model [BANK84] distinguishes between technical and scale inefficiencies by estimating pure technical efficiencies at the given scale of operation and by identifying whether increasing, decreasing, or constant returns to scale possibilities are present for further exploitation. This model interprets the efficiency of the DMUs with the underlying assumption that a VRS mechanism exists among the population of observations. It incorporates the notion that an increase in the inputs does not necessary translate to the same proportional increase in outputs throughout all scales of operation.

This is different from the CCR model, which assumes the input and output relationships of all DMUs exhibit a proportional or a linear relationship for all scales of DMUs. The BCC model allows the DMUs with varying scale sizes to be compared in the same DEA analysis. This is a result of the BCC model being technically efficient while CCR is scale and technically efficient. Technical efficiencies are efficiency measures that ignore the impact of scale-size by comparing a DMU only to other units of similar scale. On the other hand, scale efficiency depends on the size of operations and makes this optimal. Any modification to the size will cause the unit to be less efficient.

3.3.2.1 BCC Input Orientation

The input oriented BCC model focuses on maximizing the DMUs performance by reducing the inputs or, in other words, produces the observed outputs with a minimum resource level. The linear programming model for the BCC model is:

<u>Input-Oriented BCC Primal</u>	<u>Input-Oriented BCC Dual</u>
$\min_{\theta, \lambda, s^+, s^-} \quad z_0 = \theta - \varepsilon \cdot \vec{1} s^+ - \varepsilon \cdot \vec{1} s^-$	$\max_{\mu, v} \quad w_0 = \mu^T Y_0 + \mu_0$
$\text{s.t.} \quad Y\lambda - s^- = Y_0$	$\text{s.t.} \quad v^T X_0 = 1$
$\theta X_0 - X\lambda - s^+ = 0$	$\mu^T Y - v^T X + \mu_0 \vec{1} \leq 0$
$\text{(Constraint of Convexity)} \quad \vec{1} \lambda \geq 1$	$-\mu^T \leq -\varepsilon \vec{1}$
$\lambda, s^+, s^- \geq 0$	$-v^T \leq -\varepsilon \vec{1}$

Where s^+ and s^- are the input slacks and output slacks respectively; μ and v are the multipliers; μ_0 is the measure of scale efficiency. If μ_0 is negative then it indicates increasing returns to scale (IRS). If it is positive then it is operating at decreasing returns to scale (DRS), and if it is zero then it is operating CRS. Theta, θ , is the proportional reduction which has to be applied to all inputs of the DMU being evaluated to improve its efficiency. The ε allows optimization to occur in two steps. First, the inputs are

minimized by the optimal θ . Then the optimization involves a movement to the frontier by the input and output slacks. Lambda, λ , indicates the level of contribution of efficient firms to the virtual DMU created by the projection of an inefficient DMU onto the frontier. Those units that contribute to the construction of the imaginary composite unit will have non-zero dual weights, λ_k , and make up the reference set for unit DMU_0 (the DMU under consideration). The reference set for DMU_0 is thus solely comprised of efficient units and serves as a basis for computing the efficiency score of unit DMU_0 . The magnitude of λ indicates the “degree to which the characteristics of the efficient DMUs are used to construct the virtual DMU on the frontier to which the inefficient unit is projected” [SIMA00].

3.3.2.2 BCC Output Orientation

The output oriented BCC model focuses on maximizing the DMUs by proportional augmentation of the outputs. The objective is to maximize output production while not exceeding the given resource levels. The envelopment surfaces for either the input or the output-oriented BCC model are identical. The only difference is how the inefficient DMU is projected to the frontier. If ϕ is greater than one, then the DMU is inefficient.

Output-Oriented BCC Primal

$$\begin{aligned} \max_{\theta, \lambda, s^+, s^-} \quad & z_0 = \phi + \varepsilon \vec{1} s^+ + \varepsilon \vec{1} s^- \\ \text{s.t.} \quad & \phi Y_0 - Y\lambda + s^+ = 0 \\ & X\lambda + s^- = X_0 \\ & \vec{1}\lambda = 1 \\ & \lambda, s^+, s^- \geq 0 \end{aligned}$$

Output-Oriented BCC Dual

$$\begin{aligned} \min_{\mu, v} \quad & q_0 = v^T X_0 + v_0 \\ \text{s.t.} \quad & -\mu^T Y_0 = 1 \\ & -\mu^T Y + v^T X + v_0 \vec{1} \geq 0 \\ & \mu^T \geq \varepsilon \vec{1} \\ & v^T \geq \varepsilon \vec{1} \\ & v_0 \text{ free} \end{aligned}$$

3.4 Differences between the BCC and the CCR model

There are some key differences between the BCC and the CCR model. The BCC frontier does not have to start from the origin while the CCR does. In the CCR model, there are less efficient DMUs, the values of θ are generally smaller, and the values of ϕ are generally larger. To convert the BCC input oriented model to the CCR input oriented model the constraint of convexity, $\sum \lambda \geq 1$, is removed from the primal model, along with the μ_0 from the dual model. In a similar manner, $\sum \lambda = 1$ and v_0 are removed from the BCC output model to arrive at the CCR output model. Figure 3-3 depicts the differences between the models.

Figure 3-3 Graph of VRS and CRS

3.5 Interpretation of DEA

Using these formulations, DEA identifies the potential improvement for the inefficient DMUs. The information derived from the analysis is intended as a guide for policy making and managerial decision making in an organization. It provides a better

understanding of efficiency, and guides the management in establishing benchmarks for similar operations. Most importantly, the analysis helps direct management's attention to the DMUs that are not performing as well as their peers in similar environments. This knowledge directs the organization towards a more effective management process.

3.6 Advantages and Disadvantage of DEA

DEA calculations give new insight and permits new ways to examine data. Some of the new insights are:

1. Focus on individual observations in contrast to population averages
2. Produce a single aggregate measure for each DMU in terms of its utilization of input factors (independent variables) to produce desired outputs (dependent variables)
3. Can simultaneously utilize multiple outputs and multiple inputs with each being stated in different units of measurement
4. Can adjust for exogenous variables
5. Can incorporate categorical (dummy) variables
6. Are value free and do not require specification or knowledge of a priori weights or prices for the inputs or outputs
7. Place no restriction on the functional form of the production relationship
8. Can accommodate judgment when desired
9. Produce specific estimates for desired changes in inputs and/or outputs for projecting DMUs below the efficient frontier onto the efficient frontier
10. Are Pareto optimal
11. Focus on revealed best-practice frontiers rather than on central-tendency properties of frontiers
12. Satisfy strict equity criteria in the relative evaluation of each DMU

[CHAR94]

Disadvantages

Major issues with DEA are that there are no possible improvements or targets for the efficient DMUs, correlation among the variables cannot exist, and weights are assigned freely and may thus ignore important variables.

3.7 Practical Requirements of DEA

There are certain issues in DEA that need to be addressed, mainly the number of DMUs, the environment, the weights, and the difference between the data. First, DEA works best when there is at least three times as many DMUs as the sum of the number inputs and outputs. If this requirement is not met, the majority of DMUs will be on the efficient frontier and the assessment will not convey proper results. Second, it is essential that the DMUs evaluated come from a similar environment. It is not appropriate to compare manufacturing and service industries against each other since they both have very different objectives and management styles. Some further insights can be gained about DEA from the weights used. DEA assumes equally proportional improvements of all inputs or all outputs. This assumption becomes invalid when a preference structure over the improvement of inputs (outputs) is present in evaluating inefficient DMUs [THAN92]. This leads to the third issue, the unrestricted weights may mean some of the inputs or outputs, especially if the DMU is doing poorly in that dimension may be assigned a weight of zero, where in reality all of the variables contribute in some way to the overall efficiency. This stems from the fact that each unit is assigned weights so that it looks the best it can. To address this problem, the weights can be restricted using analyst and management input. Bounds can be placed on the importance of each of the factors so that the weights assigned are more realistic. Finally, if some of the data points are extremely large when compared to the rest of the variables, these DMUs have potentials to be outliers and may be anomalies in the study.

3.8 DEA Analysis and Firm Valuation

The different valuation approaches and the different applications of DEA have been discussed, but so far a discussion of the usefulness of DEA and valuations therefrom has not been covered. The main motivation for this research comes from a Ph.D. dissertation by Simak [SIMA00] on this subject. In this work, Simak examined DEA and private company valuation and proposed a DEA model to identify similar public companies to the one under scrutiny. The resulting peer groups from the DEA analysis identify the similar companies, which when combined with their efficiency scores, the “peer” companies can be found. The model uses data on 51 public manufacturing companies. The peer group for each inefficient company is identified and other companies that have the same peer groups are collected. A difference indicator variable, d_{ij} , between company i and j is introduced:

$$d_{ij} = \sum_k (\lambda_{ik} - \lambda_{jk})^2, \text{ where } k \text{ is the coefficient of all the efficient companies.}$$

The lower the d_{ij} value, the more similar the companies are. He also examined the closeness of the efficiency scores. By looking at the market capitalization (MC) of these public companies and testing if the DEA analysis found peer companies with similar MCs, the factors can be combined to reveal the best possible peer(s) for the subject-company. The results were encouraging provided adequately similar public companies were available for reference.

DEA coupled with valuation will allow multiple inputs and outputs to be used in the same model. The DEA comparable firms model is an extension of the market approach in order to find comparable companies. DEA is often used to find the most

efficient units but now it can be used to find proper peer groups. This paper will extend the approach started by Simak [SIMA00], but differs in several respects. The factors used for valuation are different. Also, two new methods are introduced, one to value efficient companies and one to determine upper bounds for the inefficient companies. No estimation of the value of efficient companies has ever been attempted before.

3.9 Novel Applications of DEA

Kim and Hendry [KIM98] utilized DEA to assess NATO burden sharing among each member nation in order to determine relative size of their net-burden. This is a novel application of DEA, which examines a net-burden index for each member nation (the ratio between contributions to an alliance and benefits received therefrom), instead of calculating relative efficiencies. In this work, two different models are evaluated and three of the nations appear on the frontier in both models. These nations are given a rank of one. Subsequently, each model is examined individually and the remaining nations are ranked according to descending net burden starting at four. Next, a cluster analysis is applied to both the models to determine the relative position of the DMUs on the frontier. Also, the efficiency score from both the models were graphed against each other to get a simulation of the frontier. The results from the cluster analysis support the frontier found from the plot of the efficiency scores.

Zhu [ZHU00] conducted one of the best studies on DEA and company efficiency. In this work Zhu examines financial performance of Fortune 500 companies using DEA. The data is from the April 1996 issue of Fortune Magazine. The investigation found that the top-ranked companies by revenue do not necessarily perform efficiently, and that only 3% of these companies were on the best-practice frontier.

Fortune magazine used 8 factors in evaluating companies, mainly revenues, profits, assets, number of employees, stockholders' equity (SE), market value, earnings per share and total return to investors. Zhu did not deem utilizing all of these factors in a single DEA model for performance satisfactory. Instead a different combination of these factors was sought. Zhu tested three models in order to obtain an overall performance index. The first model, called profitability, had three inputs (employees, assets, and stockholders' equity) and two outputs (revenues and profits). The second model, named marketability, had two inputs and three outputs. (namely the outputs from the first model were considered as the inputs into this one), and the new outputs were market value, EPS and total return to investors. The third model combined the first two models, it used the inputs from the first model and the outputs from the second model, and thus it had three inputs (employees, assets, and stockholders' equity) and three outputs (market value, earnings per share and total return to investors). This third model was meant to represent the overall performance/efficiency. The models are shown in Figure 3-4.

Figure 3-4 Zhu's DEA Model for Company Performance

Zhu showed, with this DEA analysis, that the larger companies exhibit decreasing returns to scale (DRS). Testing the data for errors using a sensitivity analysis proposed by Seiford and Zhu reveals that the best-practice frontier is reliable [ZHU00]. An input-oriented CRS model was employed in which the DEA methodology was modified to show performance measures that better reflect the way businesses rank against each other. Results showed that substantial input savings could be achieved as evidenced by the distribution of the CRS scores. Most industries performed better with model-1 (profitability) than with model 2 (marketability), and the model 2 scores were better than efficiency scores for model 3 (overall efficiency).

In addition to the CRS model Zhu also investigated the VRS model in order to examine returns to scale. The VRS version of model 1 revealed an efficiency of 0.46 as opposed to 0.4 for CRS. In model 2 it was 0.29 with CRS and 0.54 with VRS and in model 3 it was 0.25 with CRS and 0.31 with VRS. The *t*-test is applied to the CRS-inefficient companies, "the results show that the mean of the paired differences between CRS and VRS scores for the three-model evaluations are significantly greater than zero (the values are equal to 13.5, 21.5 and 14.3 for model 1, model 2 and model 3, respectively, at level 0.01)" [ZHU00]. The *t*-test indicated that the ratios were significantly less than 1. Therefore serious scale inefficiencies were present in the Fortune 500 companies. A summary of the above results is displayed in Table 3-1.

Table 3-1 Summary results for Zhu analysis

	VRS	CRS	t-test (0.01)
Model 1	0.46	0.4	13.5
Model 2	0.54	0.29	21.5
Model 3	0.31	0.25	14.3

Upon further investigation into scale efficiency and returns-to-scale. Zhu found that the top-20 companies were not only scale inefficient, but they also operated in a DRS region, while most relatively small companies operated in an IRS region.

For the performance of inefficient companies, “one may use the average factor-specific scores within each industry to characterize the factor-specific industry efficiency. However, different companies with different sizes may exist in each industry. Therefore arithmetic averages may not necessarily be a good way to characterize the industry’s efficiency, usually, one expects bigger input and output levels, from relatively big companies” [ZHU00].

To summarize, DRS are found mainly among the top ranked companies by revenue. Sensitivity analysis shows which production factor will not affect an efficient company’s financial performance given that all other production factors are kept at their current levels. This information is useful when a company considers its future policy against other companies.

4. DEA-VALUATION MODEL FORMULATION

This chapter presents the development of the DEA valuation model along with the selection of relevant inputs and outputs. After the appropriate variables are ascertained, the DEA valuation model is constructed. The variables and the model are based on available literature, expert opinion and known valuation criteria. Possible new DEA applications to business are presented as well.

4.1 Model Criteria

Due to insufficient amount of knowledge about the geographic locations, social contexts and structures and other qualitative information, this study of the frontier analysis focuses more narrowly on the available financial information. A study of just the financials leads to a much more uniform study and compensates for the different management policies and procedures that may exist among the companies.

4.2 Identification of Valuation Indicators

Following the collection of the data, the next requirement in formulating the DEA problem is the specification of the model's inputs and outputs. The three sources of information that will be used for this purpose are available literature, expert opinion and known valuation criteria.

Articles aimed at identifying the most important indicators of value include Zhu. Zhu identifies number of employees, revenues, profits, assets, shareholders' equity, market value, EPS, and total return to investors as relevant variables [ZHU00]. The current study does not have access to some of this information, for example number of employees and total return to investor, but makes use of the remaining variables. Kim [KIM99] makes use of the: preliminary offer price (POP), the offer price (OP), first

market price, proceeds, EPS, preissue book value per share ($BPS_{preissue}$), postissue book value per share ($BPS_{postissue}$), sales, P/E (OP/EPS), M/B_{pre} (OP/ $BPS_{preissue}$), M/B_{post} (OP/ $BPS_{postissue}$), P/S (OP/sales), and $MV_{postissue}$ at OP in his analysis of the value of IPOs [KIM99]. Most of these variables are specific to IPOs and were not available to this study. Many other studies quoted earlier in the literature search section examine similar financial ratios such as P/E and M/B. Investment bankers utilize accounting information, comparable firms and also market demand, to try and reach a more accurate price. The key accounting variables as determined by them are sales, earnings, operating cash flow and book value [KIM99].

Another source for information regarding value was from communications with professors that teach DCF and M&A courses. Free cash flow (FCF), 7- year revenue and profits, competing companies were some issues identified as determinants of value. There were also some qualitative issues to consider such as the quality of management, strength of market position, quality of products and services, level of customer satisfaction, strength of corporate culture, quality of investor communications, and effectiveness of new product development [HARB97]. The collection and quantification of these types of value indicators will need to be evaluated if they are to be included in the DEA models.

4.3 DEA Modeling - New DEA Company Valuation Models

There are different approaches to developing DEA models for companies. One can evaluate the service efficiency of a company and as an added feature the conversion ability of the company, or One can examine issues related to predicting market value or risk. Each of these perspectives require different variables. The choice of inputs and

outputs has to reflect the objectives of the business. In the case of valuation, one wants to examine the variables and factors that optimize the ability of the company to turn its assets into profits.

Borrowing from studies done on DEA and banking efficiency, one can apply the same models to companies with some adjustments. If a bank is measured for service efficiency, i.e. the Production Model, one looks at variables such as labour, office space, loans and deposits. Thus, the cost to produce services is considered as an input and the amounts of services are outputs.

If the bank is more concerned with maximizing profit, the major concern is the Intermediation Model, the key variables being interest expense, deposits, interest income, and loans. Thus all types of costs should be treated as inputs and all types of revenues as outputs.

Tulkens and vanden Eeckaut [BERG98] list five approaches to efficient bank management. The approaches are:

1. Profit maximization
2. Service provision
3. Intermediation
4. Utility provision
5. Risk management

One can adjust the above approaches to reflect the concerns of companies instead of banks. When determining the value of a company, the key variables are not objects such as number of employees, number of offices/stores, square footage of office space, or number of products produced, time to produce and amount of sales. These are more appropriately associated with the service efficiency of a company, and thus will be deemed the Company Model. This measure can identify how good the company is in

marketing and selling their products. For example, this model can be applied to companies such as McDonald's and other fast food restaurants to compare efficiencies.

The Value Model on the other hand, consists of the variables that make a company more profitable, valuable, and competitive. These variables can consist of net income, net sales, total assets, total liabilities, shareholders' equity, cash flow, capital expenditure, retained earnings, working capital and other quantitative and qualitative factors.

Also, risk management is a crucial concern for companies. One can view risk as an input, and the return from the risk as an output. Thus, if given a high risk more income is preferred to less, "minimize risk for a given level of gross revenues" [BERG98]. For a company, the DEA Company Risk Model can utilize the net income and net sales as outputs, and the credit rating, i.e. credit risk, will be the input to the approach.

4.4 Selection of Factors

Before the formulation of the DEA model, numerous assumptions regarding inputs and outputs has to be incorporated into the valuation model. Some of the factors involving the valuation model have been stated earlier in this thesis, however, there are a few attributes that need to be discussed. These are variables that are not readily identifiable as being relevant to either inputs or outputs in a financial operation. The characteristics of these items and other factors are discussed in this section.

The following were deemed to be the important factors used to establish the worth of a company: total assets, total liabilities, shareholders' equity, net income, net sales and

cash flow. These were chosen partly based on the literature review and partly because of their significance in a valuation study. Their significance will be described below.

4.4.1 The Inputs

4.4.1.1 Total Assets & Total Liabilities

Total assets and total liabilities are included as inputs to the operation because these are items one wants to minimize. There are some “off-balance sheet” issues with assets that need to be addressed. Total assets are composed of things such as fixed assets and some of these fixed assets may be perceived to distort the study. A separate appraisal may be required for certain fixed assets, for example, real estate. This is due to the fact that the valuation approaches used for the operating entity might not be appropriate for the appraisal of the real estate. Most small businesses and professional practices do not own the real estate they occupy. Real estate should be taken out of the balance sheet so comparisons can be made more readily. Thus, the related items from the income statement should be adjusted and instead a rent value included in the expenses.

Total assets have the characteristics of both inputs and outputs. Total assets consist of items such as cash, receivables, loans, inventories, raw materials, work-in-progress, prepaid expenses, total current assets, fixed assets (plant and equipment, leasehold improvement) and intangible assets. It can be a raw material in providing the funds for investment or collateral, while it can also be seen as a major contributor to liquidity, a highly desirable state for the company. Since the primary objective is to establish company value, it is more important to analyze how one can convert these assets to cash and hence profit. As a result, it is considered an input into the operation.

Total liabilities are generally regarded as the “cost of doing business” and typically comprise accounts payable, rent, dividends payable, total current liabilities and long term debt. It is considered an “expense” in the financial operation, for that reason this measurement would be considered an input. Placing total liabilities on the input side of the model works well with the primary objective of the DEA analysis, output maximization and input minimization. Since the maximization of it on the output side of the efficiency model is highly undesirable, this item is appropriately defined as input.

4.4.2 The Outputs

4.4.2.1 Cash flow from operation:

Cash flow, as defined in a business and finance sense, is equal to the net income after all cash expenses ignoring the effect of taxes. This means after interest costs but before non-cash items, such as depreciation and amortization. This can include amortization, amortization of deferred financing costs included in interest expense, non-cash assets paid for services rendered, and others (minority interests, gain on disposal of capital assets, development costs written off, issuance of shares to settle outstanding debt). Defined another way, it includes items such as amortization of goodwill, amortization of deferred costs, amortization of capital assets and income producing property. Cash flow from operations does not include changes in non-cash working capital items, such as accounts receivable, inventory, income taxes payable, accounts payable, accrued liabilities, prepaid expenses, share proceeds receivable, and deferred revenue. Cash flow from operations is an item that any company would desire to maximize. Accordingly, with the central theory of DEA of output maximization and input minimization, it fits well on the output side of the model.

4.4.2.2 Profit and Revenue

The outputs of the financial operation include net income and net sales. Net income includes revenues, interest and other income, depreciation and amortization, investment income, and income before tax. Net sales are revenue minus cost of goods sold. These two terms are the common items in studying the earnings potential of a company. Generally, the income from these two sources determines whether a business is profitable or not. And, of course, in the formulation of the DEA model, the maximization of these two items indicates a better performance of the business. Moreover, the inclusion of these items also allows the analyst to study the conditions of operations in these corporations and to determine their viability.

4.4.2.3 Book Value

Shareholders' equity, often referred to as book value, typically consists of equity (common and other types of shares), retained earnings, and miscellaneous shareholders' equity. To provide shareholders earnings is a paramount goal for all businesses. It can provide information on how efficient these companies are in utilizing their assets to earn profits. However, this value goes down whenever the company pays a dividend, a desirable feature. When measuring return on equity, one wants shareholders' equity to go down for a certain level of profit. It could be considered as input into the operation or an output from the operation. In this research, company valuation from the perspective of the company and not the shareholder should be examined: thus it is more appropriate to place shareholders' equity on the output side of the operation. Shareholders' equity is an output as it is desirable to maximize it.

Finally, the model constructed aims to represent the operations of the companies. Inputs and outputs selected for the model are represented in Figure 4-1. This operational representation is the basis for the formulation of the DEA model. The specification of the formulation of the DEA model to measure the relative efficiencies is discussed below.

Figure 4-1 DEA Valuation Model

4.4.3 Variables Not Included

Items that are important but were not included in this analysis are market value, price to earnings ratio (P/E), retained earnings, and working capital.

Market capitalization was not directly included in the model. It is another key variable that should be examined in a valuation analysis. However, by definition, market value only exists for publicly traded companies. To be able to adapt the model for both public and private companies the variables selected have to exist in both domains. Therefore, market value was not included in the initial analysis. Total assets can be used to account for the size differences among the companies. Market capitalization is added to the analysis after the DEA-Valuation models are run. The market values are used to

validate the results, by not including them in the analysis they can be used for this purpose.

Financial ratios are often utilized to evaluate corporate performance. The firm's ratios are compared with some benchmark value. Size is ignored and different sized firms are compared. This leads to the issue of the choice of the value to compare with, of the dozens of ratios in existence, which ratios to use, and the choice of the firms to compare with. Companies should preferably operate in the same industry and when constructing the ratio there is an assumption of proportionality among the numerator and the denominator. However, there may be instances where this does not hold [SIMA00], and this leads to problems when comparing different sized companies.

Retained earning is another very important variable in determining value. It represents the reinvested earnings over the years that have not been paid out in dividends. Many corporate raiders bought companies that had a lot of unused retained earnings, then after taking dividends resold the company. In general one wants to use the least amount of cash in the company while maintaining profit levels. Although retained earnings is not directly incorporated, the inclusion of shareholders' equity in the model accounts for it.

Next, firms need cash to pay for all their day-to-day activities. They have to pay for wages, bills, raw materials, and so on. The money available to them to do this is known as the firm's working capital. Working capital consists of current assets; these are the short-term assets that the firm can use to convert into cash. Current liabilities have to be taken into account as well to determine how much working capital a firm has at its disposal. Working capital is therefore current assets less current liabilities. An interesting issue arises when examining the assets of a company. Are the assets owned or

leased? Companies with leases may be overvalued, thus more efficient than companies owning their assets. This comes about because assets are located in the denominator of the model, so the smaller it is the better the DEA results. The companies that own their own property will have larger total assets than companies that lease. It is important to know if a company owns land or not, since it inadvertently adds to the value of the company. Thus it is justifiable to use total assets and total liabilities rather than current assets and current liabilities.

4.5 Formulation of the DEA model

In this section, the characteristics of the businesses are examined to design a DEA model that would best describe the behaviour of the industry. The available data on these companies will also be evaluated to help determine the most appropriate DEA model for valuation measurement.

A private company is a company that is not a "public" company as defined by the various securities acts. It tends to be smaller in size, and typically has one or few owners. There may be significant differences in the size of the total assets of private companies versus public companies. Actually, a private company may very well have larger assets because it does not have the motivation to use all the accounting tricks available to show a larger per share earnings. Although the market values of these companies are not directly involved in the evaluation of their efficiency scores, their behavior can be inherently different due to differences in size. Applying some banking theory, it was suggested by Piesse [PIES95] that the scale and technical efficiency measurements of financial institutions are inversely proportional, that is, the larger institutions are commonly less scale efficient than their smaller counterparts. This may be due to the

requirement for a significantly larger employee group in the larger units. One assumes the same holds true for companies. With such a significant range of magnitudes in asset values of these companies, it is unwise to assume that they can all operate with the same scale efficiency. Thus, the focus of this thesis will be only on the technical efficiencies of the companies, using VRS technology.

Technical efficiency is concerned with the relationship between inputs and outputs, where the measurement ignores the impact of scale size when comparing DMUs to others on a similar scale. A more detailed description of the concept of technical efficiency can be found in the DEA section. As mentioned above, the inclusion of various sizes of companies in this study requires the assumption of scale efficiency. Banker, Charnes and Cooper's BCC ratio model is used to measure the technical efficiency where the convexity constraint ensures that the unit under consideration is being compared only to other units of similar scale size.

The BCC ratio model, unlike the original CCR ratio model, allows for variable returns to scale where the proportional increase in the input does not translate to a proportional increase in the outputs for the entire range of DMU sizes. The efficient frontier produced by the BCC ratio model is typically a piece-wise linear surface. The slopes of the frontier representing the ratios of the efficiency scores are different in the various combinations of input and output. But all of the DMUs that are on the frontier are considered to be technically efficient.

After the determination of the appropriate DEA model, its orientation should also be decided. Companies could improve their performance by an increase in their output

levels, or by a decrease in their input levels. It is observed that with the limited information on company performance, industry trends can not be reliably predicted. Financials are available only for a single year, therefore, information regarding the growth of individual companies can not be determined. With this limitation on the data, input-orientation becomes the most appropriate approach. The output-oriented model would project an inefficient unit by increasing its total output. But, the lack of knowledge on whether this is physically possible makes such a projection infeasible.

In the analysis, the CCR model is not examined due to the existence of negative variables in the data set and because it is scale invariant. The BCC model can handle negative data because it is both scale and translation invariant. Scale invariance deals with scaling the inputs or outputs of a DMU by a certain amount where the efficiency scores are not affected. Translation invariance refers to the efficiency scores being invariant to the translation of inputs and outputs by a scalar. The BCC input oriented model is translation invariant in the outputs and vice versa. Thus the efficiency of a DMU will not be affected if the outputs of all the DMUs are translated by a scalar amount.

Summary

Formulating the DEA model with the available financial information is one of the goals of this thesis. Different articles cite different methodologies and indicators that can be included in a valuation model. The most accurate DEA model was identified along with the corresponding variables. In the analysis of the model no weights will be assigned to the variables since DEA does not require prior knowledge of the importance of each variable and will assign weights in accordance with the company appearing the best it can.

5. DATA ANALYSIS

The data consist of financial statements for 457 Canadian publicly traded companies in the manufacturing sector all having financial records from the year ending in 1998. Each company has a SIC code between 2000-3999, which entails the entire manufacturing sector. The industries range from machine manufacturing to food and kindred products (refer to Table 5-7 for a complete list). Most companies have a different fiscal year-end, however, for this study the year-end was assumed to be standard. As well, data on both private and public companies were collected.

The manufacturing sector was chosen for the purposes of this analysis because of the availability of the data. A substantial number of the companies listed on the TSE are in the manufacturing sector. Service companies, specifically high technology, are hard to monitor since most of these companies have not been in business long enough and reliable financials do not exist or go back far enough.

The data from the year 1998 were chosen because it was the most recent, available and complete. Also, when finding comparable firms for the private companies, the bigger the set of data, the better. According to Booth [BOOT00], it is better to exclude companies that deal in resources such as pulp and paper, since they are very cyclical, and he suggested looking at the 7-year profitability of the companies. Availability of this information is an issue. Perhaps for future research someone can examine only a specific group of companies (50 public and one private company, all with the same SIC Code) and get data on the past or future 5 years for these companies.

5.1 Stock Prices

To compute the market capitalization, which is equal to the outstanding shares multiplied by the stock price, historical stock quotes for the public companies had to be obtained. An arbitrary date at the end of November was chosen for this purpose.

5.2 Public Companies

The data for the public companies were gathered from a variety of sources. Mainly, Primark's⁵ "Compact D" for December 1999 and January 2000 for Canadian publicly traded companies. The information consisted of total assets, total liabilities, net income, shareholders' equity, net sales, date of fiscal year end, SIC codes, and so on. Originally, there were over 700 companies' financials available. Unfortunately, due to irregularities in the data, some filings from the late 80's & early 90's were still included. These companies were omitted from the study and finally 586 companies were left in the data set. Missing and suspicious accounting numbers were checked and corrected if necessary. After resolving the variable selection (inputs and outputs to use in the model), the missing information was collected. Most of the missing information pertained to net sales, shares outstanding, and net income. For the case of a company having two SIC codes, chiefly the primary and secondary SIC codes, only the primary was considered. Some of the companies reported in different currencies so everything had to be converted to Canadian Dollars using information on historical exchange rates. This insured that the data were consistent.

⁵ Primark is one of the leading providers of disclosure information.

The following sources in Table 5-1 were used to find the missing information:

Table 5-1 Financial Information Sources

Information	Source
Financial statements, annual / financial reports	SEDAR homepage www.sedar.com
	TSE homepage www.tse.com
The following web sites were used to find the closing market price for the stocks.	CDNX homepage (Canadian Venture Exchange) www.cdnx.com
	Yahoo Finance //ca.finance.yahoo.com
	FIS Online www.fisonline.com
	Montreal Stock Exchange www.me.org
	Stockwatch www.stockwatch.com
	Microfiche copy of the Globe & Mail newspaper from December 1998
Historical exchange rates	Oanda www.oanda.com

5.3 Statistical Testing

Statistical testing of the data was carried out by calculating the minimum, maximum, average, standard deviation, and percentiles (25, 50, and 75) of the data. This information is recorded in Table 5-2. Total assets (TA), total liabilities (TL), shareholders' equity (SE), net income (NI), net sales (NS), and cash flow (CFI) values are given in millions of dollars.

Table 5-2 Statistical Testing for the Public Companies

	SIC code	TA	TL	SE	NI	NS	CFI
		S(in millions)					
Min.	2.011	0.006	0.006	-367	-841	-0.927	-225
Max.	3.999	395.298	372.286	64.175	9.718	236.541	18.969
Mean	3.153	2.368	1.717	651	66	1.933	180
Stan. Dev.	572	20.934	18.530	3.993	599	14.806	1.421
Perc. 25	2.759	5	2	2	-2	3	-0.548
Perc. 50	3.312	33	14	18	0.021	28	1
Perc. 75	3.663	231	108	104	5	221	15

As can be seen from the variation in the standard deviations, across all factors, the data set is large and accounts for a large number of small and large companies, that causes the variation in the data. The data contain negative values since some of the companies had negative earnings. The range in total assets is wide and varied, from a minimum of \$6,000 (for Primero Industries LTD.) to a maximum of \$395 billion (for General Motors Corp.). Figure 5-1 represents the distribution of the total assets (log scale is used for the graphs to show a clearer picture):

Figure 5-1 Distribution of the Total Assets for the Public Companies

As can be seen from the graph, most of the companies, 305 to be exact, have total assets of less than \$100 million. Looking more closely at these 305 companies, one can see that 68 companies have total assets of less than \$2 million and 45 have assets greater than \$56 million and the rest lie in between, as demonstrated by Figure 5-2.

Figure 5-2 Distribution of the Total Assets for the Companies Under \$100,000,000

Statistical analysis of the firms' market capitalization(MC) was also carried out, as recorded in Table 5-3. Market capitalization and market value are used interchangeable in this research. Market value consists of the outstanding shares multiplied by the stock price.

Table 5-3 Market Value Statistics

	M.C (\$000s)	CURRENT O/S SHARES	PRICE TSE Dec-98
Minimum	190	246.288	0.03
Maximum	619.712.000	9,683,000,000	259.4
Mean	2.985.071	57.656,805	9.512
Standard deviation	32.045.700	461.969,188	20.75
Percentiles 25	5.481	8.827,620	0.45
Percentiles 50	27.396	15.471,782	2.25
Percentiles 75	156.723	31.133,213	9.58

The distribution of the market value varies widely from \$190 thousand to \$619 billion. The top five companies by market value are BP Amoco, IBM, Mobil Corp., GM, and Sony, their market capitalization are \$619, \$240, \$105, \$86 and \$53 billion respectively. Ignoring the top five companies which are multinational conglomerates, the maximum market value in the analysis becomes \$50.5 billion, which represents Nortel

followed by Thomson Corp. at \$22 billion. The five conglomerates will still be included in the DEA analysis because most likely they will be self-evaluators since they are so large and they will thus not have any negative effects on the analysis. Figure 5-3 shows a graphical representation of the market values.

Figure 5-3 Graphical Representation of the Distribution of Market Value:

There were 16 companies that have been de-listed by the TSE, CDNX or the other Canadian exchanges, so no stock prices could be found for the year 1998. These data were removed from the analysis. Upon further examination of the market value some anomalies were found. For example, there were five companies with market values of less than \$100,000. Subsequent analysis showed that at least one of these companies, Scott Paper, had been bought out by another company in the preceding year (1997 in this case) and still had 100,000 of its shares outstanding. The other four, mainly Consolidated General Diamond Corp, Diffracto Ltd., Lenox Polymers Ltd., and Vendtek Systems, upon further investigation were also excluded from the analysis.

5.4 Correlation

Another important step is the examination of potential correlation among the data items. In a typical DEA analysis, correlation among the data means that some of the variables can be eliminated from the analysis in order to simplify the model. Their inclusion in the analysis may place extra importance on these factors and skew the study.

Table 5-4 Correlation Between the Public Company Data

Correlation Matrix for 457 Companies					
	<u>TA</u>	<u>TL</u>	<u>SE</u>	<u>NI</u>	<u>NS</u>
<u>TL</u>	0.98				
<u>SE</u>	0.66	0.53			
<u>NI</u>	0.71	0.63	0.78		
<u>NS</u>	0.96	0.92	0.79	0.81	
<u>CF</u>	0.91	0.84	0.85	0.89	0.97

As is evident from Table 5-4, there is a high degree of positive correlation among some of the populations of the data. Specifically, total assets to total liabilities have a correlation coefficient of 0.98. High correlation exists because the data set includes only the manufacturing industry. Manufacturing companies tend to mostly fund their assets through borrowing, thus total assets and liabilities will be highly correlated. Because they are highly correlated, they would have similar correlations with equity. Neither assets nor liabilities tend to be highly correlated with equity, as equity tends to be much smaller. The amount of total assets gives an indication of the credit worthiness/equity of a company, while total liabilities give an indication of the debt of the company. They are both necessary in the valuation scheme. Net sales and cash flow are also highly correlated. This is partly due to the fact that companies cannot have cash flow unless they have revenues. More notably, cash flow is an indicator of financial well being, ignoring the impact of this variable on market value will render an ineffective analysis.

These variables are essential in company valuation, thus, it is justifiable to use them together in an analysis of this nature. The same argument can be used to contend the use of the other variables in this DEA-Valuation model.

5.5 Private Companies

One of the big major Canadian Banks provided the private company information. It contained statistics on the companies from the year 1988-2003, including financials, SIC codes, statement date, and other financials. From this data, all the information on the companies for the year ending 1998 were extracted, for companies with SIC codes between 2000-3999. No information about the real names of the companies was known, due to the confidentiality of the information. Thus, the companies are listed by number. The data were cleaned and any duplicates eliminated. There were a total of 84 private companies after all anomalies were sorted through. Statistical information about the private companies is located in Table 5-5.

Table 5-5 Private Company Statistical Information

	SIC Code	TA	TL	SE	NI	NS	CFI
		(S000s)					
Min.	2013	1.760	802	-3.436	-3.242	869	-2.725
Max.	3999	2,774.727	753.269	2,044.190	457.382	2,604.819	594.940
Mean	3169	69.031	29.134	39.897	9.035	92.066	11.248
Stan. Dev.	537	324.739	113.326	225.914	51.298	326.308	65.855
Perc. 25	2821	6.929	3,258	2.344	148	10.134	330
Perc. 50	3271	13.599	7,099	5.567	595	22.614	933
Perc. 75	3577	26.803	12.138	14.534	2.472	40.598	2.866

As private companies tend to be smaller in size, the data appears to be appropriate with the exception of a few large private companies. The existence of this fairly large private companies will enhance the DEA analysis since there will be ample public peers. The large private firms are namely company #156 and #198 with total assets of \$2.8

billion and \$1.2 billion respectively, and net sales of \$2.6 and \$1.5 billion. Their net income is quite reasonable at \$457 million and \$103 million respectively. The next highest values for total assets, total liabilities, shareholders' equity, net income, net sales, and cash flows are smaller at \$145, \$117, \$72, \$68, \$416, and \$68 million respectively. Below in Figure 5-4 is a histogram of the total asset distribution for the private companies.

Figure 5-4 Distribution of the Assets of the Private Companies

Table 5-6 Correlation Matrix for the Private Companies

	TA	TL	SE	NI	NS
TL	0.91				
SE	0.97	0.81			
NI	0.97	0.82	0.99		
NS	0.98	0.95	0.93	0.94	
CF	0.97	0.79	0.99	0.99	0.92

A correlation analysis for the private companies was carried out in Table 5-6 and it shows a high degree of correlation among the variables, especially net income to cash flows (0.99). The preceding section on correlation among public companies pointed out the main reasons for this. Again, the purpose of this analysis is to determine the value of

the private companies. For the application of the DEA methodology, the private companies must have the same variables as used for the public companies.

5.6 Public and Private Companies

The data was sorted by their SIC codes for both the private and the public companies. The first group included companies with SIC codes between 2000-2099; there were 18 other groups, thus altogether 19. In the first group there were 44 public companies and 4 private ones. Each of the private companies were added one at a time into the DEA model, so in this case there were 45 DMUs in the DEA analysis. The companies were analyzed one at a time in the DEA analysis so as not to change the frontier too drastically. Also, one does not want a private company to have another private company in its peer group since this would not yield any useful information. The grouping chart is shown below in Table 5-7:

Table 5-7 List of the SIC codes and the Corresponding Name of the Industry

SIC Code	Industry	# of Public Co.'s	# of Private Co.'s
2000-2099	Food & Kindred Products	44	4
2100-2199	Tobacco	0	0
2200-2299	Textile mill	1	3
2300-2399	Apparel & Textile	6	1
2400-2499	Lumber & Wood	20	2
2500-2599	Furniture & Fixtures	8	2
2600-2699	Paper & Allied products	19	3
2700-2799	Printing & Publishing's	22	5
2800-2899	Chemical & Allied Products	66	12
2900-2999	Petroleum & Coal	10	1
3000-3099	Rubber & Misc. Plastic	13	8
3100-3199	Leather Products	1	0
3200-3299	Stone, Clay, Glass	13	1
3300-3399	Primary Metal Industries	16	5
3400-3499	Fabricated Metal Products	14	9
3500-3599	Machinery Except Electrical	47	9
3600-3699	Electrical equipment	85	3
3700-3799	Transportation	22	5
3800-3899	Meas., Analyzing, & Control. Inst.	36	5
3900-3999	Misc. Mfg. (Toys, Jewelry, etc.)	9	6
		452	84

Since it is essential in a DEA study to have at least three times the number of DMUs as the sum of the inputs and outputs (6 in this case), some of these private companies can not be investigated for market value. Therefore, one needs at least (6×3) 18 DMUs for the DEA models. For the ones with less than 18 DMUs, a DEA analysis could not be carried out, as was the case for 36 of the private companies and 91 of the public companies. The shaded areas in Table 5-7 represent this. There are some models with only 19-22 DMUs. This is rather small but nevertheless a DEA analysis would be able to be carried out. The data on the public companies can be found in Appendix A.

6. ANALYSIS & DISCUSSION

Based on the models previously discussed, this chapter details the results of the DEA. The analysis is presented in five separate sections. The first section deals with public companies with SIC code 3600s only, and calculates market values for the companies. Section two is a comprehensive study of the companies that have a SIC code in the 3700s. Section three reports on companies that have a SIC code in the 2000s. Section four examines an efficient and an inefficient company compared with all 452 companies. Finally, section five examines the methods developed for valuing public companies and applies them to private companies.

The BCC model is run to classify the companies as efficient or inefficient. Then the two classifications are examined separately. For the inefficient companies, peers are found based on the other companies having the same efficient companies as their peers. The distance equation is applied and a range for the market value for the subject company is revealed. An upper bound is found for the inefficient companies as well. The upper bound is based on the lambda relations of the inefficient company to the efficient companies multiplied by the market values of the efficient companies. For the efficient companies, a lower bound can be found by finding all the companies using it as a peer, summing these values and normalizing them then multiplying these by the market values and summing them to get the lower bound.

Since there are negative variables in the data, the most negative variable is found and one plus this value is added to all the outputs in the BCC model, making them positive. This can be done since BCC is both scale and translation invariant.

6.1 BCC Analysis of Companies with SIC Code 3600s

In this section, public company analysis was carried out using the results of the DEA BCC model. The BCC model was run for the 452 companies grouped by their SIC; thus 9 models were run in total, one for each SIC grouping. The first analysis was conducted on only companies with SIC codes in the 3600s (3600-3699) and consisted of 85 DMUs. The data for these companies can be found in Appendix B. For each company one now has their associated efficiency, lambda, slack and multiplier values. The market capitalization is incorporated back into the model to validate the findings. Once a value is estimated for the company, it can be compared back to the known market capitalization of the company to see if the results are realistic. In this grouping, there are also three private companies with the same SIC code. These are added one by one into the analysis and their results are discussed in section five.

6.1.1 Summary Statistics

The average efficiency of the companies is 0.73 with a standard deviation of 0.27 and a median of 0.79. There were 23 efficient DMUs and the efficiency scores ranged from as little as 0.0653, for company Noron, to 1. Noron had \$571 thousand in total assets and \$4.4 million in total liabilities along with -\$1.3 millions in net income and -\$1.2 million in cash flow. These account for why its efficiency was so poor.

6.1.2 Inefficient Company Analysis

6.1.2.1 Subset Hammond

A subset of the 85 DMUs was chosen for this analysis. The peer group for company, Hammond was found. The peer group consisted of all the efficient companies Hammond was being compared to as well as all the inefficient companies that were being

compared to the same combination of efficient companies. In the case for Hammond the peer companies were LG Technologies, Camco Inc, TS Telecom, Calian, Primetech, and Electrohome. Table 6-1 illustrates the subset group along with efficiency scores and lambda values.

Table 6-1 Hammond Subset Statistics

DMU		Score	Market Cap. S(000s)	Efficient Peers (λ):		
#	Name			7-Camco	32-TS Tel.	67-Prime.
1	HAMMOND	0.7567	18.426	0.2217	0.4467	0.3315
6	LG TECH	0.5865	27.707	6.03E-03	0.7302	0.2637
7	CAMCO	1	100.000	1	0	0
32	TS TELECOM	1	11.832	0	1	0
34	CALIAN	0.8001	33.191	5.99E-02	0.5935	0.3466
67	PRIMETECH	1	143.365	0	0	1
74	ELECTROHOME	0.6733	11.398	7.52E-02	0.4257	0.499

Camco, TS Telecom and Primetech were on the efficient frontier and thus had a score of 1. The inefficient companies had scores ranging from as low as 0.59 to 0.8. The lambda values going across the table for each DMU should sum to unity in the BCC model; this is not the case with the CCR model. In the BCC model, this is due to the convexity constraint, the CCR model does not have this constraint so its lambda values have to be adjusted; refer to section two for an explanation of the adjustment. This subset was then analyzed with the Simak [SIMA00] distance equation. The distance for Hammond to LG Technologies is computed as:

$$d_{ij} = \sum_k (\lambda_{ik} - \lambda_{jk})^2$$

$$d_{ij} = \sum (0.2217-0.006)^2 + (0.4467-0.7302)^2 + (0.3315-0.2637)^2 = 0.1315$$

In a similar manner the remaining distances are computed for Hammond's six peers, Table 6-2.

Table 6-2 Distances to Hammond

DMU#	Distance (from DMU_{Hammond})
Hammond	0
LG Technologies	0.1315
Camco	0.9152
TS Telecom	0.4652
Calian	0.048
Primetech	0.6956
Electrohome	0.0499

All the companies that had a distance of less than 1.0 from Hammond were then compared in terms of their efficiency scores and market capitalizations. Calian was the closest company with a distance of 0.048 followed by Electrohome, LG Tech., TS Telecom. Primetech and Camco. Calian and Electrohome were also closest in terms of efficiency score, 0.80 and 0.67 respectively, compared with Hammond's efficiency of 0.76. Electrohome was second closest by market value, \$11.4 million, followed by TS Telecom at \$11.8 million. Although Primetech and Camco had a distance of less than one in relation to Hammond, they were greatly different from Hammond in terms of their efficiency scores and market values and thus can be ignored as peers. The analysis determined a range for Hammond's market value based on its peers of \$11.4 to \$33 million. Hammond's real market capitalization of \$18.4 million is in this range.

6.1.2.2 Upper Bound for Subset Hammond

In this part, a new method of determining value based on the reference units for the inefficient companies is introduced and it is argued that this is an upper bound for the inefficient company. To calculate an upper bound for Hammond one uses the market

values of the efficient companies that it was being compared to, namely, Camco, TS Telecom, and Primetech, multiplied by the lambda values of Hammond in relation to these efficient peers. The lambda values can be found in Table 6-1. This formula is exemplified by:

$$\begin{aligned} &= (0.2217 \times 100,000,000) + (0.4467 \times 11,832,000) + (0.3315 \times 143,365,000) \\ &= \$74,988,000 \end{aligned}$$

The \$75 million value thus found is considered as an upper bound on the market capitalization of Hammond, since it is based on the market values of the efficient companies. Similar analysis is carried out on the rest of the inefficient companies in this subset. The results are summarized in Table 6-3:

Table 6-3 - Subset Hammond and the Predicted Market Values

For the Inefficient Public Companies(\$)				
		Predicted Market Cap Range		
Company	Real Market Cap	Minimum	Maximum	Predicted Upper Bound
Hammond	18,426,000	11,398,000	33,191,000	74,988,000
LG Tech	27,707,000	11,398,000	33,191,000	47,055,000
Calian	33,191,000	11,398,000	27,707,000	62,705,000
Electrohome	11,398,000	11,832,000	33,191,000	84,103,000

The first two companies' actual market values falls within the predicted range, so the model appears to work well. Calian on the other hand is not within the predicted range with a difference of \$5.5 million from its predicted upper range value, so it could be overpriced, but it is less than its predicted upper bound. Electrohome seems to be undervalued, but again it is less than the predicted upper bound. It is only \$434,000 less than its predicted minimum range value.

6.1.2.3 Subset 2 - Company Inverpower

The next subset in the 3600s group consists of Inverpower and its peers, which are Avante, RIM, TS telecom, Advantedge, Fifty-Plus, Kasten Chase, Wi-Lan, Plaintiffree, Nextron, WE XL. In total there are 11 companies in this subset. RIM, TS telecom and Fifty-Plus are the efficient companies. Table 6-4 represents this set.

Table 6-4 Company Inverpower and Distance to other peers

DMU		Score	Market Cap. S(000s)	Efficient Peers (λ):			Distance (from DMU _{Inver.})
#	Name			30-RIM	32-TS Tel.	42-Fifty	
3	INVERPOWER	0.545	7.179	1.16E-02	0.920842	6.76E-02	0
9	AVANTE	0.583	2.302	2.76E-03	2.10E-02	0.976265	1.635
30	RESEARCH IN MOTION	1	585.308	1	0	6.18E-16	1.829
32	TS TELECOM	1	11.832	0	1	2.78E-17	0.0109
33	ADVANTEDGE	0.180	19.928	1.17E-02	8.91E-02	0.899219	1.383
42	FIFTY-PLUS	1	2.404	0	0	1	1.717
45	KASTEN CHASE	0.995	23.569	0.112999	0.761709	0.125291	0.0389
65	WI-LAN INC	0.873	329.339	3.59E-02	0.15989	0.804195	1.122
77	PLAINTREE	0.866	14.946	8.84E-02	0.495785	0.415858	0.308
83	NEXTRON	0.534	2.426	3.22E-03	4.52E-02	0.95158	1.548
85	WE X.L.	0.944	17.083	8.79E-03	5.95E-03	0.985255	1.679

Table 6-5 shows the predicted market values for these companies.

Table 6-5 Subset Inverpower and the Predicted Market Values

For the inefficient Public Companies(S)					
		Predicted Market Cap Range			
Company	Real Market Cap (1998)	Minimum	Maximum	Predicted upper bound	Market Value 2000 (march)
Inverpower	7.179.000	11.832.000	23.569.000	17.848.000	3.793.725
Avante	2.302.000	2.404.000	329.339.000	4.211.000	2.281.016
Advantedge	19.928.000	2.302.000	329.339.000	10.064.000	11.385.000
Kasten Chase	23.569.000	7.179.000	329.339.000	75.454.000	322.862.069
Wi-Lan	329.339.000	2.302.000	23.569.000	24.838.000	707.841.877
Plaintree	14.946.000	2.302.000	329.339.000	58.607.000	126.612.983
Nextron	2.426.000	2.302.000	329.339.000	4.707.000	1.320.900
WE XL	17.083.000	2.302.000	329.339.000	7.548.000	1.755.287

Inverpower falls short of the predicted range for its market value, this could mean it is undervalued. It is also very inefficient and an improvement in efficiency score may

enhance its market value. The predicted upper bound is 2.5 times as great as Inverpower's real market value. Avante's market value falls below the predicted range, however, DEA found two very similar peers to it, namely, Nextron and Fifty-Plus. Especially Nextron, which had a similar score and market capitalization. Avante does seem slightly undervalued, but again it is highly inefficient an increase in efficiency might help Avante improve its market value. The predicted upper bound is 1.8 times greater than the real market value of Avante. Ignoring Wi-Lan, which was greatly different from Avante in terms of the efficiency score and its market value, one can find a more appropriate range for Avante of \$2.3 to \$20 million. The same is true for Advantedge; if one ignores the effect of Wi-Lan, which was not even close in terms of efficiency or market value. Its range becomes \$2.3 to \$17 million. Also, there are closer companies like Avante, Nextron, and WE XL in terms of distance. Advantedge had the lowest efficiency score in the group at 0.18, so this seems to be a very poor company in terms of turning its assets into profits. That also explains why the upper bound is so low. By all accounts, Advantedge is overvalued. It is just 0.5 times less than its upper bound. Kasten Chase, too is not very similar to Wi-Lan, in terms of distance, efficiency score, and market value. The closest peers are TS Telecom and Plaintree. Thus, ignoring Wi-Lan the upper range becomes \$14.9 million. Kasten Chase then becomes overvalued, but it is still operating less than its upper bound and it is highly efficient at 0.994. The predicted upper bound is 3.2 times greater than Kasten's real market capitalization.

In all, 62 inefficient companies were examined and a range for market values predicted as displayed in Table 6-6. Subsequently, it was found that eleven of the companies did not yield any information due to too few peers. Of the remaining 51

companies DEA predicted a suitable range 59% of the time, although some of these ranges were quite large. Another 16% were within 25% of their actual market value, either slightly above or below. There is evidence that DEA works better when there is a bigger peer group.

Table 6-6 Inefficient DMUs and Predicted Market Values

	Company Name	Score	Market Cap 1998	Predicted Range		Upper Bound
				Minimum	Maximum	
1	HAMMOND	0.757	18,426,080	11,397,939	33,191,018	74,988,000
3	INVERPOWER	0.545	7,179,058	11,832,000	23,569,233	17,848,000
4	UNITEC	0.435	5,570,707	2,404,000	one peer	5,057,000
6	LG TECH	0.587	27,706,969	11,397,939	33,191,018	47,055,000
8	NORON	0.065	7,029,310	2,404,000	one peer	2,383,000
9	AVANTE	0.583	2,302,425	2,404,000	329,339,322	4,211,000
10	SEMI-TECH	0.215	10,025,976	100,000,000	one peer	720,885,000
11	DANBEL	0.755	5,797,576	289,000	46,091,000	30,156,000
12	AVVA	0.847	2,429,279	1,710,000	13,382,000	2,669,000
13	TIR	0.656	1,709,641	1,956,000	13,382,000	3,537,000
14	DIGITAL PROC	0.884	28,123,144	11,832,000	one peer	154,005,000
18	ABL	0.399	13,381,932	1,710,000	11,832,000	7,609,000
19	BCS TECH	0.677	1,026,687	622,999	15,697,570	2,376,000
20	BELL CAN	0.254	1,371,119,948	1,031,559,000	3,608,271,000	2,448,639,000
21	CIRCA	0.859	6,600,985	3,855,000	46,091,000	22,797,000
22	DBA	0.640	1,956,000	1,710,000	13,382,000	3,782,000
23	EIGER	0.815	8,289,000	2,404,000	3,878,000	5,512,000
24	KING	0.472	7,738,941	307,000	2,854,080	1,072,000
25	MEMOTEC	0.649	4,952,521	11,832,000	76,678,291	48,488,000
26	MICROCELL	0.066	307,086,660	3,878,432	one peer	21,615,000
28	NHC	0.671	7,317,082	2,404,000	one peer	44,411,000
31	TRADE WIND	0.676	9,699,541	307,000	15,697,570	2,485,000
33	ADVANTEDGE	0.180	19,927,644	2,302,425	329,339,322	10,064,000
34	CALIAN	0.800	33,191,018	11,397,939	27,706,969	62,705,000
36	CELL-LOC	0.980	28,669,000	1,969,999	2,404,000	23,996,000
37	COM DEV	0.863	252,315,304	112,896,710	1,031,559,000	851,037,000
39	CYGNAL	0.589	8,637,474	11,832,000	32,734,620	50,650,000
40	DIMENSIONS	0.110	1,969,999	2,404,000	28,669,000	12,241,000
41	DYNAMIC	0.939	110,353,695	80,615,000	one peer	89,291,000
43	GEMSTAR	0.232	4,887,873	1,729,263	61,220,528	3,327,000
45	KASTEN CHASE	0.995	23,569,233	7,179,058	329,339,322	75,454,000
46	MARATHON	0.604	622,999	717,010	15,697,570	2,447,000
48	SENSE	0.374	61,220,528	1,729,263	4,887,873	15,085,000
49	SIMMONDS	0.766	2,854,080	3,878,000	7,738,941	3,334,000
50	SPECTRUM	0.787	38,637,268	4,952,521	76,678,291	100,858,000
51	SR TEL	0.447	112,896,710	44,404,112	1,031,559,000	532,269,000
52	STRATEGIC	0.983	3,943,154	2,404,000	13,222,000	6,597,000
53	SYSCAN	0.657	7,259,505	2,404,000	3,855,000	5,654,000
54	TEKLOGIX	0.810	243,501,458	44,404,112	143,365,000	179,974,000
55	TRIPLE CROWN	0.526	4,978,951	1,710,000	13,382,000	4,818,000

56	TSI TELSIS	0.211	12,192,753	622,999	15,697,570	2,304,000
57	WESCAM	0.628	76,678,291	4,952,521	143,365,000	169,212,000
58	EXI TECH	0.757	9,421,665	2,404,000	one peer	14,108,000
61	SIERRA	0.996	32,734,620	3,855,000	11,832,000	107,529,000
63	STRATEGIC	0.534	1,719,718	622,999	15,697,570	2,004,000
64	SYMPLEX	0.562	5,879,226	1,710,000	13,382,000	2,657,000
65	WI-LAN	0.873	329,339,322	2,302,425	23,569,233	24,838,000
66	CIRCUIT WORLD	0.753	288,737	5,798,000	46,091,000	24,592,000
69	CORECO	0.983	44,922,938	2,404,000	51,561,300	153,477,000
71	SHELLCASE	0.085	15,697,570	622,999	12,192,753	2,141,000
72	TUNDRA	0.982	120,705,324	3,855,000	one peer	46,523,000
73	C-MAC	0.817	291,126,880	100,000,000	1,031,559,000	969,673,000
74	ELECTROHOME	0.673	11,397,939	11,832,000	33,191,018	84,103,000
75	LAMBUS	0.710	1,729,263	2,404,000	61,220,528	7,566,000
77	PLAIN TREE	0.866	14,946,155	2,302,425	329,339,322	58,607,000
78	TRI-VISION	0.743	29,930,177	2,404,000	one peer	53,470,000
80	BLUESTAR	0.555	44,404,112	112,896,710	243,501,458	173,006,000
81	COMPRESSION	0.310	717,010	622,999	15,697,570	2,391,000
82	GSI LUMONICS	0.917	129,625,600	1,031,559,000	one peer	1,037,907,000
83	NEXTRON	0.534	2,426,140	2,302,425	329,339,322	4,707,000
84	ROYAL LASER	0.684	51,561,300	2,404,000	44,922,938	151,693,000
85	WE X.L.	0.944	17,083,495	2,302,425	329,339,322	7,584,000

Figure 6-1 demonstrates the predicted and the actual market values:

Figure 6-1 Inefficient Companies and their Predicted and Actual Market Values

The real market values were also graphed against the predicted upper bound. Of the total 62 companies, 41 companies had real market caps that were less than the predicted upper market capitalization, thus DEA is correct 66% of the time in predicting an upper market cap that is truly higher than the market cap of the company. This is the result one would hope for since the upper market value is based on the efficient companies, and intuitively, the market caps of the inefficient companies should be below these values. Another 13% of companies were within 35% of their predicted upper bound.

Figure 6-2 represents the predicted upper bound versus the actual market capitalizations.

Inefficient Co's-Difference Between Real & Predicted Upper Bound MC (\$)

Figure 6-2 Inefficient Companies- Real MC versus Predicted Upper Bound

Figure 6-3 Inefficient Companies-Percent Difference (Real & Predicted Upper)

Figure 6-3 is similar to Figure 6-2 but this time the percentage difference between the real market value of the inefficient

company is plotted against the predicted upper bound market value.

Figure 6-4 Efficiency and Market Value (SIC3600)

Figure 6-4 shows that almost all the large companies are efficient with the exception of Bell Canada.

Figure 6-5 Efficiency and Total Assets (SIC3600)

The largest and smallest companies are efficient but they could be outliers. Figure 6-5 does not show correlation, the correlation coefficient is 0.13, among total assets and the efficiency scores.

6.1.3 Efficient Companies

In this part, a new way to analyze efficient companies is introduced. The analysis for the efficient companies was carried out in a different manner than for the inefficient companies. Since these efficient companies are rarely compared to other companies, one has to calculate the market value from the companies being compared to them, whether they are inefficient or efficient. One can hypothesize that this way a lower bound on the market values can be found. Since it is an efficient company, it should presumably be doing better than the market value calculated from the inefficient companies in its peer group. The lower bound was calculated based on the lambda values of the inefficient companies being compared to the efficient company. Adjustments must be made for the fact that the lambda values on the column of the matrix do not sum to unity.

6.1.3.1 Lower bound for Efficient Company Camco

Camco was analyzed first: it had 17 companies being compared to it. The lambda values of the inefficient companies in relation to Camco were summed then this sum was used to divide each lambda value to get a new normalized lambda ($\lambda / \Sigma\lambda$). For example, Hammond has a lambda relation of 0.222 to Camco, the sum of all the lambda relations to Camco equaled 1.961. Hammond's new lambda score is equal to $(0.2217/1.9605)$ 0.113 in relation to Camco. This same procedure was repeated for all the other companies' lambda values, thus the new sum of the lambda values equals one. The new, normalized lambda's of the firms were then multiplied by their market values and summed. The results are shown in Table 6-7:

Table 6-7 Efficient Company Camco Inc (#7)

DMU #	Score	Market Cap S(000)	DMU #7 (old λ)	Normalized New λ ($\lambda / \Sigma\lambda$)	M.C. S(000s) Calculation
1 HAMMOND	0.7568	18426	0.2217	0.1131	2083.92
6 LG TECH	0.5866	27707	0.006	0.0031	85.22
10 SEMI-TECH	0.2145	10026	0.7746	0.3951	3961.35
15 SONY CORP	1	5.3E+07	3.1E-15	1.6E-15	8.343E-08
17 AASTRA TECH	1	46091	6.3E-18	3.2E-18	1.483E-13
23 EIGER TECH	0.8151	8289	0.0107	0.0055	45.24
26 MICROCELL	0.0664	307087	0.1845	0.0941	28902.05
34 CALIAN TECH	0.8001	33191	0.0599	0.0305	1014.08
37 COM DEV	0.8633	252315	0.0824	0.042	10604.66
51 SR TELECOM	0.447	112897	0.1363	0.0695	7845.93
52 STRATEGIC	0.9832	3943	0.0012	0.0006	2.45
54 TEKLOGIX	0.8099	243501	0.0755	0.0385	9377.23
68 CELESTICA INC	1	2854867	2.8E-16	1.4E-16	4.092E-10
73 C-MAC	0.8171	291127	0.2202	0.1124	32707.43
74 ELECTROHOME	0.6733	11398	0.0752	0.0384	437.19
80 BLUESTAR	0.5547	44404	0.0926	0.0472	2097.3
82 GSI LUMONICS	0.9167	129626	0.0196	0.01	1295.9
SUM:			1.96053	1	\$100,460

For Camco, the predicted market capitalization is \$100.459,000; its real market value is \$100,000,000. DEA did an exceptional job at predicting the value of the public company. Similar analyses were carried out on the remaining 22 efficient companies and are recorded in Table 6-8. A complete analysis can be found in Appendix C.

Table 6-8 - Efficient DMUs & Number of Peers (SIC 3600s)

For the Efficient Public Companies (\$)					
DMU#	Company	Real Market Cap (\$)	Predicted Market Cap (Lower Bound) (\$)	Comment	# of Peers
2	Turbo Genset	80,615,000	79,412,730	Above lower	6
5	Global Therm	13,222,000	2,358,240	Above lower	4
7	Camco	100,000,000	100,459,949	Above lower	17
15	Sony	52,935,385,000	Self evaluator	no info	0
16	Cinram	1,075,691,000	Self evaluator	no info	0
17	Aastra Tech	46,091,000	4,427,000	Above lower	5
27	Mitel	1,257,378,000	Self evaluator	no info	2
29	Nortel	50,495,406,000	Self evaluator	no info	0
30	Res. In Motion	585,308,000	48,895,000	Above lower	18
32	TS Telecom	11,832,000	25,878,000	Undervalued	29
35	Cdn Marconi	426,808,000	Self evaluator	No info	0
38	Comm. Sys	3,855,000	43,170,000	Undervalued	9
42	Fifty-Plus	2,404,000	21,030,000	Undervalued	45
44	Int. Datacast.	3,893,000	5,074,000	Undervalued	4
47	Newbridge	8,125,481,000	51,858,075,000	Undervalued	2
59	Jemtec	330,000	3,943,000	Undervalued	1
60	Pacific E-link	3,878,000	86,216,000	Undervalued	18
62	Snif Security	307,000	7,164,000	Undervalued	11
67	Primetech	143,365,000	73,681,000	Above lower	15
68	Celestica	2,854,867,000	487,320,000	Above lower	6
70	Genum	576,578,000	50,868,000	Above lower	5
76	Leitch	1,031,559,000	287,982,000	Above lower	21
79	Ballard	3,608,271,000	1,371,119,000	Above lower	2

Excluding the five self-evaluators, DEA does a fairly good job of finding a reasonable or appropriate lower bound for the companies, as evidenced by the majority of companies having real market values higher than the predicted lower market value. DEA finds a lower bound that is less than the true market value 56% of the time. In some cases, there are too few peers and the calculation maybe exaggerated or the peers may be vastly different from the company under analysis. The seven companies that had market caps below the predicted lower bound can be classified as undervalued, since according to the

analysis their value can be greater. Efficient company Snif Security was the most undervalued. It had a predicted lower market cap of \$7 million when in reality it only had a market cap of \$307,000. It had a 2234% difference between its predicted and real market value. Figure 6-6 displays the real market values compared to the predicted lower bound, and Figure 6-7 shows the percentage difference between the real market value and the lower bound.

Figure 6-6 Efficient Companies-Real MC versus the Predicted Lower Bound

Figure 6-7 Efficient Companies-Percent Difference (Real & Predicted Lower MV)

6.2 Analysis of the Companies with SIC Code 3700s

A similar analysis as for SIC 3600 was carried out on the companies with a SIC code in the 3700s. This group consisted of 22 DMUs. This group was tested to see if the number of DMUs in the analysis really has an effect on the number of peers that DEA finds. All 22 DMUs were analyzed. The average efficiency of the BCC model was 0.81 with 8 efficient DMUs. The efficient DMUs are listed in Table 6-9.

Table 6-9 Efficient DMUs SIC3700s

#	DMU	# of Peers
2	GM	0
5	Budd Canada	12
6	Linamar	6
7	Magna	1
11	Spectra	6
14	Wescast	8
21	Templar	11
22	Bombardier	0

DMUs Budd and Templar are the most employed peers with 12 and 11 peers respectively, however Templar has a higher degree of influence over its peers. DMUs GM, Magna and Bombardier do not act a reference unit for any of the inefficient units. This could mean they are either efficient in a very narrow sector or that they possess a very uncommon input/output mix or they are just very different. The complete efficiency scores and lambda values are shown in Table 6-10:

Table 6-10 DMU 3700s Statistics

#	DMU	Score	SIC	Market Cap. \$(000s)	Efficient Peers (λ s):							
					1	3	6	7	11	14	21	22
1	GM	1.00	3711	86,392,582	1	0	0	2.5E-15	0	0	0	0
2	A.E. VENT.	0.80	3714	627	0	0.0036	0	0	0.0146	0	0.9818	0
3	BUDD CAN	1.00	3714	116,772	0	1	0	0	0	0	0	0
4	DECOMA	0.58	3714	560,656	0	0.4576	0.4793	0	0	0.0631	0	0
5	DEVTEK	0.67	3714	99,709	0	0.8818	0.1181	0	0	0	0	0
6	LINAMAR	1.00	3714	1,792,517	0	0	1	0	0	0	0	0
7	MAGNA	1.00	3714	7,374,103	0	0	0	1	0	6.6E-17	0	0
8	MERCH	0.65	3714	2,869	0	0	0	0	0.0195	0	0.9805	0
9	NORTHSIDE	0.90	3714	14,056	0	0.0906	0.0227	0	0	0	0.8867	0
10	ROSE	0.71	3714	25,150	0	0	0	0	0.5985	0	0.4015	0
11	SPECTRA	1.00	3714	525,280	0	7.4E-18	0	0	1	1.7E-17	9.8E-19	0
12	STACKPOLE	0.63	3714	131,497	0	0.2442	0	0	0.5083	0.2475	0	0
13	TESMA	1.00	3714	570,124	0	0.4037	0.4697	0	0	0.1266	0	0
14	WESCAST	1.00	3714	574,300	0	0	9.3E-17	0	0	1	1.5E-16	0
15	TRAILMOB.	0.97	3715	14,342	0	0.3072	0	0	0	0	0.6928	0
16	GLENDALE	0.52	3716	47,948	0	0.4337	0	0	0	0.0132	0.5531	0
17	AVCORP	0.50	3728	45,730	0	0.1315	0	0	0.4154	0	0.4531	0
18	HEROUX	0.59	3728	62,462	0	0.2724	0	0	0.4183	0.0145	0.2948	0
19	MAGELLAN	0.63	3728	496,389	0	0.5206	0.1523	0	0	0.3271	0	0
20	SERENA	0.73	3731	572	0	0	0	0	0	0	1	0
21	TEMPLAR	1.00	3732	4,576	0	0	0	0	0	0	1	0
22	BOMBARD.	1.00	3743	7,502,049	0	0	0	0	0	0	0	1

6.2.1 Efficiency and Market Value

Figure 6-8 shows the efficiency for all the DMUs in the analysis ordered by their market capitalization. It is evident from this figure that the larger companies, the ones with the white points, are all efficient or nearly so. The correlation coefficient is 0.26.

Figure 6-8 Efficiency and Market Value (SIC3700)

6.2.2 Efficiency and Total Assets

The correlation coefficient between efficiency and total assets of the DMUs is 0.15, illustrated in Figure 6-9. Thus there is great difference between the total assets of the various companies.

Figure 6-9 Efficiency and Total Assets (SIC3700)

6.2.3 Graph of Virtual Outputs

A virtual output is simply the product of a given output and its weight. Its value indicates the importance attached to a given output. In the case of the CCR model, the sum of the virtual outputs is equal to the unit's efficiency score. In the BCC model, the sum of the virtual outputs plus the measure of scale efficiency, u_0 , is equal to the unit's efficiency score. For each DMU, a stacked column that has the unit's virtual outputs as its series is plotted in Figure 6-10. It displays the relative amount that each output factor contributes. It is interesting to note that company 21 has no contribution from its outputs. It is solely made up of the contribution from its input, namely total liability. Figure 6-10 also shows that the factor shareholders' equity is the most influential output.

Figure 6-10 Virtual Outputs of Companies (SIC3700)

The numbers for the DMUs correspond to Table 6-10

6.2.4 Valuation of SIC 3700s

Table 6-11 summarizes the predicted values for the companies with SICs in the 3700s and Figure 6-11 shows the predicted ranges. There were 10 peer groups in total with some companies only being compared to efficient companies. For most DMUs there were at least three peers, with the exception of Trailmobile and Devtek, which only had two peers, and Serena which only had one.

Table 6-11 Range for Market Values (SIC3700)

For the Inefficient Public Companies(\$)				
Company	Real Market Cap	Predicted Market Cap Range		Predicted upper bound
		Minimum	Maximum	
A.E Ventures	627.000	4,576.000	45,730.000	12,581.000
Avcorp	45,730.000	627.000	525,280.000	235,632.000
Merch	2,869.000	4,576.000	25,150.000	14,730.000
Rose	25,150.000	2,869.000	525,280.000	316,213.000
Stackpole	131,497.000	116,772.000	574,300.000	437,638.000
Glendale	47,948.000	4,576.000	116,772.000	60,753.000
Trailmobile	14,342.000	4,576.000	116,772.000	39,042.000
Northside	14,056.000	4,576.000	-----	55,327.000
Heroux	62,462.000	4,576.000	525,280.000	261,222.000
Serena	572.000	4,576.000	-----	One peer
Magellan	496,389.000	116,772.000	574,300.000	521,651.000
Devtek	99,709.000	116,772.000	-----	314,710.000
Decoma	560,656.000	116,772.000	1,792,517.000	948,802.000
Tesma	570,124	116,772.000	1,792,517.000	961,817.000
For the Efficient Public Companies(\$)				
	Real M.C.	Predicted Market Cap. Lower Bound		Comment
Budd Canada	116,772.000	244,116.000		Undervalued
Linamar	1,792,517.000	502,534.000		Above lower
Spectra	525,280.000	64,357.000		Above lower
Wescast	574,300.000	383,838.000		Above lower
Templar	4,576.000	16,359.000		Undervalued
GM	86,392,582.000	Self Evaluators		No info
Magna	7,374,103.000	Self Evaluators		No info
Bombardier	7,502,049.000	Self Evaluators		No info

Figure 6-11 Range for Predicted Market Values and the Real Value (SIC3700)

Figure 6-12 Inefficient Company-Real & Predicted Upper Market Value (SIC3700)

Figure 6-13 Efficient Firms-Real and Predicted Upper Bound(SIC3700)

In the case of the inefficient companies, in Figure 6-12, DEA accurately classifies 64% of the companies, but without exception the range from the minimum to the maximum value is very large. In the instances when DEA cannot classify the companies, it is due to there being not enough similar peers. DEA correctly finds an appropriate lower bound 60% of the time for the efficient companies. Figure 6-13, with a SIC of 3700. Appendix D contains the information on the companies with a SIC in the 3700s.

6.3 Analysis of the Companies (SIC2000)

A similar analysis for companies with SIC in the 2000s was also performed. This group represented food and kindred products. There were 44 DMUs in this subset, with 15 on the efficiency frontier and an average efficiency of 0.81. The most popular efficient peers are A. L. Van Houtte Ltd. with 21 peers followed by AMT Fine Foods Ltd. with 19. Analysis of the lower bounds of the efficient companies shows that 67% of the companies are found to be undervalued, they have actual market value less than the predicted lower bound. Canada Bread Company Ltd., Seagram and Petroleal Oil Corporation are found to be self-evaluators. For the 29 inefficient companies, 10 of them do not reveal any information due to the fact they have one or no peers. The remaining 19 companies have a correct predicted market range 68% of the time. Also, 86% of the time the inefficient companies have an actual market value less than the predicted upper bound. Table 6-12 shows the range of market values for the inefficient companies and Table 6-13 demonstrates the market values for the efficient firms.

Table 6-12 Range for Market Values -Inefficient Companies(SIC2000)

For the Inefficient Public Companies(\$)					
			Predicted Market Cap Range		
Company	Efficient Peers	Real Market Cap	Minimum	Maximum	Predicted Upper Bound
3 SEPP'S	4.5.12	27.532.000	11.173.015	one peer	18.937.000
6 TML FOODS	4.33	1.782.000	11.173.015	one peer	10.684.000
7 SAPUTO	2.24.43	2.107.819.000	632.441.262	one peer	586.998.000
8 DELICIOUS	41.43	17.246.000	302.000	38.002.000	19.742.000
10 LASSONDE	2.9.43	17.825.000	15.889.000	632.441.000	328.512.000
11 GLOBAL COMM	16.41.43	14.410.000	1.917.000	3.938.000	5.567.000
14 AGRO PACIFIC	2.4.5	10.874.000	8.570.000	11.173.000	19.654.000
15 RIDLEY	2.9.24.43	160.050.000	no peers	no peers	481.981.000
18 BETA BRANDS	2.4	47.999.000	11.173.000	one peer	19.408.000
19 SMALL FRY	2.4.9	26.740.000	11.173.000	15.889.000	29.793.000
20 AFRICAN	16.41.43	683.000	302.000	1.917.000	2.537.000
21 BANFF	16.33.41	1.378.000	2.879.000	3.938.000	2.881.000
22 BIG ROCK	4.41.43	19.445.000	11.173.000	12.878.000	71.738.000
23 BRICK BREWING	4.12.43	15.421.000	11.173.000	one peer	52.811.000
25 SLEEMAN	4.24.43	126.836.000	11.173.000	632.441.000	205.764.000
26 TREE	16.41.43	1.917.000	302.000	14.410.000	2.368.000
27 UNIBROUE	4.24.43	33.828.000	11.173.000	126.836.000	84.632.000
28 ANDRES	4.9.24.43	79.826.000	11.173.000	632.441.000	139.259.000
29 MAGNOTTA	4.24.43	13.310.000	11.173.000	126.836.000	49.850.000
31 VINCOR	2.9.13.24.43	192.114.000	15.889.000	632.441.000	288.746.000
32 HIGHWOOD	4.16.41.43	2.373.000	3.938.000	one peer	6.517.000
34 ARROWHEAD	4.16.43	962.000	11.173.000	one peer	13.002.000
35 CLEARLY CDN	41.43	5.135.000	302.000	632.441.000	188.943.000
36 COTT	1.2.24	330.647.000	139.628.000	1.374.236.000	552.839.000
37 LEADING BRAND	2.4.5	8.570.000	10.874.000	11.173.000	10.947.000
39 URBAN JUICE	4.41.43	12.878.000	11.173.000	19.445.000	14.834.000
40 VIVANT	33	876.000	2.879.000	Similar to Aqua	2.879.000
42 LEF MCLEAN	4.5.9.12	3.381.000	11.173.000	one peer	14.939.000
44 ARCTIC GROUP	41.43	38.002.000	302.000	17.246.000	66.865.000

Table 6-13 Range for Market Values -Efficient Companies(SIC2000)

For the Efficient Public Companies(\$)				
	Real M.C.	Predicted. Lower Bound	Number of Peers	Comment
1 MAPLE LEAF	1,374,236.000	95,217,210	1	Above lower
2 SCHNEIDER	139,628.000	321,064,000	11	Undervalued
4 AMT FINE	11,173.000	24,079,000	19	Undervalued
5 FLETCHER'S	5,936.000	12,038,000	5	Undervalued
9 SUN-RYPE	15,889.000	75,881,000	9	Undervalued
12 DOVER	53,129.000	20,133,000	3	Above lower
13 MRRM	21,548.000	192,114,000	2	Undervalued
16 SENTEX	3,938.000	5,918,000	7	Undervalued
17 CAN BREAD	449,753.000	self evaluator	0	No info
24 FOSTER'S	556,622.000	1,060,747,000	10	Undervalued
30 SEAGRAM	19,977,447.000	self evaluator	0	No info
33 AQUA I	2,879.000	1,085,000	3	Above lower
38 PETROREAL	5,304,000	self evaluator	1	No info
41 EVEREST	302.000	13,971,000	11	Undervalued
43 A. L. VAN	632,441.000	528,193,000	21	Above lower

Appendix E contains the information on the companies with a SIC in the 2000s.

6.4 Analysis Utilizing All 452 Companies

Some may argue that using different SIC codes in the same analysis is incorrect. However, there are studies that do in fact use companies with different 4-digit SIC codes in a valuation analysis, such as Renaissance Capital [ZHU00]. To test the theory that a relevant peer group would be found when all 452 companies were included in the valuation analysis, an efficient and an inefficient DMU were analyzed with all 452 companies.

6.4.1 Inefficient Hammond compared to all 452 Companies

Comparing DMU Hammond to all of the companies resulted in Hammond having 21 peers of which 4 were efficient. The range for its market value based on these

companies was between \$3.4 to \$142.8 million. with a predicted upper bound of \$57.5 million. Hammond's real market value is \$18.4 million. The most similar companies were Patheon, Sico, and Lassonde with SIC codes of 2834, 2851 and 2034 respectively and market values of \$142.8, \$71, and \$17.8 million, respectively. The only other company with the same SIC code in the 21 peers thus found was Aastra. Even though this analysis resulted in a bigger peer group for Hammond, the results did not conclusively find a better, tighter range for its market capitalization.

6.4.2 Efficient Company Wescast Compared to all 452 Companies

An efficient company, Wescast, was also tested with all 452 companies. This time around Wescast had 97 companies utilizing it as a peer. The lower bound calculated based on these peers was \$408 million, with Wescast having a real market value of \$574 million. This amount was better than the \$383 million predicted as a lower bound for Wescast when it was compared only to companies with an SIC code in the 3700s just like itself. In this comparison, the peer group consisted of companies with SIC codes ranging from 2000 to 3900. The most comparative group were companies with SIC in the 3500's, numbering 15 in total. There were also 8 companies with SIC in the 3700s compared to Wescast, including 6 that had the same identical SIC code. Appendix F contains the information on this analysis.

6.5 Private Companies

The private companies were analyzed by adding one at a time and re-running the DEA BCC model with the 85 DMUs. Once similar reference peer units are found, the private companies can be assumed to have the market values of these reference DMUs; thus one has found a market value for the private companies based on the similar public

companies. The private companies were analyzed in the same manner as the efficient and inefficient public companies. As mentioned, there are three private companies having a SIC code in the 3600s, namely, company #55, 85, and 220.

6.5.1 Inefficient Private Companies

After the initial DEA analysis, private company #55 was found to have an efficiency score of 0.77 in BCC. It was then analyzed using the procedure applied for public companies above. Unfortunately, the company had a very unique definition of peer groups, consisting only of 4 other companies, all efficient. The peer group included Aastra Technologies, Ts Telecom, Communication Systems Internat, and Fifty-Plus.Net International. After the analysis, it was found to be most similar in terms of distance and efficiency score to TS Telecom. The actual values found are listed in Table 6-14.

Private Company #220, coincidentally, had the same peer grouping as subset Hammond above. In its peer group were LG Technologies, Camco Inc, TS Telecom, Calian, Primetech, Electrohome and Hammond. It was found to be most similar to TS Telecom, which had a market cap of \$11.8 million.

Table 6-14 Inefficient-Range for Market Values (Private Companies)

For Inefficient Private Companies (\$)				
	Predicted Market Cap Range (\$)			
Company	Minimum	Maximum	Closest to:	Predicted Upper Bound
Company #55	2,400,000	46,000,000	11,832,000	17,700,000
Company #220	11,832,000	33,191,000	11,832,000	37,414,000

6.5.2 Efficient Private Companies

For the efficient private companies the same analysis as for efficient public companies was conducted, the lower range found is listed in Table 6-15.

Table 6-15 Efficient-Range for Market Values (Private Companies)

For Efficient Private Companies	
Company	Predicted lower bound (\$)
Company #85	48,822.000

Analysis Summary

To summarize, the DEA-Valuation model is a way to identify a set of similar public companies that can be used to estimate the market value of a private company. DEA is traditionally used to measure relative efficiencies and this novel application expands its function. DEA does a fairly good job in determining appropriate peers for the companies when utilizing the BCC model. The CCR model was not employed due to the existence of negative variables in the model. The DEA-Valuation approach works better with more DMUs. There must be more than 22 DMUs for DEA to find a correct range for the company under analysis. Private companies are valued by finding suitable public peers and inferring their market values onto the private companies.

Although the range specified by the peers is sometimes quite wide, the method still does an above average job of classifying market value. For companies that have only one peer or none (the self-evaluators), the results are not binding. A larger data set, if possible, should be collected. This will increase the likelihood of correct classifications.

7. CONCLUSIONS & RECOMMENDATIONS

With a global increase in mergers and acquisitions and the number of companies going public, the need for valuation tools and methodologies increases. Determining value is a significant part of any business, be it for selling a business, divorce settlements or for mergers. Value estimates can vary widely and to insure a fair value for the business a number of issues need to be addressed.

Valuation is oftentimes a subjective task performed by valuers, business analysts, accountants, lawyers and investment bankers. The existing methods for determining this value consist of forecasting growth and future cash flows, or optimizing the value of owned assets by liquidation or finding similar companies and adjusting their forecasts and growth expectations to arrive at a value. The goal of this thesis is to develop a methodology that evaluates the market value of corporations utilizing Data Envelopment Analysis to find comparable firms and to apply this methodology to assess the worth of private companies.

A DEA analysis of manufacturing companies was studied. Valuation models for predicting market ranges were developed. Different approaches were constructed based on the performance of the company in the DEA model. Inefficient companies had their most similar peers identified which lead to a predicting of the market value range. An upper bound for their market value was determined as well. For the efficient companies, a lower bound market value predicting approach was constructed.

The results were encouraging when a highly comparable peer group existed. In total over 200 companies were examined with the DEA-Valuation method. Results showed that overall 70% of the inefficient companies were within the range predicted by

the DEA-Valuation method, and quite a number of companies were scarcely outside of their individual predicted range. Overall, the calculated upper bounds were greater than the real market value for the inefficient companies 75% of the time. For the efficient companies the lower bound was less than the real market value 50% of the time. however there were instances where it was not and this could mean that the companies are undervalued.

In summary, the DEA-Valuation model was fairly adequate in predicting appropriate market ranges. As with all valuations, this is another tool that valuers have at their disposal, and a combination of the different valuation methods will give better ranges of value.

7.1 CONTRIBUTIONS

The contributions of this thesis include novel ways to predict lower bounds for market value for efficient companies and upper bounds for inefficient ones. This work expands on the use of DEA for finding peer groups instead of its traditional role of finding efficiency measures. Valuation models were developed for both private and public companies and efficiency scores, difference indicators, market value ranges, and comparative peers were provided where appropriate. DEA was able to handle the multidimensional nature of companies because it allows multiple inputs and outputs. The work consists of a group of data, more than 500 companies all together, which can be used to determine the peer groups.

7.2 LIMITATIONS OF THE DEA APPROACH

In order to apply the DEA-Valuation Methodology there has to be a sufficient number of firms in the peer group. The number of DMUs in the analysis varied from 22-

85. The number of similar peers should at least be three in order to conduct an appropriate analysis. Increasing the number of firms in the analysis may improve and tighten the ranges for predicted market values. Ideally one wants a set with many DMUs but with very similar DMUs. Having more DMUs would not guarantee more peers however a bigger group would increase the probability of having more similar companies.

7.3 AREAS OF FUTURE WORK

The methods discussed in this thesis to determine market values represent an excellent start and show encouraging results. The above methodology can be enhanced and made stronger by applying it to different areas and comparing its results with other methods. In the following list, areas of future research are addressed and examined to advance the DEA-Valuation methodology.

- Obtain data on five-year growth forecasts for companies and run a DEA analysis
- Analyze different sectors rather than just manufacturing to see if the results hold for the other industries.
- Attempt to analyze Internet company valuation, need to somehow rank key-men and technology contributions, and it is necessary to look at other qualitative and quantitative factors. Although information of this nature was not available for this analysis, if it were, the possible models would consist of the important quantitative factors that Internet start-ups rely on. These include their burn-rate of cash and the amount of cash or investments on hand. While one wants to increase the amount of cash investments in the business, and thus maximize it, it has to be in balance with

the burn-rate. Internet companies go through an exorbitant amount of cash, called the “burn-rate”. This would be an important factor to minimize in a DEA study.

Other factors to consider are supplier relations, marketability, “killer apps” or unique technology, and customer base to make up for the fact that most Internet companies scarcely have revenue and typically, no profits.

- The weights in this study were not restricted. DEA chose the weights according to the company under analysis allowing it to appear the best it could. With expert opinion, these weights can be restricted and analyzed to test the change in market value ranges.
- According to Renaissance Capital (a research boutique) a valuation analysis can be carried out without using all the companies from the same 4-digit SIC code. The argument is that some present day public companies are so large and diversified into many forms of businesses that four digit SIC codes are no longer of significance. For example, Molson’s Canada is a brewer, i.e. Manufacturing, but at the same time it owns the Montreal Canadians Hockey Club, i.e. Non-manufacturing. This might lead to an interesting study if a lot of companies with varying SIC codes can be included in the same study.
- A complete valuation using different methodologies such as DCF, CF, asset valuation, with all the appropriate discounts applied would be the best study. As well as being the best way to compare all the methods against each other
- Find and set optimal cut-off values for the distance and the efficiency similarity when analyzing the minimum and maximum of the inefficient companies. Right now the distance is set to 1, and only companies that have a distance of less than 1

are analyzed as peers. For the efficiency scores, try to determine a percentage range that is appropriate for peer companies. For example, if the subject company has an efficiency score of 0.75 only examine other companies that are within 10% of this score.

7.3.1 New Applications for DEA

- The ranking of the reputation of the underwriters are based on pricing, selling of their allotment, post-issue price stability, market making, analyst coverage/publicity, ability to underwrite subsequent debt/equity issues. The DEA approach can be used to study IPO performance and also to determine the best underwriters based on the above factors.
- Also, as previously mentioned, DEA can be used just to find the best comparable firms, and instead of trying to estimate a market value range based on the found comparable peers, the known P/E ratios, growth forecasts and discount rates of the peers should be used in the estimation of value of the private ones.

REFERENCES:

- [BANK84] Banker, R.D., Charnes, A., Cooper, W.W., "Some Models for Estimating Technical and Scale Efficiency in Data Envelopment Analysis," *Management Science*, (1984), 30(9): 1078-1092.
- [BERG98] Bergendahl, G., "DEA and benchmarks - an application to Nordic Banks," *Annals of Operational Research*, (1998), 82: 233-249
- [BOAT81] Boatsman, J., Baskin, E., "Asset Valuation with Incomplete Markets," *The Accounting Review*, (1981) 56:38-53.
- [BOOT00] Booth, L., *Class Notes on Mergers and Acquisitions*, (2000).
- [BOOT98] Booth, L., "What Drives Shareholder Value," *Federated Press-Creating Shareholder Value Conference*, October 28, 1998.
- [BOOT98a] Booth, L., "The Capital Asset Pricing Model: Equity Risk Premiums And The Privately Held Business," *Journal of Business Valuation- Proceedings of the 3rd Joint Business Valuation Conference of the Canadian Institute of Chartered Business Valuators (CICBV) and the American Society of Appraisers (ASA)*, Montreal, (1998), 1-36.
- [BYRN94] Byrne, A., Rees, W., "The Time Series Behaviour of Initial Returns on U.K. IPOs," *Journal Of International Financial Markets, Institutions & Money*, (1994), 4(3-4): 81-100.
- [CAMP92] Campbell, I.R., "Business Valuation a Canadian Author's Perspective," *Journal of Business Valuation - Proceedings of the 11th Business Valuation Conference*, Quebec City, (1992), 135-159.
- [CBC00] CBC Newsworld Broadcast, July 22, (2000)
- [CDNX00] www.cdnx.com
- [CHAF93] Chaffe, D., "Option Pricing As A Proxy For Discount For Lack Of Marketability In Private Company Valuations: A Working Paper," *Business Valuation Review*, December (1993).
- [CHAR78] Charnes, A., Cooper, W.W., Rhodes, E.L., "Measuring the Efficiency of Decision Making Units," *European Journal of Operational Research*, (1978), 2(6):429-444.
- [CHAR94] Charnes, A., Cooper, W.W., Lewin, A.Y., Seiford, L.M., Data Envelopment Analysis: Theory, Methodology and Applications, Boston: Kluwer Academic Publishers (1994)

- [CSI89] C.S.I.. How to read financial statements, Toronto: The Canadian Securities Institute (CSI) (1989).
- [DENN00] Dennis, R., "Question and Answer on Selling A Business," The Washington Post, February 21, 2000.
- [ETTO97] Ettore, B.. "Too Much of a Bad Thing," Management Review, December 1997.
- [FARR57] Farrell, M.J.. "The Measurement of Productive Efficiency," Journal of the Royal Statistical Society, Series A, (1957), 120(3):253-290.
- [FIRT97] Firth, M., Liao-Tan, C.K.. "Signaling Models and the Valuation of New Issues: an Examination of IPOs in Singapore," Pacific-Basin Finance Journal, (1997), 5(5): 511-526.
- [FISO00] www.fisonline.com
- [FITC88] Fitchett, G.A, "Financing Closely-Held Businesses" Journal of Business Valuation- Proceedings of the 9th Biennial Conference of the CICBV, Toronto, (1988), 11-20.
- [HARB97] Harbert, T.. "Intangibles Count in a Company's Valuation," Electronic Business, November 1997.
- [HEND88] Henderson, A.R., "Key Strategies in Selling a Privately-Held Business," Journal of Business Valuation- Proceedings of the 9th Biennial Conference of the CICBV Toronto, (1988), 39-65.
- [HUNT75] Hunt, P.. "Funds Position: Keystone in Financial Planning," Harvard Business Review, May-June 1975.
- [IBBO94] Ibbotson, R., Sindelar, J.L., Ritter, J.R., "The Market's Problems With The Pricing of IPOs," Journal of Applied Corporate Finance, (1994), 7:66-74.
- [JAIN99] Jain, B.A., Kini, O., "On Investment Banker Monitoring In The New Issues Market," Journal of Banking & Finance, (1999) 23:49-84.
- [JENS76] Jensen, M., Meckling W., "Theory Of The Firm: Managerial Behavior, Agency Costs And Ownership Structure," Journal of Financial Economics, (1976) 3:305-360.
- [KAPL95] Kaplan, S.N., Ruback, R.S., "The valuation of cash flow forecasts: an empirical analysis," Journal of Finance, (1995), 50:1059-1093.

- [KIM95] Kim, J-B., Krinsky, I., Lee, J., "The Role Of Financial Variables In The Pricing Of Korean Initial Public Offerings," *Pacific-Basin Finance Journal*. (1995), 3(4):449-464.
- [KIM98] Kim, I., Hendry, L.C., "Using DEA To Assess NATO Burden-Sharing," *Journal of the Operational Research Society*. (1998). 49:228-236.
- [KIM99] Kim, M., Ritter J.R., "Valuing IPOs," *Journal of Financial Economics*, (1999), 53:409-437.
- [KLEI96] Klein, A., "The Association between the information contained in the prospectus and the price of initial public offerings," *Journal of Financial Statement Analysis*. (1996), 2:23-40.
- [LELA77] Leland, H., Pyle, D., "Informational Asymmetries, Financial Structure And Financial Intermediation," *Journal of Finance*, (1977). 32:371-387.
- [LEVI95] Levis, M., Thomas, D.C., "Investment Trust IPOs: Issuing Behaviour And Price Performance. Evidence From The London Stock Exchange," *Journal of Banking & Finance*, (1995), 19(8): 1437-1458.
- [LITT59] Little, A.J., "Valuation of Goodwill." The Valuation of Private Business and Professional Practice, Toronto: Canadian Institute of Chartered Accountants (1959), 1-6.
- [LJUN97] Ljungqvist, A., "Pricing Initial Public Offerings: Further Evidence From Germany," *European Economic Review*, (1997), 41:1309-1320.
- [LYON89] Lyons, R.P., Wilczynski, M.J., "Discounting Intrinsic Value," *Trusts and Estates*. February (1989), 22-27.
- [ME00] www.me.org
- [MERC97] Mercer, C., Quantifying Marketability Discounts, @city: Peabody Publishing (1997), 345-370.
- [MORR92] Morris, I.T., "Valuation Perspectives of a Venture Capitalist," *Journal of Business Valuation - Proceedings of the 11th Business Valuation Conference*, Quebec City, (1992), 83-90.
- [MULL90] Mullen, M., "What is a Brand Name or Trademark Really Worth - How Can that Value be Measured?" *Journal of Business Valuation- Proceedings of the 2nd Joint Business Valuation Conference of the CICBV and the ASA*, Vancouver, (1990), 203-212.

References

- [NEED86] Needham, J., Young, A., "The Leading Edge In Mergers And Acquisitions." *Mergers & Acquisitions*, November / December 1986.
- [OAND00] www.oanda.com
- [OVEN59] Ovens, G., "Valuing a Privately Owned Business." The Valuation of Private Business and Professional Practice, Toronto: Canadian Institute of Chartered Accountants (CICA) (1959), 11-18.
- [OVEN72] Ovens, G., "Introduction to the Business Valuation Field." Solving the Valuation Problem, Toronto: The CICA (1972). 7-9.
- [PIES95] Piesse, J., Townsend, R., "The Measurement of Productive Efficiency in UK Building Societies." *Applied Financial Economics*, (1995), 5:397-407.
- [PRAT93] Pratt, S., Valuing Small Businesses And Professional Practices, 2nd ed., Homewood: Dow Jones-Irwin (1993).
- [PRAT96] Pratt, S., Valuing A Business: The Analysis and Appraisal of Closely Held Companies, 3rd ed., Homewood: Dow Jones-Irwin (1996).
- [RITT84] Ritter, J.R., "Signaling And The Valuation Of Unseasoned New Issues: A Comment," *Journal of Finance*, (1984), 39:1231-1237.
- [RUBA96] Ruback, S.N., Richard, S., "The Market Pricing Of Cash Flow Forecasts: Discounted Cash Flow vs. The Method Of Comparables." *The Bank of America Journal of Applied Corporate Finance*, (1996) 8(4):45-57.
- [SEDA00] www.sedar.com
- [SEGU97] Seguin, P.J., Smoller, M.M., "Share Price and Mortality: An Empirical Evaluation of Newly Listed NASDAQ Stocks," *Journal of Financial Economics*, (1997), 45:333-363.
- [SIMA00] Simak, P.C., Paradi, J.C., "How To Estimate The Market Value Of A Private Company - A DEA Approach." University of Toronto working paper (1999).
- [STOC00] www.stockwatch.com
- [STOU98] Stoughton, N.M., Zechner, J., "IPO Mechanisms. Monitoring And Ownership Structure," *Journal of Financial Economics*, (1998), 49:45-77.
- [THAN92] Thanassoulis, E., Dyson, R.G., "Estimating Preferred Target Input Output Levels Using Data Envelopment Analysis," *European Journal of Operational Research*, (1992), 56:80-97.

References

- [TSE00] www.tse.com
- [WEAV98] Weaver, W.C., "Discounts And Other Adjustments To Fair Market Value Estimates," Orlando: William C. Weaver (1998), 1-16.
- [WISE90] Wise, R.M., "Discounts in Arriving at Share Values of Closely-Held Corporations" Journal of Business Valuation- Proceedings of the 2nd Joint Business Valuation Conference of the CICBV and the ASA, Vancouver, (1990), 127-148.
- [YAH000] ca.finance.yahoo.com
- [ZHU00] Zhu, J., "Multi-Factor Performance Measure Model With An Application To Fortune 500 Companies." European Journal of Operational Research, (2000) 123:105-124.

BIBLIOGRAPHY:

- [ALI95] Ali, A.I., Lerne, C.S., Seiford, L.M., "Components of Efficiency Evaluation in DEA." *European Journal of Operational Research*, (1995), 80:462-473
- [BERG97] Berger, A.N., Humphrey, D.B., "Efficiency of Financial Institutions: International Survey and Directions for Future Research," *European Journal of Operational Research*, (1997), 98: 175-212
- [BROC97] Brockett, P.L., Charnes, A., Cooper, W.W., Huang, Z.M., Sun, D.B., "Data Transformation in DEA Cone Ratio Envelopment Approaches for Monitoring Bank Performances," *European Journal of Operational Research*, (1997), 98: 250-268.
- [CAMP90] Campbell, I.R., Low, R.B., Murrant, N.V., The Valuation & Pricing of Privately-Held Business Interests, Toronto: Canadian Institute of Chartered Accountants (1990).
- [CHIL95] Chilingirian, J.A., "Evaluating Physician Efficiency in Hospitals: A Multivariate Analysis of Best Practice," *European Journal of Operational Research*, (1995), 80:548-574.
- [COOK90] Cook, W., Roll, Y., Kazakov, A., "A DEA model for Measuring the Relative Efficiency of Highway Maintenance Patrols," *Journal of Information*, (1990), 28(2):113-124.
- [DAUD87] Dauderis, H., Financial Accounting: An intro to decision making, Toronto: Holt, Rinehart and Winston of Canada, Ltd. (1987).
- [DROM98] Droms, W.G., Finance & Accounting for Nonfinancial Managers, all the basics you need to know, 4th ed., Reading: Addison Wesley Longman Inc. (1998).
- [ELMA95] El-Mahgary, S., "Data Envelopment Analysis: Visualizing the Results," *European Journal of Operational Research*, (1995), 85:700-710.
- [ELMA95a] El-Mahgary, S., "Data Envelopment Analysis - A Basic Glossary," *Journal of Operational Research Society*, (1995), 8(4):15-22.
- [MIKK97] Mikkelsen, W.H., Partch, M.M., Shah, K., "Ownership And Operating Performance Of Companies That Go Public," *Journal of Financial Economics*, (1997) 44:281-307.
- [MORC88] Morck, R., Shleifer, A., Vishny, R., "Management Ownership And Market Valuation: An Empirical Analysis," *Journal of Financial Economics*, (1988) 20:293-316.

Bibliography

- [PAPA97] Papagapooou, A., Mingers, J., Thanassoulis, E., "Would You Buy A Used Car With DEA?" *Journal of Operational Research Society*, (1997), 10(1):13-19.
- [PAST97] Pastor, J..M.. Perez, F., Quesada, J., "Efficiency Analysis in Banking Firms: An International Comparison," *European Journal of Operational Research*. (1997), 98: 395-407.
- [TATJ97] Tatje, E.F., Lovell, C.A.K., "The Sources of Productivity Change in Spanish Banking," *European Journal of Operational Research*. (1997), 98: 364-380.
- [TRAC99] Tracy, J.A. How To Read A Financial Report, For Managers, Entrepreneurs, Lenders, Lawyers & Investors, 5th ed., New York: John Wiley & Sons Inc. (1999).

GLOSSARY

Aggregate Efficiency	Another name for the efficiency measure as obtained from the CCR model, also known as efficiency
Appraisal	The act or process of determining the value of something
BCC Model	This model measures technical efficiency as the convexity constraint ensures that the composite unit is of similar scale size as the unit being measured; unlike the CCR model, the BCC allows variable returns to scale
Beta	A measure of the systematic risk of an asset. Compares the price volatility of a particular issue to the movement of the market in general. If the difference is great, security has a high beta; if low, has a low beta.
Binomial Model	A model where the price of an asset is monitored over successive short periods of time. In each short period it is assumed that only two price movements are possible
Binomial Tree	A tree that represents how an asset price can evolve under the binomial model
Black-Scholes Model	A model for pricing European options on stocks, developed by Fischer Black, Myron Scholes, and Robert Merton
BPS	Book value per share
Business Enterprise	An organization pursuing an economic activity on a 'for profit' basis
Business Valuation	The act of determining the value of, or the estimated value of, a business enterprise, or an interest therein
Call Option	A financial instrument that gives the owner the option to buy an asset at a certain price by a certain date
Capitalization Rate	The required rate of return that is used to convert income/cash flow into value. The inverse of the cap. Rate is referred to as the multiple or multiplier.
CAPM	The capital asset pricing model is a model relating the expected return on an asset to its beta.

Glossary

CCR Model	The CCR ratio model calculates an overall efficiency for the unit in which both its pure technical efficiency and scale efficiency are aggregated into a single value. The obtained efficiency is never absolute as it is always measured relative to the field
Closely-Held Corporation	A term used to describe a corporation whose shares are neither listed for trading on a recognized stock exchange nor traded in an over-the-counter market. Technically it has less than 51 shareholders (Canada).
Comparable Firms	Public companies that are similar in nature to private companies or other companies.
Constant Returns to Scale (CRS)	A unit operates under constant returns to scale if an increase in inputs results in a proportionate increase in the output levels. If the inputs values for a unit are all doubled, then the unit must produce twice as much outputs
DEA	Data Envelopment Analysis is a decision making tool based on linear programming for measuring the relative efficiencies of a set of comparable units
Depreciation	The systematic assignment of the cost of tangible assets to expense
Discount Rate	The annualized dollar return on a treasury bill or similar instrument expressed as a percentage of the final face value. Or, a rate of return used to convert a monetary sum, payable or receivable in the future, into present value
Discounted Cash Flow	An accounting technique for estimating the present value of anticipated future income and expenditures, such as earnings from loan principal and interest payments, and income from investment securities. It is calculated as either net present value, which expresses future cash flows in terms of current money by applying a discount rate to future receipts, or internal rate of return, which figures the average annual yield or return on capital of an investment or a bank loan over its expected lifetime
Dividend	A cash payment made to the owner of a stock
DMU	Decision Making Unit. This term emphasizes the fact that the focus was not on profit generating enterprises, but rather on decision making entities
DRS	Decreasing returns to scale
EBIT	Earnings Before Interest and Tax
EBITDA	Earnings Before Interest, Tax, Depreciation, and Amortization

Glossary

Economies of Scale	The decreases in combined operating expenses and/or increases in combined revenues, which result following the merging of two or more business operations. They are created by factors such as the elimination of duplicate overhead costs, the acquisition of a secured source of supply or enhanced combined purchasing power, more effective utilization of operating facilities, and so on.
Efficiency	A general term often associated with performing activities as well as possible.
Efficient Frontier	A frontier or surface determined from the best-observed or best practice DMUs.
Enterprise Value	The market value of equity plus its book value of cash minus cash.
Envelopment Surface	Please see Efficient Frontier
EPS	Earnings per share
Exogeneously Fixed Factor	An input or output that is beyond the control of the DMU manager
Fair market value	The highest price available in an open and unrestricted market between informed and prudent parties, acting at arm's length and under no compulsion to act, expressed in terms of cash.
Financial Ratio	Usually a ratio of financial information, aiming to capture a single dimension of corporate performance
Financial Risk	The portion of overall business risk associated with the financial structure of a business
Forced Liquidation	The sale of the assets where an immediate cessation of the business and disposition of assets is assumed on an 'as is/where is' basis. The forced liquidation of assets at auction.
Going Concern	A business enterprise that is both conducting operations at a given date, and has every reasonable expectation of doing so for the foreseeable future after that date. An accounting term used to indicate that a company is operating normally.
Going Concern Value	The present value of all future benefits expected to accrue from ownership, where a business operation is expected to continue to operate either for a finite period, or indefinitely into the future

Glossary

Goodwill	The difference between going concern value and the sum of the net tangible assets and identifiable intangible assets
Homogeneity	Degree of similarity between the units in the field
Input-oriented Model	Indicates that an inefficient unit is made efficient through the proportional reduction of its inputs while its output proportions are held constant. The CCR model yields the same efficiency regardless of whether it is input or output-oriented. this is not the case with the BCC model
Intrinsic Value	A notional market value, based upon rates of return required by investors given economic and business conditions existing at the valuation date. without consideration of possible synergistic benefits that might accrue in differing degrees to arm's length purchasers
IPO	Initial public offering
IRS	Increasing returns to scale
Lambda Values	Results from a DEA analysis that indicate the level of contribution of efficient firms to the virtual DMU created by the projection of an efficient of an inefficient DMU onto the frontier
Liquidation	The process of converting assets into cash.
Liquidation Value	The net amount of money, if any, available to equity owners following a voluntary liquidation, a reorganization of a business pursuant either to a proposal to creditors, or a liquidation of a business pursuant to a receivership or other proceeding under The Bankruptcy Act.
Liquidity	The relative ease of converting non-cash assets into cash.
Market Capitalization	The total value of a company, derived by the price of a share multiplied by the number of shares the company has outstanding
Market to Book Value (M/B)	Ratio of the market value of a security to its book value. An indication of performance of common stock equity, after accounting for such factors as dilution of stock value after a merger and market reaction to unexpected gains or losses and changes in operating income
Marketability Discount	An amount deducted from what would otherwise be the value of a shareholding in a company to reflect illiquidity, or lack of marketability
Minority Discount	The reduction from the pro rata portion of the en bloc value of the assets or ownership interests of a business as a whole to reflect the disadvantages of owning a non-controlling interest

Glossary

Multipliers	Please refer to definition for Weights
Net Book Value	With respect to a business enterprise, the difference between total assets (net of depreciation, depletion, and amortization), and total liabilities of an enterprise as they appear on the balance sheet. The term is synonymous with each of the term's book value, net worth and shareholders' equity.
Nominal Rate of Return	A discount rate, or capitalization rate, that includes both an inflation component and a real rate of return.
Notional Market	A term used to describe circumstances where it is necessary to determine fair market value, fair value, or some other value in the absence of open market negotiations
Open Market	A term used to describe the market in which arm's length, negotiated transactions take place.
Output-oriented Model	An inefficient unit is made efficient through the proportional increase of its outputs, while the inputs proportions remain unchanged
Over-the-counter Market	The trading of securities or commodities not listed on an established stock exchange
Peer Group	The set of efficient DMUs against which inefficient units are compared. The efficient targets are a linear combination of these peers.
Piecewise Linearity	An efficient frontier is piecewise linear when the underlying production function is approximated through interconnected linear segments
Price	The consideration paid in a negotiated open market transaction involving the purchase and sale of an asset
Price to Earnings Ratio (P/E)	The relationship between the current price of a stock to the earnings over any earnings period. The P/E is calculated by dividing the current stock price by the earnings per share or dividing the market value by earnings per share for the most recent 12-month period. It is used by investors to gauge the market demand for stocks. Companies with a high P/E have greater earnings potential than low P/E stocks, but also are more volatile and somewhat riskier
Privately-Held Business Interest	An en bloc, control, or minority shareholding in a private company, or all of part of the business of a private company represented by its net operating assets or all or one or more partnership interests in a partnership or a proprietorship

Glossary

Privately-Held Company	A business that is incorporated, has less than 51 shareholders (Canada), and does not offer its shares to the public
Public Company	A company whose equity shares and/or issued debt are traded on an established stock exchange or in an over-the-counter market.
Put Option	An option to sell an asset for a certain price by a certain date
Rate of Return	An amount of income realized or expected on an investment, expressed as a percentage of that investment
Real Rate of Return	A discount rate, or cap. Rate. that excludes consideration of inflation, as contrasted with a nominal rate of return
Research Boutique	Company that specializes in finding comparable companies
Risk Free Rate of Return	The prevailing rate of return on money market investments such as long term government bonds, conventional first mortgages, and high quality long term corporate bonds. These are investments which are generally free from substantial credit risk, are priced to reflect a relatively long term holding period, and hence, aside from inflation related purchasing power risk, put the investor at relatively little risk. These securities typically are fixed in income as well as in principal and, hence, generally do not offer any potential for capital growth.
RTS	Returns to scale
Rules of Thumb	Commonly used criteria within a specific industry to gauge an element of business value
Scale Efficiency	A unit is said to be scale efficient when its size of operations is optimal so that any modifications on its size will render the unit less efficient; value obtained by dividing the aggregate efficiency by the technical efficiency
Shareholders' Equity	The aggregation of a company's paid-in capital, retained earnings, contributed, appraisal and other surpluses.
Slack Variable	Result form a DEA analysis and indicates the level of input minimization or output augmentation that is required for the inefficient firm to reach the envelopment surface following the proportional change indicated by the efficiency score
Technical Efficiency	An efficiency measure that ignores the impact of scale-size by comparing a DMU only to other units of similar scale, computed using the BCC model

Glossary

Threshold Rate of Return	A benchmark, point in time related, predetermined rate of return on equity criteria that is applied to a projected after tax cash flow that includes both inflation and real growth, where leverage and related interest bearing debt considerations are excluded, and where purchaser perceived net economic value-added is taken into account
Treasury Bill	A short-term non-coupon bearing instrument issued by the government to finance its debt
Valuation	The act or process of determining the value of something
Valuation Day (V-Day)	The date proclaimed in the Income Tax Act (Canada) on which capital gains taxation in Canada came into effect. With respect to privately held business interests, this date is December 31, 1971.
Value	A return or equivalent in goods, services, or money for something exchanged
Variable	An input or output included in a DEA model
Variable Returns to Scale (VRS)	Can be increasing, decreasing, or constant. A proportionate increase in inputs can result in the non-proportionate increase in outputs
Warrant	An option issued by a company or a financial institution. Call warrants are frequently issued by companies on their own stock
Weighted Average Cost of Capital (WACC)	A discount rate that is applied to a projected after tax (generally discretionary) cash flow that includes both inflation and 'real' growth. It is determined by the appropriate capital structure (i.e. interest bearing debt/equity structure) for a given business. It weighs the cost of said appropriate indebtedness and the cost of equity capital, where the cost of equity capital is taken to be equal to the threshold rate of return. It assumes an ability to deduct interest expense when calculating taxable income.
Weights	Results from a DEA analysis and indicates the level of contribution each variable has in the determination of the DMU's efficiency score.
Working Capital	The amount by which current assets exceeds current liabilities

LIST OF ABBREVIATIONS

BPS	Book Value Per Share
Capex	Capital Expenditure
CAPM	Capital Asset Pricing Model
CDNX	Canadian Venture Exchange
CF	Comparable Firm
CFI	Cash Flow
CFO	Cash Flow from Operations
CICA	Canadian Institute of Chartered Accountants
CICBV	Canadian Institute of Chartered Business Valuers
CRS	Constant Returns to Scale
CSI	Canadian Securities Institute
DCF	Discounted Cash Flow
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
DRS	Decreasing Returns to Scale
EBITDA	Earnings Before Interest, Tax, Depreciation, and Amortization
EPS	Earnings Per Share
ESOP	Employee Stock Ownership Plan
EV	Enterprise Value
FCF	Free Cash Flow
GAAP	Generally Accepted Accounting Principles
IPO	Initial Public Offering

List of Abbreviations

IRS	Increasing Returns to Scale
M&A	Mergers and Acquisitions
M/B	Market to Book
MC	Market Capitalization
NI	Net Income
NS	Net Sales
NWC	Net Working Capital
OP	Offer Price
P/E	Price to Earnings
PER	Price Earnings Multiple
POP	Preliminary Offer Price
PPA	Pure Play Approach
RA	Redundant Assets
RFR	Risk Free Rate
SE	Shareholders' Equity
SEC	Securities Exchange Commission
SIC	Standard Industrial Classification
TA	Total Assets
TL	Total Liabilities
TSE	Toronto Stock Exchange
VRS	Variable Returns to Scale
WACC	Weighted Average Cost of Capital

APPENDIX A

Public Companies DATA 1998
SIC 2000-3999

			Market	TOTAL	TOTAL	SHAREHOLDERS	NET	NET SALES	CASH
	COMPANY	PRINCIPAL	Capitalization	ASSETS	LIABILITIES	EQUITY	INCOME	/REVENUE	FLows
	NAME	SIC			(in thousands)				
1	A. L. VAN HOUTTE LTD	2095	632,441	206,480	40,532	165,948	13,952	207,067	30,512
2	A.E. VENTURES LTD	3714	627	1,779	1,181	598	-283	1,995	11
3	AASTRA TECHNOLOGIES	3661	46,091	14,014	6,827	7,187	1,343	37,173	1,957
4	ABITIBI-CONSOLIDATED	2621	2,609,850	6,835,000	3,829,000	3,006,000	-31,000	3,657,000	316,000
5	ABL CANADA INC	3661	13,382	14,690	11,174	3,516	-3,992	16,712	-3,254
6	ACETEX CORPORATION	2869	84,226	441,481	397,653.94	43,827	-31,954	344,449	1,026
7	ADVANTEDGE INTELLIGENCE	3663	19,928	14,666	12,391	2,275	-4,137	2,809	-2,640
8	AFRICAN GEMSTONE	2066	683	2,649	755	1,895	-1,372	237	-906
9	AGRIUM INC	2873	1,541,000	2,796,692	1,686,308	1,110,383	185,832	2,772,119	319,446
10	AGRO PACIFIC INDUSTRIES	2048	10,874	40,980	26,882	14,098	-704	97,128	1,383
11	AIMGLOBAL TECHNOLOGIES	3829	155,617	87,112	10,887	76,225	4,625	78,478	7,621
12	AINSWORTH LUMBER	2411	44,467	434,862	357,966	76,896	-9,479	349,056	24,354
13	ALCAN ALUMINIUM	3353	9,435,500	15,205,956	6,729,876	8,476,080	612,784	11,962,346	1,297,751
14	ALGO GROUP INC	2329	9,266	84,550	63,220	21,330	-15,700	196,136	-3,467
15	ALGOMA STEEL INC	3312	108,383	1,521,000	1,185,000	336,000	-59,000	1,272,000	74,000
16	ALLIANCE FOREST PRODUCTS	2611	563,100	1,771,800	814,000	957,800	25,900	1,085,100	138,200
17	ALPHA COMMUNICATIONS	2731	3,019	1,238	886	352	-308	1,927	-227
18	ALTA NATURAL HEALTH	2833	6,577	1,956	613	1,343	-110	3,123	107
19	ALTAREX CORP	2834	7,100	15,160	2,513	12,647	-13,116	50	-12,736
20	ALTERRA RESOURCES	3841	340	2,146	1,945	201	-667	0	-618
21	AMR TECHNOLOGIES	2819	76,024	75,913	33,760	42,153	596	49,655	3,609
22	AMT FINE FOODS LTD	2013	11,173	1,592	696	896	164	6,188	251
23	ANDRES WINES LTD	2084	79,826	126,085	72,581	53,504	6,732	118,668	11,078
24	ANGIOTECH PHARMACEUTICALS	2834	140,743	27,508	767	26,741	-6,731	2,277	-6,325
25	AQUA 1 BEVERAGE	2086	2,879	210	97	113	-501	387	-485
26	AQUA-PURE VENTURES	2899	6,895	1,655	42	1,613	-316	14	-307
27	AQUARIUS COATINGS	3479	2,115	2,091	5,613	-3,522	-2,395	4,374	-1,868
28	ARCTIC GROUP INC	2097	38,002	36,157	17,425	18,732	-1,016	9,574	-367
29	ARROWHEAD WATER	2086	962	2,542	1,144	1,398	118	2,060	342
30	ASIA PACIFIC CONCRETE	3273	1,888	2,743	246	2,497	-803	769	-84
31	ASTAWARE TECHNOLOGIES	2741	3,178	1,385	214	1,171	-1,881	469	-1,651
32	AT PLASTICS INC	2821	153,632	505,621	317,913	187,708	10,768	229,976	27,984
33	ATS AUTOMATION TECHNOLOGIES	3569	995,530	423,519	155,313	268,206	27,362	402,920	50,659
34	AVANTE TECHNOLOGIES	3634	2,302	1,115	592	523	-625	777	-563
35	AVCORP INDUSTRIES	3728	45,730	86,856	51,803	35,053	2,810	66,903	5,032
36	AVVA TECHNOLOGIES	3646	2,429	716	476	240	-374	1,875	-311
37	AXCAN PHARMA INC	2834	165,498	88,823	18,819	70,004	1,540	43,404	2,240
38	B.C. REPORT MAGAZINE	2721	284	235	2,053	-1,818	1,885	2,498	-100
39	BALLARD POWER SYSTEMS	3691	3,608,271	690,348	62,656	627,692	765	25,078	-18,826
40	BANFF BREWERY CO	2082	1,378	937	332	605	-432	179	-372
41	BCS TECHNOLOGY INC	3661	1,027	996	914	82	-1,211	2,176	-913
42	BELL CANADA INTELLIGENCE	3661	1,371,120	2,923,589	2,385,264	538,325	-65,611	771,506	-71,291
43	BESTAR INC	2511	23,108	35,495	26,096	9,399	5,432	69,155	6,808
44	BESTAR INTERNATIONAL	2836	1,488	10,769	3,532	7,237	-697	6,280	-157
45	BETA BRANDS INC	2064	47,999	63,737	59,541	4,196	-3,460	63,870	-116
46	BIG ROCK BREWERY	2082	19,445	31,993	14,262	17,731	289	25,185	2,384
47	BIOCHEM PHARMACEUTICALS	2835	4,708,260	629,990	151,369	478,621	114,774	335,221	129,087
48	BIOTECH HOLDINGS	2834	22,801	7,987	3,778	4,209	-3,014	1,356	-1,723
49	BIOVAIL CORPORATION	2834	1,404,647	307,036	228,416	78,619	69,755	173,294	77,367
50	BIT INTEGRATION TECHNOLOGIES	3577	5,486	10,771	8,254	2,517	-5,143	2,955	-1,319

51	BLUESTAR BATTER	3692	44,404	133,332	83,377	49,955	-8,816	135,366	-3,628
52	BOLIDEN LIMITED	3339	401,312	2,831,270	1,828,276	1,002,994	-116,239	1,618,176	4,199
53	BOMBARDIER INC	3743	7,502,049	10,575,200	7,685,900	2,889,300	420,200	8,508,900	919,700
54	BORDER CHEMICAL	2819	3,725	10,174	1,515	8,659	352	14,387	790
55	BP AMOCO P.L.C	2911	619,712,000	129,775,100	65,600,161	64,174,939	5,006,708	128,595,606	14,722,179
56	BRAMPTON BRICK L	3251	33,466	64,523	20,389	44,134	7,042	34,949	10,335
57	BRICK BREWING CO	2082	15,421	19,835	7,775	12,060	694	19,923	1,570
58	BUDD CANADA INC	3714	116,772	121,603	40,977	80,626	7,359	349,036	13,728
59	BUHLER INDUSTRIE	3523	66,665	61,139	16,349	44,790	7,113	89,194	11,194
60	CAE INC	3812	917,070	928,179	651,726	276,453	70,236	922,369	87,541
61	CALIAN TECHNOLO	3663	33,191	45,533	22,936	22,597	1,408	79,928	3,007
62	CAMCO INC	3631	100,000	192,375	117,134	75,241	8,979	565,305	24,119
63	CANADA BREAD CO	2051	449,753	338,272	107,736	230,536	2,896	508,445	28,883
64	CANADIAN BANK N	2796	46,898	97,932	30,659	67,273	1,332	100,589	8,503
65	CANADIAN MANOIR	3433	3,511	11,815	9,474	2,341	370	10,155	581
66	CANADIAN MARCON	3663	426,808	495,928	113,940	381,988	28,003	291,544	39,501
67	CANAM MANAC GRO	3441	177,740	645,753	445,882	199,871	26,066	1,000,700	52,013
68	CANFIBRE GROUP L	2631	91,809	362,265	331,515	30,749	-6,334	284	-3,564
69	CANFOR CORPORAT	2421	274,251	1,864,295	1,438,247	426,048	-203,731	1,632,273	21,928
70	CANGENE CORPORA	2836	221,802	45,784	15,601	30,183	11,000	28,300	10,159
71	CANHORN CHEMICA	2869	1,792	6,382	4,858	1,524	-2,701	4,155	-1,827
72	CANTOL LIMITED	2842	2,108	6,508	1,683	4,825	-46	8,490	85
73	CARBITE GOLF INC	3949	9,240	12,271	1,034	11,237	367	24,054	1,424
74	CARDIOCOMM SOLU	3841	2,065	279	67	212	-2,515	78	-2,401
75	CASCADES INC	2611	595,430	2,485,000	1,867,000	618,000	45,000	2,527,000	185,000
76	CCL INDUSTRIES INC	2844	698,733	1,428,531	857,114	571,417	44,394	1,469,195	132,418
77	CD ROM NETWORK	2731	471	296	109	186	-206	289	-110
78	CEAPRO INC	2844	10,546	479	1,567	-1,088	-14,260	400	-1,654
79	CELESTICA INC	3674	2,854,867	2,513,222	1,193,561	1,319,661	-74,442	4,990,121	130,326
80	CELL-LOC INC	3663	28,669	2,413	142	2,271	-1,441	308	-1,403
81	CERAMIC PROTECTI	3259	2,765	7,110	2,898	4,212	-191	3,835	281
82	CFE INDUSTRIES INC	3999	7,887	3,053	3,186	-133	-518	0	-79
83	CHATEAU STORES C	2331	45,927	65,007	22,465	42,542	5,368	150,241	10,106
84	CHEMBOND LIMITE	2891	2,917	9,898	8,792	1,106	-150	15,001	-150
85	CIE-NERGY PLY-FO	3086	918	542	528	14	-873	2,066	-436
86	CIMATEC ENVIRONN	3564	4,040	1,910	283	1,627	148	1,493	232
87	CINRAM INTERNATI	3652	1,075,691	856,774	423,711	433,063	42,303	642,714	111,912
88	CIRCA ENTERPRISES	3661	6,601	11,660	5,113	6,547	1,031	21,464	1,472
89	CIRCUIT WORLD CO	3672	289	14,292	8,962	5,330	1,561	22,001	1,942
90	CLEARLY CANADIA	2086	5,135	65,775	15,267	50,508	476	61,320	3,841
91	C-MAC INDUSTRIES	3679	291,127	607,831	347,514	260,317	25,418	642,983	47,363
92	CME TELEMETRIX II	3841	27,749	5,024	1,295	3,729	-4,139	1,250	-3,826
93	CML INDUSTRIES LT	2621	7,109	19,702	12,224	7,478	21	33,152	2,159
94	COM DEV INTERNAT	3663	252,315	205,496	56,673	148,823	-18,439	175,298	-1,511
95	COMMUNICATION S	3663	3,855	4,635	1,110	3,525	424	8,350	717
96	COMPRESSION & EN	3695	717	763	753	10	-1,288	791	-278
97	CONCERT INDUSTRI	2621	48,917	57,951	35,977	21,974	1,461	12,672	2,271
98	CONSOLIDATED ECO	2844	936	636	708	-71	-538	36	-460
99	CONSOLIDATED EN	2875	5,178	22,317	14,193	8,124	-2,984	24,780	1,974
100	CONSUMERS PACKA	3221	204,373	1,631,982	1,447,727	184,255	-47,985	1,368,150	97,730
101	CORECO INC	3674	44,923	28,618	3,830	24,788	2,778	14,349	4,379
102	COREL CORPORATIO	3575	362,816	214,724	170,934	43,789	-46,646	378,139	-2,781
103	COSGROVE-MOORE	2789	3,375	6,377	3,927	2,450	291	9,403	765

104	CO-STEEL INC	3312	385,413	1,705,264	1,032,327	672,937	-80,745	1,511,432	107,310
105	COTT CORPORATION	2086	330,647	1,829,043	1,333,121	495,922	-11,198	2,152,266	67,969
106	CPI PLASTICS GROU	3089	60,851	31,709	21,973	9,736	2,726	46,501	4,160
107	CRS ROBOTICS COR	3569	3,765	9,222	5,636	3,586	1,952	13,507	865
108	CSI CREDIT SYSTEM	3577	7,616	1,732	672	1,060	-513	2,214	-319
109	CV TECHNOLOGIES	2835	12,657	3,608	1,094	2,514	-849	2,585	-791
110	CYGNAL TECHNOLC	3663	8,637	27,797	14,563	13,234	-824	24,553	717
111	DANBEL INDUSTRIE	3645	5,798	12,460	9,024	3,436	1,048	24,099	1,322
112	DATAMARK SYSTEM	2761	35,889	45,511	18,897	26,614	3,049	82,783	4,685
113	DBA TELECOM COR	3661	1,956	2,369	1,468	901	-722	4,336	-2,461
114	DECOMA INTERNAT	3714	560,656	681,894	427,116	254,778	29,307	656,175	73,649
115	DELICIOUS ALTERN	2024	17,246	14,581	8,115	6,466	-2,956	3,891	-2,664
116	DEVTEK CORPORAT	3714	99,709	279,474	178,330	101,144	7,810	425,728	24,756
117	DIAGNOCURE INC	2835	13,124	13,304	5,159	8,145	-6,052	664	-5,460
118	DIGITAL PROCESSIN	3651	28,123	39,615	10,309	29,306	-1,487	42,464	-382
119	DIMENSIONS WEST	3663	1,970	7,806	7,011	-795	-1,637	2	-229
120	DIVERSIFIED INVE	2899	13,328	5,076	1,260	3,816	1,338	3,105	1,566
121	DIVERSITY CORPOR	2899	1,096	1,143	470	673	-3,167	983	-484
122	DOFASCO INC	3312	1,603,890	3,377,100	1,548,600	1,828,500	175,700	2,982,200	416,100
123	DOMAN INDUSTRIES	2411	123,195	1,528,587	1,239,034	289,553	-74,752	779,241	-30,297
124	DOMCO TARKETT IN	3996	207,110	329,101	113,908	215,193	14,725	350,798	34,170
125	DOMTAR INC	2611	1,568,323	4,030,000	2,342,000	1,688,000	74,000	2,348,000	258,000
126	DONOHUE INC	2421	2,604,005	3,456,865	2,068,543	1,388,322	229,249	2,295,805	450,728
127	DOREL INDUSTRIES	2512	682,294	460,790	237,208	223,582	26,985	766,607	47,477
128	DOVER INDUSTRIES	2041	53,129	74,312	19,766	54,546	4,270	132,987	8,011
129	DUPONT CANADA IN	2819	4,081,770	1,831,645	621,977	1,209,668	298,772	2,025,072	282,480
130	DYNAMIC DIGITAL	3663	110,354	9,433	782	8,651	-2,062	368	-1,750
131	EAGLE PRECISION T	3542	57,395	80,655	43,411	37,244	4,364	136,618	7,508
132	EI ENVIRONMENTAL	3585	592	996	635	361	189	3,766	236
133	EIGER TECHNOLOGY	3661	8,289	9,221	6,157	3,064	84	22,734	360
134	ELECTROHOME LIM	3679	11,398	68,916	39,775	29,141	5,116	97,873	-4,342
135	ENERCHEM INTERN	2911	19,094	16,867	9,638	7,229	1,817	16,447	3,208
136	ENERFLEX SYSTEMS	3563	420,532	159,506	59,450	100,056	22,568	314,496	26,042
137	ENERSHARE TECHN	3823	9,416	9,051	7,870	1,181	93	3,330	161
138	EPIC DATA INTERNA	3571	149,403	64,302	14,012	50,290	6,512	53,174	8,627
139	EUROPEAN TECHNO	3596	6,067	5,085	587	4,498	-1,096	928	-337
140	EVEREST MINES AN	2092	302	1,570	163	1,406	-1,559	0	-527
141	EXCO TECHNOLOGII	3544	138,406	125,405	47,763	77,642	11,115	118,045	21,238
142	EXI TECHNOLOGIES	3669	9,422	4,907	1,615	3,292	99	3,027	311
143	EYELOGIC SYSTEMS	3841	1,059	1,888	883	1,005	51	958	220
144	FANTOM TECHNOLC	3589	137,839	83,206	38,193	45,013	10,318	177,585	13,185
145	FAR WEST INDUSTRI	2329	3,692	9,080	4,407	4,674	147	11,789	412
146	FIFTY-PLUS.NET INT	3663	2,404	35	52	-17	-18	151	-17
147	FLETCHER CHALLENGE	2611	2,111,217	2,530,700	355,000	2,175,700	298,600	284,100	-105,000
148	FLETCHER'S FINE FC	2013	5,936	147,365	64,204	83,161	3,656	394,015	11,377
149	FLOTEK INDUSTRIES	3533	4,750	3,658	2,608	1,050	-3,457	4,522	-1,762
150	FOREMOST INDUSTE	3533	20,332	51,999	20,732	31,267	-4,597	44,948	-4,371
151	FOSTER'S BREWING	2082	556,622	4,419,800	1,900,900	2,518,900	446,600	4,970,900	323,800
152	FOUNTAIN HOUSE H	3585	1,799	500	77	423	-300	0	-259
153	FYTOKEM PRODUCT	2833	2,996	399	149	250	-746	97	-727
154	G.T.C. TRANSCONTI	2759	559,473	1,153,587	728,641	424,946	42,104	1,336,756	127,333
155	GARNEAU INC	3499	19,557	29,250	6,044	23,206	2,012	22,477	3,163
156	GEAC COMPUTER CO	3575	2,425,988	702,572	424,815	277,757	168,685	641,731	223,762

157	GEMSTAR COMMUN	3663	4,888	470	414	56	-469	11	-462
158	GENERAL MOTORS	3711	86,392,582	395,298,026	372,285,599	23,012,427	4,539,825	236,540,844	18,968,666
159	GENNUM CORPORA	3674	576,578	82,972	24,310	58,662	16,177	83,497	19,735
160	GENOMICS ONE CO	2835	20,562	771	151	620	-237	1	-222
161	GENSCI REGENERA	3842	67,127	39,695	12,150	27,545	-10,772	16,304	-7,360
162	GILDAN ACTIVEWEA	2329	116,913	165,678	112,348	53,330	13,168	215,428	18,826
163	GLENDALE INTERNA	3716	47,948	109,606	85,247	24,359	3,773	155,141	5,967
164	GLOBAL COMMERC	2038	14,410	4,204	2,340	1,864	-130	1,736	20
165	GLOBAL THERMOEL	3629	13,222	11,804	4,892	6,912	2,115	16,273	2,806
166	GOODFELLOW INC	2421	35,136	114,590	70,322	44,268	6,364	335,696	5,284
167	GROUPE BOCENOR I	3442	27,022	28,241	18,960	9,281	3,122	68,803	3,251
168	GROUPE LAPERRIER	3569	31,218	100,557	57,961	42,596	3,653	156,206	7,403
169	GSI LUMONICS INC	3699	129,626	245,344	59,720	185,624	-12,260	221,450	-5,159
170	GST TELECOMMUNI	3357	241,954	1,151,283	1,223,029	-71,746	-154,690	163,317	-18,978
171	H. PAULIN & CO., LI	3452	23,100	52,152	29,003	23,149	2,970	96,068	4,305
172	HAEMACURE CORPO	2834	55,116	29,968	16,157	13,811	-13,656	318	-12,289
173	HALEY INDUSTRIES	3365	44,829	64,645	40,234	24,411	3,714	75,851	7,992
174	HALLMARK TECHN	3544	21,547	65,289	32,369	32,920	2,504	43,810	4,226
175	HAMMOND MANUFA	3612	18,426	86,384	53,121	33,263	3,591	166,315	7,496
176	HANKIN ATLAS IND	3589	3,315	9,237	7,882	1,356	199	11,115	986
177	HEDLEY TECHNOLO	2879	936	1,581	477	1,104	-1,108	701	-941
178	HEROUX INC	3728	62,462	110,753	60,627	50,126	3,047	120,370	10,198
179	HIGHWOOD DISTILL	2085	2,373	2,948	1,437	1,511	144	3,708	164
180	HIGHWOOD RESOUR	3295	13,017	25,035	6,232	18,803	-5,498	13,870	1,852
181	HILLESTAD PHARMA	2834	1,294	2,116	2,017	99	-60	2,809	-20
182	HOLLINGER CANAD	2711	1,218,657	2,862,252	1,780,534	1,081,718	85,506	1,569,297	234,701
183	HUSKY INJECTION M	3089	1,423,935	870,049	539,475	330,574	69,258	1,148,720	99,757
184	I.S.G. TECHNOLOGIE	3841	63,025	46,307	10,804	35,503	498	36,055	2,770
185	IBEX TECHNOLOGIE	2835	10,029	25,063	3,851	21,212	-14,075	387	-13,713
186	IDS INTELLIGENT DI	3829	45,265	60,385	6,255	54,130	-1,280	21,984	701
187	IMARK CORPORATIO	2731	7,524	11,372	2,128	9,244	-238	4,499	399
188	IMAX CORPORATION	3861	1,314,736	770,176	628,545	141,631	-375	300,542	98,652
189	IMI INTERNATIONAL	2835	11,881	1,768	121	1,647	-784	193	-728
190	IMPERIAL PLASTECH	3084	9,283	6,839	4,088	2,751	595	12,332	1,044
191	INCO LIMITED	3339	151,308	11,275,844	4,582,827	6,693,016	-116,721	2,712,223	39,931
192	INEX PHARMACEUT	2834	18,596	24,363	2,162	22,201	-13,470	851	-11,947
193	INTEPAC INC	3089	4,916	973	491	482	546	550	-344
194	INTERGOLD LTD	3911	23,762	4,422	2,802	1,620	-376	8,663	134
195	INTERNATIONAL BU	3571	240,429,832	132,232,380	102,387,179	29,845,201	9,718,542	125,424,179	15,508,508
196	INTERNATIONAL CC	3585	440,175	657,015	509,118	147,898	54,060	1,126,509	76,483
197	INTERNATIONAL DA	3663	3,893	3,043	3,494	-450	7,556	4,599	-3,277
198	INTERNATIONAL FO	2421	119,643	550,098	268,594	281,504	-58,747	597,094	-17,498
199	INTERNATIONAL HI	2439	41,177	19,900	5,408	14,492	-1,454	3,319	-665
200	INTERNATIONAL RC	3829	12,350	17,807	11,066	6,741	-3,072	20,495	109
201	INTERNATIONAL UT	3449	43,555	241,336	238,327	3,009	-13,364	158,965	-2,843
202	INTERNATIONAL WA	2621	21,998	75,952	120,151	-44,199	-153,626	139,127	1,329
203	INTERNATIONAL WA	3589	4,698	646	670	-24	-298	1,646	-275
204	INTERTAPE POLYME	2295	982,579	952,204	654,906	297,298	44,003	578,575	88,648
205	INTRACOASTAL SYS	3823	4,030	799	879	-80	-1,105	129	-1,032
206	INVENTRONICS LIM	3444	6,838	11,551	5,549	6,002	-217	17,254	385
207	INVERPOWER CONT	3625	7,179	18,796	11,548	7,248	-16,238	24,016	-4,096
208	INVESPRINT CORPO	2752	39,825	86,229	56,610	29,619	-1,504	74,269	4,453
209	IPEC LTD	3533	26,958	32,605	20,128	12,477	2,092	58,017	4,536

210	IPL INC	3081	80,755	95,087	40,721	54,366	7,034	113,775	15,050
211	IPSCO INC	3317	1,098,993	1,936,237	723,248	1,212,989	113,241	1,099,320	144,040
212	IRWIN TOY LIMITED	3944	14,586	70,913	47,929	22,984	-1,015	103,658	1,558
213	IVACO INC	3312	122,952	1,312,530	906,244	406,286	-17,988	1,194,563	46,311
214	IVI CHECKMATE CO	3578	143,572	127,209	42,714	84,495	-7,634	164,518	1,124
215	JANNOCK LIMITED	3251	503,302	1,015,800	506,900	508,900	44,900	1,405,300	99,000
216	JEMTEC INC	3669	330	1,023	579	444	-246	640	284
217	KAFUS INDUSTRIES	2493	144,464	554,206	525,999	28,207	-18,282	577	-17,646
218	KASTEN CHASE APP	3663	23,569	24,457	2,942	21,515	-5,311	23,306	-3,382
219	KELMAN TECHNOLOG	2911	15,111	26,578	10,550	16,028	-1,071	17,668	3,697
220	KING PRODUCTS INC	3661	7,739	7,309	12,801	-5,492	-5,441	11,018	-4,961
221	KRYSTAL BOND INC	2891	1,398	8,099	2,463	5,636	-5,108	3,070	-2,556
222	LABOPHARM INC	2834	44,269	20,896	2,974	17,922	-6,027	1,301	-4,039
223	LAFARGE CORPORA	3241	4,330,770	4,461,187	2,287,763	2,173,424	361,681	3,759,953	614,467
224	LAMBUS ENTERPRIS	3679	1,729	634	243	391	-473	88	-179
225	LANDOVER ENERGY	2869	2,846	316	6	310	-152	7	-47
226	LASSONDE INDUSTR	2034	17,825	137,251	66,296	70,955	5,877	182,434	18,555
227	LBL SKYSYSTEMS C	3231	7,113	24,018	17,627	6,391	304	40,142	951
228	LE PRINT EXPRESS I	2759	8,776	4,799	1,423	3,376	-4,108	4,742	-3,640
229	LEADER INDUSTRIES	3851	13,556	14,625	10,629	3,996	1,417	22,106	2,822
230	LEADING BRANDS, I	2086	8,570	27,899	20,858	7,041	-7,722	35,667	-1,239
231	LEF MCLEAN BROTH	2092	3,381	17,037	8,881	8,156	604	31,232	1,570
232	LEITCH TECHNOLOG	3679	1,031,559	193,542	21,556	171,986	23,393	147,743	29,672
233	LG TECHNOLOGIES	3629	27,707	38,659	22,771	15,888	-9,463	45,616	916
234	LINAMAR CORPORA	3714	1,792,517	669,641	246,351	423,290	84,385	998,312	150,854
235	LITHOS CORPORATI	2819	10,733	8,212	4,430	3,782	-21,878	1,686	-1,146
236	LOGICSYS INC	3823	3,337	1,210	1,092	118	-338	5,868	-232
237	LUXELL TECHNOLO	3575	24,493	5,596	2,637	2,959	-2,548	1,372	-2,096
238	MAAX INC	3088	307,970	168,735	84,927	83,808	12,224	174,841	20,084
239	MAGELLAN AEROSP	3728	496,389	407,960	231,548	176,412	32,336	426,942	41,918
240	MAGNA INTERNATIO	3714	7,374,103	8,620,700	3,675,300	4,945,400	506,200	9,190,800	803,498
241	MAGNIFOAM TECHN	2821	20,940	24,131	5,532	18,599	-4,289	6,640	-2,898
242	MAGNOTTA WINERY	2084	13,310	26,530	17,764	8,766	1,432	16,537	2,415
243	MALETTE QUEBEC I	2672	56,024	187,413	91,403	96,010	2,801	111,829	13,498
244	MAPLE LEAF FOODS	2011	1,374,236	1,406,595	1,007,339	399,256	-23,257	3,281,464	44,280
245	MARATHON FOODS	3663	623	3,296	2,862	434	-464	6,350	-277
246	MARINE BIOPRODU	2833	19,046	6,518	2,581	3,937	-2,171	46	-1,942
247	MARSHALL-BARWIC	3441	23,227	41,445	9,428	32,017	2,093	51,589	-1,117
248	MAXILL INC	3991	1,570	1,797	922	874	2	1,166	134
249	MCCARTHY CORPOR	2731	29,396	69,530	50,470	19,060	-21,559	5,278	-14
250	MCGRAW-HILL RYE	2731	39,533	62,348	21,193	41,155	5,207	68,356	8,094
251	MDC CORPORATION	2759	242,559	740,013	541,869	198,144	14,108	476,727	45,072
252	MEMOTEC COMMUN	3661	4,953	30,281	15,913	14,368	-2,360	37,926	864
253	MERCER INTERNATI	2611	138,461	333,284	180,265	153,019	9,012	174,896	15,009
254	MERCH PERFORMAN	3714	2,869	1,991	1,394	597	-754	498	-642
255	METHANEX CORPO	2869	1,370,334	2,762,996	1,061,960	1,701,037	-105,122	1,107,126	75,783
256	MICROCELL TELECO	3661	307,087	720,969	1,087,657	-366,688	-408,920	143,412	-224,510
257	MILLTRONICS LTD	3823	222,793	105,188	15,320	89,868	10,006	125,053	14,499
258	MITEC TELECOM IN	3571	56,401	35,958	6,456	29,502	2,638	34,343	4,619
259	MITEL CORPORATIO	3661	1,257,378	1,237,700	802,200	435,500	91,900	888,500	125,600
260	MOBIL CORPORATIO	2911	105,489,100	65,661,593	37,448,947	28,212,646	2,617,003	80,076,612	8,145,883
261	MOBILE CLIMATE C	3585	33,407	31,158	17,796	13,362	2,865	29,118	3,922
262	MOORE CORPORATI	2761	1,428,580	2,650,998	1,713,937	937,061	-841,413	4,173,847	133,682

263	MRRM INC	2044	21,548	25,062	6,696	18,366	2,030	42,797	1,784
264	MULTIMEDIA WTM	2711	223	6,162	4,489	1,673	314	4,019	470
265	MURPHY OIL CORP	2911	2,968,466	3,324,115	1,821,744	1,502,370	-22,106	2,602,367	506,135
266	NAPIER INTERNATI	2879	32,776	2,012	324	1,688	-854	524	-813
267	NATION WIDE RESO	2951	796	1,035	156	879	186	1,045	105
268	NATRACEUTICALS I	2834	8,108	10,425	10,639	-214	-2,437	23,453	-1,759
269	NAVITRAK INTERNA	2752	9,541	1,497	2,132	-635	-1,555	281	-1,278
270	NEWBRIDGE NETWC	3663	8,125,481	1,966,825	733,205	1,233,620	-18,318	1,620,620	323,961
271	NEXFOR INC	2426	929,923	2,775,000	1,493,000	1,282,000	48,000	2,426,000	260,000
272	NEXTRON CORPORA	3699	2,426	1,764	1,026	738	-581	1,410	-188
273	NHC COMMUNICATI	3661	7,317	12,791	5,116	7,675	979	5,620	-385
274	NORDEX EXPLOSIVE	2892	530	2,177	738	1,439	-441	1,247	-366
275	NORON TECH LTD	3631	7,029	571	4,450	-3,879	-1,317	159	-1,201
276	NORTEL NETWORKS	3661	50,495,406	30,304,406	12,542,879	17,761,527	-824,725	26,991,685	1,397,578
277	NORTH AMERICAN I	3829	7,036	25,060	11,001	14,059	333	17,704	851
278	NORTH AMERICAN M	3841	7,100	2,467	2,698	-231	-591	2,306	6
279	NORTHSIDE GROUP	3714	14,056	29,179	21,295	7,884	2,115	54,256	4,581
280	NORTHSIDE MINERA	3533	4,066	560	693	-133	-2,192	2,195	-396
281	NORWALL GROUP IN	2621	10,959	69,109	43,268	25,841	1,387	82,761	7,388
282	NOVA CHEMICALS C	2821	1,838,447	3,580,000	2,068,000	1,512,000	18,000	2,075,000	170,000
283	NQL DRILLING TOOL	3533	71,671	102,082	34,350	67,732	9,807	61,289	16,033
284	NTS COMPUTER SYS	3571	48,091	38,093	18,551	19,542	3,593	34,030	5,266
285	NU-GRO CORPORAT	2879	41,449	61,530	36,407	25,123	4,763	91,653	8,033
286	OFFICE SPECIALTY I	2521	286,013	82,129	12,242	69,887	16,039	94,565	16,869
287	OMNI-LITE INDUSTR	3297	23,659	3,007	683	2,324	801	1,701	997
288	ORALIFE GROUP. IN	2834	2,931	8,169	341	7,828	-3,003	158	-2,745
289	OTATCO INC	3533	40,576	9,778	4,544	5,234	-3,286	20,186	2,247
290	PACIFIC E-LINK COR	3669	3,878	15,142	10,375	4,767	-882	47,950	784
291	PACIFIC RANGER PE	3443	771	6,048	4,558	1,490	-59	10,611	213
292	PACIFIC SAFETY PR	3842	5,040	9,117	5,772	3,345	-522	9,312	-380
293	PALLET PALLET INC	2448	5,466	38,736	34,364	4,373	-39,299	96,915	-4,412
294	PAPERBOARD INDUS	2631	95,201	1,010,933	759,556	251,377	-13,284	840,418	26,530
295	PARKLAND INDUSTI	2911	51,484	95,561	44,671	50,890	3,554	255,374	9,709
296	PATHEON INC	2834	142,814	62,244	35,379	26,865	3,982	70,473	6,485
297	PEARL RIVER HOLD	3089	1,942	12,287	3,247	9,040	-724	14,831	684
298	PELORUS NAVIGATI	3812	8,812	7,413	917	6,496	-2,471	2,069	-1,227
299	PERFECT FRY CORP	3589	1,925	2,302	472	1,831	-127	1,681	33
300	PERKINS PAPERS LT	2676	293,634	295,686	112,233	183,453	27,235	281,807	52,292
301	PETROREAL OIL CO	2086	5,304	626	294	332	-126	42	-153
302	PFB CORPORATION	2821	24,080	28,549	6,065	22,484	3,085	41,967	6,030
303	PHARMEX INDUSTR	2834	4,651	1,781	1,995	-214	-927	-927	-140
304	PIH PACIFIC INTERN	2421	2,384	7,352	4,167	3,185	-487	2,069	-464
305	PLAINTREE SYSTEM	3679	14,946	20,915	4,695	16,220	-24,147	15,711	-20,259
306	PLC SYSTEMS INC	3845	3,356	24,968	8,594	16,373	-25,499	8,743	-20,630
307	PLM GROUP LTD	2759	40,707	83,089	66,044	17,045	2,828	91,559	9,796
308	POLYAIR INTER PAC	3086	27,260	72,331	49,663	22,668	2,132	101,408	6,052
309	POLYCORP INC	3061	28,084	9,891	4,226	5,665	1,338	14,274	1,943
310	POLYMER SOLUTION	2851	3,207	3,271	3,478	-207	-870	7,329	-756
311	POLY-PACIFIC INTE	2821	1,251	1,968	800	1,168	394	2,247	493
312	POLYPHALT INC	2951	2,796	3,013	135	2,878	-2,035	532	-1,365
313	POPI GROUP INC	2369	602	6,424	2,334	4,090	-21	4,627	450
314	POTASH CORPORAT	2873	5,261,648	6,963,712	3,195,226	3,768,486	400,848	3,544,262	853,651
315	PREMDOR INC	2431	646,260	887,934	484,907	403,026	47,290	1,462,734	78,532

316	PRICE MANUFACTU	2515	2,339	4,214	2,178	2,036	-4,015	6,650	-3,216
317	PRIMERO INDUSTRI	3822	498	6	142	-136	-707	0	-94
318	PRIMETECH ELECTR	3672	143,365	56,143	14,201	41,942	11,074	89,013	11,208
319	PRIMEX FOREST PR	2421	56,925	99,053	33,341	65,712	6,447	168,079	12,450
320	PROCESS CAPITAL C	2911	5,667	3,455	1,810	1,645	-877	150	571
321	PROFAB ENERGY SE	3533	2,980	3,929	1,737	2,192	122	6,766	190
322	PROMATEK INDUST	3841	10,374	2,876	402	2,474	936	3,144	966
323	PROMETIC LIFE SCIE	2833	78,451	36,374	16,463	19,911	-7,497	10,586	-6,807
324	PRUDENTIAL STEEL	3498	205,602	154,315	26,004	128,311	12,886	175,656	16,766
325	QLT PHOTOTHERAPI	2834	974,676	103,223	8,145	95,078	-24,071	2,004	-22,859
326	QSOUND LABS, INC	3846	92,229	7,372	331,7328	7,039	-1,900	3,244	-1,729
327	QUEBECOR PRINTIN	2759	3,821,070	5,900,722	3,497,957	2,402,765	245,052	5,848,564	653,148
328	R.P.M. TECH INC	3531	6,266	24,369	15,507	8,862	851	36,090	1,474
329	RAINBOW GROUP OI	3812	11,864	4,147	1,067	3,080	-631	0	-548
330	RE-CON BUILDING P	3272	1,974	25,055	17,683	7,372	899	11,908	-3,222
331	REKO INTERNATIONAL	3544	38,558	89,410	41,474	47,936	5,247	67,927	9,654
332	RESEARCH IN MOTIO	3661	585,308	153,347	3,292	150,054	540	33,159	2,732
333	REX DIAMOND MINI	3915	47,331	79,183	22,551	56,632	-6,216	11,362	-2,538
334	RIDLEY INC	2048	160,050	230,838	124,222	106,616	13,479	398,004	27,007
335	RIVERSIDE FOREST	2421	75,896	371,272	240,418	130,854	-7,845	450,942	14,783
336	ROBERT MITCHELL	3535	19,851	55,849	10,636	45,213	378	78,722	2,788
337	ROLLAND INC	2621	149,295	309,616	197,876	111,740	18,817	670,669	31,292
338	ROSE CORPORATION	3714	25,150	56,382	21,009	35,373	1,144	5,799	1,944
339	ROYAL GROUP TECH	3089	2,920,250	1,551,652	736,578	815,074	120,024	1,050,103	196,819
340	ROYAL LASER TECH	3699	51,561	37,376	16,244	21,132	3,301	19,361	4,616
341	SACO SMARTVISION	3861	59,149	94,451	70,716	23,735	-20,785	70,184	3,333
342	SADDLEROCK RESO	2449	570	569	88	481	-74	1	-38
343	SALIX PHARMACEU	2834	14,803	12,680	2,196	10,483	-11,379	2,394	-11,239
344	SAMUEL MANU-TEC	3316	310,901	524,402	319,020	205,382	23,393	735,475	46,800
345	SAPUTO GROUP INC	2022	2,107,819	896,662	526,769	369,893	45,745	817,255	63,972
346	SCHNEIDER CORPO	2011	139,628	278,877	175,296	103,581	10,524	905,908	18,180
347	SCI INCOME TRUST	2515	75,019	89,371	18,542	70,829	9,714	104,803	14,047
348	SCI-TEC INSTRUMEN	3826	5,721	11,174	6,437	4,737	-1,460	12,595	-573
349	SEAGRAM COMPAN	2084	19,977,447	22,179,000	12,863,000	9,316,000	946,000	9,714,000	90,000
350	SEMI-TECH CORPOR	3639	10,026	3,335,258	3,064,548	270,711	-659,573	1,562,558	-212,843
351	SENCO SENSORS INC	3823	26,212	1,757	178	1,579	-2,469	439	-2,421
352	SENSE TECHNOLOGI	3663	61,221	2,820	1,834	986	-671	0	-511
353	SENTEX SYSTEMS L	2048	3,938	1,671	462	1,209	159	2,702	165
354	SEPP'S GOURMET FC	2011	27,532	34,064	20,260	13,804	331	43,175	1,509
355	SEPROTECH SYSTEM	3569	1,589	2,331	931	1,400	-334	3,357	-177
356	SERENA RESOURCES	3731	572	37	795	-758	-755	0	-289
357	SHAW INDUSTRIES I	2899	767,740	556,897	237,363	319,534	69,624	769,017	95,051
358	SHELLCASE LTD	3674	15,698	2,792	6,040	-3,248	-2,954	799	-2,587
359	SHERMAG INC	2511	185,957	109,171	51,509	57,662	9,507	109,438	12,252
360	SICO INC	2851	71,059	102,844	59,751	43,093	6,156	206,086	11,067
361	SIERRA WIRELESS, I	3669	32,735	24,812	3,723	21,089	2,529	26,400	3,192
362	SIGNALGENE INC	2836	17,484	4,340	1,103	3,237	-5,782	25	-4,301
363	SIMMONDS CAPITAL	3663	2,854	16,802	33,825	-17,023	-12,245	40,791	-8,175
364	SINO-FOREST CORPO	2411	119,484	154,349	23,544	130,806	32,811	142,384	21,678
365	SIRIT TECHNOLOGIE	3829	2,977	12,296	3,250	9,046	-1,428	11,466	-1,112
366	SKYJACK INC	3537	192,829	104,140	42,537	61,603	8,155	199,433	10,407
367	SLATER STEEL INC	3316	84,802	414,209	203,572	210,637	-7,507	509,610	10,927
368	SLEEMAN BREWERI	2082	126,836	105,655	54,240	51,415	6,755	76,023	11,283

369	SMALL FRY SNACK	2064	26,740	70,175	50,468	19,707	-4,708	159,810	5,268
370	SMARTIRE SYSTEMS	3823	81,369	14,186	802	13,384	-6,693	2,057	-5,840
371	SMARTOR PRODUCT	3822	524	3,398	3,179	219	-895	2,686	-715
372	SMED INTERNATIONAL	2522	87,643	208,794	102,963	105,831	8,169	1,835,770	18,576
373	SNIF SECURITY INC	3669	307	261	2,622	-2,361	-324	947	-190
374	SOFAME TECHNOLO	3433	6,843	1,721	434	1,287	-143	3,028	85
375	SONY CORPORATION	3651	52,935,385	68,454,933	49,044,834	19,410,099	2,374,129	72,222,944	6,324,079
376	SPECTRA PREMIUM	3714	525,280	66,530	7,042	59,488	11,146	50,577	13,174
377	SPECTRUM GAMES C	3944	327	6	516	-510	-106	0	-105
378	SPECTRUM SIGNAL	3663	38,637	34,379	12,793	21,586	-1,863	39,931	1,226
379	SR TELECOM INC	3663	112,897	303,790	199,505	104,285	3,229	180,014	7,210
380	ST. LAURENT PAPER	2631	529,380	1,613,224	728,433	884,791	-35,727	1,216,211	64,938
381	ST. LAWRENCE CEM	3241	714,241	738,856	319,950	418,906	65,090	850,410	103,188
382	STACKPOLE LIMITE	3714	131,497	210,530	101,756	108,774	3,528	181,455	21,755
383	STELCO INC	3312	841,840	2,833,000	1,394,000	1,439,000	119,000	3,168,000	276,000
384	STELLA-JONES INC	2491	19,540	51,234	24,069	27,165	3,821	82,014	5,371
385	STRATEGIC TECHNC	3663	3,943	5,156	2,269	2,887	382	7,318	1,171
386	STRATEGIC VISTA II	3669	1,720	1,981	2,473	-492	-1,778	3,408	-1,373
387	STRESSGEN BIOTEC	2836	44,932	33,477	6,678	26,799	-14,209	2,626	-13,494
388	SUN ICE LIMITED	2329	190	1,368	3,764	-2,396	-1,221	5,064	-1,362
389	SUN-RYPE PRODUCT	2033	15,889	36,678	22,529	14,149	1,814	83,811	5,556
390	SYMPLEX COMMUN	3669	5,879	2,452	1,999	453	-1,323	4,352	-425
391	SYNSORB BIOTECH	2836	77,292	29,441	15,438	14,003	-13,487	633	-13,016
392	SYSCAN INTERNATI	3663	7,260	4,340	2,376	1,964	159	5,778	425
393	TANBRIDGE CORPOI	3111	9,639	45,351	19,938	25,413	2,880	78,064	4,711
394	TECHMIRE LTD	3542	2,698	8,951	5,531	3,419	821	16,517	1,555
395	TECHNILAB PHARM	2834	107,756	66,571	21,146	45,425	4,422	53,624	9,388
396	TEKLOGIX INTERNA	3663	243,501	89,633	39,342	50,291	-8,238	127,613	360
397	TEKNION CORPORA	2521	977,251	204,952	89,601	115,351	56,015	483,695	62,094
398	TELEPANEL SYSTEM	3571	10,082	9,450	12,806	-3,357	-8,958	9,577	-5,789
399	TEMBEC INC	2611	583,665	2,496,900	1,535,200	961,700	61,100	1,422,900	207,000
400	TEMPLAR RESOURC	3732	4,576	7	580	-573	-94	2	-94
401	TERRA INDUSTRIES	2873	716,918	3,555,603	2,407,052	1,148,551	-40,313	3,797,974	217,142
402	TESMA INTERNATIC	3714	570,124	399,331	137,858	261,473	29,654	645,894	58,310
403	THERATECHNOLOGI	2834	57,159	19,085	2,325	16,760	-5,146	708	-5,036
404	THERMAL ENERGY I	3564	1,327	434	1,407	-973	-390	1,196	-321
405	THOMSON CORPORA	2711	21,769,346	19,116,103	8,757,132	10,358,971	2,835,087	9,627,930	1,893,641
406	TIMBERWEST FORES	2411	616,034	1,144,600	425,800	718,800	21,800	399,800	53,000
407	TIMMINCO LIMITED	3356	54,968	118,143	72,651	45,492	3,125	95,162	8,276
408	TIR SYSTEMS LTD	3648	1,710	1,787	1,072	715	-1,079	3,333	-960
409	TML FOODS INC	2013	1,782	5,876	6,297	-421	-1,498	5,846	-1,207
410	TOROMONT INDUST	3585	456,602	442,972	259,376	183,596	38,188	683,482	43,386
411	TRADE WIND COMM	3661	9,700	7,708	6,569	1,139	-1,201	16,548	-528
412	TRAILMOBILE CANA	3715	14,342	38,434	45,884	-7,450	-7,905	107,224	-6,525
413	TREE BREWING CON	2082	1,917	1,986	656	1,330	-634	1,144	-832
414	TRINORTH CAPITAL	3011	3,313	70,210	52,409	17,801	-29,271	59,796	-4,106
415	TRIPLE CROWN ELE	3663	4,979	5,405	3,754	1,651	-1,494	8,167	-1,406
416	TRITECH PRECISION	3369	194,222	347,339	220,883	126,456	14,455	328,565	37,472
417	TRI-VISION INTERNA	3679	29,930	20,026	6,044	13,983	62	7,463	233
418	TROJAN TECHNOLO	3826	594,264	106,845	47,662	59,183	2,828	26,767	6,670
419	TS TELECOM LTD	3661	11,832	9,189	3,201	5,988	2,281	25,653	-470
420	TSI TELSIS CORPOR	3663	12,193	8,912	8,662	249	-9,313	6,006	-8,949
421	TUNDRA SEMICOND	3674	120,705	14,889	3,156	11,733	473	20,142	2,242

422	TURBO GENSET INC	3621	80,615	6,325	156	6,169	-1,919	35	-1,743
423	ULTRAMAR DIAMON	2911	3,323,827	8,162,777	6,037,230	2,125,547	-119,946	17,100,519	374,735
424	UNIBROUE INC	2082	33,828	29,284	9,219	20,065	2,113	21,814	4,047
425	UNIFORET INC	2421	136,498	409,914	281,618	128,296	-22,244	292,357	-8,208
426	UNILENS VISION INC	3851	199	3,016	7,038	-4,022	-979	4,905	-256
427	UNIROM TECHNOLO	3825	441	402	680	-278	-3,096	0	-108
428	UNITEC INTERNATIO	3625	5,571	2,513	1,933	580	17	2,474	166
429	UNITED DOMINION I	3325	1,258,176	3,245,637	1,867,593	1,378,044	153,101	3,102,890	220,582
430	UPLAND GLOBAL CO	2834	11,221	12,415	3,672	8,743	171	13,753	1,774
431	URBAN JUICE AND S	2086	12,878	4,055	1,728	2,327	-2,342	7,011	-1,904
432	VELAN INC	3494	793,613	256,957	89,449	167,508	34,156	284,483	42,370
433	VENTRA GROUP INC	3465	159,396	350,343	233,907	116,436	13,294	467,340	38,419
434	VICEROY HOMES LI	2452	29,840	47,082	4,129	42,953	833	44,425	1,316
435	VINCOR INTERNATIO	2084	192,114	203,096	100,753	102,343	10,825	204,810	18,956
436	VISIBLE GENETICS I	3826	155,833	42,669	20,279	22,390	-22,870	16,702	-19,190
437	VITREOUS CAPITAL	3291	914	5,385	2,865	2,520	230	5,017	460
438	VIVANT GROUP INC	2086	876	956	1,432	-476	-1,611	284	-1,517
439	WAJAX LIMITED	3569	120,082	637,973	436,146	201,827	9,469	992,248	20,213
440	WARWICK COMMUN	2731	240	1,301	505	796	36	1,190	79
441	WE X.L. HOLDINGS C	3699	17,083	1,523	185	1,338	-1,647	593	-1,624
442	WESCAM INC	3663	76,678	87,312	44,893	42,419	2,865	79,904	8,494
443	WESCAST INDUSTRI	3714	574,300	280,367	42,594	237,773	47,856	284,861	67,277
444	WEST FRASER TIMB	2611	880,003	2,108,930	1,211,299	897,631	5,625	1,863,399	161,198
445	WFI INDUSTRIES LT	3567	9,697	37,881	16,541	21,338	-1,017	53,595	-119
446	WI-LAN INC	3669	329,339	8,022	1,689	6,333	-6,292	5,414	-5,220
447	WINPAK LTD	2656	318,500	254,737	122,150	132,587	16,138	336,397	37,018
448	WOOD COMPOSITE T	3089	9,334	4,504	2,733	1,771	-732	85	-688
449	WORLD SPORTS MEI	3949	4,932	538	1,075	-536	-1,838	123	-1,814
450	XEROX CANADA INC	3579	2,561,066	2,575,618	2,061,952	513,666	69,826	1,550,412	158,732
451	XILLIX TECHNOLOG	3841	22,149	16,596	1,400	15,196	-2,984	5,602	-2,511
452	ZEMEX CORPORATIO	3299	86,904	228,628	102,849	125,779	8,240	159,560	7,128

APPENDIX B

DEA Model Results and Market Value Analysis of the Inefficient Companies-SIC 3600

APPENDIX B Efficient and Inefficient Companies (SIC3600)

No.	DMU	Score	Reference set (lambda)				
1	HAMMOND	0.7568	CAMCO I 0.2217 TS TELEI	0.4467	PRIMETE	0.3315	
2	TURBO	1.0000	TURBO C 1.0000				
3	Inverpower	0.5446	RESEAR 0.0116 TS TELEI	0.9208	FIFTY-PL	0.0676	
4	UNITEC	0.4349	GLOBAL 0.0217 AASTRA	0.0472	FIFTY-PL	0.9285	PRIMETEC 0.0025
5	GLOBAL	1.0000	GLOBAL 1.0000				
6	LG TECH	0.5866	CAMCO I 0.0060 TS TELEI	0.7302	PRIMETE	0.2637	
7	CAMCO	1.0000	CAMCO I 1.0000				
8	NORON	0.0653	FIFTY-PL 0.9899 SNIF SEC	0.0101			
9	AVANTE	0.5830	RESEAR 0.0028 TS TELEI	0.0210	FIFTY-PL	0.9763	
10	SEMI-TECH	0.2145	CAMCO I 0.7746 CELESTI	0.2254			
11	DANBEL	0.7553	GLOBAL 0.0556 AASTRA	0.6210	FIFTY-PL	0.3099	INTERNAT 0.0135
12	AVVA	0.8473	TS TELEI 0.0245 FIFTY-PL	0.9525	PACIFIC	0.0230	
13	TIR SYS	0.6557	TS TELEI 0.1198 FIFTY-PL	0.8776	PACIFIC	0.0027	
14	DIGITAL	0.8843	RESEAR 0.0034 TS TELEI	0.8591	LEITCH 1	0.1375	
15	SONY	1.0000	SONY CC 1.0000				
16	CINRAM	1.0000	CINRAM 1.0000				
17	AASTRA	1.0000	AASTRA 1.0000				
18	ABL	0.3991	TS TELEI 0.5432 FIFTY-PL	0.4001	PACIFIC	0.0567	
19	BCS TECH	0.6766	FIFTY-PL 0.9156 PACIFIC	0.0417	SNIF SEC	0.0428	
20	BELL	0.2541	CELESTI 0.1402 LEITCH 1	0.4090	BALLAR	0.4507	
21	CIRCA	0.8595	AASTRA 0.2780 TS TELEI	0.0737	COMMUP	0.6009	PRIMETEC 0.0474
22	DBA TEL	0.6399	TS TELEI 0.1446 FIFTY-PL	0.8450	PACIFIC	0.0104	
23	EIGER	0.8151	CAMCO I 0.0107 TS TELEI	0.1798	FIFTY-PL	0.5594	PACIFIC E- 0.2501
24	KING	0.4719	PACIFIC 0.2143 SNIF SEC	0.7857			
25	MEMOTEC	0.6492	TS TELEI 0.8199 PRIMETE	0.1655	LEITCH 1	0.0146	
26	MICROCELL	0.0664	CAMCO I 0.1845 PACIFIC	0.8155			
27	MITEL	1.0000	MITEL CC 1.0000				
28	NHC	0.6709	RESEAR 0.0132 FIFTY-PL	0.9257	INTERNA	0.0279	LEITCH TE 0.0333
29	NORTEL	1.0000	NORTEL 1.0000				
30	RIM	1.0000	RESEAR 1.0000				
31	TRADE WINI	0.6762	FIFTY-PL 0.4601 PACIFIC	0.3397	SNIF SEC	0.2002	
32	TS TEL	1.0000	TS TELEI 1.0000				
33	ADVANTEDC	0.1804	RESEAR 0.0117 TS TELEI	0.0891	FIFTY-PL	0.8992	
34	CALIAN	0.8001	CAMCO I 0.0599 TS TELEI	0.5935	PRIMETE	0.3466	
35	CDN marconi	1.0000	CANADIA 1.0000				
36	CELL-LOC	0.9803	TURBO C 0.2345 RESEAR	0.0056	FIFTY-PL	0.7599	
37	COM DEV	0.8633	CAMCO I 0.0824 PRIMETE	0.1168	LEITCH 1	0.8008	
38	COMM	1.0000	COMMUP 1.0000				
39	CYGNAL	0.5892	RESEAR 0.0242 TS TELEI	0.6881	COMMUP	0.2612	LEITCH TE 0.0265
40	DIMENSION	0.1103	TURBO C 0.1233 RESEAR	0.0003	FIFTY-PL	0.8763	
41	DYNAMIC	0.9394	TURBO C 0.9828 RESEAR	0.0172			
42	FIFTY-PLUS	1.0000	FIFTY-PL 1.0000				

APPENDIX B Efficient and Inefficient Companies (SIC3600)

43	GEMSTAR	0.2324	TURBO C	0.0118	FIFTY-PL	0.9882		
44	INTER DATA	1.0000	INTERNA	1.0000				
45	Kasten chase	0.9949	RESEAR	0.1130	TS TELE	0.7617	FIFTY-PL	0.1253
46	MARATHON	0.6045	FIFTY-PL	0.8016	PACIFIC	0.1285	SNIF SEC	0.0699
47	NEWBRIDGE	1.0000	NEWBRI	1.0000				
48	SENSE TEC	0.3741	TURBO C	0.1621	FIFTY-PL	0.8379		
49	SIMMONDS	0.7663	PACIFIC	0.8477	SNIF SEC	0.1523		
50	SPECTRUM	0.7867	TS TELE	0.8465	PRIMETE	0.0760	LEITCH 1	0.0775
51	SR TEL	0.4470	CAMCO I	0.1363	PRIMETE	0.4192	LEITCH 1	0.4445
52	STRATEGIC	0.9832	GLOBAL	0.3983	CAMCO I	0.0012	FIFTY-PL	0.4871
53	SYSCAN	0.6574	AASTRA	0.0522	COMMUP	0.4233	FIFTY-PL	0.5220
54	TEKLOGIX	0.8099	CAMCO I	0.0755	PRIMETE	0.8796	LEITCH 1	0.0449
55	Triple crown	0.5260	TS TELE	0.2507	FIFTY-PL	0.7153	PACIFIC	0.0339
56	TSI	0.2112	FIFTY-PL	0.7477	PACIFIC	0.1203	SNIF SEC	0.1320
57	WESCAM	0.6285	TS TELE	0.1979	PRIMETE	0.7437	LEITCH 1	0.0584
58	EXI	0.7569	RESEAR	0.0117	COMMUP	0.2240	FIFTY-PL	0.7599
59	JEMTEC	1.0000	JEMTEC	1.0000				
60	PACIFIC	1.0000	PACIFIC	1.0000				
61	SIERRA	0.9963	RESEAR	0.0052	TS TELE	0.2631	COMMUP	0.6358
62	SNIF	1.0000	SNIF SEC	1.0000				
63	STRATEGIC	0.5342	FIFTY-PL	0.6999	PACIFIC	0.0642	SNIF SEC	0.2359
64	SYMPLEX	0.5622	TS TELE	0.0143	FIFTY-PL	0.9054	PACIFIC	0.0802
65	WI-LAN	0.8732	RESEAR	0.0359	TS TELE	0.1599	FIFTY-PL	0.8042
66	CIRCUIT	0.7525	GLOBAL	0.4312	AASTRA	0.4006	FIFTY-PL	0.1531
67	PRIMETECH	1.0000	PRIMETE	1.0000				
68	CELESTICA	1.0000	CELESTI	1.0000				
69	CORECO	0.9834	FIFTY-PL	0.8480	GENNUM	0.0119	LEITCH 1	0.1402
70	GENNUM	1.0000	GENNUM	1.0000				
71	SHELLCASE	0.0847	FIFTY-PL	0.8555	PACIFIC	0.0113	SNIF SEC	0.1332
72	TUNDRA	0.9817	TS TELE	0.1004	COMMUP	0.7976	PRIMETE	0.0710
73	C-MAC	0.8171	CAMCO I	0.2203	MITEL C	0.1599	CELESTI	0.0588
74	Electrohome	0.6733	CAMCO I	0.0752	TS TELE	0.4257	PRIMETE	0.4990
75	LAMBUS	0.7096	TURBO C	0.0660	FIFTY-PL	0.9340		
76	LEITCH	1.0000	LEITCH 1	1.0000				
77	PLAINTREE	0.8663	RESEAR	0.0884	TS TELE	0.4958	FIFTY-PL	0.4159
78	TRI-VISION	0.7426	RESEAR	0.0850	TS TELE	0.1415	COMMUP	0.1094
79	BALLARD	1.0000	BALLAR	1.0000				
80	BLUESTAR	0.5548	CAMCO I	0.0926	PRIMETE	0.8695	LEITCH 1	0.0379
81	COMPRES	0.3105	FIFTY-PL	0.9716	PACIFIC	0.0131	SNIF SEC	0.0153
82	GSI Lumonics	0.9167	CAMCO I	0.0196	CELESTI	0.0135	LEITCH 1	0.9669
83	NEXTRON	0.5345	RESEAR	0.0032	TS TELE	0.0452	FIFTY-PL	0.9516
84	ROYAL LASE	0.6837	FIFTY-PL	0.8098	GENNUM	0.1021	LEITCH 1	0.0881
85	WE X.L.	0.9437	RESEAR	0.0088	TS TELE	0.0060	FIFTY-PL	0.9853

ABL CANADA (SIC 3600)

DMU #	Score	Market Cap \$(000s)	Distance	Efficient Peers 32	Efficient Peers 42	Efficient Peers 60
18 ABL CAN	0.399	13,382	0.0000	0.5432	0.4001	0.0567
13 TIR SYS	0.656	1,710	0.4101	0.1198	0.8776	0.0027
12 AVVA TE	0.847	2,429	0.5753	0.0245	0.9525	0.0230
22 DBA TEL	0.64	1,956	0.3590	0.1446	0.8450	0.0104
55 TRIPLE C	0.526	4,979	0.1854	0.2507	0.7153	0.0339
64 SYMPLE	0.562	5,879	0.5356	0.0143	0.9054	0.0802
32 TS TELE	1	11,832	0.3720	1.0000	0.0000	0.0000
42 FIFTY-PI	1	2,404	0.6581	0.0000	1.0000	0.0000
60 PACIFIC	1	3,878	1.3450	0.0000	0.0000	1.0000

Ranking, according to the distances that are less than 1 (for ABL CANADA):

ABL CAN	0.399	13,382	0.0000
TRIPLE C	0.526	4,979	0.1854
DBA TEL	0.64	1,956	0.3590
TS TELE	1	11,832	0.3720
TIR SYS	0.656	1,710	0.4101
SYMPLE	0.562	5,879	0.5356
AVVA TE	0.847	2,429	0.5753
FIFTY-PI	1	2,404	0.6581

Similarity of the efficiency scores (difference between ABL CANADA's score):

ABL CAN	0.399	13,382	0.0000
TRIPLE C	0.526	4,979	0.1854
SYMPLE	0.562	5,879	0.5356
DBA TEL	0.64	1,956	0.3590
TIR SYS	0.656	1,710	0.4101
AVVA TE	0.847	2,429	0.5753
TS TELE	1	11,832	0.3720
FIFTY-PI	1	2,404	0.6581

Similarity of the Market Cap. (difference between ABL CANADA's market cap.):

TIR SYS	0.656	1,710	0.4101
DBA TEL	0.64	1,956	0.3590
FIFTY-PI	1	2,404	0.6581
AVVA TE	0.847	2,429	0.5753
TRIPLE C	0.526	4,979	0.1854
SYMPLE	0.562	5,879	0.5356
TS TELE	1	11,832	0.3720

Range for ABL CANADA's market cap. based on peer group is \$1,710,000 and \$11,832,000
ABL is a little bit overvalued

Market Capitalization of ABL CANADA based on EFFICIENT PEERS
\$7,609 thousand

ADVANTEDGE INTERNATIONAL INC (SIC 3600)

DMU #	Score	Market C. \$(000s)	Distance (displayed)	Efficient Peers 30	32	Distance 42 Formula
33 ADVANTEDGE	0.180379	19,928	0.00000	0.0117	0.0891	0.8992 0.0000
9 AVANTE TEC	0.582956	2,302	0.01065	0.0028	0.0210	0.9763 0.0107
3 INVERPOWE	0.544648	7,179	1.38339	0.0116	0.9208	0.0676 1.3834
30 RESEARCH I	1	585,308	1.79327	1.0000	0.0000	0.0000 1.7933
32 TS TELECOM	1	11,832	1.63847	0.0000	1.0000	0.0000 1.6385
42 FIFTY-PLUS	1	2,404	0.01823	0.0000	0.0000	1.0000 0.0182
45 KASTEN CH/	0.994883	23,569	1.06163	0.1130	0.7617	0.1253 1.0616
65 WI-LAN INC	0.87321	329,339	0.01463	0.0359	0.1599	0.8042 0.0146
77 PLAINTREE :	0.866344	14,946	0.40491	0.0884	0.4958	0.4159 0.4049
83 NEXTRON C	0.534451	2,426	0.00474	0.0032	0.0452	0.9516 0.0047
85 WE X.L. HOL	0.94369	17,083	0.01432	0.0088	0.0060	0.9853 0.0143

Ranking, according to the distances that are less than 1 (for ADVANTEDGE TECHNOLOGIES I

Nextron	0.00474
Avante	0.01065
WE X.L. Hold	0.01432
Wi-Lan	0.01463
Fifty-plus	0.01823
Plaintree	0.40491

Similarity of the efficiency scores (difference between ADVANTEDGE score (0.18):

Nextron	-0.354072
Avante	-0.402577
WE X.L. Hold	-0.763311
Wi-Lan	-0.692832
Fifty-plus	-0.819621
Plaintree	-0.685966

ADVANTEDGE's efficiency score is not close to any of the others, the closest is Nextron at (

Similarity of the Market Cap. (difference between ADVANTEDGE's market cap. (\$19,92

Nextron	17,502 (19,928-2	2,426
Avante	17,625	2,302
WE X.L. Hold	2,844	17,083
Wi-Lan	-309,412	329,339
Fifty-plus	17,524	2,404
Plaintree	4,981	14,946

Range for ADVANTEDGE's market cap. based on peer group is \$2,302,000 - \$329,339,000

ADVANTEDGE's real market cap of \$19,928,000 falls between this range.

Market Capitalization of ADVANTEDGE based on EFFICIENT PEERS

$[(0.012 \times 585,308) + (0.089 \times 11,832) + (0.90 \times 2,404)]$
is \$10,064 thousand

AVANTE TECHNOLOGIES INC (SIC 3600)

DMU #	Score	Market C. Distance \$(000s)	Efficient Peers (displayed)	30	32	42
9 AVANTE T	0.5829556	2,302	0.00000	0.0028	0.0210	0.9763
3 INVERPOI	0.5446483	7,179	1.63547	0.0116	0.9208	0.0676
30 RESEARC	1	585,308	1.94802	1.0000	0.0000	0.0000
32 TS TELEC	1	11,832	1.91154	0.0000	1.0000	0.0000
33 ADVANTE	0.1803789	19,928	0.01065	0.0117	0.0891	0.8992
42 FIFTY-PLL	1	2,404	0.00101	0.0000	0.0000	1.0000
45 KASTEN C	0.994883	23,569	1.28496	0.1130	0.7617	0.1253
65 WI-LAN IN	0.8732104	329,339	0.05000	0.0359	0.1599	0.8042
77 PLAINTRE	0.8663444	14,946	0.54681	0.0884	0.4958	0.4159
83 NEXTRON	0.5344511	2,426	0.00120	0.0032	0.0452	0.9516
85 WE X.L. H	0.9436897	17,083	0.00034	0.0088	0.0060	0.9853

Ranking, according to the distances that are less than 1 (for AVANTE TECHNOLOGIES INC):

WE X.L. H	0.00034
Fifty-plus	0.001
Nextron	0.0012
Advantedg	0.0106
Wi-Lan	0.05
Plaintree	0.5468

Similarity of the efficiency scores (difference between AVANTE's score (0.583):

WE X.L. H	-0.360734
Fifty-plus	-0.417044
Nextron	0.0485045
Advantedg	0.4025768
Wi-Lan	-0.290255
Plaintree	-0.283389

AVANTE's efficiency score is very close to Nextron's than Plaintree

Similarity of the Market Cap. (difference between AVANTE's market cap. (\$2,302,000):

WE X.L. H	-14,781 (2,302-17,083)
Fifty-plus	-101 (2,302-2,404)
Nextron	-124
Advantedg	-17,625
Wi-Lan	-327,037
Plaintree	-12,644

Range for AVANTE's market cap. based on peer group is between \$2,404,000 and \$329,339,000
AVANTE's real market cap of \$2,302,000 falls below this range.

Market Capitalization of AVANTE based on EFFICIENT PEERS

$[(0.0028 \times 585,308) + (0.021 \times 11,832) + (0.98 \times 2,404)]$
is \$4, 21 thousand

AVVA (SIC 3600)

DMU #	Score	Market Cap \$(000s)	Distance	Efficient Peers:			
				32	42	60	Distance
12 AVVA TECH	0.84726	2,429	0.0000	0.0245	0.9525	0.0230	0.0000
32 TS TELECO	1	11,832	1.8594	1.0000	0.0000	0.0000	1.8594
18 ABL CANAD	0.39914	13,382	0.5753	0.5432	0.4001	0.0567	0.5753
55 TRIPLE CRC	0.52596	4,979	0.1076	0.2507	0.7153	0.0339	0.1076
22 DBA TELEC	0.63987	1,956	0.0261	0.1446	0.8450	0.0104	0.0261
13 TIR SYSTEM	0.65569	1,710	0.0151	0.1198	0.8776	0.0027	0.0151
64 SYMPLEX C	0.56217	5,879	0.0056	0.0143	0.9054	0.0802	0.0056
42 FIFTY-PLUS	1	2,404	0.0034	0.0000	1.0000	0.0000	0.0034
60 PACIFIC E-L	1	3,878	1.8624	0.0000	0.0000	1.0000	1.8624

Ranking, according to the distances that are less than 1 (for AVVA):

AVVA TECH	0.84726	2,429	0.0000
FIFTY-PLUS	1	2,404	0.0034
SYMPLEX C	0.56217	5,879	0.0056
TIR SYSTEM	0.65569	1,710	0.0151
DBA TELEC	0.63987	1,956	0.0261
TRIPLE CRC	0.52596	4,979	0.1076
ABL CANAD	0.39914	13,382	0.5753

Similarity of the efficiency scores (difference between AVVA's score):

ABL CANAD	0.39914	13,382	0.5753
TRIPLE CRC	0.52596	4,979	0.1076
SYMPLEX C	0.56217	5,879	0.0056
DBA TELEC	0.63987	1,956	0.0261
TIR SYSTEM	0.65569	1,710	0.0151
AVVA TECH	0.84726	2,429	0.0000
FIFTY-PLUS	1	2,404	0.0034

Similarity of the Market Cap. (difference between AVVA's market cap.):

TIR SYSTEM	0.65569	1,710	0.0151
DBA TELEC	0.63987	1,956	0.0261
FIFTY-PLUS	1	2,404	0.0034
AVVA TECH	0.84726	2,429	0.0000
TRIPLE CRC	0.52596	4,979	0.1076
SYMPLEX C	0.56217	5,879	0.0056
ABL CANAD	0.39914	13,382	0.5753

Range for AVVA's market cap. based on peer group is \$1,710,000 and \$13,382,000

AVVA's real market cap of \$2,429,000 is right in this range

Market Capitalization of AVVA based on EFFICIENT PEERS

\$2,669 thousand

BCS TECH (SIC 3600)

DMU #	Score	Market Cap \$(000s) b	Efficient Peers (lambdas)				
			42	60	62	distance	
19 BCS TECH	0.6766	1,027	0.0000	0.9156	0.0417	0.0428	0.0000
31 TRADE WI	0.6762	9,700	0.3210	0.4601	0.3397	0.2002	0.3210
46 MARATHC	0.6045	623	0.0213	0.8016	0.1285	0.0699	0.0213
56 TSI TELS	0.2112	12,193	0.0423	0.7477	0.1203	0.1320	0.0423
63 STRATEG	0.5342	1,720	0.0843	0.6999	0.0642	0.2359	0.0843
71 SHELLCA	0.0847	15,698	0.0127	0.8555	0.0113	0.1332	0.0127
81 COMPRES	0.3105	717	0.0047	0.9716	0.0131	0.0153	0.0047
42 FIFTY-PLL	1.0000	2,404	0.0107	1.0000	0.0000	0.0000	0.0107
60 PACIFIC E	1.0000	3,878	1.7584	0.0000	1.0000	0.0000	1.7584
62 SNIF SEC	1.0000	307	1.7562	0.0000	0.0000	1.0000	1.7562

Ranking, according to the distances that are less than 1 (for BCS TECH):

BCS TECH	0.6766	1,027	0.0000
COMPRES	0.3105	717	0.0047
FIFTY-PLL	1.0000	2,404	0.0107
SHELLCA	0.0847	15,698	0.0127
MARATHC	0.6045	623	0.0213
TSI TELS	0.2112	12,193	0.0423
STRATEG	0.5342	1,720	0.0843
TRADE WI	0.6762	9,700	0.3210

Similarity of the efficiency scores (difference between BCS TECH's score):

SHELLCA	0.0847	15,698	0.0127
TSI TELS	0.2112	12,193	0.0423
COMPRES	0.3105	717	0.0047
STRATEG	0.5342	1,720	0.0843
MARATHC	0.6045	623	0.0213
TRADE WI	0.6762	9,700	0.3210
BCS TECH	0.6766	1,027	0.0000
FIFTY-PLL	1.0000	2,404	0.0107

Similarity of the Market Cap. (difference between BCS TECH's market cap.):

MARATHC	0.6045	623	0.0213
COMPRES	0.3105	717	0.0047
BCS TECH	0.6766	1,027	0.0000
STRATEG	0.5342	1,720	0.0843
FIFTY-PLL	1.0000	2,404	0.0107
TRADE WI	0.6762	9,700	0.3210
TSI TELS	0.2112	12,193	0.0423
SHELLCA	0.0847	15,698	0.0127

Range for BCS TECH's market cap. based on peer group is \$623,000 to \$15,698,000

Market Capitalization of BCS TECH based on EFFICIENT PEERS
\$2,376 thousand

VALUATION ANALYSIS - BELL CANADA INTERN (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers 68	76	79	distance
20 BELL CANADA II	0.25406	1,371,120	0.14023	0.40904	0.45073	0.0000
68 CELESTICA INC	1	2,854,867	1	3.97E-16	0	1.1097
76 LEITCH TECHN	1	1,031,559	0	1	0	0.5721
79 BALLARD POWE	1	3,608,271	0	0	1	0.4887

Bell is similar to Leitch and Ballard

Therefore, Market Value range of \$1,031,559,000 to \$3,608,271,000

Upper bound

\$2,448,639,000

BLUESTAR BATTERY SYSTEMS INTER. (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers: 7	67	76	distance
80 BLUESTAR BAT	0.55479	44,404	9.26E-02	0.86946	3.79E-02	0.00000
51 SR TELECOM IN	0.44695	112,897	0.13625	0.41924	0.44451	0.36994
37 COM DEV INTEF	0.86326	252,315	8.24E-02	0.1168	0.80078	1.14858
54 TEKLOGIX INTE	0.80991	243,501	7.55E-02	0.87962	4.49E-02	0.00044
7 CAMCO INC	1	100,000	1	0	0	1.58077
67 PRIMETECH ELI	1	143,365	0	1	0	0.02705
76 LEITCH TECHN	1	1,031,559	0	0	1	1.69017

Distance

BLUESTAR BAT	0.55479	44,404	0
TEKLOGIX INTE	0.80991	243,501	0.00044
PRIMETECH ELI	1	143,365	0.02705
SR TELECOM IN	0.44695	112,897	0.36994

Market value range: \$112,897,000 to \$243,501,000

It appears to be undervalued.

Upper bound

\$173,006 thousand

VALUATION ANALYSIS FOR CALIAN TECHNOLOGY LTD (34)

DMU #	Score	Market Cap \$(000s)	Distance (displayed)	Efficient Peers 7	32	Distance 67 (formula)
34 CALIAN TECHI	0.80014	33,191	0.00000	0.0599	0.5935	0.3466
6 LG TECHNOLC	0.58659	27,707	0.02846	0.0060	0.7302	0.2637
1 HAMMOND MA	0.75677	18,426	0.04795	0.2217	0.4467	0.3315
7 CAMCO INC	1	100,000	1.35618	1.0000	0.0000	0.0000
32 TS TELECOM I	1	11,832	0.28897	0.0000	1.0000	0.0000
67 PRIMETECH E	1	143,365	0.78275	0.0000	0.0000	1.0000
74 ELECTROHOM	0.67333	11,398	0.05162	0.0752	0.4257	0.4990

Accordingly, Calian is closest to (in distance):

CALIAN TECHI 0.00000

LG TECHNOLC 0.02846

HAMMOND MA 0.04795

ELECTROHOM 0.05162

TS TELECOM I 0.28897

PRIMETECH E 0.78275

Similarity of efficiency scores (Distance of Calian. to):

LG tech 0.21356

Hammond 0.04337

Electrohome 0.12681

TS telecom -0.19986

Primetech -0.19986

Similarity in Market Caps (Calian-- M.C. minus):

LG tech 5,484

Hammond 14,765

Electrohome 21,793

TS telecom 21,359

Primetech -110,174

Range for Calian's market cap based on peer groups is \$11,398,000 to \$27,707,000

By adding Primetech we can increase this range to a max of \$143,365,000

But, Primetech is the most different from Calian in terms of efficiency score, distance, and m.v.

Calian's real market cap. of \$33,191,000 falls just out of this range

UPPER BOUND CALCULATION:

Based on lambda relation of CALIAN to efficient peers

Looks like: $[(0.0599 \times 100,000) + (0.59 \times 11,832) + (0.35 \times 143,365)]$

\$62,705 thousand

CELL-LOC INC & CIRCA (SIC 3600)

DMU #	Score	Market Cap \$(000s)	Distance	Efficient Peers 2	30	42	Distance
36 CELL-LOC INC	0.9803	28,669	0.0000	0.2345	0.0056	0.7599	0.0000
40 DIMENSIONS	0.11029	1,970	0.0259	0.1233	0.0003	0.8763	0.0259
2 TURBO GEN	1	80,615	1.1635	1.0000	0.0000	0.0000	1.1635
30 RESEARCH II	1	585,308	1.6214	0.0000	1.0000	0.0000	1.6214
42 FIFTY-PLUS.I	1	2,404	0.1126	0.0000	0.0000	1.0000	0.1126
Distance							
CELL-LOC INC	0.9803	28,669	0.0000				
DIMENSIONS	0.11029	1,970	0.0259				
FIFTY-PLUS.I	1	2,404	0.1126				
Efficiency:							
DIMENSIONS	0.11029	1,970	0.0259				
CELL-LOC INC	0.9803	28,669	0.0000				
FIFTY-PLUS.I	1	2,404	0.1126				
Market Value							
DIMENSIONS	0.11029	1,970	0.0259				
FIFTY-PLUS.I	1	2,404	0.1126				
CELL-LOC INC	0.9803	28,669	0.0000				

Range for market value \$1,970,000 to \$2,404,000

Upper Range
\$23,996 thousand

CIRCA

DMU	Score	Market Cap						
#		\$(000s)	17	32	38	67		
21 CIRCA ENTERPRISE	0.85947	6,601	0.2780	0.0737	0.6009	0.0474	0.0000	
17 AASTRA TECH	1	46,091	1.0000	0.0000	0.0000	0.0000	0.8900	
32 TS TELECOM	1	11,832	0.0000	1.0000	0.0000	0.0000	1.2986	
38 COMMUNICARE	1	3,855	0.0000	0.0000	1.0000	0.0000	0.2442	
67 PRIMETECH INC	1	143,365	0.0000	0.0000	0.0000	1.0000	1.3512	

Similar to Aastra and Communication, therefore
range for market value of \$3,855,000 to \$46,091,000

Upper bound
\$22,797 thousand
\$22,797,000

CIRCUIT WORLD CORPORATION & C MAC (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers:				
			5	17	42	44	distance
66 CIRCUIT WK	0.75253	289	0.4312	0.4006	0.1531	0.0151	0.0000
11 DANBEL INI	0.75534	5,798	0.0556	0.6210	0.3099	0.0135	0.2142
5 GLOBAL TH	1	13,222	1.0000	0.0000	0.0000	0.0000	0.5077
17 AASTRA TE	1	46,091	0.0000	1.0000	0.0000	0.0000	0.5689
42 FIFTY-PLUS	1	2,404	0.0000	0.0000	1.0000	0.0000	1.0638
44 INTERNATIK	1	3,893	0.0000	0.0000	0.0000	1.0000	1.3399

In terms of distance, Circuit is closest to Danbel, then Global, then Aastra

In terms of efficiency score it is closest to Danbel

Range for market cap. \$5,798,000 to \$46,091,000

Market Capitalization of Circuit World based on EFFICIENT PEERS

\$24,592 thousand

Thus it seems that Circuit World is undervalued

VALUATION ANALYSIS FOR C-MAC INDUSTRIES INC (SIC3600)

DMU #	Score	Market Cap \$(000s)	7	27	68	76	distance
73 C-MAC INDI	0.81714	291,127	0.2203	0.1599	0.0588	0.5610	0.0000
7 CAMCO INC	1	100,000	1.0000	0.0000	0.0000	0.0000	0.9518
27 MITEL CORI	1	1,257,378	0.0000	1.0000	0.0000	0.0000	1.0725
68 CELESTICA	1	2,854,867	0.0000	0.0000	1.0000	0.0000	1.2747
76 LEITCH TEC	1	1,031,559	0.0000	0.0000	0.0000	1.0000	0.2702

MV range \$100 million to \$1 billion, based on peers Leitch and Camco

Upper bound:

\$969,673 thousand

COM DEV INTERNATIONAL LTD & DANBEL (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers	7	67	76 distance
37 COM DEV INT	0.86326	252,315	0.0824	0.1168	0.8008	0.0000
51 SR TELECO	0.44695	112,897	0.1363	0.4192	0.4445	0.2213
80 BLUESTAR	0.55479	44,404	0.0926	0.8695	0.0379	1.1486
54 TEKLOGIX I	0.80991	243,501	0.0755	0.8796	0.0449	1.1533
7 CAMCO INC	1	100,000	1.0000	0.0000	0.0000	1.4969
67 PRIMETECH	1	143,365	0.0000	1.0000	0.0000	1.4281
76 LEITCH TEC	1	1,031,559	0.0000	0.0000	1.0000	0.0601

Two peers: Leitch and SR Tel

Market value range: \$112,897,000 to \$1,031,559,000

Upper bound estimate:

\$851,037 thousand

DANBEL INDUSTRIES CORPORATION (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers	5	17	42	44 distance
11 DANBEL INC	0.75534	5,798	0.0556	0.6210	0.3099	0.0135	0.0000
5 GLOBAL TH	1	13,222	1.0000	0.0000	0.0000	0.0000	1.3737
66 CIRCUIT WK	0.75253	289	0.4312	0.4006	0.1531	0.0151	0.2142
17 AASTRA TE	1	46,091	0.0000	1.0000	0.0000	0.0000	0.2429
42 FIFTY-PLUS	1	2,404	0.0000	0.0000	1.0000	0.0000	0.8652
44 INTERNATI	1	3,893	0.0000	0.0000	0.0000	1.0000	1.4579

In terms of distance, Danbel is nearest Circuit, then Aastra, then Fifty

In terms of efficiency score it is closest to Circuit

Range for market cap. \$289,000 to \$46,091,000

Market Capitalization of DANBEL based on EFFICIENT PEERS

\$30,156 thousand

COMPRESSION & ENCRYPTION TECH (SIC3600)

DMU #	Score	Market Cap Distance \$(000s)	Efficient Peers	42	60	62 distance
81 COMPRESS	0.31046	717	0.0000	0.9716	0.0131	0.0153
71 SHELLCASE	8.47E-02	15,698	0.0274	0.8555	0.0113	0.1332
63 STRATEGIC	0.53425	1,720	0.1251	0.6999	0.0642	0.2359
56 TSI TELSIS	0.21119	12,193	0.0752	0.7477	0.1203	0.1320
46 MARATHON	0.6045	623	0.0452	0.8016	0.1285	0.0699
31 TRADE WIN	0.67621	9,700	0.4024	0.4601	0.3397	0.2002
19 BCS TECH	0.67662	1,027	0.0047	0.9156	0.0417	0.0428
42 FIFTY-PLUS	1	2,404	0.0012	1.0000	0.0000	0.0000
60 PACIFIC E-L	1	3,878	1.9182	0.0000	1.0000	0.0000
62 SNIF SECUI	1	307	1.9138	0.0000	0.0000	1.0000

Ranking, according to the distances that are less than 1 (for COMPRESSION):

COMPRESS	0.31046	717	0.0000
FIFTY-PLUS	1	2,404	0.0012
BCS TECH	0.67662	1,027	0.0047
SHELLCASE	8.47E-02	15,698	0.0274
MARATHON	0.6045	623	0.0452
TSI TELSIS	0.21119	12,193	0.0752
STRATEGIC	0.53425	1,720	0.1251
TRADE WIN	0.67621	9,700	0.4024

Similarity of the efficiency scores (difference between COMPRESSION's score):

SHELLCASE	8.47E-02	15,698	0.0274
TSI TELSIS	0.21119	12,193	0.0752
COMPRESS	0.31046	717	0.0000
STRATEGIC	0.53425	1,720	0.1251
MARATHON	0.6045	623	0.0452
TRADE WIN	0.67621	9,700	0.4024
BCS TECH	0.67662	1,027	0.0047
FIFTY-PLUS	1	2,404	0.0012

Similarity of the Market Cap. (difference between COMPRESSION's market cap.):

MARATHON	0.6045	623	0.0452
COMPRESS	0.31046	717	0.0000
BCS TECH	0.67662	1,027	0.0047
STRATEGIC	0.53425	1,720	0.1251
FIFTY-PLUS	1	2,404	0.0012
TRADE WIN	0.67621	9,700	0.4024
TSI TELSIS	0.21119	12,193	0.0752
SHELLCASE	8.47E-02	15,698	0.0274

Range for COMPRESSION's market cap. based on peer group is \$623,000 to \$15,698,000

Market Capitalization of COMPRESSION based on EFFICIENT PEERS
\$2,391 thousand

VALUATION ANALYSIS FOR CORECO INC (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers 42	70	76	distance
69 CORECO IN	0.98338	44,923	0.8480	0.0119	0.1402	0.0000
84 ROYAL LAS	0.68375	51,561	0.8098	0.1021	0.0881	0.0123
42 FIFTY-PLUS	1	2,404	1.0000	0.0000	0.0000	0.0429
70 GENNUM C	1	576,578	0.0000	1.0000	0.0000	1.7150
76 LEITCH TEC	1	1,031,559	0.0000	0.0000	1.0000	1.4585

Coreco's peers are Royal Laser and Fifty plus

MV range \$2.4 to \$51 million

Upper bound estimate (based on efficient peers):

\$153,477 thousand

ROYAL LASER TECH CORP (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers 42	70	76	distance
84 ROYAL LAS	0.68375	51,561	0.8098	0.1021	0.0881	0.0000
69 CORECO IN	0.98338	44,923	0.8480	0.0119	0.1402	0.0123
42 FIFTY-PLUS	1	2,404	1.0000	0.0000	0.0000	0.0544
70 GENNUM C	1	576,578	0.0000	1.0000	0.0000	1.4697
76 LEITCH TEC	1	1,031,559	0.0000	0.0000	1.0000	1.4977

Royal's peers are Coreco and Fifty **MV range \$2.4 to \$45 million**

Upper bound estimate (based on efficient peers):

\$151,693 thousand

CYGNAL TECHNOLOGIES CORP (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers: 30	32	38	76	Cygnal distance
39 CYGNAL TE	0.58919	8,637	0.0242	0.6881	0.2612	0.0265	0.0000
61 SIERRA WIF	0.99635	32,735	0.0052	0.2631	0.6358	0.0959	0.3260
30 RESEARCH	1	585,308	1.0000	0.0000	0.0000	0.0000	1.4945
32 TS TELECO	1	11,832	0.0000	1.0000	0.0000	0.0000	0.1668
38 COMMUNIC	1	3,855	0.0000	0.0000	1.0000	0.0000	1.0205
76 LEITCH TEC	1	1,031,559	0.0000	0.0000	0.0000	1.0000	1.4899

Cygnal is similar to Sierra and TS telecom in terms of distance

Therefore, market value range: \$11,832,000 to \$32,735,000

UPPER BOUND:

Market Capitalization of CYGNAL based on EFFICIENT PEERS

\$50,650 thousand

**Sierra
distance**

SIERRA WIRELESS, INC (SIC3600)

0.32603

Sierra is similar to Comm, Cygnal and TS telecom

0

Market range \$3,855,000 to \$11,832,000

1.47229

UPPER BOUND:

0.9564

Market Capitalization of SIERRA based on EFFICIENT F

0.21112

\$107,529 thousand

1.29087

DBA (SIC 3600)

DMU #	Score	Market Cap \$(000s)	Distance	Efficient Peers:			
				32	42	60	Distance
22 DBA TELEC	0.63987	1,956	0.0000	0.14457	0.84501	0.01040	0.00000
18 ABL CANAD	0.39914	13,382	0.3590	0.54321	0.40014	0.05670	0.35897
13 TIR SYSTEM	0.65569	1,710	0.0017	0.11977	0.87756	0.00267	0.00173
12 AVVA TECH	0.84726	2,429	0.0261	0.02450	0.95252	0.02300	0.02613
55 TRIPLE CRC	0.52596	4,979	0.0286	0.25074	0.71533	0.03390	0.02864
64 SYMPLEX C	0.56217	5,879	0.0255	0.01430	0.90542	0.08020	0.02549
32 TS TELECO	1	11,832	1.4459	1.00000	0.00000	0.00000	1.44591
42 FIFTY-PLUS	1	2,404	0.0450	0.00000	1.00000	0.00000	0.04503
60 PACIFIC E-L	1	3,878	1.7142	0.00000	0.00000	1.00000	1.71425

Ranking, according to the distances that are less than 1 (for DBA):

DBA TELEC	0.63987	1,956	0.0000
TIR SYSTEM	0.65569	1,710	0.0017
SYMPLEX C	0.56217	5,879	0.0255
AVVA TECH	0.84726	2,429	0.0261
TRIPLE CRC	0.52596	4,979	0.0286
FIFTY-PLUS	1	2,404	0.0450
ABL CANAD	0.39914	13,382	0.3590

Similarity of the efficiency scores (difference between DBA's score):

ABL CANAD	0.39914	13,382	0.3590
TRIPLE CRC	0.52596	4,979	0.0286
SYMPLEX C	0.56217	5,879	0.0255
DBA TELEC	0.63987	1,956	0.0000
TIR SYSTEM	0.65569	1,710	0.0017
AVVA TECH	0.84726	2,429	0.0261
FIFTY-PLUS	1	2,404	0.0450

Similarity of the Market Cap. (difference between DBA's market cap.):

TIR SYSTEM	0.65569	1,710	0.0017
DBA TELEC	0.63987	1,956	0.0000
FIFTY-PLUS	1	2,404	0.0450
AVVA TECH	0.84726	2,429	0.0261
TRIPLE CRC	0.52596	4,979	0.0286
SYMPLEX C	0.56217	5,879	0.0255
ABL CANAD	0.39914	13,382	0.3590

Range for DBA's market cap. based on peer group is \$1,710,000 and \$13,382,000

Market Capitalization of DBA based on EFFICIENT PEERS

\$3,782 thousand

DIGITAL PROCESSING SYSTEMS INC (SIC3600)

DMU #	Score	Market Cap \$(000s)	30	32	76	
14 DIGITAL PR	0.88428	28,123	3.45E-03	0.85907	0.13748	0.00000
30 RESEARCH	1	585,308	1	0	0	1.75002
32 TS TELECO	1	11,832	0	1	0	0.03877
76 LEITCH TEC	1	1,031,559	0	0	1	1.48196

Digital is only similar to TS telecom, minimum of \$11.8 million

UPPER BOUND:

Market Capitalization of DIGITAL based on EFFICIENT PEERS

\$154,005 thousand

DIMENSIONS WEST ENERGY INC (SIC 3600)

DMU #	Score	Market Cap \$(000s)	Distance	Efficient Peers	2	30	42	Distance
40 DIMENSION	0.11029	1,970	0.0000	0.12335	0.00033	0.87633	1.32805	
36 CELL-LOC II	0.9803	28,669	0.0259	0.23449	0.00558	0.75993	0.98501	
2 TURBO GEN	1	80,615	1.5365	1.00000	0.00000	0.00000	0.03876	
30 RESEARCH	1	585,308	1.7825	0.00000	1.00000	0.00000	1.48194	
42 FIFTY-PLUS	1	2,404	0.0305	0.00000	0.00000	1.00000	1.75691	

Distance

DIMENSION	0.11029	1,970	0.0000
CELL-LOC II	0.9803	28,669	0.0259
FIFTY-PLUS	1	2,404	0.0305

Efficiency:

DIMENSION	0.11029	1,970	0.0000
CELL-LOC II	0.9803	28,669	0.0259
FIFTY-PLUS	1	2,404	0.0305

Market Value

DIMENSION	0.11029	1,970	0.0000
FIFTY-PLUS	1	2,404	0.0305
CELL-LOC II	0.9803	28,669	0.0259

Range for market value \$2,404,000 to \$28,669,000

Upper Range

\$12,241 thousand

DYNAMIC SIC 3600

DMU #	Score	Market Cap \$(000s)	Distance	Efficient Peers	2	30 Distance
41 DYNAMIC	0.939	110,354	0.0000	0.98275	0.01720	0.00000
2 TURBO	1	80,615	0.0006	1.00000	0.00000	0.00059
30 RESEAR	1	585,308	1.9317	0.00000	1.00000	1.93169
Distance						
DYNAMIC	0.939	110,354	0.0000			
TURBO	1	80,615	0.0006			
Minimum market value is \$80,615,000						
Upper Range						
\$89,291 thousand						

VALUATION ANALYSIS FOR EIGER TECHNOLOGY INC (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers	7	32	42	60 Distance
23 EIGER T	0.815	8,289	0.01070	0.17981	0.55943	0.25006	0.00000
7 CAMCO	1	100,000	1.00000	0.00000	0.00000	0.00000	1.38654
32 TS TELE	1	11,832	0.00000	1.00000	0.00000	0.00000	1.04832
42 FIFTY-PL	1	2,404	0.00000	0.00000	1.00000	0.00000	0.28908
60 PACIFIC	1	3,878	0.00000	0.00000	0.00000	1.00000	0.90782
Eiger is similar to Fifty-plus and Pacific E-link, therefore its market value is between \$2.4 to 3.9 million							
Eiger seems overvalued at \$8 million							
Upper Bound							
\$5,512 thousand							

Valuation Analysis for EXI TECHNOLOGIES INC (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers	30	38	42	76 Distance
58 EXI TECI	0.757	9,422	0.01170	0.22403	0.75986	0.00443	0.00000
30 RESEAR	1	585,308	1.00000	0.00000	0.00000	0.00000	1.60433
38 COMMUI	1	3,855	0.00000	1.00000	0.00000	0.00000	1.17967
42 FIFTY-PL	1	2,404	0.00000	0.00000	1.00000	0.00000	0.10802
76 LEITCH	1	1,031,559	0.00000	0.00000	0.00000	1.00000	1.61887
Minimum mv of \$2,404,000 (one peer)							

UPPER BOUND:

Market Capitalization of EXI based on EFFICIENT PEERS
\$14,108 thousand

VALUATION ANALYSIS FOR ELECTROHOME LIMITED (SIC3600)

DMU #	Score	Market Cap \$(000s)	Distance (displayed)	Efficient Peers 7 32		Distance 67 (formula)	
74 ELECTROHOM	0.67333	11,398	0.00000	0.0752	0.4257	0.4990	0.0000
6 LG TECHNO	0.586585	27,707	0.15288	0.0060	0.7302	0.2637	0.1529
1 HAMMOND I	0.756773	18,426	0.04998	0.2217	0.4467	0.3315	0.0500
7 CAMCO INC	1	100,000	1.28554	1.0000	0.0000	0.0000	1.2855
32 TS TELECOM	1	11,832	0.58451	0.0000	1.0000	0.0000	0.5845
34 CALIAN TEC	0.800142	33,191	0.05162	0.0599	0.5935	0.3466	0.0516
67 PRIMETECH	1	143,365	0.43784	0.0000	0.0000	1.0000	0.4378

Similarity of efficiency scores (Distance of Electrohome. to):

hammond	-0.083443
calian	-0.126813
LG Tech	0.086745
prime tech	-0.32667
TS telecom	-0.32667

similarity in Market Caps (Electrohome— M.C. minus):

hammond	-7,028
calian	-21,793
LG Tech	-16,309
prime tech	-131,967
TS telecom	-435

Range for Electrohome market cap based on peer groups is \$11,832,000 to \$33,191,000
And Electrohomes real market cap. of \$11,398,000 falls below this range

UPPER BOUND:

Market Capitalization of ELECTROHOME based on EFFICIENT PEERS

Looks like: $[(0.075 \times 100,000) + (0.43 \times 11,832) + (0.5 \times 143,365)]$

\$84,103 thousand

GEMSTAR COMMUNICATIONS INC (SIC 3600)

DMU #	Score	Market C. \$(000s)	Distance	Efficient Peers 2 42 Distance
43 GEMSTAR CC 0.2324		4,888	0.0000	0.0118 0.9882 0.0000
48 SENSE TECH 0.3741		61,221	0.0452	0.1621 0.8379 0.0452
75 LAMBUS EN 0.7096		1,729	0.0059	0.0660 0.9340 0.0059
2 TURBO GEN 1		80,615	1.9531	1.0000 0.0000 1.9531
42 FIFTY-PLUS.I 1		2,404	0.0003	0.0000 1.0000 0.0003
Distance				
GEMSTAR CC 0.2324		4,888	0.0000	
FIFTY-PLUS.I 1		2,404	0.0003	
LAMBUS EN 0.7096		1,729	0.0059	
SENSE TECH 0.3741		61,221	0.0452	
Efficiency:				
GEMSTAR CC 0.2324		4,888	0.0000	
SENSE TECH 0.3741		61,221	0.0452	
LAMBUS EN 0.7096		1,729	0.0059	
FIFTY-PLUS.I 1		2,404	0.0003	
Market Value				
LAMBUS EN 0.7096		1,729	0.0059	
FIFTY-PLUS.I 1		2,404	0.0003	
GEMSTAR CC 0.2324		4,888	0.0000	
SENSE TECH 0.3741		61,221	0.0452	

Range for market value \$1,729,000 to \$61,221,000

Upper Range

\$3,327 thousand

VALUATION ANALYSIS FOR GSI LUMONICS INC (SIC3600)

DMU #	Score	Market Cap \$(000s)	7	68	76 distance
82 GSI LUMONIK 0.9167		129,626	0.0196	0.0135	0.9669 0.0000
7 CAMCO INC 1		100,000	1.0000	0.0000	0.0000 1.8962
68 CELESTICA II 1		2,854,867	0.0000	1.0000	0.0000 1.9084
76 LEITCH TECH 1		1,031,559	0.0000	0.0000	1.0000 0.0017

Minimum market value of \$1,031,559,000, based on one peer

Upper bound:

\$1,037,907 thousand

VALUATION ANALYSIS - HAMMOND MANUFACTURING (SIC 3600)

Based on BCC-I

DMU #	Score	Market	Distance	Efficient Peers		Distance	
		\$(000s)	(displayed better)	7	32	67 (formula)	
1 HAMMOND	0.7568	18,426	0.0000	0.2217	0.4467	0.3315	0.0000
6 LG TECHN	0.5866	27,707	0.1315	0.0060	0.7302	0.2637	0.1315
7 CAMCO IN	1.0000	100,000	0.9152	1.0000	0.0000	0.0000	0.9152
32 TS TELECO	1.0000	11,832	0.4652	0.0000	1.0000	0.0000	0.4652
34 CALIAN TE	0.8001	33,191	0.0480	0.0599	0.5935	0.3466	0.0480
67 PRIMETEC	1.0000	143,365	0.6956	0.0000	0.0000	1.0000	0.6956
74 ELECTROI	0.6733	11,398	0.0500	0.0752	0.4257	0.4990	0.0500

Accordingly, Hammond is closest to (in distance):

CALIAN TE	0.0480
ELECTROI	0.0500
LG TECHN	0.1315
TS TELECO	0.4652
PRIMETEC	0.6956
CAMCO IN	0.9152

Similarity of efficiency scores (Hammond to):

Calian	-0.0434
Electrohor	0.0834
LG Tech	0.1702
TS	-0.2432
Primetech	-0.2432
Camco	-0.2432

Similarity in Market Caps (Hammond M.C. minus):

Calian	-14,765
Electrohor	7,028
LG Tech	-9,281
TS	6,594
Primetech	-124,939
Camco	-81,574

Range for Hammonds market cap based on peer groups is \$11,398,000 to \$143,365,000

Ignoring the two biggest companies, which are least similar to Hammond in terms of distance and efficiency score, the range for Hammonds market cap is \$11,398,000 to \$33,191,000
Hammond's real market cap. of \$18,426,000 falls right between this range

UPPER BOUND CALCULATION:

Looks like: $[(0.22 \times 100,000) + (0.45 \times 11,832) + (0.33 \times 143,365)]$

\$74,988 thousand

Valuation Analysis of INVERPOWER (SIC 3600)

DMU #	Score	Market C. Distance	Efficient Peers	Distance
		\$(000s)	(displayed 30 32 42)	Formula
			(better)	
3 INVERPOI	0.5446	7,179	0.00000	0.0116 0.9208 0.0676 0.0000
9 AVANTE T	0.583	2,302	1.63547	0.0028 0.0210 0.9763 1.6355
30 RESEARC	1	585,308	1.82945	1.0000 0.0000 0.0000 1.8295
32 TS TELEC	1	11,832	0.01097	0.0000 1.0000 0.0000 0.0110
33 ADVANTE	0.1804	19,928	1.38339	0.0117 0.0891 0.8992 1.3834
42 FIFTY-PLL	1	2,404	1.71745	0.0000 0.0000 1.0000 1.7175
45 KASTEN C	0.9949	23,569	0.03893	0.1130 0.7617 0.1253 0.0389
65 WI-LAN IN	0.8732	329,339	1.12221	0.0359 0.1599 0.8042 1.1222
77 PLAINTRE	0.8663	14,946	0.30786	0.0884 0.4958 0.4159 0.3079
83 NEXTRON	0.5345	2,426	1.54824	0.0032 0.0452 0.9516 1.5482
85 WE X.L. H	0.9437	17,083	1.67913	0.0088 0.0060 0.9853 1.6791

Ranking, according to the distances that are less than 1 (for INVERPOWER):

TS Telecor 0.011
Kasten 0.039
Plaintree 0.31

Similarity of the efficiency scores (difference between INVERPOWER's score (0.545):

TS Telecor -0.455
Kasten -0.45
Plaintree -0.322

INVERPOWER CONTROLS LTD's efficiency score is not close to the efficiency score of it's peers

Similarity of the Market Cap. (difference between INVERPOWER's market cap.):

TS Telecor -4,653 (7,179-11,832)
Kasten -16,390 (7,179-23,569)
Plaintree -7,767 (7,179-14,946)

Range for INVERPOWER's market cap. based on peer group is \$11,832,000 to \$23,569,000
INVERPOWER CONTROLS LTD real market cap of \$7,179,000 falls below this range

Market Capitalization of INVERPOWER based on EFFICIENT PEERS

$[(0.0116 \times 585,308) + (0.92 \times 11,832) + (0.0676 \times 2,404)]$
is \$17,84 thousand

KASTEN CHASE APPLIED RESEARCH INC (SIC 3600)

Based on BCC-I for public company

DMU #	Score	Market C. Distance \$(000s)	Efficient Peers (displayed)	30	32	42	Distance Formula
45 KASTEN CHA	0.9949	23,569	0.00000	0.1130	0.7617	0.1253	0.0000
33 ADVANTEDG	0.1804	19,928	1.06163	0.0117	0.0891	0.8992	1.0616
9 AVANTE TEC	0.5830	2,302	1.28496	0.0028	0.0210	0.9763	1.2850
3 INVERPOWEI	0.5446	7,179	0.03893	0.0116	0.9208	0.0676	0.0389
30 RESEARCH II	1.0000	585,308	1.38267	1.0000	0.0000	0.0000	1.3827
32 TS TELECOM	1.0000	11,832	0.08525	0.0000	1.0000	0.0000	0.0852
42 FIFTY-PLUS.I	1.0000	2,404	1.35809	0.0000	0.0000	1.0000	1.3581
65 WI-LAN INC	0.8732	329,339	0.82904	0.0359	0.1599	0.8042	0.8290
77 PLAINTREE S	0.8663	14,946	0.15575	0.0884	0.4958	0.4159	0.1557
83 NEXTRON CC	0.5345	2,426	1.20819	0.0032	0.0452	0.9516	1.2082
85 WE X.L. HOLI	0.9437	17,083	1.32157	0.0088	0.0060	0.9853	1.3216

Ranking, according to the distances that are less than 1 (for KASTEN):

Inverpower	0.0389
Ts Telecom	0.0852
Plaintree	0.1557
Wi-Lan	0.8290

Similarity of the efficiency scores (difference between KASTEN score (0.18):

Inverpower	0.4502
Ts Telecom	-0.0051
Plaintree	0.1285
Wi-Lan	0.1217

KASTEN's efficiency score is very close to that of TS telecom

Similarity of the Market Cap. (difference between KASTEN's market cap. (\$19,928,000):

Inverpower	16390.18
Ts Telecom	11736.78
Plaintree	8623.08
Wi-Lan	-305770.09

Range for KASTEN's market cap. based on peer group is between \$7,179,000 and \$329,339,000
KASTEN's real market cap of \$23,569,000 falls between this range. Ignoring the biggest market cap. company in the peer group (Wi-Lan), the range is between \$7,179 and \$14,946 million

KASTEN seems either slightly overvalued when one examines the market cap., however it is perform near the efficient frontier, with an efficiency score of 0.99, thus it may well be undervalued

Market Capitalization of KASTEN based on EFFICIENT PEERS

$$[(0.11 \times 585,308) + (0.76 \times 11,832) + (0.13 \times 2,404)]$$

is \$75,454 thousand

Valuation Analysis of KING PRODUCTS INC (SIC3600)

DMU #	Score	Market C. Efficient Peers: \$(000s)	King 60	Simmond 62	Distance	Distance
24 KING PRC	0.47195	7,739	0.214263	0.785737	0	0.8025
60 PACIFIC E	1	3,878	1	7.15E-16	1.2348	0.0464
49 SIMMOND	0.76631	2,854	0.847691	0.152309	0.8025	0
62 SNIF SEC	1	307	1.62E-18	1	0.0918	1.4372

King is most similar to Simmonds and Snif security, therefore its market value ranges from \$307,000 to \$2,854,000

UPPER BOUND:

Market Capitalization of KING based on EFFICIENT PEERS

\$1,072 thousand

King is overvalued according to its peers

Valuation Analysis of SIMMONDS CAPITAL LIMITED (SIC3600)

Simmond is closest to King and Pacific E-link
Market value range is \$3.8 to \$7.7 million

Market Capitalization of SIMMOND based on EFFICIENT PEERS

\$3,334 thousand

Simmond is undervalued according to its peers

MICROCELL TELECOMMUNICATIONS INC (SIC3600)

DMU #	Score	Market Cap \$(000s)	7	60 distance
26 MICROCE	6.64E-02	307,087	0.184519	0.815481
7 CAMCO IN	1	100,000	1	0
60 PACIFIC E	1	3,878	0	1

Microcell is at least **\$3,878,000**, based on its one peer.

Upper bound

\$21,615 thousand

LAMBUS ENTERPRISES INC (SIC 3600)

DMU #	Score	Market C. Distance \$(000s)	Efficient Peers 2	Distance 42
75 LAMBUS E	0.709557	1,729	0.0000	0.0660
48 SENSE TE	0.374065	61,221	0.0185	0.1621
43 GEMSTAR	0.232398	4,888	0.0059	0.0118
2 TURBO GI	1	80,615	1.7448	1.0000
42 FIFTY-PLL	1	2,404	0.0087	0.0000
Distance				
LAMBUS E	0.709557	1,729	0.0000	
GEMSTAR	0.232398	4,888	0.0059	
FIFTY-PLL	1	2,404	0.0087	
SENSE TE	0.374065	61,221	0.0185	
Efficiency:			Market Value	
GEMSTAR	0.232398	4,888	0.0059	LAMBU 0.7096 1,729 0.0000
SENSE TE	0.374065	61,221	0.0185	FIFTY-F 1 2,404 0.0087
LAMBUS E	0.709557	1,729	0.0000	GEMST 0.2324 4,888 0.0059
FIFTY-PLL	1	2,404	0.0087	SENSE 0.3741 61,221 0.0185
Range for market value \$2,404,000 to \$61,221,000				
Upper Range				
\$7,566 thousand				

FOR LG TECHNOLOGIES GROUP INC (6)

DMU #	Score	Market C. Distance \$(000s)	Distance (displayed better)	Efficient Peers 7	Distance 32	Distance 67 (formula)
6 LG TECHN	0.586585	27,707	0.00000	0.0060	0.7302	0.2637 1.4640
1 HAMMONI	0.756773	18,426	0.13148	0.2217	0.4467	0.3315 0.8169
7 CAMCO IN	1	100,000	1.59077	1.0000	0.0000	0.0000 0.0044
32 TS TELEC	1	11,832	0.14237	0.0000	1.0000	0.0000 1.8724
34 CALIAN TI	0.800142	33,191	0.02846	0.0599	0.5935	0.3466 1.2365
67 PRIMETEC	1	143,365	1.07534	0.0000	0.0000	1.0000 1.8724
74 ELECTRO	0.67333	11,398	0.15288	0.0752	0.4257	0.4990 1.1679

Accordingly, LG TECH is closest to (in distance):

CALIAN TI	0.02846
HAMMONI	0.13148
TS TELEC	0.14237
ELECTRO	0.15288
PRIMETEC	1.07534 (VALUES greater than one are ignored the analysis)
CAMCO IN	1.59077

Similarity of efficiency scores (LG TECH. to):

Calian	-0.213557
Electrohon	-0.086745
TS telecon	-0.413415
Hammond	-0.170187

Similarity in Market Caps:

Calian	-5,484
Electroh	16,309
TS telec	15,875
Hammo	9,281

Range for LG TECH's market cap based on peer groups is \$11,398,000 to \$33,191,000

UPPER BOUND CALCULATION:

\$47,055 thousand

MARATHON FOODS INC (SIC 3600)

DMU #	Score	Market C. Distance	Efficient Peers:				
		\$(000s)		42	60	62 distance	
46 MARATHC	0.604497	623	0.0000	0.80157	0.128525	6.99E-02	0.0000
31 TRADE WI	0.676206	9,700	0.1781	0.46014	0.339707	0.200154	0.1781
19 BCS TECH	0.676619	1,027	0.0213	0.91557	4.17E-02	4.28E-02	0.0213
56 TSI TELS	0.211188	12,193	0.0068	0.74767	0.120293	0.132032	0.0068
63 STRATEG	0.53425	1,720	0.0421	0.69985	6.42E-02	0.235936	0.0421
71 SHELLCA	8.47E-02	15,698	0.0207	0.85545	1.13E-02	0.133211	0.0207
81 COMPRES	0.310462	717	0.0452	0.97158	1.31E-02	1.53E-02	0.0452
42 FIFTY-PLL	1	2,404	0.0608	1	0	0	0.0608
60 PACIFIC E	1	3,878	1.4069	0	1	7.15E-16	1.4069
62 SNIF SECI	1	307	1.5241	0	1.62E-18	1	1.5241

Ranking, according to the distances that are less than 1 (for MARATHON):

MARATHC	0.604497	623	0.0000
TSI TELS	0.211188	12,193	0.0068
SHELLCA	8.47E-02	15,698	0.0207
BCS TECH	0.676619	1,027	0.0213
STRATEG	0.53425	1,720	0.0421
COMPRES	0.310462	717	0.0452
FIFTY-PLL	1	2,404	0.0608
TRADE WI	0.676206	9,700	0.1781

Similarity of the efficiency scores (difference between MARATHON's score):

SHELLCA	8.47E-02	15,698	0.0207
TSI TELS	0.211188	12,193	0.0068
COMPRES	0.310462	717	0.0452
STRATEG	0.53425	1,720	0.0421
MARATHC	0.604497	623	0.0000
TRADE WI	0.676206	9,700	0.1781
BCS TECH	0.676619	1,027	0.0213
FIFTY-PLL	1	2,404	0.0608

Similarity of the Market Cap. (difference between MARATHON's market cap.):

MARATHC	0.604497	623	0.0000
COMPRES	0.310462	717	0.0452
BCS TECH	0.676619	1,027	0.0213
STRATEG	0.53425	1,720	0.0421
FIFTY-PLL	1	2,404	0.0608
TRADE WI	0.676206	9,700	0.1781
TSI TELS	0.211188	12,193	0.0068
SHELLCA	8.47E-02	15,698	0.0207

Range for MARATHON's market cap. based on peer group is \$717,000 to \$15,698,000

Marathon seems to be undervalued

Market Capitalization of MARATHON based on EFFICIENT PEERS

\$2,447 thousand

Valuation Analysis for MEMOTEC (SIC3600)

DMU	Score	Market C.	Efficient Peers			
#		\$(000s)	32	67	76	distance
25 MEMOTEC	0.6492	4,953	0.8199	0.1655	0.0146	0.0000
50 SPECTRU	0.7867	38,637	0.8465	0.0760	0.0775	0.0127
57 WESCAM	0.6285	76,678	0.1979	0.7437	0.0584	0.7232
32 TS TELEC	1	11,832	1.0000	0.0000	0.0000	0.0601
67 PRIMETEC	1	143,365	0.0000	1.0000	0.0000	1.3688
76 LEITCH TE	1	1,031,559	0.0000	0.0000	1.0000	1.6706

Memotec's peers are: Spectrum, TS Tel, and Wescam

Market Value

Range \$11,832,000 to \$76,678,000

Upper bound

\$48,488 thousand

Valuation Analysis for SPECTRUM (SIC3600)

DMU	Score	Market C.	Efficient Peers			
#		\$(000s)	32	67	76	distance
50 SPECTRU	0.7867	38,637	0.8465	7.60E-02	7.75E-02	0.00000
25 MEMOTEC	0.6492	4,953	0.8199	0.165499	1.46E-02	0.01268
57 WESCAM	0.6285	76,678	0.1979	0.743748	5.84E-02	0.86696
32 TS TELEC	1	11,832	1	0	0	0.03535
67 PRIMETEC	1	143,365	0	1	0	1.57633
76 LEITCH TE	1	1,031,559	0	0	1	1.57333

Spectrum is nearest Memotec, Ts Tel and Wescam

Market Value

Range \$4,953,000 to \$76,678,000

Upper bound

\$100,858 thousand

Valuation Analysis for WESCAM (SIC3600)

DMU	Score	Market C.	Efficient Peers			
#		\$(000s)	32	67	76	distance
57 WESCAM	0.6285	76,678	0.1979	0.7437	0.0584	0.0000
50 SPECTRU	0.7867	38,637	0.8465	0.0760	0.0775	0.8670
25 MEMOTEC	0.6492	4,953	0.8199	0.1655	0.0146	0.7232
32 TS TELEC	1	11,832	1.0000	0.0000	0.0000	1.2000
67 PRIMETEC	1	143,365	0.0000	1.0000	0.0000	0.1082
76 LEITCH TE	1	1,031,559	0.0000	0.0000	1.0000	1.4789

Wescam is nearest Primetech, Memotec, then Spectrum

Market Value

Range \$4,953,000 to \$143,365,000

Upper bound

\$169,212 thousand

NEXTRON (SIC 3600)

DMU #	Score	Market \$(000s)	Distance (display better)	Efficient Peers 30	32	Distance 42	Formula
83 NEXTRO	0.534	2,426	0.00000	0.0032	0.0452	0.9516	0.0000
77 PLAINTR	0.866	14,946	0.49728	0.0884	0.4958	0.4159	0.4973
65 WI-LAN I	0.873	329,339	0.03594	0.0359	0.1599	0.8042	0.0359
3 INVERPC	0.545	7,179	1.54824	0.0116	0.9208	0.0676	1.5482
9 AVANTE	0.583	2,302	0.00120	0.0028	0.0210	0.9763	0.0012
30 RESEAR	1	585,308	1.90112	1.0000	0.0000	0.0000	1.9011
32 TS TELE	1	11,832	1.81716	0.0000	1.0000	0.0000	1.8172
42 FIFTY-PI	1	2,404	0.00440	0.0000	0.0000	1.0000	0.0044
33 ADVANT	0.18	19,928	0.00474	0.0117	0.0891	0.8992	0.0047
45 KASTEN	0.995	23,569	1.20819	0.1130	0.7617	0.1253	1.2082
85 WE X.L. I	0.944	17,083	0.00271	0.0088	0.0060	0.9853	0.0027

Ranking, according to the distances that are less than 1 (for NEXTRON):

NEXTRO	0.534	2,426	0.00000
AVANTE	0.583	2,302	0.00120
WE X.L. I	0.944	17,083	0.00271
FIFTY-PI	1	2,404	0.00440
ADVANT	0.18	19,928	0.00474
WI-LAN I	0.873	329,339	0.03594
PLAINTR	0.866	14,946	0.49728

Similarity of the efficiency scores (difference between NEXTRON's score (0.534):

ADVANT	0.18	19,928	0.00474
NEXTRO	0.534	2,426	0.00000
AVANTE	0.583	2,302	0.00120
PLAINTR	0.866	14,946	0.49728
WI-LAN I	0.873	329,339	0.03594
WE X.L. I	0.944	17,083	0.00271
FIFTY-PI	1	2,404	0.00440

Similarity of the Market Cap. (difference between NEXTRON's market cap. (\$2,426,000):

AVANTE	0.583	2,302	0.00120
FIFTY-PI	1	2,404	0.00440
NEXTRO	0.534	2,426	0.00000
PLAINTR	0.866	14,946	0.49728
WE X.L. I	0.944	17,083	0.00271
ADVANT	0.18	19,928	0.00474
WI-LAN I	0.873	329,339	0.03594

**Range for NEXTRON's market cap. based on peer group is \$2,302,000 and \$329,339,000
NEXTRON's real market cap of \$2,426,000 is right in this range**

Market Capitalization of NEXTRON based on EFFICIENT PEERS

\$4,707 thousand

Valuation Analysis for NHC COMMUNICATIONS INC (SIC3600)

DMU #	Score	Market C. Efficient Peers: \$(000s)	30	42	44	76	Distance
28 NHC COMM	0.670855	7,317	1.32E-02	0.92567	0.0279	3.33E-02	0.0000
30 RESEARCH	1	585,308	1	6.18E-16	0	0	1.8325
42 FIFTY-PLUS	1	2,404	0	1	0	0	0.0076
44 INTERNATI	1	3,893	0	1.30E-17	1	0	1.8032
76 LEITCH TE	1	1,031,559	0	0	0	1	1.7923

NHC is only similar to Fifty plus
therefore, minimum range is \$2,404,000

UPPER BOUND:

Market Capitalization of NHC based on EFFICIENT PEERS
\$44,411 thousand

Valuation Analysis for NORON TECH LTD (SIC3600)

DMU #	Score	Market C. Efficient Peers \$(000s)	42	62	distance	Distance
8 NORON TE	6.53E-02	7,029	0.98995	1.01E-02	0.0000	0
42 FIFTY-PLUS	1	2,404	1	0	0.0002	0.000203
62 SNIF SECU	1	307	0	1	1.9599	1.959903

Noron only has Fifty plus close to it in terms of distance, therefore its market value should be near \$2.4 million

Upper Bound

\$2,383 thousand

According to the upper bound Noron is overvalued

VALUATION ANALYSIS FOR SEMI-TECH CORPORATION (SIC 3600)

DMU #	Score	Market Cap \$(000s)	7	68	Distance
10 SEMI-TECH	0.214508	10,026	0.774623	0.22538	0
7 CAMCO INC	1	100,000	1	0	0.1016
68 CELESTICA	1	2,854,867	2.81E-16	1	1.2001

In terms of distance only Camco is close, therefore lower bound of \$100 million

Upper bound:

\$720,885 thousand

PLAINTREE (SIC 3600)

DMU #	Score	Market C. Distance	Efficient Peers	Distance
		\$(000s)	30 32	42 Formula
77 PLAINTRE	0.8663	14,946	0.00000 0.0884	0.4159 0.0000
65 WI-LAN IN	0.8732	329,339	0.26639 0.0359	0.1599 0.8042 0.2664
3 INVERPO\	0.5446	7,179	0.30786 0.0116	0.9208 0.0676 0.3079
9 AVANTE T	0.583	2,302	0.54681 0.0028	0.0210 0.9763 0.5468
30 RESEARC	1	585,308	1.24976 1.0000	0.0000 0.0000 1.2498
32 TS TELEC	1	11,832	0.43498 0.0000	1.0000 0.0000 0.4350
42 FIFTY-PLL	1	2,404	0.59484 0.0000	0.0000 1.0000 0.5948
33 ADVANTE	0.1804	19,928	0.40491 0.0117	0.0891 0.8992 0.4049
45 KASTEN C	0.9949	23,569	0.15575 0.1130	0.7617 0.1253 0.1557
83 NEXTRON	0.5345	2,426	0.49728 0.0032	0.0452 0.9516 0.4973
85 WE X.L. H	0.9437	17,083	0.57049 0.0088	0.0060 0.9853 0.5705

Ranking, according to the distances that are less than 1 (for PLAINTREE):

PLAINTRE	0.8663	14,946	0.00000
KASTEN C	0.9949	23,569	0.15575
WI-LAN IN	0.8732	329,339	0.26639
INVERPO\	0.5446	7,179	0.30786
ADVANTE	0.1804	19,928	0.40491
TS TELEC	1	11,832	0.43498
NEXTRON	0.5345	2,426	0.49728
AVANTE T	0.583	2,302	0.54681
WE X.L. H	0.9437	17,083	0.57049
FIFTY-PLL	1	2,404	0.59484

Similarity of the efficiency scores:

ADVANTE	0.1804	19,928	0.40491
NEXTRON	0.5345	2,426	0.49728
INVERPO\	0.5446	7,179	0.30786
AVANTE T	0.583	2,302	0.54681
PLAINTRE	0.8663	14,946	0.00000
WI-LAN IN	0.8732	329,339	0.26639
WE X.L. H	0.9437	17,083	0.57049
KASTEN C	0.9949	23,569	0.15575
TS TELEC	1	11,832	0.43498
FIFTY-PLL	1	2,404	0.59484

Similarity of the Market Cap.:

AVANTI	0.583	2,302	0.54681
FIFTY-F	1	2,404	0.59484
NEXTR	0.5345	2,426	0.49728
INVERF	0.5446	7,179	0.30786
TS TELI	1	11,832	0.43498
PLAINT	0.8663	14,946	0.00000
WE X.L.	0.9437	17,083	0.57049
ADVAN	0.1804	19,928	0.40491
KASTEI	0.9949	23,569	0.15575
WI-LAN	0.8732	329,339	0.26639

Range for PLAINTREE's market cap. based on peer group is \$2,302,000 and \$329,339,000

Market Capitalization of PLAINTREE based on EFFICIENT PEERS

\$58,607 thousand

SENSE TECHNOLOGIES INC (SIC 3600)

DMU #	Score	Market C. Distance	Efficient Peers	2	42	Distance
		\$(000s)				
48 SENSE TE	0.3741	61,221	0.0000	0.1621	0.8379	0.0000
43 GEMSTAR	0.2324	4,888	0.0452	0.0118	0.9882	0.0452
75 LAMBUS E	0.7096	1,729	0.0185	0.0660	0.9340	0.0185
2 TURBO GI	1	80,615	1.4040	1.0000	0.0000	1.4040
42 FIFTY-PLL	1	2,404	0.0526	0.0000	1.0000	0.0526

Distance

SENSE TE	0.3741	61,221	0.0000
LAMBUS E	0.7096	1,729	0.0185
GEMSTAR	0.2324	4,888	0.0452
FIFTY-PLL	1	2,404	0.0526

Efficiency:

GEMSTAR	0.2324	4,888	0.0452
SENSE TE	0.3741	61,221	0.0000
LAMBUS E	0.7096	1,729	0.0185
FIFTY-PLL	1	2,404	0.0526

Market Value

LAMBUS E	0.7096	1,729	0.0185
FIFTY-PLL	1	2,404	0.0526
GEMSTAR	0.2324	4,888	0.0452
SENSE TE	0.3741	61,221	0.0000

Range for market value \$1,729,000 to \$4,888,000

Upper Range

\$15,085 thousand

Valuation Analysis for STRATEGIC TECHNOLOGIES INC (SIC3600)

DMU #	Score	Market C. Efficient Peers	5	7	42	59	Distance
		\$(000s)					
52 STRATEG	0.9832	3,943	0.3983	0.0012	0.4871	0.1133	0.0000
5 GLOBAL T	1	13,222	1.0000	0.0000	0.0000	0.0000	0.6122
7 CAMCO IN	1	100,000	0.0000	1.0000	0.0000	0.0000	1.4064
42 FIFTY-PLL	1	2,404	0.0000	0.0000	1.0000	0.0000	0.4345
59 JEMTEC II	1	330	0.0000	0.0000	0.0000	1.0000	1.1822

In terms of distance, similar to Global and Fifty plus

Range for market value \$2,404,000 to \$13,222,000

Upper bound

\$6,597 thousand

Based on BCC-I for public company SHELLCASE (SIC 3600)

DMU #	Score	Market C. Distance \$(000s)	Efficient Peers 42	60	62	distance
71 SHELLCA	8.47E-02	15,698	0.0000	0.8555	0.0113	0.1332
63 STRATEG	0.53425	1,720	0.0376	0.6999	0.0642	0.2359
56 TSI TELS	0.211188	12,193	0.0235	0.7477	0.1203	0.1320
46 MARATHC	0.604497	623	0.0207	0.8016	0.1285	0.0699
31 TRADE W	0.676206	9,700	0.2686	0.4601	0.3397	0.2002
19 BCS TECH	0.676619	1,027	0.0127	0.9156	0.0417	0.0428
81 COMPRES	0.310462	717	0.0274	0.9716	0.0131	0.0153
42 FIFTY-PL	1	2,404	0.0388	1.0000	0.0000	0.0000
60 PACIFIC E	1	3,878	1.7271	0.0000	1.0000	0.0000
62 SNIF SEC	1	307	1.4832	0.0000	0.0000	1.0000

Ranking, according to the distances that are less than 1 (for SHELLCASE):

SHELLCA:	8.47E-02	15,698	0.0000
BCS TECH	0.676619	1,027	0.0127
MARATHC	0.604497	623	0.0207
TSI TELS	0.211188	12,193	0.0235
COMPRES	0.310462	717	0.0274
STRATEG	0.53425	1,720	0.0376
FIFTY-PL	1	2,404	0.0388
TRADE W	0.676206	9,700	0.2686

Similarity of the efficiency scores (difference between SHELLCASE's score):

SHELLCA:	8.47E-02	15,698	0.0000
TSI TELS	0.211188	12,193	0.0235
COMPRES	0.310462	717	0.0274
STRATEG	0.53425	1,720	0.0376
MARATHC	0.604497	623	0.0207
TRADE W	0.676206	9,700	0.2686
BCS TECH	0.676619	1,027	0.0127
FIFTY-PL	1	2,404	0.0388

Similarity of the Market Cap. (difference between SHELLCASE's market cap.):

MARATHC	0.604497	623	0.0207
COMPRES	0.310462	717	0.0274
BCS TECH	0.676619	1,027	0.0127
STRATEG	0.53425	1,720	0.0376
FIFTY-PL	1	2,404	0.0388
TRADE W	0.676206	9,700	0.2686
TSI TELS	0.211188	12,193	0.0235
SHELLCA:	8.47E-02	15,698	0.0000

Range for SHELLCASE's market cap. based on peer group is \$623,000 to \$12,193,000

Market Capitalization of SHELLCASE based on EFFICIENT PEERS

\$2,141 thousand

VALUATION ANALYSIS FOR SR TELECOM INC (SIC3600)

DMU #	Score	Market C. Efficient Peers: \$(000s)	7	67	76 distance
51 SR TELEC	0.447	112,897	0.1363	0.4192	0.4445 0.0000
80 BLUESTAI	0.5548	44,404	0.0926	0.8695	0.0379 0.3699
37 COM DEV	0.8633	252,315	0.0824	0.1168	0.8008 0.2213
54 TEKLOGI	0.8099	243,501	0.0755	0.8796	0.0449 0.3753
7 CAMCO IN	1	100,000	1.0000	0.0000	0.0000 1.1194
67 PRIMETEC	1	143,365	0.0000	1.0000	0.0000 0.5534
76 LEITCH TE	1	1,031,559	0.0000	0.0000	1.0000 0.5029

Companies ranked by Distance:

SR TELEC	0.447	112,897	0
COM DEV	0.8633	252,315	0.2213
BLUESTAI	0.5548	44,404	0.3699
TEKLOGI	0.8099	243,501	0.3753
LEITCH TE	1	1,031,559	0.5029
PRIMETEC	1	143,365	0.5534

Rank by Efficiency score

SR TELEC	0.447	112,897	0
BLUESTAI	0.5548	44,404	0.3699
TEKLOGI	0.8099	243,501	0.3753
COM DEV	0.8633	252,315	0.2213
LEITCH TE	1	1,031,559	0.5029
PRIMETEC	1	143,365	0.5534

By market value

BLUESTAI	0.5548	44,404	0.3699
SR TELEC	0.447	112,897	0
PRIMETEC	1	143,365	0.5534
TEKLOGI	0.8099	243,501	0.3753
COM DEV	0.8633	252,315	0.2213
LEITCH TE	1	1,031,559	0.5029

Market value range: \$44,404,000 to \$1,031,559,000

Upper bound

\$532,269 thousand

STRATEGIC VISTA (SIC 3600)

DMU #	Score	Market C. Distance \$(000s)	Efficient Peers:	42	60	62 distance
63 STRATEG	0.53425	1,720	0.0000	0.6999	0.0642	0.2359 0.0000
56 TSI TELS	0.211188	12,193	0.0162	0.7477	0.1203	0.1320 0.0162
46 MARATHC	0.604497	623	0.0421	0.8016	0.1285	0.0699 0.0421
31 TRADE W	0.676206	9,700	0.1346	0.4601	0.3397	0.2002 0.1346
19 BCS TECH	0.676619	1,027	0.0843	0.9156	0.0417	0.0428 0.0843
71 SHELLCA	8.47E-02	15,698	0.0376	0.8555	0.0113	0.1332 0.0376
81 COMPRES	0.310462	717	0.1251	0.9716	0.0131	0.0153 0.1251
42 FIFTY-PL	1	2,404	0.1499	1.0000	0.0000	0.0000 0.1499
60 PACIFIC E	1	3,878	1.4212	0.0000	1.0000	0.0000 1.4212
62 SNIF SECI	1	307	1.0777	0.0000	0.0000	1.0000 1.0777

Ranking, according to the distances that are less than 1 (for STRATEGIC VISTA):

STRATEG	0.53425	1,720	0.0000
TSI TELS	0.211188	12,193	0.0162
SHELLCA	8.47E-02	15,698	0.0376
MARATHC	0.604497	623	0.0421
BCS TECH	0.676619	1,027	0.0843
COMPRES	0.310462	717	0.1251
TRADE W	0.676206	9,700	0.1346
FIFTY-PL	1	2,404	0.1499

Similarity of the efficiency scores (difference between STRATEGIC VISTA's score):

SHELLCA	8.47E-02	15,698	0.0376
TSI TELS	0.211188	12,193	0.0162
COMPRES	0.310462	717	0.1251
STRATEG	0.53425	1,720	0.0000
MARATHC	0.604497	623	0.0421
TRADE W	0.676206	9,700	0.1346
BCS TECH	0.676619	1,027	0.0843
FIFTY-PL	1	2,404	0.1499

Similarity of the Market Cap. (difference between STRATEGIC VISTA's market cap.):

MARATHC	0.604497	623	0.0421
COMPRES	0.310462	717	0.1251
BCS TECH	0.676619	1,027	0.0843
STRATEG	0.53425	1,720	0.0000
FIFTY-PL	1	2,404	0.1499
TRADE W	0.676206	9,700	0.1346
TSI TELS	0.211188	12,193	0.0162
SHELLCA	8.47E-02	15,698	0.0376

Range for STRATEGIC VISTA's market cap. based on peer group is \$623,000 to \$15,698,000

Market Capitalization of STRATEGIC VISTA based on EFFICIENT PEERS
\$2,004 thousand

SYMPLEX (SIC 3600)

DMU #	Score	Market \$(000s)	Distance	Efficient Peers	32	42	60 Distance
64 SYMPLE	0.562	5,879	0.0000	0.0143	0.9054	0.0802	0.0000
55 TRIPLE C	0.526	4,979	0.0942	0.2507	0.7153	0.0339	0.0942
22 DBA TEL	0.64	1,956	0.0255	0.1446	0.8450	0.0104	0.0255
18 ABL CAN	0.399	13,382	0.5356	0.5432	0.4001	0.0567	0.5356
13 TIR SYS	0.656	1,710	0.0179	0.1198	0.8776	0.0027	0.0179
12 AVVA TE	0.847	2,429	0.0056	0.0245	0.9525	0.0230	0.0056
32 TS TELE	1	11,832	1.7978	1.0000	0.0000	0.0000	1.7978
42 FIFTY-PI	1	2,404	0.0156	0.0000	1.0000	0.0000	0.0156
60 PACIFIC	1	3,878	1.6660	0.0000	0.0000	1.0000	1.6660

Ranking, according to the distances that are less than 1 (for SYMPLEX):

SYMPLE 0.562	5,879	0.0000
AVVA TE 0.847	2,429	0.0056
FIFTY-PI 1	2,404	0.0156
TIR SYS 0.656	1,710	0.0179
DBA TEL 0.64	1,956	0.0255
TRIPLE C 0.526	4,979	0.0942
ABL CAN 0.399	13,382	0.5356

Similarity of the efficiency scores (difference between SYMPLEX's score):

ABL CAN 0.399	13,382	0.5356
TRIPLE C 0.526	4,979	0.0942

SYMPLE 0.562	5,879	0.0000
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DBA TEL 0.64	1,956	0.0255
TIR SYS 0.656	1,710	0.0179
AVVA TE 0.847	2,429	0.0056
FIFTY-PI 1	2,404	0.0156

Similarity of the Market Cap. (difference between SYMPLEX's market cap.):

TIR SYS 0.656	1,710	0.0179
DBA TEL 0.64	1,956	0.0255
FIFTY-PI 1	2,404	0.0156
AVVA TE 0.847	2,429	0.0056
TRIPLE C 0.526	4,979	0.0942

SYMPLE 0.562	5,879	0.0000
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ABL CAN 0.399	13,382	0.5356
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Range for SYMPLEX's market cap. based on peer group is \$1,710,000 and \$13,382,000

Market Capitalization of SYMPLEX based on EFFICIENT PEERS
\$2,657 thousand

SYSCAN INTERNATIONAL INC (SIC 3600)

DMU #	Score	Market Cap \$(000s)	17	38	42	67	Distance
53 SYSCAN II	0.6574	7,260	0.052205	0.423308	0.521971	2.52E-03	0.0000
17 AASTRA T	1	46,091	1	0	0	0	1.3500
38 COMMUNI	1	3,855	0	1	1.29E-18	0	0.6078
42 FIFTY-PLL	1	2,404	0	0	1	0	0.4104
67 PRIMETEC	1	143,365	0	8.70E-17	0	1	1.4493

Range for mv: \$2.4 to 3.8 million

Upper bound
\$5,654 thousand

VALUATION ANALYSIS FOR TEKLOGIX INTERNATIONAL INC (SIC3600)

DMU #	Score	Market C. Efficient Peers: \$(000s)	7	67	76	distance
54 TEKLOGIX	0.8099	243,501	7.55E-02	0.879623	4.49E-02	0.00000
51 SR TELECOM	0.447	112,897	0.13625	0.419239	0.444511	0.37533
80 BLUESTAR	0.5548	44,404	9.26E-02	0.869458	3.79E-02	0.00044
37 COM DEV	0.8633	252,315	8.24E-02	0.116802	0.800779	1.15330
7 CAMCO INC	1	100,000	1	0	0	1.63045
67 PRIMETEC	1	143,365	0	1	0	0.02221
76 LEITCH TEL	1	1,031,559	0	0	1	1.69165

Three peers: Bluestar, Primetech, and SR Tel

Market value range: \$44,404,000 to \$143,365,000

Upper bound
\$179,974 thousand

Public company TIR (SIC 3600)

DMU #	Score	Market C. Distance	Efficient Peers				
		\$(000s)		32	42	60	Distance
13 TIR SYSTI	0.6557	1,710	0.0000	0.1198	0.8776	0.0027	0.0000
12 AVVA TEC	0.8473	2,429	0.0151	0.0245	0.9525	0.0230	0.0151
18 ABL CANA	0.3991	13,382	0.4101	0.5432	0.4001	0.0567	0.4101
55 TRIPLE CF	0.526	4,979	0.0444	0.2507	0.7153	0.0339	0.0444
22 DBA TELE	0.6399	1,956	0.0017	0.1446	0.8450	0.0104	0.0017
64 SYMPLEX	0.5622	5,879	0.0179	0.0143	0.9054	0.0802	0.0179
32 TS TELEC	1	11,832	1.5449	1.0000	0.0000	0.0000	1.5449
42 FIFTY-PLL	1	2,404	0.0293	0.0000	1.0000	0.0000	0.0293
60 PACIFIC E	1	3,878	1.7791	0.0000	0.0000	1.0000	1.7791

Ranking, according to the distances that are less than 1 (for TIR):

TIR SYSTI	0.6557	1,710	0.0000
DBA TELE	0.6399	1,956	0.0017
AVVA TEC	0.8473	2,429	0.0151
SYMPLEX	0.5622	5,879	0.0179
FIFTY-PLL	1	2,404	0.0293
TRIPLE CF	0.526	4,979	0.0444
ABL CANA	0.3991	13,382	0.4101

Similarity of the efficiency scores (difference between TIR's score):

ABL CANA	0.3991	13,382	0.4101
TRIPLE CF	0.526	4,979	0.0444
SYMPLEX	0.5622	5,879	0.0179
DBA TELE	0.6399	1,956	0.0017
TIR SYSTI	0.6557	1,710	0.0000
AVVA TEC	0.8473	2,429	0.0151
FIFTY-PLL	1	2,404	0.0293
FIFTY-PLL	1	2,404	0.0034

Similarity of the Market Cap. (difference between TIR's market cap.):

TIR SYSTI	0.6557	1,710	0.0000
DBA TELE	0.6399	1,956	0.0017
FIFTY-PLL	1	2,404	0.0293
FIFTY-PLL	1	2,404	0.0034
AVVA TEC	0.8473	2,429	0.0151
TRIPLE CF	0.526	4,979	0.0444
SYMPLEX	0.5622	5,879	0.0179
ABL CANA	0.3991	13,382	0.4101

Range for TIR's market cap. based on peer group is \$1,956,000 and \$13,382,000
TIR's real market cap of \$1,710,000 falls just short of this amount

Market Capitalization of TIR based on EFFICIENT PEERS
\$3,537 thousand

TRADE WIND COMMUNICATIONS LTD (SiC 3600)

DMU #	Score	Market C. \$(000s)	Distance	Efficient Peers	42	60	62 distance
31 TRADE WI	0.67621	9,700	0.0000	0.4601	0.3397	0.2002	0.0000
19 BCS TECH	0.67662	1,027	0.3210	0.9156	0.0417	0.0428	0.3210
46 MARATHC	0.60450	623	0.1781	0.8016	0.1285	0.0699	0.1781
56 TSI TELS	0.21119	12,193	0.1355	0.7477	0.1203	0.1320	0.1355
63 STRATEG	0.53425	1,720	0.1346	0.6999	0.0642	0.2359	0.1346
71 SHELLCA	0.08470	15,698	0.2686	0.8555	0.0113	0.1332	0.2686
81 COMPRES	0.31046	717	0.4024	0.9716	0.0131	0.0153	0.4024
42 FIFTY-PL	1.00000	2,404	0.4469	1.0000	0.0000	0.0000	0.4469
60 PACIFIC E	1.00000	3,878	0.6878	0.0000	1.0000	0.0000	0.6878
62 SNIF SECI	1.00000	307	0.9669	0.0000	0.0000	1.0000	0.9669

Ranking, according to the distances that are less than 1 (for TRADE WIND):

TRADE WI	0.67621	9,700	0.0000
STRATEG	0.53425	1,720	0.1346
TSI TELS	0.21119	12,193	0.1355
MARATHC	0.60450	623	0.1781
SHELLCA	0.08470	15,698	0.2686
BCS TECH	0.67662	1,027	0.3210
COMPRES	0.31046	717	0.4024
FIFTY-PL	1.00000	2,404	0.4469
PACIFIC E	1.00000	3,878	0.6878
SNIF SECI	1.00000	307	0.9669

Similarity of the efficiency scores:

SHELLCA	0.08470	15,698	0.2686
TSI TELS	0.21119	12,193	0.1355
COMPRES	0.31046	717	0.4024
STRATEG	0.53425	1,720	0.1346
MARATHC	0.60450	623	0.1781
TRADE WI	0.67621	9,700	0.0000
BCS TECH	0.67662	1,027	0.3210
FIFTY-PL	1.00000	2,404	0.4469
PACIFIC E	1.00000	3,878	0.6878
SNIF SECI	1.00000	307	0.9669

Similarity of the Market Cap.:

SNIF SE	1	307	0.9669
MARAT	0.6045	623	0.1781
COMPF	0.31046	717	0.4024
BCS TE	0.67662	1,027	0.3210
STRATI	0.53425	1,720	0.1346
FIFTY-F	1	2,404	0.4469
PACIFC	1	3,878	0.6878
TRADE	0.67621	9,700	0.0000
TSI TEL	0.21119	12,193	0.1355
SHELLC	8.47E-02	15,698	0.2686

Range for TRADE WIND's market cap. based on peer group is \$307,000 to \$15,698,000

Market Capitalization of TRADE WIND based on EFFICIENT PEERS
\$2,485 thousand

For public company TRIPLE CROWN (SIC 3600)

DMU #	Score	Market C. Distance	Efficient Peers:				
		\$(000s)		32	42	60	Distance
55 TRIPLE CF	0.526	4,979	0.0000	0.2507	0.7153	0.0339	0.0000
22 DBA TELE	0.6399	1,956	0.0286	0.1446	0.8450	0.0104	0.0286
18 ABL CANA	0.3991	13,382	0.1854	0.5432	0.4001	0.0567	0.1854
13 TIR SYSTI	0.6557	1,710	0.0444	0.1198	0.8776	0.0027	0.0444
12 AVVA TEC	0.8473	2,429	0.1076	0.0245	0.9525	0.0230	0.1076
64 SYMPLEX	0.5622	5,879	0.0942	0.0143	0.9054	0.0802	0.0942
32 TS TELEC	1	11,832	1.0742	1.0000	0.0000	0.0000	1.0742
42 FIFTY-PLL	1	2,404	0.1451	0.0000	1.0000	0.0000	0.1451
60 PACIFIC E	1	3,878	1.5079	0.0000	0.0000	1.0000	1.5079

Ranking, according to the distances that are less than 1 (for TRIPLE CROWN):

TRIPLE CF	0.526	4,979	0.0000
DBA TELE	0.6399	1,956	0.0286
TIR SYSTI	0.6557	1,710	0.0444
SYMPLEX	0.5622	5,879	0.0942
AVVA TEC	0.8473	2,429	0.1076
FIFTY-PLL	1	2,404	0.1451
ABL CANA	0.3991	13,382	0.1854

Similarity of the efficiency scores (difference between TRIPLE CROWN's score):

ABL CANA	0.3991	13,382	0.1854
TRIPLE CF	0.526	4,979	0.0000
SYMPLEX	0.5622	5,879	0.0942
DBA TELE	0.6399	1,956	0.0286
TIR SYSTI	0.6557	1,710	0.0444
AVVA TEC	0.8473	2,429	0.1076
FIFTY-PLL	1	2,404	0.1451

Similarity of the Market Cap. (difference between TRIPLE CROWN's market cap.):

TIR SYSTI	0.6557	1,710	0.0444
DBA TELE	0.6399	1,956	0.0286
FIFTY-PLL	1	2,404	0.1451
AVVA TEC	0.8473	2,429	0.1076
TRIPLE CF	0.526	4,979	0.0000
SYMPLEX	0.5622	5,879	0.0942
ABL CANA	0.3991	13,382	0.1854

Range for TRIPLE CROWN's market cap. based on peer group is \$1,710,000 - \$13,382,000

Market Capitalization of TRIPLE CROWN based on EFFICIENT PEERS
\$4,818 thousand

Valuation Analysis for TRI-VISION INTERNATIONAL LTD (SIC3600)

DMU	Score	Market C. Efficient Peers:					
#		\$(000s)	30	32	38	42	distance
78 TRI-VISIOI	0.7426	29,930	0.0850	0.1415	0.1094	0.6641	0.0000
30 RESEARC	1	585,308	1.0000	0.0000	0.0000	0.0000	1.3101
32 TS TELEC	1	11,832	0.0000	1.0000	0.0000	0.0000	1.1973
38 COMMUNI	1	3,855	0.0000	0.0000	1.0000	0.0000	1.2614
42 FIFTY-PLL	1	2,404	0.0000	0.0000	0.0000	1.0000	0.1521

Minimum mv \$2.4 million, one peer

UPPER BOUND:

Market Capitalization of TRI based on EFFICIENT PEERS

\$53,470 thousand

TUNDRA SEMICONDUCTOR CORP (SIC3600)

DMU	Score	Market C. Efficient Peers					
#		\$(000s)	32	38	67	76	distance
72 TUNDRA S	0.9817	120,705	0.1004	0.7976	0.0710	0.0311	0.0000
32 TS TELEC	1	11,832	1.0000	0.0000	0.0000	0.0000	1.4515
38 COMMUNI	1	3,855	0.0000	1.0000	0.0000	0.0000	0.0571
67 PRIMETEC	1	143,365	0.0000	0.0000	1.0000	0.0000	1.5102
76 LEITCH TE	1	1,031,559	0.0000	0.0000	0.0000	1.0000	1.5900

Minimum mv \$3.8 million

UPPER BOUND:

Market Capitalization of TUNDRA based on EFFICIENT PEERS

\$46,523 thousand

Valuation Analysis for UNITEC INTERNATIONAL CONTROLS (SIC3600)

DMU	Score	Market C. Distanc	Efficient Peers					
#		\$(000s)		5	17	42	67	distance
4 UNITEC IN	0.4349	5,571	0.0000	0.0217	0.0472	0.9285	0.0025	0.0000
5 GLOBAL T	1	13,222	1.8215	1.0000	0.0000	0.0000	0.0000	1.8215
17 AASTRA T	1	46,091	1.7705	0.0000	1.0000	0.0000	0.0000	1.7705
42 FIFTY-PLL	1	2,404	0.0078	0.0000	0.0000	1.0000	0.0000	0.0078
67 PRIMETEC	1	143,365	1.8598	0.0000	0.0000	0.0000	1.0000	1.8598

Fifty-Plus is only similar to Unitec in terms of distance, therefore it should have a market cap near \$2.4 million

Market Capitalization of UNITEC based on EFFICIENT PEERS

UPPER BOUND

\$5,057 thousand

TSI TEL (SIC 3600)

DMU #	Score	Market C. Distance \$(000s)	Efficient Peers	42	60	62 distance
56 TSI TELS	0.21119	12,193	0.0000	0.7477	0.1203	0.1320 0.0000
46 MARATHC	0.60450	623	0.0068	0.8016	0.1285	0.0699 0.0068
31 TRADE WI	0.67621	9,700	0.1355	0.4601	0.3397	0.2002 0.1355
19 BCS TECH	0.67662	1,027	0.0423	0.9156	0.0417	0.0428 0.0423
63 STRATEG	0.53425	1,720	0.0162	0.6999	0.0642	0.2359 0.0162
71 SHELLCA	0.08470	15,698	0.0235	0.8555	0.0113	0.1332 0.0235
81 COMPRES	0.31046	717	0.0752	0.9716	0.0131	0.0153 0.0752
42 FIFTY-PLL	1.00000	2,404	0.0956	1.0000	0.0000	0.0000 0.0956
60 PACIFIC E	1.00000	3,878	1.3503	0.0000	1.0000	0.0000 1.3503
62 SNIF SECI	1.00000	307	1.3269	0.0000	0.0000	1.0000 1.3269

Ranking, according to the distances that are less than 1 (for TSI TEL):

TSI TELS	0.21119	12,193	0.0000
MARATHC	0.60450	623	0.0068
STRATEG	0.53425	1,720	0.0162
SHELLCA	0.08470	15,698	0.0235
BCS TECH	0.67662	1,027	0.0423
COMPRES	0.31046	717	0.0752
FIFTY-PLL	1.00000	2,404	0.0956
TRADE WI	0.67621	9,700	0.1355

Similarity of the efficiency scores (difference between TSI TEL's score):

SHELLCA	0.08470	15,698	0.0235
TSI TELS	0.21119	12,193	0.0000
COMPRES	0.31046	717	0.0752
STRATEG	0.53425	1,720	0.0162
MARATHC	0.60450	623	0.0068
TRADE WI	0.67621	9,700	0.1355
BCS TECH	0.67662	1,027	0.0423
FIFTY-PLL	1.00000	2,404	0.0956

Similarity of the Market Cap. (difference between TSI TEL's market cap.):

MARATHC	0.60450	623	0.0068
COMPRES	0.31046	717	0.0752
BCS TECH	0.67662	1,027	0.0423
STRATEG	0.53425	1,720	0.0162
FIFTY-PLL	1.00000	2,404	0.0956
TRADE WI	0.67621	9,700	0.1355
TSI TELS	0.21119	12,193	0.0000
SHELLCA	0.08470	15,698	0.0235

Range for TSI TEL's market cap. based on peer group is \$623,000 to \$15,698,000

Market Capitalization of TSI TEL based on EFFICIENT PEERS

\$2,304 thousand

WE X.L (SIC 3600)

DMU	Score	Market C. Distance	Efficient Peers			Distance	
#		\$(000s)		30	32	42	Formula
85 WE X.L. H	0.94369	17,083	0.00000	0.00879	0.00595	0.98526	0.00000
83 NEXTRON	0.53445	2,426	0.00271	0.00322	0.04520	0.95158	0.00271
77 PLAINTRE	0.86634	14,946	0.57049	0.08840	0.49579	0.41586	0.57049
65 WI-LAN IN	0.87321	329,339	0.05722	0.03590	0.15989	0.80420	0.05722
3 INVERPOI	0.54465	7,179	1.67913	0.01160	0.92084	0.06760	1.67913
9 AVANTE T	0.58296	2,302	0.00034	0.00276	0.02100	0.97626	0.00034
30 RESEARC	1.00000	585,308	1.95326	1.00000	0.00000	0.00000	1.95326
32 TS TELEC	1.00000	11,832	1.95894	0.00000	1.00000	0.00000	1.95894
42 FIFTY-PLL	1.00000	2,404	0.00033	0.00000	0.00000	1.00000	0.00033
33 ADVANTE	0.18038	19,928	0.01432	0.01170	0.08910	0.89922	0.01432
45 KASTEN C	0.99488	23,569	1.32157	0.11300	0.76171	0.12529	1.32157

Ranking, according to the distances that are less than 1 (for WE X.L.):

WE X.L. H	0.94369	17,083	0.00000
FIFTY-PLL	1.00000	2,404	0.00033
AVANTE T	0.58296	2,302	0.00034
NEXTRON	0.53445	2,426	0.00271
ADVANTE	0.18038	19,928	0.01432
WI-LAN IN	0.87321	329,339	0.05722
PLAINTRE	0.86634	14,946	0.57049

Similarity of the efficiency scores (difference between WE X.L's score (0.94):

ADVANTE	0.18038	19,928	0.01432
NEXTRON	0.53445	2,426	0.00271
AVANTE T	0.58296	2,302	0.00034
PLAINTRE	0.86634	14,946	0.57049
WI-LAN IN	0.87321	329,339	0.05722
WE X.L. H	0.94369	17,083	0.00000
FIFTY-PLL	1.00000	2,404	0.00033

Similarity of the Market Cap. (difference between WE X.L's market cap. (\$17,083,000):

AVANTE T	0.58296	2,302	0.00034
FIFTY-PLL	1.00000	2,404	0.00033
NEXTRON	0.53445	2,426	0.00271
PLAINTRE	0.86634	14,946	0.57049
WE X.L. H	0.94369	17,083	0.00000
ADVANTE	0.18038	19,928	0.01432
WI-LAN IN	0.87321	329,339	0.05722

Range for WE X.L's market cap. based on peer group is \$2,302,000 and \$329,339,000

WE X.L's real market cap of \$17,083,000 is right in this range

Especially after ignoring the effect of Wi-lan, the range is between \$2.3 and \$20 million

Market Capitalization of WE X.L based on EFFICIENT PEERS

\$7,584 thousand

Valuation Analysis for WI-LAN (SIC 3600)

DMU #	Score	Market C. Distance \$(000s)	Efficient Peers 30	32	42	Distance Formula
65 WI-LAN IN	0.87321	329,339	0.00000	0.0359	0.1599	0.8042 0.0000
3 INVERPOI	0.54465	7,179	1.12221	0.0116	0.9208	0.0676 1.1222
9 AVANTE T	0.58296	2,302	0.05000	0.0028	0.0210	0.9763 0.0500
30 RESEARC	1.00000	585,308	1.60178	1.0000	0.0000	0.0000 1.6018
32 TS TELEC	1.00000	11,832	1.35380	0.0000	1.0000	0.0000 1.3538
33 ADVANTE	0.18038	19,928	0.01463	0.0117	0.0891	0.8992 0.0146
42 FIFTY-PLL	1.00000	2,404	0.06519	0.0000	0.0000	1.0000 0.0652
45 KASTEN C	0.99488	23,569	0.82904	0.1130	0.7617	0.1253 0.8290
77 PLAINTRE	0.86634	14,946	0.26639	0.0884	0.4958	0.4159 0.2664
83 NEXTRON	0.53445	2,426	0.03594	0.0032	0.0452	0.9516 0.0359
85 WE X.L. H	0.94369	17,083	0.05722	0.0088	0.0060	0.9853 0.0572

Ranking, according to the distances that are less than 1 (for WI-LAN):

WI-LAN IN	0.87321	329,339	0.00000
ADVANTE	0.18038	19,928	0.01463
NEXTRON	0.53445	2,426	0.03594
AVANTE T	0.58296	2,302	0.05000
WE X.L. H	0.94369	17,083	0.05722
FIFTY-PLL	1.00000	2,404	0.06519
PLAINTRE	0.86634	14,946	0.26639
KASTEN C	0.99488	23,569	0.82904

Similarity of the efficiency scores (difference between WI-LAN's score (0.873):

ADVANTE	0.18038	19,928	0.01463
NEXTRON	0.53445	2,426	0.03594
AVANTE T	0.58296	2,302	0.05000
PLAINTRE	0.86634	14,946	0.26639
WI-LAN IN	0.87321	329,339	0.00000
WE X.L. H	0.94369	17,083	0.05722
KASTEN C	0.99488	23,569	0.82904
FIFTY-PLL	1.00000	2,404	0.06519

Similarity of the Market Cap. (difference between WI-LAN's market cap. (\$329,339,000):

AVANTE T	0.58296	2,302	0.05000
FIFTY-PLL	1.00000	2,404	0.06519
NEXTRON	0.53445	2,426	0.03594
PLAINTRE	0.86634	14,946	0.26639
WE X.L. H	0.94369	17,083	0.05722
ADVANTE	0.18038	19,928	0.01463
KASTEN C	0.99488	23,569	0.82904
WI-LAN IN	0.87321	329,339	0.00000

Range for WI-LAN's market cap. based on peer group is \$2,302,000 and \$23,569,000
WI-LAN CONTROLS LTD real market cap of \$329,339,000 is far above this range

Market Capitalization of WI-LAN based on EFFICIENT PEERS

\$24,838 thousand

APPENDIX C

Efficient Companies-SIC 3600 Market Value Analysis

Based on BCC-I
For Company Aastra (17)

DMU #	Score	Market Cap \$(000s)	17	17	
17 AASTRA TE	1	46,091	1 normalized		
4 UNITEC INT	0.43488	5,571	4.72E-02	0.033738	187.9442594
53 SYSCAN IN	0.657407	7,260	0.052205	0.037316	270.8941374
21 CIRCA ENTI	0.859468	6,601	0.278	0.198711	1311.689405
66 CIRCUIT WK	0.75253	289	0.400605	0.286347	82.67916377
11 DANBEL INI	0.755337	5,798	0.621007	0.443888	2573.473118
			1.399018	1	\$4,427
REAL MARKET CAP of Aastra Tech					46,091

(as can be seen it is really similar to some really small companies)
Therefore, very small estimated market cap

Based on BCC-I
For Company Research in Motion (30)

DMU #	Score	Market Cap \$(000s)	30	30	
30 RESEARCH	1	585,308	1 normalized		
79 BALLARD P	1	3,608,271	3.12E-16	7.07E-16	2.55E-09
40 DIMENSION	0.110285	1,970	3.26E-04	7.39E-04	1.46E+00
9 AVANTE TE	0.582956	2,302	2.76E-03	6.25E-03	1.44E+01
83 NEXTRON C	0.534451	2,426	3.22E-03	7.30E-03	1.77E+01
14 DIGITAL PR	0.884281	28,123	3.45E-03	7.82E-03	2.20E+02
61 SIERRA WIF	0.996348	32,735	5.19E-03	1.18E-02	3.85E+02
36 CELL-LOC II	0.980304	28,669	5.58E-03	1.26E-02	3.63E+02
85 WE X.L. HOI	0.94369	17,083	8.79E-03	1.99E-02	3.40E+02
3 INVERPOW	0.544648	7,179	1.16E-02	2.63E-02	1.89E+02
33 ADVANTED	0.180379	19,928	1.17E-02	2.65E-02	5.28E+02
58 EXI TECHN	0.756899	9,422	1.17E-02	2.65E-02	2.50E+02
28 NHC COMM	0.670855	7,317	1.32E-02	2.99E-02	2.19E+02
41 DYNAMIC D	0.939374	110,354	1.72E-02	3.90E-02	4.30E+03
39 CYGNAL TE	0.589195	8,637	0.024202	5.48E-02	4.74E+02
65 WI-LAN INC	0.87321	329,339	3.59E-02	8.14E-02	2.68E+04
78 TRI-VISION	0.742628	29,930	0.085046	1.93E-01	5.77E+03
77 PLAINTREE	0.866344	14,946	8.84E-02	2.00E-01	2.99E+03
45 KASTEN CH	0.994883	23,569	0.112999	2.56E-01	6.04E+03
			4.41E-01	1.00E+00	\$48,895
Real Market Cap of Research in Motion					585,308

Lower Bound for CELESTICA(68)

BCC-I, for public companies only and SIC code of 3600s

DMU #	Score	Market Cap \$(000s)	Lambda 68		
68 CELESTIC	1	2,854,867	1	Norm	MC CALC
10 SEMI-TEC	0.214508	10,026	0.225377	0.514668	5160.04695
20 BELL CAN	0.254057	1,371,120	0.140231	0.320229	439072.5952
73 C-MAC INI	0.817145	291,127	5.88E-02	0.134275	39090.97203
82 GSI LUMO	0.916721	129,626	1.35E-02	0.030828	3996.146357
47 NEWBRID	1	8,125,481	4.70E-18	1.07E-17	8.72095E-11
TOTAL-----			0.437908	1	\$487,320 (000s)

Lower Bound for COMMUNICATION SYSTEMS INTERNAT (#38) BASED on BCC-I

DMU #	Score	Market Cap \$(000s)	38		
38 COMMUNI	1	3,855	1	NORM	MC CALC
21 CIRCA EN	0.859468	6,601	0.600904	0.196875	1299.569207
39 CYGNAL T	0.589195	8,637	0.261215	0.085582	739.2136901
53 SYSCAN II	0.657407	7,260	0.423308	0.138689	1006.81347
58 EXI TECHI	0.756899	9,422	0.224029	0.073399	691.5412618
61 SIERRA W	0.996348	32,735	0.635775	0.2083	6818.61277
62 SNIF SECI	1	307	0	0	0
72 TUNDRA S	0.98174	120,705	0.797585	0.261314	31541.98388
78 TRI-VISIOI	0.742628	29,930	0.109395	0.035841	1072.72965
			3.052211	1	\$43,170,000
			3,855,000		

Comm appears undervalued based on its peers.

Lower Bound for BALLARD POWER SYSTEMS INC (79) Based on BCC-I

DMU #	Score	Market Cap \$(000s)	79		
79 BALLARD	1	3,608,271	1		
20 BELL CAN	0.254057	1,371,120	0.450728	1	1371119.948
47 NEWBRID	1	8,125,481	1.88E-17	4.17E-17	3.38916E-10
			0.450728	1	\$1,371,120

Lower Bound for LEITCH TECHNOLOGY CORPORATION (76)

DMU #	Score	Market Cap \$(000s)	76		
14 DIGITAL P	0.884281	28,123	0.137482	3.46E-02	9.73E+02
20 BELL CAN	0.254057	1,371,120	0.409041	1.03E-01	1.41E+05
25 MEMOTEC	0.649191	4,953	1.46E-02	3.68E-03	1.82E+01
28 NHC COM	0.670855	7,317	3.33E-02	8.38E-03	6.13E+01
35 CANADIAN	1	426,808	4.53E-17	1.14E-17	4.87E-12
37 COM DEV	0.863264	252,315	0.800779	2.02E-01	5.09E+04
39 CYGNAL T	0.589195	8,637	2.65E-02	6.67E-03	5.76E+01
50 SPECTRU	0.78669	38,637	7.75E-02	1.95E-02	7.54E+02
51 SR TELEC	0.446954	112,897	0.444511	1.12E-01	1.26E+04
54 TEKLOGIX	0.809908	243,501	4.49E-02	1.13E-02	2.75E+03
57 WESCAM	0.628467	76,678	5.84E-02	1.47E-02	1.13E+03
58 EXI TECHI	0.756899	9,422	4.43E-03	1.12E-03	1.05E+01
61 SIERRA W	0.996348	32,735	9.59E-02	2.41E-02	7.90E+02
68 CELESTIC	1	2,854,867	3.97E-16	9.99E-17	2.85E-10
69 CORECO I	0.983382	44,923	0.140155	3.53E-02	1.58E+03
70 GENNUM I	1	576,578	1.21E-18	3.05E-19	1.76E-13
72 TUNDRA S	0.98174	120,705	3.11E-02	7.83E-03	9.45E+02
73 C-MAC INI	0.817145	291,127	0.56102	1.41E-01	4.11E+04
80 BLUESTAF	0.55479	44,404	3.79E-02	9.54E-03	4.24E+02
82 GSI LUMO	0.916721	129,626	0.966892	2.43E-01	3.16E+04
84 ROYAL LA	0.683747	51,561	8.81E-02	2.22E-02	1.14E+03
TOTAL-----			3.972509	1	\$287,982 Lower bound
			REAL		\$1,031,559 (000s)

Lower Bound For Efficient Company CANADIAN MARCONI(35) Based on BCC-I (for public companies only)

DMU #	Score theta	Market Cap \$(000s)	
35 CANADIAN	1	426808.3836	1
16 CINRAM II	1	1075690.711	8.52E-17
47 NEWBRID	1	8125481.339	6.94E-17

CANADIAN MARCONI is a self evaluator

Valuation Analysis for Efficient Company SNIF SECURITY INC (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peer		MC Calc.
			62	Norm	
62 SNIF SECURITY	1	307	1		
8 NORON TECH	6.53E-02	7,029	1.01E-02	5.68E-03	3.99E+01
19 BCS TECHNO	0.676619	1,027	4.28E-02	2.41E-02	2.47E+01
24 KING PRODUI	0.471945	7,739	0.785737	4.42E-01	3.42E+03
31 TRADE WIND	0.676206	9,700	0.200154	1.13E-01	1.09E+03
46 MARATHON F	0.604497	623	6.99E-02	3.93E-02	2.45E+01
49 SIMMONDS C	0.766307	2,854	0.152309	8.57E-02	2.45E+02
56 TSI TELSYS C	0.211188	12,193	0.132032	7.43E-02	9.06E+02
60 PACIFIC E-LIN	1	3,878	7.15E-16	4.02E-16	1.56E-12
63 STRATEGIC V	0.53425	1,720	0.235936	1.33E-01	2.28E+02
71 SHELLCASE L	8.47E-02	15,698	0.133211	7.49E-02	1.18E+03
81 COMPRESSIC	0.310462	717	1.53E-02	8.61E-03	6.17E+00
			1.78E+00	1.00E+00	\$7,164 thousand
					Lower Bound
					Undervalued

For Efficient Company Primetech Elect. (67)
Based on BCC-I (for public companies only, SIC 3600s)

DMU #	Score theta	Market Cap \$(000s)	Efficient Peers	Normalized	Market Cap Calculation
67 PRIMETECH ELECTRO	1	143,365	1		
53 SYSCAN INTERNATIONAL	0.657407	7,260	2.52E-03	0.000521	3.783845053
4 UNITEC INTERNATIONAL	0.43488	5,571	2.53E-03	0.000523	2.915121209
21 CIRCA ENTERPRISES I	0.859468	6,601	4.74E-02	0.009804	64.71617937
72 TUNDRA SEMICONDUCT	0.98174	120,705	7.10E-02	0.014685	1772.599234
50 SPECTRUM SIGNAL PF	0.78669	38,637	7.60E-02	0.015720	607.3594372
37 COM DEV INTERNATIONAL	0.863264	252,315	0.116802	0.024159	6095.657577
25 MEMOTEC COMMUNICATION	0.649191	4,953	0.165499	0.034231	169.5303344
6 LG TECHNOLOGIES GROUP	0.586585	27,707	0.263744	0.054552	1511.462381
1 HAMMOND MANUFACTURING	0.756773	18,426	0.331523	0.068571	1263.491358
34 CALIAN TECHNOLOGY	0.800142	33,191	0.346617	0.071693	2379.555791
51 SR TELECOM INC	0.446954	112,897	0.419239	0.086714	9789.678782
74 ELECTROHOME LIMITED	0.67333	11,398	0.499049	0.103221	1176.509313
57 WESCAM INC	0.628467	76,678	0.743748	0.153834	11795.71314
80 BLUESTAR BATTERY SYSTEMS	0.55479	44,404	0.869458	0.179835	7985.415051
54 TEKLOGIX INTERNATIONAL	0.809908	243,501	0.879623	0.181938	44302.0801
			4.834752	1.000000	\$88,920
			REAL CAP		\$143,365

Lower Bound for PACIFIC E-LINK CORPORATION (60) Based on BCC-I

DMU #	Score	Market Cap \$(000s)	Lambda 60		
60 PACIFIC E	1	3,878	1 Norm	MC Calc	
12 AVVA TEC	0.847256	2429.2787	0.023	0.007533	18.300002
13 TIR SYSTE	0.655687	1709.641	0.00267	0.000874	1.4950721
18 ABL CANA	0.399144	13381.932	0.0567	0.018571	248.51227
19 BCS TECH	0.676619	1026.6865	0.0417	0.013658	14.02232
22 DBA TELE	0.639866	1955.55915	0.0104	0.003406	6.661166
23 EIGER TEI	0.815085	8289	0.250062	0.081902	678.88359
24 KING PRO	0.471945	7738.941	0.214263	0.070177	543.09339
26 MICROCEI	0.0664	307086.6603	0.815481	0.267091	82020.155
31 TRADE WI	0.676206	9699.5409	0.339707	0.111263	1079.2008
32 TS TELEC	1	11832.45295	0	0	0
46 MARATHC	0.604497	622.9986	0.128525	0.042095	26.225257
49 SIMMOND	0.766307	2854.08	0.847691	0.277641	792.40911
55 TRIPLE CF	0.525957	4978.951	0.0339	0.011103	55.28197
56 TSI TELS	0.211188	12192.7525	0.120293	0.039399	480.38494
62 SNIF SECI	1	306.57981	1.62E-18	5.31E-19	1.627E-16
63 STRATEGI	0.53425	1719.7179	0.0642	0.021027	36.160814
64 SYMPLEX	0.562167	5879.226	0.0802	0.026268	154.43313
71 SHELLCAS	0.0847	15697.57	0.0113	0.003701	58.097418
81 COMPRES	0.310462	717.01003	0.0131	0.004291	3.0763978
TOTAL:		3.053191	1	\$86,216	(000s)
			REAL	3,878	(000s)

For Company SONY (15)

DMU #	Score	Market Cap \$(000s)	Efficient Peers
15 SONY CORI	1	52,935,385	1
1 HAMMOND	0.756773	18,426	0
2 TURBO GEI	1	80,615	0
3 INVERPOW	0.544648	7,179	0
4 UNITEC INT	0.43488	5,571	0

Sony is a Self Evaluator

For Company Cinram (16)

16 CINRAM INT	1	1,075,691	1
1 HAMMOND	0.756773	18,426	0
2 TURBO GEI	1	80,615	0
3 INVERPOW	0.544648	7,179	0

Cinram is a self evaluator

For Company MITEL (27)

27 MITEL COR	1	1,257,378	1
15 SONY CORI	1	52,935,385	1.38E-15
73 C-MAC INDI	0.817145	291,127	0.159901
			0.159901

MITEL Corp is a SELF evaluator

Based on BCC-I

For Company Nortel (29)

DMU #	Score	Market Cap \$(000s)	
29 NORTEL NE	1	50,495,406	1
80 BLUESTAR	0.55479	44,404	0
81 COMPRESS	0.310462	717	0
82 GSI LUMON	0.916721	129,626	0

NORTEL is a Self Evaluator

Lower Bound for NEWBRIDGE NETWORKS CORPORATION (47) based on BCC-I

DMU #	Score	Market Cap \$(000s)	47			
47 NEWBRIDGE	1	8,125,481	1			
15 SONY CORPC	1	52,935,385	4.25E-16	5.58E-01	2.96E+07	
29 NORTEL NET	1	50,495,406	3.36E-16	4.42E-01	2.23E+07	
			7.61E-16	1.00E+00	\$51,858,075	
					51,858,075	

Lower Bound for efficient JEMTEC INC (59) Based on BCC-I

DMU #	Score	Market Cap \$(000s)	59			
59 JEMTEC INC	1	330	1			
52 STRATEGIC T	0.983221	3,943	0.113323	1	3,943,000	lower bound
			0.113323		undervalued	

Lower Bound for INTERNATIONAL DATACASTING CORP based on BCC-I

DMU #	Score	Market Cap \$(000s)	44			
44 INTERNATIONAL	1	3,893	1	norm	mc calc	
5 GLOBAL THEI	1	13221.8604	9.54E-18	1.69E-16	2.2342E-12	
11 DANBEL INDL	0.755337	5797.576	0.0135	0.239124	1386.34114	
28 NHC COMMUI	0.670855	7317.08222	0.027856	0.493411	3610.32741	
66 CIRCUIT WOF	0.75253	288.73734	0.0151	0.267465	77.2271112	
			5.65E-02	1.00E+00	\$5,074	(000s)

Lower Bound for GENNUM CORPORATION (70) Based on BCC-I

DMU #	Score	Market Cap \$(000s)	70			
70 GENNUM COF	1	576,578	1			
16 CINRAM INTE	1	1,075,691	2.20E-17	1.93E-16	2.08E-10	
27 MITEL CORPC	1	1,257,378	5.55E-17	4.87E-16	6.12E-10	
47 NEWBRIDGE	1	8,125,481	1.20E-16	1.05E-15	8.55E-09	
69 CORECO INC	0.983382	44,923	1.19E-02	1.04E-01	4.69E+03	
84 ROYAL LASEF	0.683747	51,561	0.102096	8.96E-01	4.62E+04	
			1.14E-01	1.00E+00	\$50,868	lower bound

FIFTY-PLUS.NET INTERNATIONAL INC (42) (SIC 3600s)

DMU #	Score	Market Cap \$(000s)	Efficient Peers 42 (lambda)	Normalized Market Caps
42 FIFTY-PLUS.NET INT	1-	2,404	1	
8 NORON TECH LTD	6.53E-02	7.029	0.9899	0.0342 240.374
43 GEMSTAR COMMU	0.232398	4.888	0.9882	0.0341 166.850
85 WE X.L. HOLDING	0.94369	17.083	0.9853	0.0340 581.417
9 AVANTE TECHNOI	0.582956	2.302	0.9763	0.0337 77.645
81 COMPRESSION & E	0.310462	717	0.9716	0.0336 24.064
19 BCS TECHNOLOGY	0.676619	1.027	0.9576	0.0331 33.963
12 AVVA TECHNOLO	0.847256	2.429	0.9525	0.0329 79.931
83 NEXTRON CORPO	0.534451	2.426	0.9516	0.0329 79.749
75 LAMBUS ENTERPR	0.709557	1.729	0.9340	0.0323 55.794
4 UNITEC INTERNA	0.43488	5.571	0.9285	0.0321 178.676
28 NHC COMMUNICA	0.670855	7.317	0.9257	0.0320 233.968
64 SYMPLEX COMMU	0.562167	5.879	0.9054	0.0313 183.879
33 ADVANTEDGE INT	0.180379	19.928	0.8992	0.0311 618.990
13 TIR SYSTEMS LTD	0.655687	1.710	0.8776	0.0303 51.826
46 MARATHON FOOD	0.604497	623	0.8703	0.0301 18.729
40 DIMENSIONS WES	0.110285	1.970	0.8687	0.0300 59.118
71 SHELLCASE LTD	8.47E-02	15.698	0.8555	0.0295 463.863
69 CORECO INC	0.983382	44.923	0.8480	0.0293 1315.834
22 DBA TELECOM CO	0.639866	1.956	0.8450	0.0292 57.081
48 SENSE TECHNOLO	0.374065	61.221	0.8379	0.0289 1771.866
84 ROYAL LASER TEC	0.683747	51.561	0.8098	0.0280 1442.287
65 WI-LAN INC	0.87321	329.339	0.8042	0.0278 9148.869
24 KING PRODUCTS I	0.471945	7.739	0.7727	0.0267 206.551
36 CELL-LOC INC	0.980304	28.669	0.7599	0.0263 752.576
58 EXI TECHNOLOGIE	0.756899	9.422	0.7599	0.0262 247.298
56 TSI TELSIS CORP	0.211188	12.193	0.7477	0.0258 314.903
55 TRIPLE CROWN EL	0.525957	4.979	0.7153	0.0247 123.029
63 STRATEGIC VISTA	0.53425	1.720	0.6999	0.0242 41.574
78 TRI-VISION INTER	0.742628	29.930	0.6641	0.0229 686.587
31 TRADE WIND COM	0.676206	9.700	0.6570	0.0227 220.116
23 EIGER TECHNOLO	0.815085	8.289	0.5594	0.0193 160.181
53 SYSCAN INTERNA	0.657407	7.260	0.5220	0.0180 130.893
52 STRATEGIC TECH	0.983221	3.943	0.4871	0.0168 66.354
77 PLAINTREE SYSTE	0.866344	14.946	0.4159	0.0144 214.702
18 ABL CANADA INC	0.399144	13.382	0.4001	0.0138 184.965
11 DANBEL INDUSTR	0.755337	5.798	0.3099	0.0107 62.056
66 CIRCUIT WORLD C	0.75253	289	0.1531	0.0053 1.527
49 SIMMONDS CAPIT	0.766307	2.854	0.1498	0.0052 14.766
45 KASTEN CHASE AI	0.994883	23.569	0.1253	0.0043 102.007
3 INVERPOWER CON	0.544648	7.179	0.0676	0.0023 16.764
		28.9493	1.0000	\$20,432 (000s)
			Real	\$2,404 (000s)

FOR TS TELECOM(32) (SIC3600)

DMU #	Score	Market Cap \$(000s)	Efficient Peers 32	Normalized	
85 WE X.L. H	0.94369	17.083	0.0060	0.0006	10.203
64 SYMPLEX	0.562167	5.879	0.0143	0.0014	8.439
9 AVANTE 1	0.582956	2.302	0.0210	0.0021	4.853
12 AVVA TEC	0.847256	2.429	0.0245	0.0025	5.974
83 NEXTRON	0.534451	2.426	0.0452	0.0045	11.007
21 CIRCA EN	0.859468	6.601	0.0737	0.0074	48.832
33 ADVANTE	0.180379	19.928	0.0891	0.0089	178.221
72 TUNDRA S	0.98174	120.705	0.1004	0.0101	1216.243
13 TIR SYSTE	0.655687	1.710	0.1198	0.0120	20.554
78 TRI-VISIO	0.742628	29.930	0.1415	0.0142	425.022
22 DBA TELE	0.639866	1.956	0.1446	0.0145	28.377
65 WI-LAN IN	0.87321	329.339	0.1599	0.0160	5285.542
23 EIGER TEC	0.815085	8.289	0.1798	0.0180	149.603
57 WESCAM	0.628467	76.678	0.1979	0.0199	1522.969
55 TRIPLE CR	0.525957	4.979	0.2507	0.0252	125.311
61 SIERRA W	0.996348	32.735	0.2631	0.0264	864.595
74 ELECTROI	0.67333	11.398	0.4257	0.0427	487.049
1 HAMMON	0.756773	18.426	0.4467	0.0448	826.268
77 PLAINTRE	0.866344	14.946	0.4958	0.0498	743.788
18 ABL CANA	0.399144	13.382	0.5432	0.0545	729.641
34 CALIAN T.	0.800142	33.191	0.5935	0.0596	1977.292
39 CYGNAL 1	0.589195	8.637	0.6881	0.0691	596.540
6 LG TECHN	0.586585	27.707	0.7302	0.0733	2030.833
45 KASTEN C	0.994883	23.569	0.7617	0.0765	1802.024
25 MEMOTEC	0.649191	4.953	0.8199	0.0823	407.562
50 SPECTRUM	0.78669	38.637	0.8465	0.0850	3282.881
14 DIGITAL P	0.884281	28.123	0.8591	0.0862	2425.045
3 INVERPOV	0.544648	7.179	0.9208	0.0924	663.557
			9.96	1.00	25,878 REAL MC 11,832

FOR CAMCO INC (7)

52 STRATEGI	0.983221	3943.1541	0.00122	0.00062	2.454
6 LG TECHN	0.586585	27706.969	0.00603	0.00308	85.218
23 EIGER TEC	0.815085	8289	0.0107	0.00546	45.239
82 GSI LUMO	0.916721	129625.6	0.0196	0.01000	1295.904
34 CALIAN T.	0.800142	33191.018	0.0599	0.03055	1014.082
74 ELECTROI	0.67333	11397.939	0.0752	0.03836	437.190
54 TEKLOGI	0.809908	243501.46	0.0755	0.03851	9377.226
37 COM DEV	0.863264	252315.3	0.0824	0.04203	10604.658
80 BLUESTAI	0.55479	44404.112	0.0926	0.04723	2097.297
51 SR TELECI	0.446954	112896.71	0.1363	0.06950	7845.925
26 MICROCEI	0.0664	307086.66	0.1845	0.09412	28902.052
73 C-MAC INI	0.817145	291126.88	0.2203	0.11235	32707.433
1 HAMMON	0.756773	18426.08	0.2217	0.11310	2083.925
10 SEMI-TECI	0.214508	10025.976	0.7746	0.39511	3961.346
			1.9605	1	\$100,460 REAL MC \$100,000

APPENDIX D

Analysis of Efficient and Inefficient Companies SIC 3700

BUDD CANADA INC (3) (SIC 3700s)

Based on BCC-I for public companies

DMU #	Score	Market PRIMAf Capitalization SIC (000s) 1998	Efficient Peer 3			
3 BUDD CANAI	1	3714 116,772	1.00000			
				Norm	MC Calc	
1 GENERAL MC	1	3711 86,392,582	0.0000	0	0.0000	
2 A.E. VENTUR	0.8	3714 627	0.0036	0.00096	0.6006	
4 DECOMA INT	0.58	3714 560,656	0.4576	0.12212	68469.6354	
5 DEVTEK COF	0.67	3714 99,709	0.8819	0.23535	23467.0717	
6 LINAMAR CO	1	3714 1,792,517	0.0000	0	0.0000	
7 MAGNA INTE	1	3714 7,374,103	0.0000	0	0.0000	
8 MERCH PERI	0.65	3714 2,869	0.0000	0	0.0000	
9 NORTHSIDE	0.9	3714 14,056	0.0906	0.02418	339.8526	
10 ROSE CORP	0.71	3714 25,150	0.0000	0	0.0000	
11 SPECTRA PF	1	3714 525,280	0.0000	2E-18	0.0000	
12 STACKPOLE	0.63	3714 131,497	0.2442	0.06518	8571.3271	
13 TESMA INTEI	1	3714 570,124	0.4037	0.10774	61425.8952	
14 WESCAST IN	1	3714 574,300	0.0000	0	0.0000	
15 TRAILMOBILI	0.97	3715 14,342	0.3072	0.08198	1175.8158	
16 GLENDALE II	0.52	3716 47,948	0.4337	0.11574	5549.4522	
17 AVCORP IND	0.5	3728 45,730	0.1315	0.03509	1604.6554	
18 HEROUX INC	0.59	3728 62,462	0.2724	0.0727	4541.1077	
19 MAGELLAN A	0.63	3728 496,389	0.5206	0.13894	68970.6190	
20 SERENA RES	0.73	3731 572	0.0000	0	0.0000	
21 TEMPLAR RE	1	3732 4,576	0.0000	0	0.0000	
22 BOMBARDIEI	1	3743 7,502,049	0.0000	0	0.0000	
		Sum:	3.75	1	\$244,116 Calculated	\$116,772 Real

This is a lower bound for the efficient company, BUDD Canada, based on the inefficient companies being compared to it

Thus it seems that BUDD CANADA is rather undervalued

LINAMAR CORPORATION (6) (SIC 3700s)
Based on BCC-I for public companies

DMU #	Score	Market	Efficient Peer			
		PRIMA Capitalizati	6			
		SIC (000s) 1998				
6 LINAMAR CC	1	3714 1,792,517	1			
Norm MC Calc.						
3 BUDD CANAL	1	3714 116,772	0.0000	0	0.0000	
1 GENERAL MC	1	3711 86,392,582	0.0000	0	0.0000	
2 A.E. VENTUR	0.79684	3714 627	0.0000	0	0.0000	
4 DECOMA INT	0.57823	3714 560,656	0.4793	0.386	216331.3983	
5 DEVTEK COF	0.66674	3714 99,709	0.1181	0.095	9481.6534	
7 MAGNA INTE	1	3714 7,374,103	0.0000	0	0.0000	
8 MERCH PERI	0.65439	3714 2,869	0.0000	0	0.0000	
9 NORTHSIDE	0.89812	3714 14,056	0.0227	0.018	256.8636	
10 ROSE CORP	0.70626	3714 25,150	0.0000	0	0.0000	
11 SPECTRA PF	1	3714 525,280	0.0000	0	0.0000	
12 STACKPOLE	0.63128	3714 131,497	0.0000	0	0.0000	
13 TESMA INTEI	0.99948	3714 570,124	0.4697	0.378	215595.3103	
14 WESCAST IN	1	3714 574,300	0.0000	7E-17	0.0000	
15 TRAILMOBILI	0.97208	3715 14,342	0.0000	0	0.0000	
16 GLENDALE II	0.51504	3716 47,948	0.0000	0	0.0000	
17 AVCORP IND	0.50231	3728 45,730	0.0000	0	0.0000	
18 HEROUX INC	0.5871	3728 62,462	0.0000	0	0.0000	
19 MAGELLAN A	0.62997	3728 496,389	0.1523	0.123	60868.6475	
20 SERENA RES	0.72956	3731 572	0.0000	0	0.0000	
21 TEMPLAR RE	1	3732 4,576	0.0000	0	0.0000	
22 BOMBARDIEI	1	3743 7,502,049	0.0000	0	0.0000	
Sum:			1.24214	1	\$502,534 Calculated	
					\$1,792,517 Real	

This is a lower bound for the efficient company, LINAMAR CORP., based on the inefficient companies being compared to it

AVCORP INDUSTRIES INC (SIC 3700)

Based on BCC-I for public company

DMU #	Score	Market			Efficient Peers			
		PRIM	Capitali	Distance	3	11	21	Distance
		SIC	(000s)	1998				
# AVCORP	0.502312	3728	45,730	0.0000	0.131	0.415	0.453	0.000
2 A.E. VEN	0.796841	3714	627	0.4565	0.004	0.015	0.982	0.456
3 BUDD CA		1 3714	116,772	1.1322	1.000	0.000	0.000	1.132
# SPECTRA		1 3714	525,280	0.5643	0.000	1.000	0.000	0.564
# TEMPLAF		1 3732	4,576	0.4889	0.000	0.000	1.000	0.489

AVCORP only has 4 other peers, 3 of which are efficient

As can be seen from the distances, AVCORP is closest to AE Venture's (d=0.456)

Similarity of the efficiency scores (difference between AVCORP score (0.50):

AE Ventur -0.294529

Templar -0.497688

Spectra -0.497688

AVCORP efficiency score is not close to any of the others, the closest is AE Venture at 0.797

Similarity of the Market Cap. (difference between AVCORP market cap. (\$45,730,000):

AE Ventur 45,103

Templar 41,154

Spectra -479,550

AVCORP market cap is not close to any of the others.

Range for AVCORP market cap. based on peer group is between \$627,000 and \$525,280,000

AVCORP real market cap. of \$45,730,000 falls into such a great range with ease

Market Capitalization of AVCORP based on EFFICIENT PEERS

$[(0.131 \times 116772) + (0.415 \times 525280) + (0.45 \times 4576)]$

is \$235,632 million

APPENDIX E

**Analysis of Efficient and Inefficient
Companies SIC 2000**

Valuation Analysis for A. L. VAN HOUTTE LTEE (SIC2000)

DMU #	Score	Market PRIMA SIC	Capitalizati (000s) 1998	43.0000	Norm.	MC Calc.
43 A. L. VA	1	2095	632,441	1.0000		
7 SAPUT	0.787	2022	2,107,819	0.8086	0.2161	\$455,509
15 RIDLEY	0.9894	2048	160,050	0.7010	0.1873	\$29,983
10 LASSO	0.9632	2034	17,825	0.4980	0.1331	\$2,372
31 VINCOI	0.7498	2084	192,114	0.4271	0.1141	\$21,928
25 SLEEM	0.8323	2082	126,836	0.3086	0.0825	\$10,462
35 CLEAR	0.9535	2086	5,135	0.2984	0.0798	\$410
28 ANDRE	0.7103	2084	79,826	0.1964	0.0525	\$4,189
27 UNIBRC	0.9878	2082	33,828	0.1176	0.0314	\$1,063
44 ARCTIC	0.6402	2097	38,002	0.1053	0.0281	\$1,069
22 BIG RO	0.6985	2082	19,445	0.1013	0.0271	\$527
23 BRICK	0.7797	2082	15,421	0.0669	0.0179	\$276
29 MAGNC	0.6915	2084	13,310	0.0614	0.0164	\$218
8 DELICK	0.5398	2024	17,246	0.0308	0.0082	\$142
39 URBAN	0.8089	2086	12,878	0.0083	0.0022	\$28
11 GLOBA	0.5749	2038	14,410	0.0037	0.0010	\$14
20 AFRICA	0.8332	2066	683	0.0031	0.0008	\$1
34 ARROV	0.8705	2086	962	0.0030	0.0008	\$1
32 HIGHW	0.7103	2085	2,373	0.0022	0.0006	\$1
26 TREE E	0.8365	2082	1,917	0.0002	0.0000	\$0
24 FOSTE	1	2082	556,622	0.0000	0.0000	\$0
17 CANAD	1	2051	449,753	0.0000	0.0000	\$0
				3.7418	1.0000	\$528,193 thousand
						LOWER BOUND

Valuation Analysis of AMT Fine Food (SIC2000)

DMU #	Score	Market Capitaliz (000s)	Efficient Peer 19: AMT norm.	mc calc.
4 AMT FINE F	1	11,173	1	
34 ARROWHEA	0.8705	962	0.9897	0.082
6 TML FOODS	0.2571	1,782	0.9410	0.078
29 MAGNOTTA	0.6915	13,310	0.9376	0.078
18 BETA BRAN	0.3039	47,999	0.9359	0.078
23 BRICK BRE	0.7797	15,421	0.9307	0.077
37 LEADING BF	0.4515	8,570	0.9256	0.077
27 UNIBROUE I	0.9878	33,828	0.8817	0.073
39 URBAN JUIC	0.8089	12,878	0.8568	0.071
14 AGRO PACII	0.7703	10,874	0.8567	0.071
42 LEF MCLEAI	0.7971	3,381	0.8124	0.067
3 SEPP'S GOL	0.5941	27,532	0.7773	0.065
25 SLEEMAN B	0.8323	126,836	0.6861	0.057
22 BIG ROCK B	0.6985	19,445	0.6795	0.056
19 SMALL FRY	0.7801	26,740	0.3538	0.029
28 ANDRES WI	0.7103	79,826	0.2890	0.024
32 HIGHWOOD	0.7103	2,373	0.1831	0.015
24 FOSTER'S E	1	556,622	0.0000	0.000
12 DOVER INDI	1	53,129	0.0000	0.000
9 SUN-RYPE f	1	15,889	0.0000	0.000
		12.037	1.000	
				\$24,079 thousand
				lower bound

Valuation Analysis for AGRO & LEADING SIC2000

	Score	MC	Efficient Peer				
		\$(000s)	SCHNEI	AMT	FIN	FLETCH	Distance
14 AGRO PAC	0.77034	10,874	6.91E-02	0.85666	7.43E-02	0.0000	0.0094
37 LEADING E	0.45155	8,570	1.23E-03	0.92561	7.32E-02	0.0094	0.0000
2 SCHNEIDE	1	139,628	1			1.6060	1.8597
4 AMT FINE I	1	11,173		1		0.0308	0.0109
5 FLETCHER	1	5,936			1	1.5956	1.7158

Agro is similar to Leading and AMT

Market Value range: \$8,570,000 to \$11,173,000

Upper Bound

\$19,654 thousand

Leading is similar to Agro and AMT

Market Value: \$10,874,000 to \$11,173,000

Upper Bound

\$ 10,947 thousand

APPENDIX F

**Analysis Utilizing All
452 Companies**

HAMMOND compared to all 452 Companies

DMU #	Score	Market Value	SIC	Distance	Efficient Peers			
					73	322	372	443
175 HAMMOI	0.51431	18,426,080	3612	0.0000	0.667	0.187	0.070	0.075
83 CHATEA	0.82904	45,927,284	2331	0.0268	0.764	0.064	0.053	0.118
59 BUHLER	0.87389	66,664,560	3523	0.0248	0.751	0.088	0.016	0.145
296 PATHEO	0.52526	142,814,041	2834	0.0366	0.565	0.341	0.019	0.074
226 LASSON	0.63848	17,824,705	2034	0.0463	0.543	0.156	0.054	0.247
231 LEF MCL	0.58608	3,380,635	2092	0.1897	0.440	0.547	0.010	0.003
141 EXCO TE	0.73515	138,405,738	3544	0.1483	0.383	0.305	0.012	0.300
99 CONSOL	0.44399	5,177,589	2875	0.4791	0.249	0.732	0.007	0.012
302 PFB COF	0.94048	24,080,255	2821	0.4206	0.245	0.675	0.007	0.073
284 NTS COM	0.60877	48,091,341	3571	0.4685	0.226	0.707	0.005	0.062
163 GLEND A	0.31597	47,948,068	3716	0.5248	0.164	0.708	0.073	0.055
360 SICO INC	0.5653	71,058,787	2851	0.4547	0.158	0.625	0.089	0.128
242 MAGNOI	0.39093	13,310,001	2084	0.6923	0.147	0.831	0.003	0.020
210 IPL INC	0.69724	80,755,275	3081	0.5509	0.110	0.658	0.028	0.204
3 AASTRA	0.69365	46,090,505	3661	0.8635	0.075	0.899	0.016	0.010
308 POLYAIF	0.41828	27,260,000	3086	0.7992	0.054	0.838	0.043	0.065
93 CML IND	0.50334	7,109,353	2621	0.9865	0.029	0.944	0.014	0.014
261 MOBILE	0.52422	33,407,325	3585	0.9949	0.013	0.937	0.007	0.043
73 CARBITE	1	9,240,498	3949	0.1564	1.000	0.000	0.000	0.000
322 PROMAT	1	10,374,300	3841	1.1160	0.000	1.000	0.000	0.000
372 SMED IN	1	87,643,098	2522	1.3514	0.000	0.000	1.000	0.000
443 WESCAS	1	574,299,775	3714	1.3404	0.000	0.000	0.000	1.000

\$57,473,975 Upper bound based on Efficient Peers

Initially, Hammond was found to have 21 peers

RANKED BY DISTANCE TO HAMMOND

HAMMOI	0.51431	18,426,080	3612	0.0000
BUHLER	0.87389	66,664,560	3523	0.0248
CHATEA	0.82904	45,927,284	2331	0.0268
PATHEO	0.52526	142,814,041	2834	0.0366
LASSON	0.63848	17,824,705	2034	0.0463
EXCO TE	0.73515	138,405,738	3544	0.1483
CARBITE	1	9,240,498	3949	0.1564
LEF MCL	0.58608	3,380,635	2092	0.1897
PFB COF	0.94048	24,080,255	2821	0.4206
SICO INC	0.5653	71,058,787	2851	0.4547
NTS COM	0.60877	48,091,341	3571	0.4685
CONSOL	0.44399	5,177,589	2875	0.4791
GLEND A	0.31597	47,948,068	3716	0.5248
IPL INC	0.69724	80,755,275	3081	0.5509

MAGNOT	0.39093	13,310,001	2084	0.6923
POLYAIF	0.41828	27,260,000	3086	0.7992
AASTRA	0.69365	46,090,505	3661	0.8635
CML IND	0.50334	7,109,353	2621	0.9865
MOBILE	0.52422	33,407,325	3585	0.9949

RANKED BY EFFICIENCY

GLEND A	0.31597	47,948,068	3716	0.5248
MAGNOT	0.39093	13,310,001	2084	0.6923
POLYAIF	0.41828	27,260,000	3086	0.7992
CONSOL	0.44399	5,177,589	2875	0.4791
CML IND	0.50334	7,109,353	2621	0.9865
HAMMOI	0.51431	18,426,080	3612	0.0000
MOBILE	0.52422	33,407,325	3585	0.9949
PATHEO	0.52526	142,814,041	2834	0.0366
SICO INC	0.5653	71,058,787	2851	0.4547
LEF MCL	0.58608	3,380,635	2092	0.1897
NTS CO	0.60877	48,091,341	3571	0.4685
LASSON	0.63848	17,824,705	2034	0.0463
AASTRA	0.69365	46,090,505	3661	0.8635
IPL INC	0.69724	80,755,275	3081	0.5509
EXCO TE	0.73515	138,405,738	3544	0.1483
CHATEA	0.82904	45,927,284	2331	0.0268
CHATEA	0.87389	66,664,560	3523	0.0248
CHATEA	0.94048	24,080,255	2821	0.4206
CHATEA	1	9,240,498	3949	0.1564

RANKED BY MARKET CAPITALIZATION

LEF MCL	0.58608	3,380,635	2092	0.1897
CONSOL	0.44399	5,177,589	2875	0.4791
CML IND	0.50334	7,109,353	2621	0.9865
CARBITE	1	9,240,498	3949	0.1564
MAGNOT	0.39093	13,310,001	2084	0.6923
LASSON	0.63848	17,824,705	2034	0.0463
HAMMOI	0.51431	18,426,080	3612	0.0000
PFB COF	0.94048	24,080,255	2821	0.4206
POLYAIF	0.41828	27,260,000	3086	0.7992
MOBILE	0.52422	33,407,325	3585	0.9949
CHATEA	0.82904	45,927,284	2331	0.0268
AASTRA	0.69365	46,090,505	3661	0.8635
GLEND A	0.31597	47,948,068	3716	0.5248
NTS CO	0.60877	48,091,341	3571	0.4685
BUHLER	0.87389	66,664,560	3523	0.0248
SICO INC	0.5653	71,058,787	2851	0.4547
IPL INC	0.69724	80,755,275	3081	0.5509
EXCO TE	0.73515	138,405,738	3544	0.1483
PATHEO	0.52526	142,814,041	2834	0.0366

MARKET VALUE of WESCAST INDUSTRIES INC

Compared to All 452 Companies

DMU	Score	SIC	MC	443			
443 WESCAST INDI	1	3714	574,300	1 NORM	MC CALC		
33 ATS AUTOMATIC	0.7513	3569	995,530	0.757	0.0400	39815.81	1
300 PERKINS PAPER	0.746	2676	293,634	0.744	0.0393	11538.89	2
66 CANADIAN MARC	0.8897	3663	426,808	0.688	0.0363	15499.48	3
91 C-MAC INDUSTR	0.5323	3679	291,127	0.679	0.0359	10438.65	4
402 TESMA INTERNA	0.8329	3714	570,124	0.668	0.0353	20112.65	5
127 DOREL INDUSTR	0.6254	2512	682,294	0.639	0.0338	23032.51	6
114 DECOMA INTERP	0.5014	3714	560,656	0.625	0.0330	18493.70	7
344 SAMUEL MANU-T	0.5054	3316	310,901	0.618	0.0327	10154.30	8
251 MDC CORPORAT	0.3267	2759	242,559	0.617	0.0326	7909.67	9
410 TOROMONT INDI	0.5549	3585	456,602	0.569	0.0301	13723.41	10
204 INTERTAPE POL	0.4225	2295	982,579	0.566	0.0299	29384.66	11
239 MAGELLAN AER	0.5323	3728	496,389	0.505	0.0267	13248.18	12
447 WINPAK LTD	0.6517	2656	318,500	0.500	0.0264	8413.73	13
432 VELAN INC	0.7829	3494	793,613	0.500	0.0264	20946.55	14
124 DOMCO TARKET	0.7649	3996	207,110	0.480	0.0253	5247.18	15
67 CANAM MANAC (	0.4373	3441	177,740	0.461	0.0243	4323.78	16
416 TRITECH PRECI	0.4673	3369	194,222	0.447	0.0236	4588.68	17
63 CANADA BREAD	0.8189	2051	449,753	0.392	0.0207	9321.81	18
1 A. L. VAN HOUTT	0.9167	2095	632,441	0.391	0.0206	13055.57	19
32 AT PLASTICS INC	0.4201	2821	153,632	0.382	0.0202	3100.59	20
136 ENERFLEX SYST	0.8131	3563	420,532	0.366	0.0193	8125.80	21
232 LEITCH TECHNO	0.9981	3679	1,031,559	0.359	0.0189	19547.02	22
406 TIMBERWEST FC	0.761	2411	616,034	0.347	0.0183	11289.75	23
294 PAPERBOARD IN	0.3156	2631	95,201	0.333	0.0176	1673.56	24
334 RIDLEY INC	0.5976	2048	160,050	0.308	0.0163	2603.03	25
433 VENTRA GROUP	0.4732	3465	159,396	0.307	0.0162	2583.31	26
141 EXCO TECHNOL	0.7351	3544	138,406	0.300	0.0158	2191.58	27
337 ROLLAND INC	0.5274	2621	149,295	0.287	0.0152	2266.88	28
345 SAPUTO GROUP	0.5408	2022	2,107,819	0.277	0.0146	30834.88	29
357 SHAW INDUSTRI	0.8167	2899	767,740	0.271	0.0143	10999.64	30
226 LASSONDE INDL	0.6385	2034	17,825	0.247	0.0131	232.77	31
116 DEVTEK CORPO	0.4756	3714	99,709	0.235	0.0124	1236.16	32
210 IPL INC	0.6972	3081	80,755	0.204	0.0108	871.24	33
12 AINSWORTH LUM	0.2531	2411	44,467	0.199	0.0105	467.50	34
159 GENNUM CORPC	0.9264	3674	576,578	0.188	0.0099	5715.96	35
439 WAJAX LIMITED	0.4234	3569	120,082	0.187	0.0099	1185.35	36
382 STACKPOLE LIM	0.6015	3714	131,497	0.184	0.0097	1276.12	37
253 MERCER INTERN	0.5056	2611	138,461	0.161	0.0085	1177.89	38
318 PRIMETECH ELE	0.943	3672	143,365	0.157	0.0083	1189.87	39
59 BUHLER INDUST	0.8739	3523	66,665	0.145	0.0076	509.71	40
144 FANTOM TECHN	0.7381	3589	137,839	0.134	0.0071	976.71	41
435 VINCOR INTERN	0.5921	2084	192,114	0.133	0.0070	1354.22	42
324 PRUDENTIAL STI	0.9378	3498	205,602	0.131	0.0069	1419.85	43
360 SICO INC	0.5653	2851	71,059	0.128	0.0067	478.55	44
60 CAE INC	0.4545	3812	917,070	0.122	0.0065	5932.56	45
238 MAAX INC	0.5946	3088	307,970	0.122	0.0065	1990.95	46
162 GILDAN ACTIVEV	0.4694	2329	116,913	0.121	0.0064	747.32	47
83 CHATEAU STORI	0.829	2331	45,927	0.118	0.0063	287.17	48

62 CAMCO INC	0.6324	3631	100,000	0.115	0.0061	606.87	49
367 SLATER STEEL I	0.6055	3316	84,802	0.109	0.0058	488.52	50
335 RIVERSIDE FORI	0.432	2421	75,896	0.101	0.0053	403.70	51
281 NORWALL GROL	0.4815	2621	10,959	0.084	0.0044	48.50	52
70 CANGENE CORP	0.9171	2836	221,802	0.083	0.0044	974.63	53
175 HAMMOND MANI	0.5143	3612	18,426	0.075	0.0040	73.28	54
296 PATHEON INC	0.5253	2834	142,814	0.074	0.0039	560.42	55
302 PFB CORPORATI	0.9405	2821	24,080	0.073	0.0038	92.59	56
283 NQL DRILLING T	0.7518	3533	71,671	0.069	0.0036	260.05	57
346 SCHNEIDER COF	0.5659	2011	139,628	0.067	0.0036	496.29	58
173 HALEY INDUSTR	0.5094	3365	44,829	0.067	0.0035	158.63	59
285 NU-GRO CORPO	0.5592	2879	41,449	0.067	0.0035	146.45	60
308 POLYAIR INTERI	0.4183	3086	27,260	0.065	0.0034	93.44	61
284 NTS COMPUTER	0.6088	3571	48,091	0.062	0.0033	157.47	62
257 MILLTRONICS LT	0.967	3823	222,793	0.060	0.0031	700.12	63
243 MALETTE QUEBE	0.5702	2672	56,024	0.057	0.0030	167.18	64
163 GLENDALE INTE	0.316	3716	47,948	0.055	0.0029	139.28	65
261 MOBILE CLIMATE	0.5242	3585	33,407	0.043	0.0022	74.99	66
369 SMALL FRY SNA	0.4344	2064	26,740	0.034	0.0018	47.73	67
56 BRAMPTON BRIC	0.7719	3251	33,466	0.028	0.0015	49.84	68
347 SCI INCOME TRL	0.9085	2515	75,019	0.025	0.0013	99.95	69
196 INTERNATIONAL	0.4766	3585	440,175	0.022	0.0012	509.12	70
242 MAGNOTTA WINI	0.3909	2084	13,310	0.020	0.0011	14.20	71
209 IPEC LTD	0.5671	3533	26,958	0.019	0.0010	26.48	72
58 BUDD CANADA II	0.8532	3714	116,772	0.016	0.0009	99.56	73
368 SLEEMAN BREW	0.5592	2082	126,836	0.016	0.0008	105.17	74
93 CML INDUSTRIE	0.5033	2621	7,109	0.014	0.0007	5.29	75
99 CONSOLIDATED	0.444	2875	5,178	0.012	0.0006	3.17	76
389 SUN-RYPE PROI	0.6215	2033	15,889	0.011	0.0006	9.15	77
421 TUNDRA SEMICC	0.8818	3674	120,705	0.011	0.0006	66.94	78
3 AASTRA TECHN	0.6936	3661	46,091	0.010	0.0005	24.59	79
309 POLYCORP INC	0.7287	3061	28,084	0.010	0.0005	14.98	80
165 GLOBAL THERM	0.8089	3629	13,222	0.009	0.0005	6.23	81
131 EAGLE PRECISIK	0.5777	3542	57,395	0.007	0.0004	21.58	82
219 KELMAN TECHN	0.6784	2911	15,111	0.007	0.0004	5.36	83
135 ENERCHEM INTE	0.6288	2911	19,094	0.005	0.0003	5.50	84
106 CPI PLASTICS GI	0.4861	3089	60,851	0.005	0.0003	15.72	85
89 CIRCUIT WORLD	0.5216	3672	289	0.005	0.0003	0.07	86
384 STELLA-JONES I	0.6417	2491	19,540	0.004	0.0002	4.24	87
167 GROUPE BOCEN	0.5427	3442	27,022	0.004	0.0002	5.29	88
107 CRS ROBOTICS	0.55	3569	3,765	0.004	0.0002	0.71	89
231 LEF MCLEAN BR	0.5861	2092	3,381	0.003	0.0002	0.62	90
88 CIRCA ENTERPR	0.6802	3661	6,601	0.003	0.0001	0.98	91
100 CONSUMERS PA	0.2496	3221	204,373	0.002	0.0001	26.44	92
120 DIVERSIFIED INV	0.9812	2899	13,328	0.002	0.0001	1.46	93
430 UPLAND GLOBAL	0.7845	2834	11,221	0.001	0.0001	0.65	94
289 OTATCO INC	0.7962	3533	40,576	0.001	0.0000	1.80	95
47 BIOCHEM PHARM	1	2835	4,708,260	0.000	0.0000	0.00	96
234 LINAMAR CORPC	1	3714	1,792,517	0.000	0.0000	0.00	97
				18.93	1	\$408,330 thousand	
				Real Market Cap		574,300 thousand	

APPENDIX G

SIC 2800

#	DMU	naï Score	MC	min	max	upper bound	(real-min)	(real-max)	(real-upper)
INEFFICIENT COMPANIES									
						/real	/real	/real	
50	ACETEX	0.486	\$84,226	\$71,059	one peer	\$242,296	15.63%	#VALUE!	-187.68%
15	ALTARE	0.858	\$7,100	\$2,931	\$57,159	\$65,669	58.72%	-705.01%	-824.86%
1	AMR TE	0.697	\$76,024	\$24,080	\$153,632	\$202,026	68.33%	-102.08%	-165.74%
5	AT PLAS	0.516	\$153,632	\$24,080	\$974,676	\$1,033,335	84.33%	-534.42%	-572.60%
17	AXCAN	0.954	\$165,498	\$24,080	\$974,676	\$576,269	85.45%	-488.94%	-248.20%
39	BESTAR	0.754	\$1,488	\$3,725	\$44,269	\$14,971		-2875.48%	-906.25%
18	BIOTEC	0.554	\$22,801	\$530	\$32,776	\$20,020	97.68%	-43.75%	
51	CANHOI	0.385	\$1,792	\$6,577	one peer	\$6,844	-267.05%	#VALUE!	-281.96%
44	CANTOL	0.902	\$2,108	\$3,725	\$6,577	\$5,223		-211.97%	-147.75%
45	CCL INC	0.877	\$698,733	\$767,740	one peer	\$1,123,751	-9.88%	#VALUE!	-60.83%
46	CEAPRC	0.991	\$10,546	\$936	\$2,996	\$2,866	91.12%		
61	CHEMBI	0.752	\$2,917	\$2,846	\$3,207	\$6,809	2.42%	-9.95%	-133.44%
47	CONSOI	0.515	\$936	\$2,846	\$10,546	\$2,848		-1026.76%	-204.25%
57	CONSOI	0.629	\$5,178	\$6,577	one peer	\$13,950	-27.03%	#VALUE!	-169.43%
34	CV TECI	0.778	\$12,657	\$530	\$32,776	\$6,883	95.81%	-158.95%	
35	DIAGNC	0.630	\$13,124	\$2,846	\$140,743	\$43,307	78.31%	-972.45%	-229.99%
66	DIVERS	0.748	\$1,096	\$2,846	one peer	\$3,835	-159.69%	#VALUE!	-249.93%
12	FYTOKE	0.883	\$2,996	\$936	\$10,546	\$2,851	68.76%	-252.04%	
36	GENOM	0.823	\$20,562	\$2,846	one peer	\$3,809	86.16%	#VALUE!	
20	HAEMAC	0.474	\$55,116	\$19,046	\$77,292	\$71,869	65.44%	-40.24%	-30.40%
58	HEDLEY	0.753	\$936	\$530	\$32,776	\$5,034	43.37%	-3402.04%	-437.85%
21	HILLES	0.811	\$1,294	\$2,846	one peer	\$3,743	-119.99%	#VALUE!	-189.34%
37	IBEX TE	0.871	\$10,029	\$2,931	\$57,159	\$111,292	70.77%	-469.94%	-1009.70%
38	IMI INTE	0.960	\$11,881	\$530	\$32,776	\$9,599	95.54%	-175.86%	
22	INEX PH	0.937	\$18,596	\$2,931	\$140,743	\$116,560	84.24%	-656.85%	-526.81%
62	KRYSTA	0.745	\$1,398	\$530	\$32,776	\$22,496	62.10%	-2243.72%	-1508.61%
23	LABOPH	0.886	\$44,269	\$1,488	\$140,743	\$91,225	96.64%	-217.92%	-106.07%
4	LITHOS	0.489	\$10,733	\$530	\$32,776	\$16,647	95.06%	-205.37%	-55.10%
7	MAGNIF	0.821	\$20,940	\$3,725	\$78,451	\$77,282	82.21%	-274.65%	-269.07%
13	MARINE	0.621	\$19,046	\$2,931	\$77,292	\$19,274	84.61%	-305.82%	-1.20%
59	NAPIER	0.880	\$32,776	\$530	\$140,743	\$8,790	98.38%	-329.41%	
63	NORDE	0.727	\$530	\$936	\$12,657	\$5,166		-2286.47%	-874.02%
8	NOVA C	0.679	\$1,838,447	\$4,081,770	one peer	\$3,906,485	-122.02%	#VALUE!	-112.49%
60	NU-GRC	0.866	\$41,449	\$24,080	\$71,059	\$56,297	41.90%	-71.44%	-35.82%
25	ORALIF	0.985	\$2,931	\$6,895	\$57,159	\$40,000		-1849.89%	-1264.54%
26	PATHEC	0.684	\$142,814	\$24,080	one peer	\$27,505	83.14%	#VALUE!	
27	PHARMI	0.177	\$4,651	\$2,846	one peer	\$2,846	38.80%	#VALUE!	
14	PROME	0.591	\$78,451	\$20,940	\$140,743	\$80,431	73.31%	-79.40%	-2.52%
29	SALIX P	0.861	\$14,803	\$530	\$32,776	\$51,195	96.42%	-121.42%	-245.85%
41	SIGNAL	0.766	\$17,484	\$2,931	\$57,159	\$15,545	83.24%	-226.92%	
42	STRESS	0.825	\$44,932	\$140,743	one peer	\$140,881	-213.23%	#VALUE!	-213.54%
43	SYNSOF	0.489	\$77,292	\$2,931	\$140,743	\$72,892	96.21%	-82.09%	
30	TECHNI	0.871	\$107,756	\$24,080	\$153,632	\$259,036	77.65%	-42.57%	-140.39%
31	THERAT	0.903	\$57,159	\$2,931	\$140,743	\$87,578	94.87%	-146.23%	-53.22%
32	UPLANC	0.868	\$11,221	\$3,725	\$13,328	\$9,949	66.80%	-18.78%	
28/34 within range									33/45 upper than real

EFFICIENT COMPANIES

		Real	Lower Bound	real-lower/real	
2 BORDEI	1	\$3,725	\$17,264	-363.51%	1
3 DUPON	1	\$4,081,770	\$1,541,128	62.24%	2
9 PFB CO	1	\$24,080	\$102,332	-324.96%	3
10 POLY-P	1	\$1,251	self evaluator	#VALUE!	4
11 ALTA NA	1	\$6,577	\$2,622	60.14%	5
16 ANGIOT	1	\$140,743	\$36,862	73.81%	6
19 BIOVAIL	1	\$1,404,647	self evaluator	#VALUE!	7
24 NATRAC	1	\$8,108	self evaluator	#VALUE!	8
28 QLT PH	1	\$974,676	\$139,816	85.66%	9
33 BIOCHE	1	\$4,708,260	\$146,983	96.88%	10
40 CANGEI	1	\$221,802	\$66,915	69.83%	11
48 POLYME	1	\$3,207	\$3,600	-12.27%	12
49 SICO IN	1	\$71,059	\$73,206	-3.02%	13
52 LANDON	1	\$2,846	\$9,042	-217.67%	14
53 METHAN	1	\$1,370,334	self evaluator	#VALUE!	15
54 AGRILUM	1	\$1,541,000	self evaluator	#VALUE!	16
55 POTASH	1	\$5,261,648	self evaluator	#VALUE!	17
56 TERRA I	1	\$716,918	self evaluator	#VALUE!	18
64 AQUA-P	1	\$6,895	\$25,847	-274.87%	19
65 DIVERS	1	\$13,328	self evaluator	#VALUE!	20
67 SHAW II	1	\$767,740	\$539,758	29.70%	21

7/13 lower than real