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How a DuPont Roadmap Leads to an Equity Valuation Strategy: Monte Carlo Simulation and the Probability of a Mispriced Security

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Abstract

It is a common belief that capital intensive corporations are associated with relatively low profit margins. They operate in environments where it may be a struggle to keep returns in excess of their capital costs. This further implies a possible decline in stock value because of these lower margins. This paper extends the financial literature on the effects of capital intensity on firm performance through the introduction of the Cash DuPont Model in conjunction with a Monte Carlo Simulation. The model's use of the free cash flow to equity (FCFE), cash conversion factor (CCF), and resulting Cash ROE ultimately leads to the determination of the fair price to book value multiple. All of these data metrics are blended into a process of stock price valuation that explains both the possibility and probability of the mispricing of a stock. The results reveal that a capital-intensive firm can show undervalued tendencies despite low profit margins.

Introduction

It is widely accepted that a major goal of financial managers is to maximize shareholder wealth (Ross, Westerfield, and Jordan, 2021). Firms which experience relatively high capital intensity may be subject to greater firm risk as there is a greater variability in profitability (Shapiro and Titman, 1986). The logic is that a company which incurs large commitments to fixed costs may find these costs do not vary directly with sales volume and this can cause a variation in profitability (Brealy & Myers, 1984). The argument is made that the higher risk caused by higher capital intensity forces the cost of capital to increase thereby decreasing the value of the firm.

This is not a settled issue as it was found that an industry having relatively high capital-intensive companies can reduce risk that it faces because the prior commitment of cash to the purchase of fixed assets is a sunk cost thereby potentially reducing future costs which translate into a cost savings. Focusing on the capital-intensive restaurant industry, the increased capital intensity firm, decreased their risk, lowered their cost of capital and so enhanced firm performance and value (Lubatkin and Chatterjee, 1994). In a contrasting work, where firms followed a strategy of franchising operations, it resulted in a reduction of a firm's capital intensity requirement. Those firms that adopt this strategy will tend to own smaller amounts of fixed assets relative to their sales levels and maintain structured revenue streams. This can lead to firms being relatively less capital intensive thereby reducing their risk that can reduce the cost of capital facing the firm (Andrew, et al., 2007).

This paper next reviews the literature on capital intensity and profit margins followed by methodologies that describe the Dupont Return on Equity model and a focus on a unique extension of its use. A Monte Carlo Simulation is adapted to the data. A summary of results concludes the study.

Literature Review

Capital intensity is known to vary among industries and is usually closely tied to a firm's operating leverage. A review of capital-intensive industries was done by Schmidgall (2006) where utilities, mining, railroads, airlines, hotels, and restaurants were reviewed. Their emphasis was on the hospitality industry. Hsu and Jang's (2008) work tied capital intensity with idiosyncratic risk, finding a positive relationship.

Other key relationships have been looked at by comparing the capital intensity of a firm to its cost of capital and price performance. While high capital-intensive firms were associated with high price-cost margins there was a negative situation with firm performance. These discrepancies could have been due to how capital intensity was measured and even model specification errors (Scott and Pascoe, 1984).

The research on the relationship between capital intensity and risk is mixed. Brealy and Myers (1984) find that relatively high capital intensity impacts a firm's operating leverage and subsequently the risk factor. This is supported by Shapiro and Titman (1986). However, it has also been found that capital intensive firms could actually reduce costs in periods of uncertain economic conditions. There was a negative relationship with unsystematic risk (Lubatkin and Chatterjee (1994) which does not support other noted works.

The impact of capital intensity on market returns was found to be positive where cumulative average returns were enhanced, implying that the committed funds which created the firm's capital intensity may help decrease the need for future capital expenditures which would lead to an improvement in market returns (Reitenga, 2000).

The economic environment of capital-intensive industries is characterized by relatively low profit margins which tend to increase the cost of capital as to be above the return on equity capital. This is not a sign of value creation. In a study of 30 companies across the paper, steel, cement, aluminum, and tire industries, all characterized as being capital intensive, they were associated with a return on capital employed (ROCE) of only 5.40% A paradox is presented as supply-demand imbalance has forced prices downward and has led to declining profits yet the capital needed to finance capital intensive (CAPEX) industries is available However, the study also found evidence of capital-intensive firms whose actions resulted in higher profit margins. Several factors were isolated that led to the positive relationship. Firms chose to exit sectors that once were considered to be core but now moved into related sectors where new technologies provide an advantage. An example is the steelmaker Thyssen Krupp sold its steel business in order to move into higher profit margin products and services. Another factor that firms embrace is the reduction of costs and improvement of CAPEX efficiency. Firms need to rethink and reallocate their geographic footprint. A global chemistry company reduced their number of plant locations by 32%. This led to a reduction in the capital tied up in the property, plant and equipment and profit margins increased by 5%. Finally, capital intensive industries need to invest more in consumer services. A global power equipment manufacturer expanded its strategy to also focus on servicing its products to offset falling profit margins. The gross margin in service was 42% higher than the gross margin on its power equipment (Rousseau and Caruso, 2016).

With the mixed results found in the financial literature, this study enhances the existing financial literature on the effects of capital intensity on firm performance by creating an equity valuation model built upon DuPont methodology where the capital intensity (Capex), profit margin (PM), financial leverage (FL), cash conversion factor (CCF), and the cash return on equity (CROE) will proxy for a forecasted book value. Ultimately, the use of the current book value per share in conjunction with this cash-based equity model will place a value on the equity of the firm. The determination of equity value is further extended by the inclusion of probability distributions as determined by a Monte Carlo Probability Simulation.

Methodology

DuPont Analysis

An accepted practice in the analysis of a corporation's financial statements is to begin with an industry review (Palepu, Healy, and Bernard 2000). Yet, there is support on the notion that total profitability metrics such as the Return on Assets (ROA) and subsequently, the Return on Equity (ROE), will revert to economy-wide benchmarks (Fama and French 2000). However, further research shows that the components of the Returns on Assets and Equity, as delineated by the DuPont analysis format, will not revert to economy-wide levels. It is posited that the uniqueness of a specific industry environment can cause these ratios to cluster due to the inclusion of the firm in that industry.

In a work by Nissim and Penman (2001), it shows that average industry profit margins and asset turnovers had negative correlations which implies that these industries may have similar levels of ROA but have varying combinations of its components. The takeaway is that while the ROA and ROE can revert to economy-wide levels, it is likely that the components of profit margins (PM) and asset turnovers (AT) revert to industry levels. This paper focuses on firms within a capital-intensive industry and their respective DuPont profitability components.

A three-stage Return on Equity (ROE) Dupont model is utilized in this research. Under this approach, the Return on Equity is decomposed into three multiplicative components: asset turnover (ATO), profit margin (PM), and Financial Leverage (FL). The asset turnover ratio is closely tied in with the recognition of a firm's degree of being capital intensive. The reciprocal is the measure of capital intensity and is referred to as the CAPEX ratio. The following is the breakout of the profitability ratio:

Asset Turnover = Sales/Assets
Profit Margin = Net Income/Sales
Financial Leverage = Assets / Equity
Return on Equity = Sales/Assets * Net Income/Sales * Assets / Equity
Where Capital Intensity Ratio = Assets/Sales

The asset turnover ratio measures how efficiently the firm is utilizing its assets to generate sales revenues. A normal ratio will vary from industry to industry. Its calculation is helpful in establishing a means of comparison of firms within an industry or an industry-type (i.e., capital intensity). An increasing ratio implies an improving efficiency and possible increase to company cash flows.

The profit margin ratio measures the contribution of sales in-order-to determine how efficiently management is turning the sales revenue into profits for the company. Improvements can be seen where there is a reduction in costs and/or increase in stock price.

The financial leverage ratio measures the use of debt used by the corporation to fund its purchase of assets. Many companies in capital intensive industries use both debt and equity to fund their growth. The use of excessive debt in order to improve financial leverage and the return on equity can bring about higher levels of risk.

Capital intensive industries are those that require relatively large commitment of capital in order to fund needed fixed assets. Firms in capital intensive industries are characterized by high levels of property, plant, and equipment and associated depreciation expense. The ratio is the reciprocal of the asset turnover ratio where its calculated as total assets/Sales. A capital intensive firm is expected to have a CAPEX greater than 1.0.

Monte Carlo Simulation

The Monte Carlo Simulation is used to analyze models that contain uncertainty. It offers the ability to simulate a model so a variety of scenarios that might occur can be seen rather than a single best guess scenario. This is a perfect application for this test of pricing capital intensive firms. There were fourteen input metrics overall that could potentially change over time. Traditional analysis would treat them all as static over a fixed time horizon. Here, they are all modeled with probability distributions in order to see to what degree they may be considered as critical decision variables. These probability distributions produce parameters such as the mean, minimum, maximum, and standard deviation of a normal distribution along with the determination of a lower 5% percentile and upper 95% percentile. In the running of the simulation, there is a recalculation based on ten thousand iterations. After each iteration, a sample random variable is generated for each decision variable containing the probability distribution. For any stochastic model, the first requirement is the ability to generate random variables. The reproduction of a sequence of random numbers is important for reducing the variance of the distribution (McLeish, 2005). The analysis is performed in Excel and makes use of @RISK software. There are two key functions. The first is the =NORMINV(Rand()), mean, standarddev) which returns the inverse of the normal cumulative distribution for the specified mean and standard deviation. It uses an iterative search technique. Within this function, the Rand() function returns a random number greater than or equal to zero and less than 1, evenly distributed and changed on recalculation. It takes the cumulative probability as input and provides the value of the decision variable corresponding to that cumulative probability. This paper incorporates a Monte Carlo Simulation as it includes fourteen unique decision input balance sheet, income statement, and cash flow variables. The by product will be the determination of the output decision variables along with several probability calculations regarding the movement of the stock price.

Data for a Capital-Intensive Firm and the Cash DuPont Equity Valuation Model

Industries whose firms require large investment commitments in order to produce goods and services will tend to have a high percentage of fixed assets, such as property plant and equipment (PP&E). These industries are capital intensive. It is not surprising that firms within a capital-intensive industry have high levels of depreciation on said assets. In order for firms, within these industries, to generate an acceptable return on their investments, high profit margins must exist. Prime examples of capital-intensive industries include automobile manufacturing, oil refining, oil production, restaurants, steel production, and transportation sectors like railways and airlines (Downes and Goodman 1998). However, as mentioned in the literature review, the common finding is just the opposite as capital intensive industries are associated with low profit margins. Healthier margins may be achieved by focusing on the most profitable sectors and improving capex efficiency (Rousseau and Caruso 2016). The capex ratio is the measure of capital intensity and is calculated as the total assets divided by total sales which is the reciprocal of the asset turnover ratio found in the DuPont method.

The financial literature is extended by the subsequent formation of an equity valuation model that is driven by the DuPont Method which is modified through a free cash flow adjustment. The cash flow influenced model creates a proxy for the Expected Price to Book Ratio which is compared to the Realized Price to Book. An Alpha value is calculated whereby the sign designates whether the stock is undervalued or overvalued. The process begins with the determination of the three-stage Dupont. This paper chooses a firm which is in a capital-intensive industry and experiences a relatively common low profit margin. With this backdrop, a model is created, relying on DuPont Analysis, that ultimately transforms the accounting return on equity into a financial 'Cash ROE'. This unique feature of the model enables the subsequent proxy for a 'fair' price to book ratio (FPB). It is this fair price to book ratio when utilized with the realized book value per share that enables the Dupont Equity Valuation Model to work.

This paper models the valuation process based on the following metrics:

1. Asset Turnover Ratio (ATR) and Capex Intensity (Capex)
2. Profit Margin (PM)
3. Financial Leverage (FL)
4. Cash Conversion Factor (CCF)
5. Cash ROE (CROE)
6. Forecasted Fair Price to Book Value Ratio (FPB)

The Dupont three-factor model for the Return on Equity (ROE) is as follows:
*Return on Equity (ROE) = Total Asset Turnover * Profit Margin * Financial Leverage*
*Return on Equity (ROE) = (sales/total assets) * (net income/sales) * (total assets/total equity)*
The data is taken from the time-period of 2016 through 2020 (Finviz.com).

Total Asset Turnover and the Capex Intensity (Capital Intensity Ratio)

Total Asset Turnover = Net Revenues / Total Assets
Capital Intensity = Total Assets / Net Revenues

While the total asset turnover shows how much revenues the firm has generated for every $1 in assets, the capital intensity ratio reveals how much of the firm's assets must be used to generate $1 in revenue. The asset turnover ratio measures how sales are linked to the assets of the firm. Looking at this same ratio from the perspective of capital intensity, the Capex ratio becomes the reciprocal of the total asset turnover or (total assets / sales). The Capex measures the ability of firm to effectively use its assets. At the heart of Capex is a measure of the investment by a corporation in their respective current assets, fixed assets (property, plant, and equipment), and other assets (patents and goodwill) in-order-to generate $1 of sales revenue. The actual Capex formula is the total assets divided by sales revenue for a specified period. It is the reciprocal of the asset turnover ratio found in DuPont. As the asset turnover increases, the capital intensity of a firm decreases. A firm with a relatively high capital-intensive ratio implies that the firm has to make significant investments in assets relative to the amount of sales revenue those assets can produce. In assessing the capital intensity ratio, it must be compared with the ratios of similar businesses. This would include competitors or other businesses within the same industry. If possible, the average capital intensity ratio of the industry the business operates within should be compared. Capital intensive firms are expected to have CAPEX ratios greater than 1.0.

The ratio can be more easily interpreted, and decisions based on the interpretation will be meaningful. An example would be the review of two firms within the same industry. Firm Alpha has a Capex of 1.35 and Firm Beta has a Capex of 1.55. The interpretation is that since the capital intensity of Beta is higher than that of Alpha, Firm Beta has used more assets to generate lesser sales revenues. It may even be the case that both the assets and revenues of Beta exceed that of Alpha, the take-away is that Alpha was more efficient in the handling of its resources.

Profit Margin

The Profit Margin (PM) is a measure of a firm's profitability as it shows the percentage of sales that have been turned into profits. It is important to remember that it is the asset expenditures (Capex) of the firm that generate the needed sales revenue. The ratio shows the profits generated for each $1 of sales. If a business has a 25% profit margin, it means that it had a net income of $0.25 for each dollar of sales generated. What constitutes an 'acceptable margin' will vary from industry to industry, the following are generally accepted as a norm; A PM of 20% is Good, PM of 10% is Average, and a PM of 5% is low. Capital Intensive industries tend to fall in the latter category. The profit margin (PM) ratio is found by dividing net income by revenue and in-order-to make the margin a percentage, multiply the result by 100.

The calculation of the margin is:

Net Profit Margin = (Revenue-Cost of Sales-Operating Expenses-Other Expenses-Interest Expense-Tax Provision) / Sales Revenue
Net Profit Margin = (Net Income/Revenue)

The following schedule reflects average profit margins for some of the most common industries in the USA:

Industry Average Net Profit Margins

Auto Repair	12%	Restaurants	15%
Construction	5%	Retail.	5%
Hotels	8%.	Tax Service.	20%
Maintenance Serv	10%.	Transportation	19%

Financial Leverage (FL)

The financial leverage ratio measures the amount of the firm's assets that are financed by its shareholders by comparing total assets with total shareholders' equity.

It shows the percentage of assets that are financed or owned by the shareholders. It is a simple ratio of the Total Assets divided by Total Equity. A subtle, yet critical implication of the FL ratio, is that it reflects the level of debt financing that is used by the firm to acquire assets and maintain operations. In essence, it's a measure of the reliance on debt financing in the procurement of fixed assets. This use of debt adds risk for creditors as now the firm must generate sufficient cash flows to service the current debt obligations. When a firm's assets are primarily funded by debt, we would expect the Capex ratio of the firm to be relatively high and presents more risk for investors. Firms with the lower FL are less dependent on debt financing and do not have high debt servicing costs. An increase in the Financial Leverage can be defined as every dollar invested in common equity results in an increase in assets. Cash flow is strengthened. Also, implicit, is that an increase signals the use of more debt relative to equity. The additional effect will be an increase in interest obligations. While this is a burden on cash flows, interest payments on debt are tax deductible and so this higher proportion of debt leads to a higher ROE. The benefits of financial leverage will decline as the default risk on interest payments increase. If too much debt is undertaken, the benefits of financial leverage diminish as the risk of defaulting on interest payments increases. The cost of debt will rise as higher risk premiums are demanded by creditors and ROE will decline. A positive impact occurs where the firm's ROE exceeds the after-tax cost of debt.

The FL is used in the DuPont Analysis to illustrate how leverage affects a firm's return on equity (ROE). In a logical financial context, a firm with a relatively high Capex will likely have high depreciation expenses due to the increase in fixed assets. The securing of these assets required the use of cash and, more likely, the procurement of debt. If a company operated in an industry that required a high number of assets to produce relatively low sales revenue, that could account for the relatively low profit margins seen in capital intensive industries.

Accounting Return on Equity (ROE)

The traditional accounting return on equity (ROE) is a measure of the profitability of a business in relation to the equity. It measures how many dollars of profit are generated for each dollar of shareholder's equity. It is a metric of how well the firm utilizes its equity to generate profits. The ROE = Net Income (after preferred dividends but before common dividends), Divided by total equity (excluding preferred shares), expressed as a percentage. It is used for comparing the performance of companies in the same industry.

It is a measure of management's ability to generate income from the equity available to it. This paper makes use of the DuPont method as it will decomposes the ROE into three critical components in order to view the performance of the firm and ultimately place a value on its stock price. The DuPont ROE is calculated as (ATR x PM x FL). Splitting DuPont ROE into three parts makes it easier to understand changes over time. It also allows us to focus on capital intensive industries**.** Our expectations regarding the model components are that an increase in the PM implies that every sales dollar contributes to higher profits and increased cash flow**,** resulting in a higher ROE. If the asset turnover ratio increases, every dollar invested in assets results in more sales and increased cash flows, resulting in a higher ROE.

Cash Conversion Factor (CCF) and the Free Cash Flow to Equity (FCFE)

A unique feature of this paper is the introduction of the cash conversion factor (CCF) which is used to convert the accounting ROE into a financial 'Cash ROE'. The CCF compares a firm's operating cash flows with its profitability. The model measures how efficiently the firm converts its profits into cash flows. From the statement of cash flows, the Free Cash Flow to Equity (FCFE) needs to be determined. This is accomplished as follows:

Free Cash Flow to Equity (FCFE)
Net Cash Flow from Operations + Net Cash Flow from Capital Expenditures + Net Cash Flow from Long-Term Borrowing
Where
Net Cash Flow from Capital Expenditures = Sale of Property, Plant, and Equipment – Capital Expenditures
Net Cash Flow from Long Term Borrowing = Long Term Debt Issued – Long Term Debt Repaid

The net operating cash flows are adjusted for any net capital investment expenditures and long-term borrowing and then divided by the net income of the firm**.** This is the critical step that converts net income into 'cash income'.

Cash Conversion Factor = (Free Cash Flow to Equity / Net Income)

This cash conversion factor is useful in analyzing the credit policy of a firm as it helps to understand a company's cash generation. Specifically, for this paper, it will enhance the equity valuation process by assessing a company's earnings quality. The cash conversion factor can be expressed as either a multiple or as a percentage, the former is used in this paper.

If the cash conversion factor is greater than 1.0, it indicates a business can convert a majority of its earnings into cash. Even firms, with relatively high earnings, must be able to convert these earnings into cash on a timely basis so it can meet both short-term and long-term funding needs. A high cash conversion factor may imply the efficient use of its working capital, such as strong receivable and inventory turnovers and good credit terms with suppliers.

In contrast, a cash conversion factor that is below 1.0 can indicate that the funding requirements of the company may be constrained and could suggest that a firm is concealing poor underlying performance. This is because cashflows are often affected by poor performance before profits. A low cash conversion factor could be due to slow inventory turnover or late receivables collection. The latter could be influenced by bad debts or suppliers tightening their credit terms because they are concerned about the business. (Kazi, 2021).

In the case of the capital-intensive firms within this study, their cash conversion factor had a multiple of less than 1.0. The capital-intensive industry firms posted a relatively poor performance as several years revealed net losses. The strong commitment to capital expenditures mitigated their respective cash flows

Cash Defined DuPont Return on Equity (CROE)

While this empirical work does not conduct a Discounted Cash Flow (DCF) valuation, the need to focus on forecasting free cash flows to arrive at the value of a stock still exists. The numerator of the CCF is the free cash flow to equity of the firm. The Cash DuPont ROE model, just like the DCF, involves several assumptions. Specifically, in the case of the cash conversion factor ratio, expectations are that this multiple will indicate the state of a business' investment requirements and environment. Based upon the cash conversion factor, the accounting ROE is now defined in terms of the firm's free cash flow to equity.

*Cash Defined Dupont ROE = Cash Conversion Factor (CCF) * Accounting Dupont ROE*

Expected Fair Price to Book Value

Utilizing both the annualized S&P 500 Index return and the latter Cash Defined DuPont Return on Equity, the Expected Fair Price to Book Value Ratio is constructed.

Expected Fair Price to Book Value (FPB) = Cash Defined DuPont ROE / Annualized Market Index Return

The market return is a measure of the performance of the S&P 500 Index. The annualized market return is computed using the buy and sell prices and a specific holding time period. Here, the holding period is from November 1, 2016 through November 1, 2021. The interest rate is computed so that if compounded for the holding period, it gives the final investment value for the initial amount invested. That interest rate is called the annualized rate of return. Because the annualized return standardizes the holding period to one year, you can compare returns for investments with different holding periods. It is common to use annualized returns to evaluate the performance of investments (Robert Shiller - Long Term Stock Data, 2021).

The Price to Book (P/B) is an equity valuation ratio that compares the stock price per share to the book value per share. The book value represents the equity of shareholders. It is expressed as a multiple that represents how many times the book value stock investors are willing to pay to acquire a company's stock. Book value is a calculation of the company's recorded assets, minus the liabilities shown on its balance sheet. It is a per-share estimate of the liquidation value of the company. It's useful to look at the P/B evaluation along with ROE evaluation as they both factor in the book value of equity. There can be sizable divergences between the two measures. Ideally, P/B and ROE move in tandem. Usually, a high P/B and a low ROE indicates overvalued securities. While a low P/B with a high ROE indicates undervalued securities. (Maverick, J.B. 2019).

The value of an investment is based on the cash that can be withdrawn from it over time. Hence, an investment's "right" price to book value ratio should be determined by its free cash return on tangible assets times its acceptable leverage ratio. Note that the construct of the expected fair price to book value (FPB) is based on DCF techniques that define a present value of an asset. Here, the cash defined Dupont ROE is treated as a perpetuity-like item that is being discounted at the prevailing market rate of return. Through this latter action, the result of the calculation is a present value. It represents a 'fair' value as it depends upon the overall market return. It allows the calculated price to book to be referred to as the 'Fair Price to Book Value'. Any subsequent attempt to forecast the future value of the stock can be interpreted as its 'fair price'. A comparison of the fair price to its actual price will determine if it's over or under valued.

Connection between Price to Book Ratio (PB) and the Cash ROE

The accounting definition of net worth is the differential between assets and liabilities which results in the equity of the firm. This net worth or equity is also referred to as the firm's book value. The price to book value ratio tells us that at any given stock price, how much is the market willing to pay for the net worth or book value of the firm. This Cash DuPont Equity Valuation model creates a 'Cash ROE' and capitalizes it by dividing it by the market index rate of return. This market index return represents an investor's required return, a benchmark of the least acceptable return an investor will accept. Hence, the ratio of the Cash ROE to the required market index return creates the 'fair' value or price at which an investor should pay for the book value of the firm. This ratio serves as a proxy for the estimated price to book value ratio. When this estimated price to book value is multiplied by the actual book value per share, it results in the estimated intrinsic value of the firm. It represents the 'fair' value of the stock. If the actual stock price is above this estimated fair price, the investor will not earn the required market return making it relatively expensive. An Alpha-like value is created as the differential between the Cash-Equity Model determined estimated price to book value and the actual price to book value.

A positive Alpha implies that the stock is mispriced and specifically that it is undervalued. Likewise, a negative Alpha implies a stock overvaluation.

One takeaway from this Cash DuPont Valuation Model is that investors need to look beyond the trending of prices to make a statement about its fair value. Markets are expectational and stock values must reflect these expectations. The Cash Dupont ROE model presented in this paper gives the investor a more comprehensive way to justify their stock purchase. With the construct of the model, investors can now point to capital intensity, profit margin, financial leverage and the unique "Cash ROE" to explain the possible mispricing of the stock. From this DuPont model, the fair price to book ratio can also be proxied. Another strength of this model is that it is rooted in the concepts of discount cash flow analysis.

Data Sources and Segmentation for the Cash-Dupont Equity Valuation Model

To perform the analysis, a capital-intensive industry and subsequently one of its firms, had to be determined. The first step in securing the data was to use the stock screener process found in FINVIZ.com. The filtering process resulted in finding the leading firms in the Oil and Gas Extraction Industry, the latter is typically thought of as being capital intensive. Three examples of oil extraction firms that 'filtered' through were the Baker Hughes Corporation (NASDAQ, BKR), the Haliburton Company (NYSE, HAL), and Schlumberger Limited (NYSE, SLB). All three were leading companies within the industry. However, to be included in this study, a firm had to also meet the criteria of capital intensity whereby the CAPEX is greater than 1.0. All the firms listed by FINVIZ met this requirement. The detailed financial data for the firms was then obtained from the Capital IQ data base (capitaliq.com), covering the years 2016 through 2020. The following table presents the average Capex and Profit Margin data for the three representative stocks over this time period.

Table 1

Oil Extraction Firms
Average Capital Intensity and Profit Margins
Period: 2016 through 2020

Firm	Capital Intensity	Profit Margin
Baker Hughes (BKR)	2.37	(11.39%)
Haliburton (HAL)	1.27	(8.88%)
Schlumberger (SLB)	2.16	(14.71%)

Data from Capitaliq.com
Note that all three firms have a capital intensity ratio greater than 1.0.
Capital Intensity Ratio is equal to total assets divided by total revenue.
All three firms are characterized by relatively low profit margins.
Over the time period of 2016 through 2020, they all experienced negative profit margins.

This paper will concentrate on Baker Hughes, with its relatively high capital-intensive ratio and low profit margin. The proposed equity valuation model converts an accounting ROE, using a cash conversion factor based upon the free cash flow to equity (FCFE), into a finance 'cash' ROE (CROE). A forecasted fair price to book value is formulated based on the relationship between the Cash ROE and the market return.

The product of the estimated price to book value and the average book value per share, results in the ability to speculate whether the security is undervalued or overvalued. The data analytics is further enhanced through the creation of a probability distribution of various inputs and outputs as delineated in Table 2 that follows:

Table 2
Baker Hughes Company
Decision Variables Utilized in a Monte Carlo Simulation
Within a DuPont Analysis

Input Decision Variables:

1. Net Income Available to Common Stockholders
2. Total Revenue
3. Total Assets
4. Total Equity
5. Net Cash Flow from Continuing Operating Activities
6. Net Cash Flow from Long Term Capital Expenditures
7. Net Cash Flow from Long Term Borrowing
8. Free Cash Flow to Equity (FCFE)
9. Annualized Required Market Rate of Return (K)
10. Current Price of the Stock (Po)
11. Current Price to Book Value (P/B)
12. Current Book Value per Share (BVPS)
13. Cash Conversion Factor (CCF)
14. Cash Return on Equity (CROE)

Output Decision Variables:

1. Accounting Return on Equity (ROE)
2. Cash Return on Equity (CROE)
3. Estimated Fair Price to Book Ratio
4. Alpha Value
5. Estimated Intrinsic Fair Price of the Stock

Monte Carlo Probabilities:

1. Probability that Alpha will be positive or negative
2. Probability that the Forecasted Fair Price will be above a Specific Future Price
3. Probability that the Forecasted Fair Price will be below a Specific Future Price

The Monte Carlo simulation creates a probability distribution of results. Table Two presents the "input" variables needed in the construction of the accounting DuPont ROE and its subsequent conversation to the finance Cash Dupont ROE. The "output" metrics are also presented. A major contribution of the simulation is the ability to compute thousands of iterations (10,000 iterations) of our model forming the distribution of results enabling the investor to determine the probabilities of specific tests of equity valuation. The results present not only the possibility of an event but also the probability as well.

The Roadmap of the Cash DuPont Analysis and its Impact on Stock Valuation Strategy

It is an accepted view that capital intensive industries usually have low profit margins. This taken by itself would appear to be a weakness of the firms within such an industry. Incorporating the DuPont Analysis, investors see a broader economic picture facing the firm. As the asset turnover increases (decreases), the capital intensity (decreases)increases. The associated degree of financial leverage may play a vital role in the determination of the return on equity (ROE). Do the characteristically low profit margins of capital-intensive firms adversely impact stock value?

This paper's goal is to create a model that will lead to a fair valuation of the security. The Accounting ROE Model is modified and converted into a 'Cash' ROE to better forecast future stock movement. Borrowing from 'cash flow concepts', the latter metric is used to calculate a 'fair' price to book ratio which then is multiplied by the actual book value per share to determine the expected future fair price of the security. This data is further analyzed with the introduction of a Monte Carlo simulation which performs a detailed statistical analysis on all the 'input' variables and the subsequent 'output' valuation metrics. The summary of input decision variables is presented in Table 3 below.

Table 3
Baker Hughes Company
Summary Statistics of the Input Decision Variables
For the Cash DuPont Equity Valuation Model
Generated by the Monte Carlo Simulation

Summary Statistics				
Input	Mean	Std Dev	5%	95%
Net Income Available to Common Stockholders	-$ 2,430.01	$ 243.00	-$ 2,829.83	-$ 2,030.42
Total Revenue	$ 21,149.72	$ 2,114.95	$ 17,669.30	$ 24,627.89
Total Assets	$ 50,079.03	$ 5,007.66	$ 41,841.23	$ 58,311.04
Total Equity	$ 31,540.89	$ 3,154.00	$ 26,353.01	$ 36,726.52
Net Cash Flow from Continuing Operating Activties, Indirect	$ 1,098.25	$ 109.99	$ 917.28	$ 1,279.12
Net Cash Flow from LT Investments	-$ 698.25	$ 70.00	-$ 813.45	-$ 583.12
Net Cash Flow from LT Borrowing	$ 1,282.75	$ 130.04	$ 1,068.92	$ 1,496.50
Free Cash Flow to Equity	$ 1,269.99	$ 130.00	$ 1,056.08	$ 1,483.80
Annualized Required Market Rate of Return	10.00%	1.00%	8.35%	11.64%
Actual average Price of the stock	$22.08	$4.00	$15.50	$28.66
Actual average PB	0.7375	0.0100	0.7210	0.7539
Actual average BVPS	$29.85	$2.00	$26.56	$33.13
Cash Conversion Factor	-3.1412	1.0000	-4.7861	-1.4971
Cash ROE	8.23%	1.00%	6.59%	9.88%

The advantage of utilizing a Monte Carlo simulation will become apparent as the resulting equity valuation model is no longer dependent on single static decision variables but now incorporates a stochastic distribution of values.

The appropriateness of the traditional DuPont model is that it addresses both the asset turnover and profit margin metrics. In the case of capital-intensive firms, like Baker Hughes, the model addresses the degree of capital intensity (the reversal of the asset turnover) and the relative low profit margin. Another characteristic of a capital-intensive firm is its large commitment to capital expenditures which are typically funded through long term debt. The use of debt by the firm is captured in the financial leverage component. It is likely the financial leverage that compensates for the company's low profit margins and results in strong accounting return on equity (ROE).

The financial literature is extended by the conversion of the accounting Return on Equity (ROE) into a finance Cash Return on Equity (CROE). The model introduces the free cash flow to equity (FCFE) which recognizes a firm's use of depreciation which is expected to be relatively high for a capital-intensive company. In addition, the impact of net cash flows from capital expenditures and long-term borrowing are also incorporated. These latter two calculations are expected to be relatively high for capital-intensive firm like Baker Hughes. It is the FCFE that is used to create the cash conversion factor (CCF) which ultimately changes the accounting ROE into a Cash ROE (CROE). This is a critical step in the valuation process. The Cash ROE takes into account the required market portfolio (S&P 500 Index) return to determine the estimated fair price to book value (FPB). Utilizing the actual average book value per share (BVPS), the estimated intrinsic value of the stock (Po) can be found.

Subsequently, an 'Alpha' value is determined by recording the differential between the estimated price to book value and the actual average price to book value. When Alpha is greater than 1.0, the stock is considered undervalued. If Alpha is less than 1.0, the stock is considered overvalued.

The Static Cash Dupont Model for Baker Hughes shows that based on its Cash ROE (CROE) and estimated fair price to book value (FPB), the stock was undervalued over the time period. However, the results become more informative upon the running of the Monte Carlo simulation where probability distributions are created for all the input variables and output metrics. The result is a Stochastic Cash DuPont Model providing broader implications for each of its output variables. The Cash Dupont Equity Valuation Model process is presented in Table 4 below.

Table 4
Baker Hughes Company
Static Cash DuPont Equity Valuation Model Process

Asset Turnover (AT)	.43
Profit Margin (PM)	-11.80%
Financial Leverage (FL)	3.09
Accounting ROE	-19.03%
Free Cash Flow to Equity (FCFE)	$1,270.0
Cash Conversion Factor (CCF)	-3.14
Cash ROE (CROE)	8.23%
Required Market Return	10%
Estimated Price to Book Value	.82
Actual Average Price to Book Value.	.72
Alpha is positive; Undervalued	
Actual Average Book Value per Share	$29.85
Estimated Intrinsic Stock Value	$24.56
Actual Average Stock Price	$22.08

These metrics represent **averages over the time period of 2016 through 2020.
Dollars are in millions.

A critical observation from the model is that Baker Hughes has an average negative accounting ROE over the designated time period, however, after applying the cash conversion factor, the resulting Cash Return on Equity (CROE) is positive. One strength of the model is that it makes no pre-suppositions about a firm's profit/loss situation. This provides a more accurate assessment of Baker Hughes's true return on equity. The inclusion of the Free Cash Flow to Equity (FCFE) in the model recognizes the impact of depreciation, capital expenditures, and long-term borrowing as it converts the traditional ROE into a Cash ROE. On average, over the designated time period, Baker Hughes experienced a positive Alpha value implying an undervaluation. Interesting results will be seen in the output generated by the Monte Carlo Simulation presented in Tables 5 and 6 that follows.

Table 5
Baker Hughes Company
Empirical Output Metrics for the Stochastic Cash Dupont Equity Valuation Model Generated by the Monte Carlo Simulation

Output	NPM	Asset Turnover	ROA	Financial Leverage	Acct ROE	CCF	Cash ROE
Statistic							
Minimum	-21.15%	0.24382	-8.2856%	0.9141	-13.86%	-7.1274	4.42%
Maximum	-6.30%	0.70381	-2.7511%	2.7958	-3.95%	0.6138	12.01%
Mean	-11.61%	0.42674	-4.9024%	1.6041	-7.78%	-3.1412	8.23%
Mode	-11.63%	0.43709	-5.0185%	1.5487	-7.45%	-3.1788	8.27%
Std. Deviation	1.68%	0.0619	0.71%	0.2311	1.12%	1.0000	1.00%
Percentiles							
1%	-16.17%	0.3002	-6.82%	1.1408	-10.78%	-5.47	5.90%
2.5%	-15.30%	0.3190	-6.46%	1.2046	-10.20%	-5.10	6.27%
5%	-14.63%	0.3344	-6.15%	1.2621	-9.71%	-4.79	6.59%
10%	-13.78%	0.3525	-5.83%	1.3235	-9.22%	-4.42	6.95%
20%	-12.95%	0.3745	-5.46%	1.4058	-8.69%	-3.98	7.39%
25%	-12.64%	0.3833	-5.33%	1.4411	-8.49%	-3.82	7.56%
50%	-11.48%	0.4221	-4.85%	1.5863	-7.72%	-3.14	8.23%
75%	-10.44%	0.4646	-4.41%	1.7506	-7.00%	-2.47	8.90%
80%	-10.18%	0.4758	-4.32%	1.7915	-6.84%	-2.30	9.07%
90%	-9.59%	0.5069	-4.05%	1.9058	-6.40%	-1.86	9.51%
95%	-9.08%	0.5362	-3.83%	2.0011	-6.06%	-1.50	9.88%
97.5%	-8.67%	0.5638	-3.66%	2.1128	-5.81%	-1.18	10.19%
99%	-8.16%	0.5950	-3.45%	2.2355	-5.53%	-0.82	10.55%

The empirical output metrics for Baker Hughes, generated by the Monte Carlo Simulation, are presented in Table 5, above. When the Static DuPont Equity Valuation model was used, it was shown that on average, the Baker Hughes stock is undervalued. The Alpha value is positive and the average intrinsic stock price is greater than the average actual stock price. However, informative information becomes available after the running of the simulation. Is there a possibility that Baker Hughes could be overvalued? Within the generated probability distribution, within the lower quartiles of 1% through 20%, the Alpha Value is negative. This represents periods of time where Baker Hughes will be overvalued. The probability quartiles of 25% through 99% have the stock being undervalued. This is a critical fact that any static model cannot capture. The Stochastic DuPont Equity Valuation Model recognizes not only the possibility of a mispricing of the stock but generates a series of the probabilities of both an undervaluation and overvaluation.

Another important observation is that while the average accounting ROE was negative over the time period, the Cash ROE was positive. This is due to the cash conversion factor (CCF) depending on the free cash flow to equity (FCFE). The latter metric incorporating depreciation expense, capital expenditures, and long-term borrowing. All three are strong attributes of a capital-intensive firm like Baker Hughes. They more than compensated for the low negative profit margins of the firm. The ability of the CCF to account for any profit/loss situation is a strength of the valuation model. While the accounting ROE is negative in all the quartiles, the Cash ROE remains positive throughout the distribution. The estimated price to book value is greater than the average actual price to book value within the distribution quartiles of 25% through 99%. The estimated intrinsic value follows both the Alpha value and Cash ROE as it is greater than the average actual stock price within the 25% through 99% quartiles, too.

Table 6
Baker Hughes Company
Stochastic Cash DuPont Equity Valuation Model
Estimated Intrinsic Value and Alpha Value Implication
Generated by the Monte Carlo Simulation

Output	Actual PB	Estimated PB	Alpha Value		Estimated Intrinsic Value		Capital Intensity
Statistic							
Minimum	**0.6999**	**0.41263**	**-0.3322**		**$ 11.83**		**1.42**
Maximum	**0.7756**	**1.54089**	**0.7980**		**$ 49.71**		**4.10**
Mean	**0.7375**	**0.83151**	**0.0940**		**$ 24.82**		**2.39**
Mode	**0.7374**	**0.83496**	**0.1075**		**$ 24.23**		**2.29**
Std. Deviation	**0.0100**	**0.13272**	**0.1332**		**$ 4.32**		**0.35**
Percentiles							
1%	**0.7142**	**0.5511**	**-0.1841**		**$ 15.99**		**1.68**
2.5%	**0.7179**	**0.5946**	**-0.1450**		**$ 17.24**		**1.77**
5%	**0.7210**	**0.6289**	**-0.1090**		**$ 18.34**		**1.87**
10%	**0.7247**	**0.6691**	**-0.0694**		**$ 19.58**		**1.97**
20%	**0.7291**	**0.7197**	**-0.0176**		**$ 21.17**		**2.10**
25%	**0.7307**	**0.7395**	**0.0012**		**$ 21.81**		**2.15**
50%	**0.7375**	**0.8239**	**0.0865**		**$ 24.50**		**2.37**
75%	**0.7442**	**0.9153**	**0.1782**		**$ 27.50**		**2.61**
80%	**0.7459**	**0.9384**	**0.2010**		**$ 28.27**		**2.67**
90%	**0.7503**	**1.0023**	**0.2651**		**$ 30.31**		**2.84**
95%	**0.7539**	**1.0640**	**0.3269**		**$ 32.33**		**2.99**
97.5%	**0.7571**	**1.1138**	**0.3766**		**$ 34.28**		**3.13**
99%	**0.7607**	**1.1778**	**0.4426**		**$ 36.28**		**3.33**

An advantage of the Cash Equity Model is that there is no presumption on whether a firm experiences a profit or a loss. The determination of the cash conversion factor (CCF), the free cash flow to equity (FCFE) divided by the net income, is the critical component of the model. If a firm has a net loss instead of a net income, as is the case for Baker Hughes, there will be a negative ROE. The cash conversion factor will also be negative. This will result in positive Cash ROE leading to the estimated price to book ratio. Likewise, if the firm has a net income, the cash conversion factor (CCF) is positive and results in a positive Cash ROE.

This paper posits that through a Cash Dupont Equity model, the fair price of a security can be assessed. Specifically, the accounting DuPont ROE, through the use of the free cash flow to equity (FCFE), is converted into a Cash DuPont ROE. After creating the ratio of the Cash ROE to the required market index return, an estimated 'fair' price to book value results. Utilizing the actual book value per share, the estimated intrinsic value is found. The calculation of an Alpha value supports the notion of a mispricing of the security. Additional information on the probability of Baker Hughes being undervalued or overvalued is found as a byproduct of the Monte Carlo Simulation. The empirical result from the 50% distribution quartile is presented in Table 7, below.

Table 7
Baker Hughes Company
Probability of Stock being Mispriced
@50% Distribution Quartile
Generated by the Monte Carlo Simulation

Over the given time period of 2017 through 2020, the stock value of the Baker Hughes Company experienced the following probabilities of being either overvalued or undervalued. The cumulative normal distributions were constructed through the Monte Carlo Simulation.

50% Distribution Quartile

The Estimated Price to Book Value	= .8239
The Actual Average Price to Book Value	= .7375
The Average Alpha Value is a Positive	= .0865
Estimated Intrinsic Value	= $24.50
Actual Average Stock Price	= $22.08
Baker Hughes stock is Undervalued by an average of	= $2.42

While the DuPont Equity Valuation Model addresses the 'possibility' of the mispricing of Baker Hughes stock value, it is the Monte Carlo Simulation that supplies the critical 'probability' of that occurrence:

Probability that the Actual Average Stock Price > the Estimated Intrinsic Price = 26.7%.
Probability that the Actual Average Stock Price < the Estimated Intrinsic Price = 73.3%.
The predictive power of the Cash Dupont Equity Valuation Model appears quite consistent over the various percentage distribution quartiles found in this study.

Summary and Conclusion

It is intuitive that the value of Baker Hughes be based on the cash flows that can be withdrawn from it over time. This Cash DuPont ROE valuation model creates a proxy for this concept through the inclusion of the Free Cash Flow to Equity (FCFE). Would an investor be willing to pay book value for Baker Hughes? The answer should be affirmative as long as the price of the stock used in the P/BV ratio is a 'fair' one.

A stock's 'fair' price as used in the price to book ratio (P/BV) should be determined by its free cash return on tangible assets. This implies that the price/book value ratio and the Cash DuPont ROE can be used to determine the "fair value" of the stock. The expected return on a stock is not based on past results as markets are expectational and so are all the assets within it. This paper posits that the components of the Cash Dupont Equity Valuation Model, the future profit margin, asset turnover, leverage ratio, and cash conversion factor all are needed in order to find the fair value. A unique and critical step in the valuation process is the creation of the ratio of the Cash ROE to the expected future market return (i.e., S&P 500 Index). This establishes the "fair" Price to Book Value (FPB) multiple for a stock to trade at. The product of this FPB multiple and the actual average book value per share (BVPS) will determine the intrinsic price of the security.

Look at Table 6 at the 50% probability quartile. The estimated fair price to book multiple is .8239 and the average actual multiple is .7379. This means that Baker Hughes should trade at a price multiple of approximately .82 in order to earn the required market index return of 10%. The Cash DuPont model predicts the price to be $24.50 while the average actual price is $22.08. The positive Alpha value indicates an undervaluation.

In contrast to the latter scenario, at the 20% distribution quartile, the estimated fair PB multiple is .7197 and the actual PB multiple is .7291. Here, the Alpha value is negative implying that the actual price of Baker Hughes exceeds its intrinsic value. It appears to be overvalued. In order to earn the required market index return, Baker Hughes must trade at a price multiple of approximately .72.

An important takeaway from the analysis is that one cannot merely state that Bakers Hughes (BKR) is worth $24.50 a share. There must be something in the valuation model that's actually going to get better in the future that will justify the purchase price of the stock. With the traditional DuPont analysis, investors can formulate investment strategies that discuss the impact of a relatively strong or weak asset turnover, its counterpart capital intensity, profit margin, and financial leverage.

This paper is not trying to support a particular argument about capital intensive firms, but rather extend the literature by examining the relationship between capital intensity and book value and the ultimate pricing of the security. Capital intensive firms are usually associated with low profit margins which may signal weak performance for these firms where returns on assets suffer. The use of the DuPont analysis expands the view of business operations.

The value of an investment is based on the cash flows that can be withdrawn from it over time. The implication then is that an investment's "right" price to book value should be determined by its cash return on assets times its acceptable leverage ratio.

The financial literature is extended by the introduction of the Cash DuPont Model in conjunction with a Monte Carlo Simulation. The model's use of the free cash flow to equity (FCFE), cash conversion factor (CCF), and resulting Cash ROE ultimately leads to the determination of the fair price to book value multiple. All of these data metrics are blended into a process of stock price valuation that explains both the possibility and probability of the mispricing of a stock.

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