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Abstract

Supply chain management techniques such as just-in-time, lean manufacturing, and total quality management have become a focus point in modern manufacturing. One would hope that improvements in management techniques would result in higher returns and/or valuations. This study investigates the link between a firm's supply chain performance measures and the performance and valuation of its stock. We find that supply chain measures are strongly related to market valuations as measured by a variation of *Tobin's Q*, but are only weakly related to abnormal stock returns.

Introduction and Literature Review

Over the past decade supply chain management has grown in importance and complexity, especially among manufacturers. The rise of global markets has led to increased competition, but it also allows – or perhaps requires – firms to seek out the best suppliers around the world. Technological advances and the internet allow for instant business-to-business communication and transactions. New manufacturing philosophies such as just in time (JIT), lean manufacturing, theory of constraints, and 5S have focused on improving efficiency in manufacturing, while total quality management, ISO9000:2000 certification, and six sigma focus on improving quality.

The question then arises as to what effect supply chain management has on a firm's performance. A joint research study undertaken by Accenture, INSEAD, and Stanford University (2003) attempts to find a link by investigating 636 global companies in 24 industries. Three measures of supply chain performance – inventory turns, cost of goods sold as a percent of revenue, and return on assets – were calculated for each firm for the years 1995 to 1997 and 1998 to 2000. A firm was classified as a *superior* supply chain performer over a time period if they ranked in the top third for at least two of these variables. The firms were then placed in one of four categories. *Leaders* exhibited superior performance in both time periods and made up 18 percent of the sample. *Transformers* moved up to superior performance in the second time period and were 10 percent of the sample. *Decliners* fell from superior over time and made up 11 percent of the sample. *Laggards* did not achieve superior performance in either time period and made up 63percent of the sample.

A similar process used a company's compound average growth rate of market capitalization to classify financial performance. Firms with growth rates above the industry average over a time period were classified as *superior*. Firms were then classified as *leaders* (23 percent), *transformers* (24 percent), *decliners* (27 percent), or *laggards* (28 percent). Cross-tabulations were used to determine the relationship between a firm's supply chain classification and their financial classification. Revealed was that firms are more likely to have the same classification for both supply chain performance and financial performance than would be expected if there were no relationship between the two measures. An interesting finding is that supply chain transformers outperformed leaders in the second time period, while decliners underperformed laggards in the second time period. This indicates that financial markets reward improvements and punish declines in supply chain performance.

Hypotheses, Data, and Methodology

By testing two hypotheses this study takes a more direct approach. The first hypothesis is that supply chain measures are related to a stock's abnormal return. While it seems logical that better-managed firms would have higher

returns, this might not be true if the market has previously recognized and incorporated the superior management in its stock's price. This leads to the second hypothesis that measures of supply chain management are related to firm valuations as measured by a variation of Tobin's Q.

The question arises as to how supply chain performance should be measured. Brewer and Speh (2000), among others, suggest a 'balanced scorecard' that considers measures from a customer perspective, an internal perspective, an innovation perspective, and a financial perspective. However, many of the recommended metrics are internal and/or qualitative in nature. For example, the customer perspective measures include the internal measure of customer contact points and the qualitative measure of customer perception of flexibility. However, the financial perspective measures include profit margin and return on supply chain assets.

Copacino and Byrnes (2001) argue that many companies fall into the "efficiency trap" where they put too much focus on cost control instead of creating supply chain strategies that drive revenues. They suggest that firms focus on five crucial areas in order to gain market share and increase revenue*: account selection, in-customer operations*, *channel strategy*, *core operations capabilities*, and *management/organization structure*.

Webster (2002) discusses firms as being part of a supply system where each firm has a role in the system, but no firm dominates the system. Systems can then be thought of as on a continuum from lean to agile. *Lean* manufacturing systems produce high volumes of commodity products and should use metrics focused on efficiency and cost. *Agile* systems need to produce customized output and should use metrics focused on the firm's flexibility and innovation.

Since one objective of this study is to find measures that could be used by outside shareholders to evaluate firms, our measures are restricted to publicly available financial data. While this eliminates many of the internal and qualitative measures suggested in the literature, it still leaves an almost infinite number of measures. Some other measures suggested in the literature, such as return on assets, are arguably not really supply chain measures. In keeping with the spirit of the existing literature, we tried to use metrics that reflected a variety of supply chain management goals including *efficiency*, *speed*, *revenue enhancement*, and *innovation*.

Our first supply chain measure is gross profit margin (PM) calculated as revenues less costs (excluding depreciation) divided by revenues. Profit margin, along with inventory turnover, are widely mentioned supply chain metrics representing a firm's ability to sell finished goods and contain costs. *Hypothesized is that profit margin will be positively related to performance and valuation.*

Inventory turnover (IT) is our second measure calculated as the firm's costs (excluding depreciation) divided by their year-end Inventory. Low levels of inventory and high turnover are a primary component of just-in-time and lean manufacturing. Under our hypotheses, we expect turnover to be positively related to performance and valuation. One concern with these two measures is that management techniques that focus primarily on inventory may involve higher prices for inputs and/or cutting selling prices in order to move inventory. Thus, we also investigate possible negative correlations between inventory turnover and profit margin.

The use of supply chain strategies to enhance revenues has been brought up by several authors. We have chosen fixed asset turnover (FATO) as our measure of revenue enhancement because it represents a firm's ability to efficiently use their resources. We calculate it as revenues divided by net property, plant, and equipment and would expect a positive relationship between FATO and share performance and valuation.

Finally, we wanted to include a measure that represents a firm's willingness to adapt, innovate, and invest. We calculated an investment (CapEx) measure defined as net capital expenditures divided by total assets. This measure represents a firm's willingness to purchase new equipment and modernize as market conditions change. We expect this measure to be positively related to performance and valuation.

The two dependent variables represent a firm's performance and valuation. The market model approach was used to calculate abnormal returns to acquiring firm shareholders. Annual holding period returns (Rjt) for each stock are calculated as the split-adjusted ending stock price plus dividends all divided by the beginning price. The parameters for the model are estimated using five years of monthly data prior to the start of the fiscal year being investigated. The market return (Rmt) on the S&P 500 index over the same period is calculated the same way using S&P Depository Receipts (Ticker Symbol: SPY) as a proxy for the market.

$$R_{jt} = Alpha_j + Beta_j * R_{mt} + Error_{jt} \quad (1)$$

The estimated *beta parameter* is then used to determine a security's expected return given the market return and the risk free return (Rft) calculated as the return on the ten-year Treasury bond. The expected return is then subtracted from the security's actual return to determine the abnormal return (ARjt) for each period.

$$AR_{jt} = R_{jt} - (R_{ft} + Beta_j*(R_{mt} - R_{ft})) \quad (2)$$

While a stock's *beta sensitivity* to the overall market is often used in determining it's expected return, many other factors have been found to affect returns. Fama and French (1992) show that smaller firms and value firms with high book-to-market ratios tend to outperform their expected return, and they suggest comparing the firm's return to portfolios based on size and book-to-market. Barber and Lyon (1997) show that these replicating portfolios result in misspecified test statistics when examining long-run abnormal stock returns, and they suggest using matched firms in order to calculate abnormal returns. We have included a matched-firm analysis by pairing up firms with the same four-digit SIC code and fiscal year end. In cases where there are multiple firms meeting this criteria, we match them based on total assets, resulting in a total of 42 pairs of firms (126 firm years). We then repeat the regression analysis on the difference between the firms' measures. This analysis more clearly compares firms within the same industry to see whether supply chain management differences explain performance and valuation differences.

Our market valuation measure is calculated using a variation of *Tobin's Q*, which is defined as the market value of a firm's financial claims divided by the replacement cost of the firm's assets. A value greater than one means that it costs more to buy the company than it would cost to buy the assets by themselves. It can be inferred that this higher value represents management's ability to utilize the assets more efficiently. While it is impractical to exactly measure market values and replacement costs, a simplified estimation of Q can be calculated.

$$Q = \frac{\text{Market Value of Comm. Stock + Book Value of Pref. Stock and Liab.}}{\text{Book Value of Total Assets}} \qquad (3)$$

We test these hypotheses by examining 192 manufacturing firms (SIC Code 2000-3999) in the S&P 500 as of December 31, 2004. In order to be included in the final sample, financial statement date had to be available for the three fiscal years ending in 2002, 2003, and 2004. Additionally, stock price and dividend data had to be available from 1996 through 2004 in order to estimate the abnormal returns. While few if any large firms could be classified as purely manufacturing, the SEC uses the firm's predominant code for classification purposes. Financial statements for these firms covering the fiscal years ended in 2002, 2003, and 2004 are used to calculate our four measures of supply chain management for each firm-year. The use of financial statement data leads to potential problems such as the use of different accounting methods among firms, different demand cycles throughout the year, and possible window dressing or outright fraud in the financial statements. While these concerns are recognized, the data is taken as is for the purposes of this paper. For purposes of consistency and to ensure public availability, all of our financial statement data was pulled from the msnmoney website. In order to calculate the firm's financial

performance and valuation, stock price and dividend information for the firm and the market is also taken as of each firm's fiscal year end from Yahoo!.

In testing the effect on share performance, we use the three years of data for each firm resulting in a total of 576 firm years in our sample. A multiple regression is run to determine the overall model significance and the effect of individual variables. In testing the effect on stock valuation, however, we follow the same procedure, except that we use the average of the variables over the three years for a total of 192 firms in our sample regression.The reason for this is that a firm's abnormal return should be independent from year to year, but their market valuation is not.

As part of our additional analysis, the firms are also classified by their two-digit SIC code for industries with at least 20 firms. These industries included 32 Chemical and Allied Products firms (SIC Code 28), 28 Industrial and Commercial Machinery and Computer Equipment firms (SIC Code 35), 32 Electronic and Other Electrical Equipment and Components firms (SIC Code 36), and 20 Measuring, Analyzing and Controlling Instruments firms (SIC Code 38).

Empirical Results

Table 1 (below) has the descriptive statistics for all of our variables. Among the interesting findings revealed here are the high maximum values for the turnover ratios. Not surprisingly, these ratios are for Dell because this firm is well known for its lean manufacturing techniques.

Table 1: Descriptive Statistics

	AbnRet	ProfMgn	InvTO	FATO	CapEx
Mean	0.0875	0.4390	8.3475	4.9568	0.0454
Median	0.0773	0.4256	5.4569	4.1409	0.0367
St. Dev.	0.3041	0.2035	11.8639	3.8046	0.0816
Min	-1.2291	-0.2342	-0.2582	0.5421	-0.8649
Max	1.7452	1.0215	102.8410	38.7777	0.4075

	AvgQ	AvgPM	AvgIT	AvgFATO	AvgCapEx
Mean	2.4035	0.4390	8.3475	4.9568	0.0454
Median	1.9563	0.4276	5.4535	4.1517	0.0435
St. Dev.	1.2903	0.2014	11.7316	3.5518	0.0513
Min	0.6598	-0.0343	0.5331	0.7236	-0.2462
Max	7.1984	0.8917	96.1828	34.6103	0.1569

Table 2 (below) presents the correlations among the variables used in our study. The correlation between profit margin and inventory turnover is negative

and significant. This could be the result of firms with low inventories being forced to replenish at higher prices or the result of firms cutting their prices on finished goods in order to get rid of excess inventory. The two turnover measures have a significant positive correlation as they are determined by the firm's level of sales and cost of sales.

Table 2: Correlation Analysis

	AbnRet	ProfMgn	InvTO	FATO	CapEx
Excess Return	1.0000				
ProfMgn	-0.0916**	1.0000			
InvTO	0.0264	-0.2589***	1.0000		
FATO	0.1080***	-0.1326***	0.3215***	1.0000	
CapEx	0.0211	0.0600	-0.0312	-0.0479	1.0000

	AvgQ	AvgPM	AvgIT	AvgFATO	AvgCapEx
AvgQ	1.0000				
AvgPM	0.6859***	1.0000			
AvgIT	-0.0147	-0.2626***	1.0000		
AvgFATO	0.1194*	-0.1447**	0.3605***	1.0000	
AvgCapEx	0.0825	0.0785	-.0457	-0.0992	1.0000

Significance at the 10 percent, 5 percent, and 1 percent level are marked with *, **, and *** respectively.

Table 3 (below) presents the excess return regression results for the overall sample, matched sample, and the four industry subsamples. The overall model is significant, with profit margin being negatively related to abnormal returns, while fixed asset turnover is positively related to abnormal returns. For the chemical subsample, the model is significant at the one percent level with profit margin being negatively related to abnormal returns at the 5 percent confidence level and fixed asset turnover being positively related to abnormal returns at the one percent level. However, neither the matched firm analysis nor the other industry subsamples reveal a significant relationship between abnormal returns and supply chain measures.

Table 3: Expected Return Regressions

Sample	Whole Sample	Matched Firms	Chemicals (SIC Code 28)	Machinery (SIC code 35)	Electrical (SIC Code 36)	Measurement (SIC Code 38)
Size	576	126	96	84	96	60
Adj. R-Sq.	0.0126	-0.0160	0.1379	0.0312	-0.0316	0.0027
Model F	2.8274	0.5086	4.7985	1.6681	0.2722	1.0403
(significance)	0.0242**	0.7295	0.0015***	0.1657	0.8952	0.3949
PM coeff.	-0.1298	0.2430	-0.2915	-0.3845	0.0647	0.2594
(p-value)	0.0439**	0.3491	0.0492**	0.0967	0.8050	0.4554
IT coeff.	-0.0008	-0.0011	0.0043	-0.0001	-0.0065	0.0050
(p-value)	0.6609	0.8233	0.6317	0.9392	0.7868	0.7415
FATO coeff.	0.0086	0.0106	0.0438	0.0040	0.0073	0.0306
(p-value)	0.0146**	0.3770	0.0004***	0.5328	0.5940	0.1021
CapEx coeff.	0.1137	0.1345	0.3495	0.3913	-0.3370	0.2106
(p-value)	0.4631	0.6584	0.1907	0.2158	0.4666	0.7291

For each equation, the overall model Adjusted R-Squared, F-statistic and significance is provided along with the coefficients and p-values for each variable. Significance at the 10 percent, 5 percent, and one percent level are marked with *, **, and *** respectively.

Table 4 (below) presents the regression results using *Tobin's Q* as the independent variable. For the overall sample, the model is highly significant in explaining variations in *Tobin's Q* with profit margin and fixed asset turnover both being positive and significant at the one percent level and inventory turnover being significant at the 5 percent level. The overall significance of the model and of profit margin is consistent across the matched firm results and the industry results; however, the significance of the other variables depends on the industry. For chemicals, profit margin, fixed asset turnover, and capital expenditure growth are all significant at the one percent level, while inventory turnover is significant at the 10 percent level. For Machinery, profit margin and inventory turnover are significant at the one percent and 5 percent levels, respectively. For Electrical Equipment and Measurement Equipment, profit margin is the only significant variable.

Table 4: *Tobin's Q* **Regressions**

Sample	Whole Sample	Matched Firms	Chemicals (SIC Code 28)	Machinery (SIC code 35)	Electrical (SIC Code 36)	Measurement (SIC Code 38)
Size	192	42	32	28	32	20
Adj. R-Sq.	0.5222	0.5037	0.7054	0.5179	0.5505	0.6720
Model F	53.1946	11.4011	19.5549	8.2504	10.49	10.7318
(significance)	0.0000***	0.0000***	0.0000***	0.0003***	0.0000***	0.0003***
Avg PM	4.7367	8.5558	2.6940	3.5604	5.0599	8.0849
(p-value)	0.0000***	0.0000***	0.0090***	0.0021***	0.0000***	0.0012***
Avg IT	0.0124	0.0352	-0.0404	0.0233	0.0521	0.1025
(p-value)	0.0415**	0.1640	0.4887	0.0307**	0.6171	0.2589
Avg FATO	0.0692	0.1177	0.4621	0.0478	0.0605	0.0832
(p-value)	0.0005***	0.0787*	0.0000***	0.2144	0.3595	0.4284
Avg CapEx	1.2209	3.5622	6.0657	2.0743	-7.0282	7.3946
(p-value)	0.3360	0.1874	0.0321**	0.3643	0.0226**	0.2055

For each equation, the overall model adjusted R-Squared, F-statistic and significance is provided along with the coefficients and p-values for each variable. Significance at the 10 percent, 5 percent, and 1 percent level are marked with *, **, and *** respectively.

Conclusions

Our research provides evidence that the stock market and investors do consider a firm's supply chain management in their analysis. However, this consideration is displayed primarily through higher market valuations, rather than through higher annual returns. While it is not too surprising that superior supply chain management does not result in higher abnormal returns, there may still be a relationship between the variables. For instance, returns might be more closely related to improvements in supply chain management as opposed to superior management. Also, there may be a leading or lagging relationship between superior management and excess returns. These tests are left for additional research.

The finding that supply chain measures, especially profit margin and fixed asset turnover, explains market valuations is to be expected. *Tobin's Q* and other market to book valuation measures are often taken as the market's evaluation of how well a firm is being managed. Since higher valuations are the cumulative result of past stock performance, this also might demonstrate that a firm's supply chain management has already been recognized by the market without being rewarded with positive excess returns year after year.

Perhaps more surprising is the relative lack of support for inventory turnover as a significant variable for either performance or valuation. Inventory management strategies such as JIT or lean manufacturing place a great deal of emphasis on turnover, but we find very little evidence that the market places a great deal of value on that emphasis.

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