

The influence of supply chains on a company's financial
performance

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Introduction

It is widely acknowledged that the performance of the supply chain has a significant impact on a company's financial performance. The challenges that confront supply chain professionals include: how to measure supply chain performance and which technologies, strategies, solutions and approaches should be adopted to deliver improved financial results.

Supply chains are inherently complex and subject to a number of conflicting requirements; this complexity and pressure from multiple agendas is reflected in the array of measures that have been developed to support performance management and tactical and strategic decision making. Whilst many of these metrics provide valuable operational insight, they fail to provide an overall measure of supply chain performance or link supply chain decisions directly to overall financial performance. The lack of an effective approach to assessing supply chain performance is being increasingly recognised. This paper contributes to the discussion by presenting the results of research conducted by Cranfield School of Management into linking supply chain performance directly to overall financial performance. The paper goes further by presenting a "proxy" for supply chain performance that is shown to be statistically linked to financial performance based on analysis of 117 companies over a ten year period.

The evolving role of the supply chain

The business environment is becoming more competitive. Collapsing product and technology lifecycles, the advent of internet technology fuelling a global customer and supply base, and increased demand for variety, together with unprecedented rates of change are all increasing the pressure on businesses and stimulating a change in the role of the supply chain. Whilst the underlying business fundamentals of buying, selling and managing customers, suppliers and resources remain true; the world in which they need to be managed is becoming more complex, uncertain and volatile; a situation compounded by the accelerating rate of change. It is against this

back cloth that the role of the supply chain and its contribution to business performance needs to be assessed.

Professor Michael Porter¹ stated that there are two major strategies to winning business: differentiation and cost advantage. Differentiation is achieved through providing customers with an offering that they perceive as having higher value whilst cost advantage is gained by doing things more economically than the competition. Historically, the focus for securing differentiation has been product differentiation. With life cycles now measured in months, sometimes weeks, rather than years the opportunities to secure sustained benefit through product differentiation is diminishing. More and more companies are turning to service-based differentiation to secure price advantage. Even when a product based-strategy prevails the elapsed time for maximising profit is becoming shorter and more difficult to hit such that a minor disruption to product availability has a major impact on financial return. The supply chain has, therefore, become either the driver or critical enabler for differentiation. The role of the supply chain as a major driver of cost has long been recognised. It is estimated that the supply chain accounts for up to 70% of a product's cost. The supply chain, therefore, offers considerable opportunity for delivering cost advantage.

In addition to securing differentiation and cost advantage the role of the supply chain has taken on two further dimensions arising from the need to ensure resilience, responsiveness and flexibility in an increasingly volatile and uncertain world. Typically, the supply chain accounts for 50% of a company's assets. Assets, by their very nature, prescribe a limited range of working patterns and methods, thereby exposing an organisation to significant changes in market dynamics. The nature and structure of the asset base, the balance of fixed assets to current assets, the profile of inventory and cash all influence the resilience of the supply chain and help mitigate risk. At an operational level, customers are becoming increasingly demanding in terms of both responsiveness and flexibility, and the design of the supply chain, in terms of structure, management, systems and processes impacts directly the ability of an organisation to respond to customer needs. In summary, the increasing

¹ Porter, M.E. (1980) *Competitive Advantage*. New York: The Free Press.

competitive pressure on companies, coupled with the unprecedented rate of change has elevated the role of the supply chain as one of, if not the principal, drivers of business performance.

The role of the supply chain and the focus for supply chain management can be summarised as the supporting of an organisation in winning business competitively by addressing the imperatives of:

- Differentiation
- Cost advantage
- Resilience
- Responsiveness and flexibility

When it comes to supply chains, organisations rarely suffer from a shortage of objectives. In fact, the more common problem is that there are too many objectives leading to greater complexity: Would you like to:

- Reduce the cost of supply chain operations?
- Accelerate the flow of goods through the chain?
- Increase flexibility to meet changing demand?
- Reduce inventory levels?
- Improve on-time deliveries?
- Increase your fill rates?

Few managers find themselves able to say "no" to any of these objectives, but inherent trade-offs exist among them that can't be avoided. Understanding these trade-offs and striking the right balance among them is the essence of supply chain strategy. Aligning the supply chain strategy with the business strategy and ensuring it delivers improved financial performance is the fundamental role of senior supply chain management. The question, is given the evolving role of the supply chain, how well equipped are they to do it?

This work is not about a crusade for the holy grail/definitive measure of supply chain performance. Viewing this as the pursuit of a panacea is analogous to viewing the Just-in-Time 'revolution' of the 1980s as the pursuit of on-time delivery, rather than what it was - a challenge to conventional thinking and practices that focused on the elimination of waste. The message that we're attempting to convey is - take the supply chain out of the warehouse and into the boardroom; the supply chain is not a consumer of cost but a driver of financial performance and enhanced customer value.

Linking supply chain management to overall financial performance

“Supply chain management can significantly affect a company’s financial performance – both positively and negatively.”²

Whilst anecdotally the link between supply chains and a company’s financial performance has been made, it has proved to be problematic to empirically link positive supply chain and financial performance. Sales growth, operating profit margin, working capital investment and fixed capital investment impact shareholder value³, all are within the influence of the supply chain management function. Sales growth can be enhanced through delivering improved service to customers and operating profit margin can be achieved via improvements in supply chain operating costs. A reduction in working and fixed capital investment can be “engineered” by increased outsourcing to third party providers.

There has been research that examined the impact of functional improvements in the supply chain on selected financial indicators. In the short-term high levels of inventory have been proven to have no impact on price-to-book ratio but in the long-term companies with abnormally high inventory have poor stock market performance⁴. Conversely, companies with low, but not the lowest, levels of

² Ellram, L. M. and Liu, B. (2002) The Financial Impact of Supply Management. Supply Chain Management Review, Vol. 6, No. 6, pp. 30-7.

³ Rappaport, A. (1998), Creating Shareholder Value. New York: The Free Press.

⁴ Chen, H., Frank, M.Z. and Wu, O.Q. (2005) What Actually Happened to the Inventories of American Companies between 1981 and 2000? Management Science, Vol. 51, No. 7, pp. 1015-1031.

inventory had unusually good long-term stock market performance⁵. It has also been shown that a reduction in work-in-progress leads to an increase in productivity within companies in the Japanese automotive supply chain⁶. There has been work that indicated that the integration of information systems led to supply chain integration which leads, in turn, to improved customer service performance and on to improved financial performance⁷. Ted Farris and Paul Hutchison⁸ proposed that cash-to-cash is a key measure for supply chain success although limited leverage can be applied to suppliers and customers without irreparably damaging relations. There is a further pool of work that has attempted to deliver a more consolidated view of supply chain and financial performance.

The AMR Research Supply Chain Top 25⁹ quantifies supply chain performance using return on assets, inventory turns, company growth and the subjective opinion of AMR experts, with the greatest onus placed upon the expert's opinion. Whilst there is no doubt about the pedigree of the companies within the Top 25, there will always be doubts about subjective analysis and there are doubts in the comparison of dissimilar companies. An example of this is in comparing the return on assets (ROA) of Nokia (14.1%) and Toyota (4.8%) or the inventory turns of Dell (86.8pa) and Johnson & Johnson (3.0pa).

Work by INSEAD / Accenture / Stanford¹⁰ attempted to link supply chain metrics-inventory turns, cost of goods sold as a percentage of revenue and return on assets-to superior firm performance - quantified as the compound average growth rate (CAGR) of market capitalisation within an industry. Whilst the research team indicated that 9% of the 636 respondent companies were leaders in both supply

⁵ *ibid.*

⁶ Lieberman, M.B. and Demeester, L. (1999) Inventory Reduction and Productivity Growth: Linkage in the Japanese Automotive Industry. *Management Science*, Vol. 45, No. 4, pp. 466-485.

⁷ Vickery, S.K., Jayaram, J., Droge, C. and Calantone, R. (2003) The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships. *Journal of Operations Management*, Vol. 21, No. 5, pp. 523-539.

⁸ Farris, M.T. and Hutchison, P.D. (2002) Cash-to-cash: the new supply chain management metric. *International Journal of Physical Distribution and Logistics Management*, Vol. 32, No. 4, pp. 288-298.

⁹ Friscia, T. O'Marah, K. and Souza, J. (2005) The AMR Research Supply Chain Top 25 for 2005. AMR Research Report AMR-R-8813.

¹⁰ d'Avanzo, R., von Lewinski, H. and van Wassenhove, L.N. (2003) The Link between Supply Chain and Financial Performance. *Supply Chain Management Review*, November/December 2003, pp. 40-47.

chain and financial performance, some 19% of the respondents were classified as being laggards in supply chain performance but “transformers” (moving towards becoming a leader) in financial performance. They went on to assert that leaders in supply chain performance were also leaders in financial performance. This is a view that is consistent with the work that others have carried out and many argue is intuitively correct. However, this assertion is not supported by objective, statistically robust research.

David Berman¹¹ argues that in the retail sector; specifically stores, there is a relationship between the floor space of the store and inventory turns with better performing stores having higher inventory turns per unit area. This in turn creates a linkage between inventory turnover, gross margin and capital intensity. This link is easy to form as there is a greater probability that stores do not manufacture, thus do not have high levels of capital assets. They are also likely, within market sectors, to carry roughly the same range of products that is similar across competitors.

Professors Serguei Roumatsiev and Serguei Netessine attempted to determine the alignment of inventory policies of US companies with market demand using a concept called ‘supply chain elasticity’¹². This work uses creditor days, debtor days and stock turns as the primary units of analysis. The assumption that debtor and creditor days, respectively, are equivalent to customer and supplier lead-time is flawed as they are unlikely to align. An example of this is the aerospace industry where lead-times are of the order of years whilst payment terms will be measured in months.

A series of three papers by Professors Kevin Hendricks and Vinod Singhal has proven that publicly announced disruptions to supply chains have an impact on the financial performance of a company. In the first study of 519 supply chain disruptions between 1989-2000 they estimated that a supply chain glitch leads to a 10.82%

¹¹ Raman, A. and Gaur, V. (2005) David Berman. Harvard Business School Case #9-605-081.

¹² Roumiantsev, S. & Netessine, S. (2005) Should inventory policy be lean or responsive? Evidence for US public companies. Working Paper: The Wharton School.

decrease in shareholder value¹³. In an extended study of 827 supply chain disruptions announced in 1989-2000 they estimated that the long-term decrease on the share price of the glitch is almost 40% of shareholder wealth and an increase in equity risk due to increased share price volatility¹⁴. In the third study of 885 disruptions over the period 1992-1999 they estimated that the glitch led to an average of 6.93% lower sales growth, 10.66% cost increase, 6.08% asset increase and a 13.88% growth in assets¹⁵.

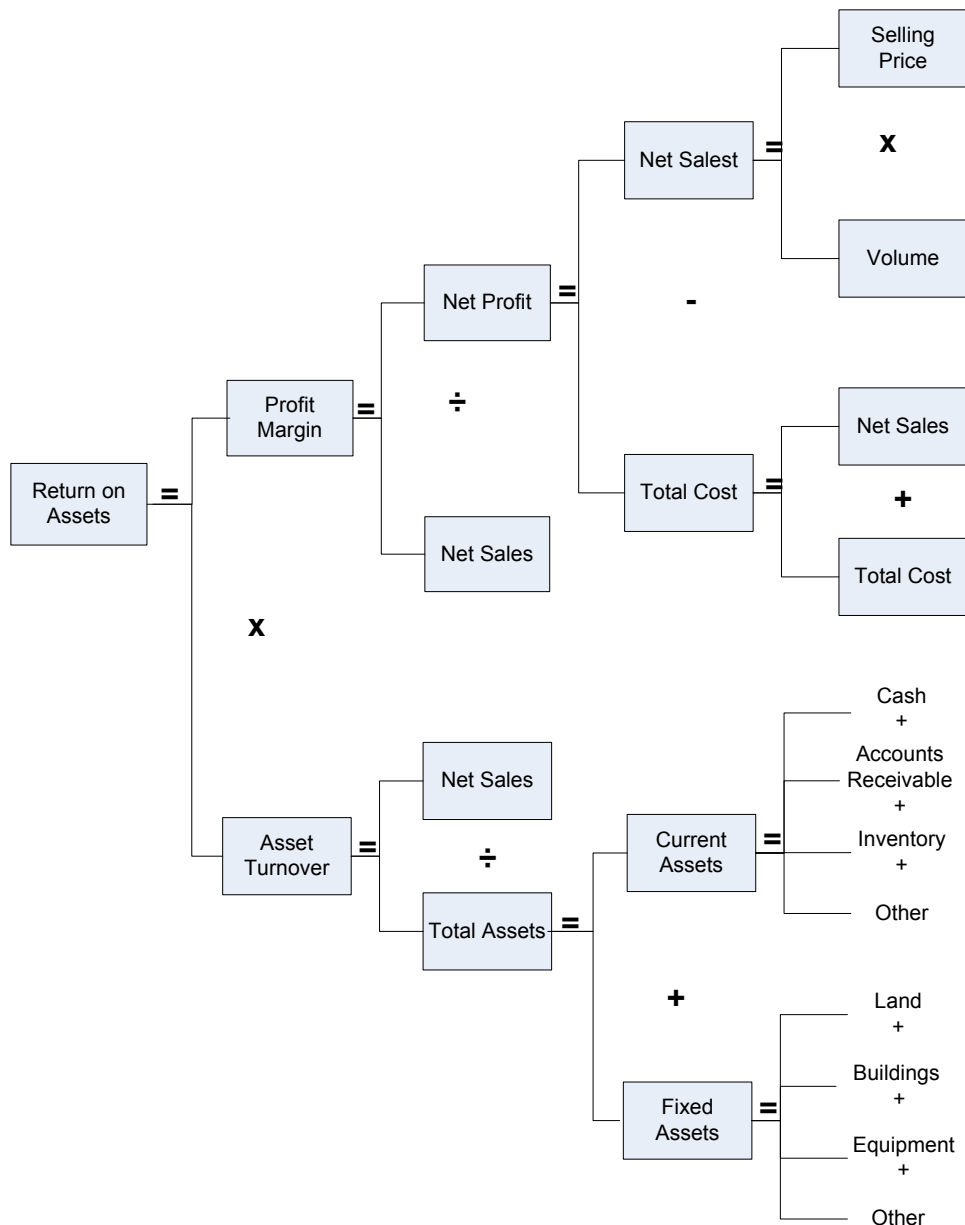
There is work that conceptualises the impact the supply chain has upon a company's financial performance that has not been quantified¹⁶. This work utilises the framework developed by DuPont where Return on Equity (RoE) is used as the key measure of business performance. All the factors with a causal relationship to RoE are nested below this with Return on Assets (ROA) representing the "operational" stream and "financial leverage" - a composite of total assets / equity - representing the "investment" stream. The DuPont model can be used to quantify the impact that a decision will have on the decision. For example: a decision to reduce inventory will reduce the value of inventory used to calculate current assets, in turn reducing the total assets employed by the business. As the denominator for the asset turnover ratio is total assets, if sales (numerator) remain the same then the asset turnover ratio will increase. The asset turnover ratio multiplied by the profit margin gives the return on assets which feeds into the return on equity calculation. Whilst the model is capable of examining the impact of decisions from the profitability and asset utilisation perspectives, it does not examine liquidity. The figure below shows the operational stream of the DuPont model.

¹³ Hendricks, K.B. and Singhal, V.R. (2003) The effect of supply chain glitches on shareholder wealth. *Journal of Operations Management*, Vol. 21, No. 5, pp. 501-522.

¹⁴ Hendricks, K.B. and Singhal, V.R. (2005) An Empirical Analysis of the Effect of Supply Chain Disruptions on Long-Run Stock Price Performance and Equity Risk of the Firm. *Production & Operations Management*, Vol. 14, No. 1, pp. 35-52.

¹⁵ Hendricks, K.B. and Singhal, V.R. (2005) Association Between Supply Chain Glitches and Operating Performance. *Management Science*, Vol. 51, No. 5, pp. 695-711.

¹⁶ Lambert, D.M. and Burduroglu, R. (2000) Measuring and Selling the Value of Logistics. *The International Journal of Logistics Management*, Vol. 11, No. 1, pp. 1-18.



There are a number of drawbacks to the approaches discussed previously. Some approaches rely on subjective analysis, removing the robustness and lack of bias associated with objective data. Other work takes a simplistic view of the key impacts on the supply chain, whilst other work looks at the negative impacts of poor supply chain performance and other approaches do not allow a balanced view through the exclusion of key factors. There is a clear need for a different approach, which this work attempts, that gives a convergent approach to assessing supply chain performance. Any new approach needs to be capable of:

- Linking the strategic and operational agendas;
- Providing a basis for conflict resolution and trade-off analysis;
- Equipping the supply chain community with the knowledge to participate in the strategic debate;
- And: assessing the impact of isolated changes.

The succeeding sections detail the development and empirical testing of a financial proxy that links the performance of a company's supply chain to accepted financial metrics.

Introduction to the research

Whilst it has been stated that supply chains compete, not companies¹⁷, it has proven to be problematic to demonstrate the relationship between company's financial performance and supply chain performance¹⁸. This research begins to explore whether supply chain performance influences company performance by:

- developing a financial ratio (proxy) that represents the supply chain;
- empirically testing the ratio using publicly available accounts.

The research made use of traditional financial ratios, widely used to evaluate the financial performance of organisations with regard to profitability, liquidity, asset utilisation, productivity and capital structure. The data were used to statistically analyse and explore the relationships between supply chain and firm performance. The analysis was performed on a sample frame consisting of 117 UK based manufacturing firms that were publicly traded over the period 1995-2004. The dataset consisted of 1,040 distinct datasets - representing the financial data for the company within the year. The analysis was performed on data that had been converted to represent the annual change (i.e. change in ROCE). By using change in values the research was able to more accurately determine whether changes in

¹⁷ Christopher, M.G. (2004) Logistics and Supply Chain Management: Creating Value-Adding Networks. London: FT Prentice Hall.

¹⁸ Frohlich, M.T. and Westbrook, R. (2001) Arcs of integration: an international study of supply chain strategies. Journal of Operations Management, Vol. 19, No. 2, pp. 185-200.

supply chain performance yielded change in firm performance. The scope of the supply chain within the analysis covered all of the activities, functions and assets under the direct control and ownership of the company, from procurement of raw materials, through production, to delivery to the final customer.

The limitation of this approach is that it does not stratify the supply chains into their components as the unit of analysis is the supply chain. Also: as the analysis is at a high-level there is a lack of resolution in identifying discrete causes. Furthermore, the use of secondary data, which are quasi-static, means that the research can only take yearly snapshots of firm and supply chain performance.

Creating a financial proxy for the supply chain

Underpinning this paper was the need to develop and empirically test a proxy that could be used to determine supply chain efficacy. This proxy measures the positive and negative change of supply chain performance compared to financial and operational measures of firm performance. Professor Martin Christopher identified three financial dimensions - profitability, liquidity and asset utilization - that supply chain practitioners need to take into consideration when formulating their supply chain strategy¹⁹. Professor Lisa Ellram and Dr. Baohong Liu²⁰ also identified these as critical business areas which supply chain and purchasing initiatives impact on.

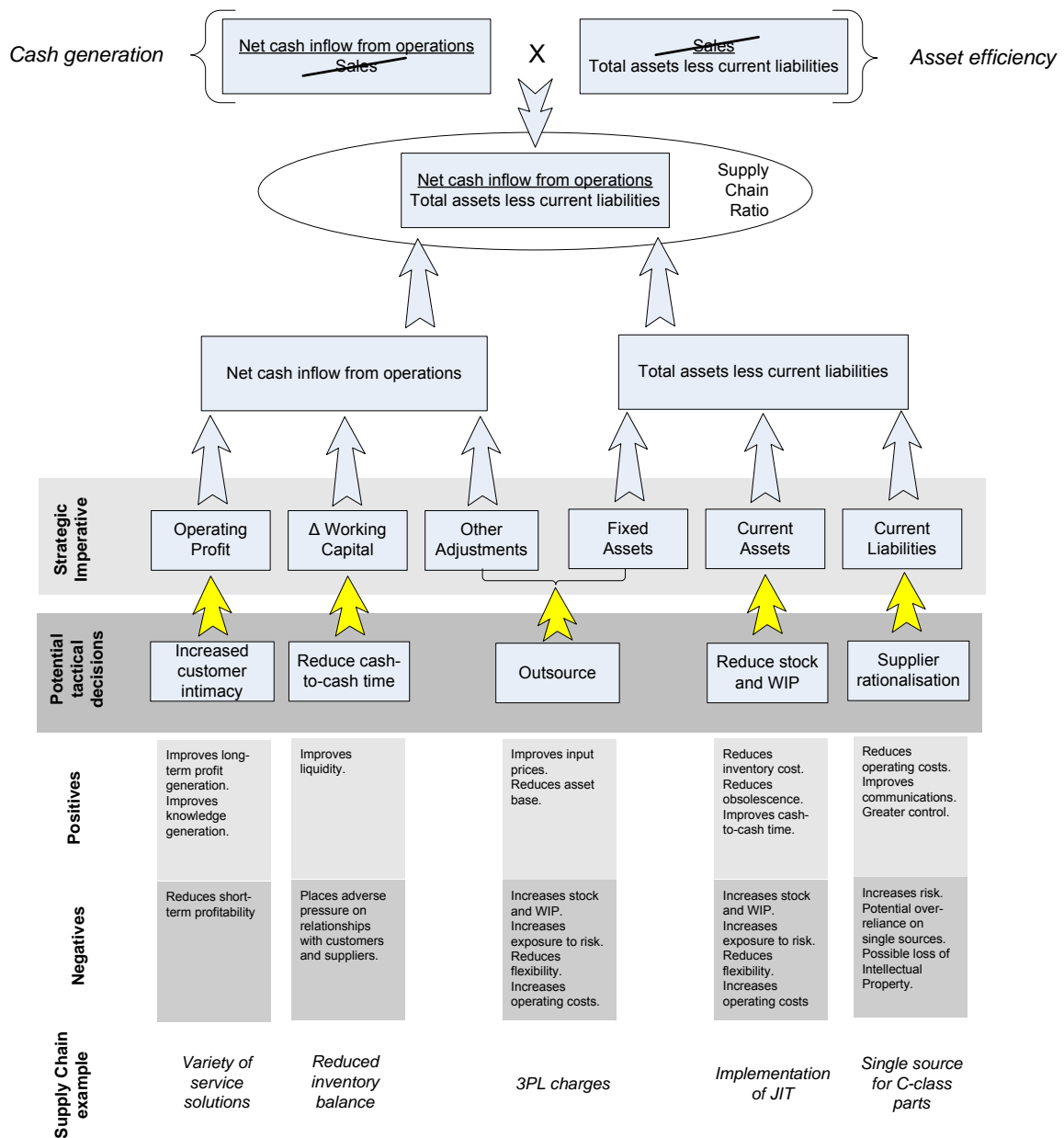
Constructing and testing the proxy required identifying financial attributes for each of the four business imperatives impacted significantly by supply chain performance. The financial attributes are summarised below:

¹⁹ Christopher (2004)

²⁰ Ellram, L. M. and Liu, B. (2002) The Financial Impact of Supply Management. Supply Chain Management Review, Vol. 6, No. 6 pp. 30-37.

Business imperative impacted by supply chain performance	Commentary	Financial attribute
Differentiation	The level of differentiation is reflected in the incremental value as perceived by the customer. Value is invariably measured by what a customer is prepared to pay for the goods or service. Price, or collectively turnover, needs to be factored into the proxy.	Sales
Cost advantage	The supply chain structure and performance drives fixed and variable operating costs (COGS, logistics etc). For many organisations this represents in excess of 70% of the cost base.	Operating costs
Resilience	The resilience of the supply chain is represented by its ability to recover readily from changes to market conditions and demands. Supply chains are asset intensive. The structure and profile of the asset base limits impedes an organisation's ability to change its ways of working in line with a shift in market dynamics.	Fixed assets Current assets
Responsiveness and flexibility	If the supply chain is to react quickly in a world of increasing volatility and uncertainty such that it can readily modify its response to customers without "breaking" it needs to be able to maintain the highest level of operational flexibility. This means retaining the greatest range of options and deferring the point of commitment until as late as possible. Cash provides the supply chain with the greatest set of options (it is equivalent to the "stem cell" of the supply chain), once committed however the range of options is reduced significantly. The quicker the cash can be re-cycled through the supply chain the greater the level of responsiveness and flexibility.	Cash-to-cash cycle

Shown below is the supply chain proxy that we developed through the research. The rationale and explanations of the sources of financial information follow the diagram.



The supply chain proxy is derived from two financial ratios. The first measures the cash generation from sales in a financial period. The second measures asset efficiency through dividing the value of sales generated by total assets less current liabilities in the same financial period.

Cash generation ratio

Net cash inflow from operations, the numerator of the ratio, is determined by taking the operating profit from the income statement and then adjusting for non-cash items

(depreciation and amortisation) which are disclosed in notes to the annual report and accounts. The other adjustment takes into consideration the change in working capital (inventories, debtors and creditors) in the financial period. The denominator is the value of sales for the financial period and is taken from the organisation's income statement.

Asset efficiency ratio

The asset efficiency ratio uses as its numerator the organisation's sales value from the income statement and the denominator is the value of the organisation's total assets (fixed and current assets) minus the current liabilities as disclosed in the balance sheet.

Any supply chain tactical decision will have an impact on one or more of the financial variables that underpins profitability, liquidity and asset utilisation. The focus for managers should be to develop a combination of supply chain initiatives which will increase the cash generated from operations - improving profitability and liquidity - and improve the efficiency of the total assets employed in the organisation. This will increase the proxy by impacting on both the numerator (increasing cash generation) and the denominator (reducing the total assets employed).

The supply chain proxy can be linked back to the generic organisational strategies as differentiation leads to increased profitability and cost advantage leads to greater profitability and asset utilisation whilst an increase in liquidity leads to the mitigation of risk. An increase in liquidity mitigates risk through providing an increase in cash which can be invested to provide strategic advantage to the organisation.

Comparison with other measures

The supply chain proxy can be used at a strategic and tactical level within an organisation and considers profitability (differentiation), efficiency (cost advantage), liquidity (supply chain velocity) and risk.

The suitability of the proxy is contrasted with other, commonly used measures below.

Return on Capital Employed (ROCE)

ROCE measures the efficiency and profitability of a company's capital investments. It is calculated as:

$$\text{ROCE} = \frac{\text{EBIT}}{\text{Total Assets} - \text{Current Liabilities}}$$

ROCE is used to analyse the productivity of capital employed within the company. It can be used in the supply chain context to understand the linkages between supply chain decisions and financial performance, for example in an outsourcing decision where profit may be increased and capital employed reduced. Whilst ROCE is a primary performance measure it does not incorporate measures of liquidity or cash generation. The capital employed does not distinguish between fixed and current assets, nor does it distinguish between cash and inventory to reflect levels of postponement and implicitly flexibility and responsiveness.

Return on Investment (ROI)

ROI is used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. To calculate ROI, the benefit (return) of an investment is divided by the cost of the investment; the result is expressed as a percentage or a ratio. It is calculated as:

$$\text{ROI} = \frac{(\text{Gain from investment} - \text{Cost of investment})}{\text{Cost of investment}}$$

ROI is often utilised to measure the performance of managers with respect to the assets within their control. Within the supply chain it can be used to determine whether increased asset productivity and cost management improves financial performance. Whilst ROI measures the profitability and efficiency it does not

measure liquidity nor provide any indication of the impact of the decision on resilience, responsiveness or flexibility

Economic Value Added (EVA™)

EVA™ measures financial performance based on the residual wealth calculated by deducting cost of capital from its operating. It is calculated as:

$$\text{EVA} = \text{Net Operating Profit After Taxes [NOPAT]} - (\text{Capital} \times \text{Cost of Capital})$$

EVA™ measures the profit less the cost-of-capital. It is typically used to compare companies externally and its use in assessing supply chain performance is to assess competing scenarios in terms of profitability. It does not take into consideration liquidity or asset profile.

Payback period analysis

Payback period is a measure of the length of time required to recover the cost of an investment. It is calculated as:

$$\text{Payback period} = \frac{\text{Cost of project}}{\text{Annual cash inflows}}$$

Payback period analysis, of various forms, is used in projects to evaluate the recovery of initial outlay in various investment scenarios. The use of payback period analysis within a supply chain context is to assess individual projects and investment decisions. It does not take into account profitability or cash-to-cash time and can result in sub-optimal decisions as it favours liquidity as opposed to profitability.

Net Present Value (NPV) and Internal Rate of Return (IRR)

Net present value (NPV) is used to assess capital investment. It measures the excess or shortfall of cash flows, in present value (PV) terms – acknowledging the time value of money - once financing charges are met.

$$NPV = \text{Present value of net cash flows}$$

IRR is an alternative capital investment appraisal technique based on discounted net cash flow. IRR seeks to determine the internal rate of return required to align the total NPV and the total initial cost.

Both NPV and IRR are discounted cash flow techniques used to evaluate capital investment opportunities. They incorporate the temporal nature of projects and consider the opportunity costs of financing. Within the supply chain they are used to evaluate investment decisions in projects incorporating both capital and operational expenditure. When comparing alternative projects the highest NPV and IRR values are accepted. Both NPV and IRR do not consider asset profile or operating cash-to-cash time. A comparison between the supply chain proxy and other financial measures is given below.

	Relevance to imperative			
	<i>Differentiation</i>	<i>Cost advantage</i>	<i>Resilience</i>	<i>Responsiveness and flexibility</i>
ROCE	***	***	**	○
ROI	***	***	*	○
EVA™	***	***	**	○
Payback period	○	**	***	○
NPV	○	**	***	○
IRR	○	**	***	○
SC ratio	***	***	***	***

- Associations:
 ***: Strong
 **: Medium
 *: Weak
 ○: None

Methodology

The sample companies used to test the proxy were UK publicly limited companies with turnovers greater than £15m per annum from the SIC groups 28XX-36XX: the manufacturing sector. These were for the last ten years of available data. The data for company financial performance were extracted from DataStream and pooled to provide the sample frame which consisted of data from 117 companies, comprising 1,040 discrete datasets. The rationale behind the selection of a focussed sample frame was in order to minimise errors and biases due to the non-generalisable nature of sectors. This can be illustrated by comparing the cash-to-cash time, total assets and number of employees, in the 2004 financial year, of Tesco compared (-11.9 days; £20.5bn; 242,980) to BAE Systems (31.9 days; £15.2bn; 69,400). We also suggest that the analysis is facilitated by the selection of firms in a sector where quantification of assets is relatively simple. A counterpoint would be the analysis of a professional services firm where assets are of the intellectual as opposed to the physical variety.

The data were analysed over three stages: clustering, correlation and multiple regression. Clustering was used to determine which data were excluded and included, respectively, in the analysis. A dendrogram for the cluster analysis is included in Appendix A, this indicates that the variables in the analysis were independent enough to include. Correlation was performed over a suite of financial and operation variables; only statistically significant correlations, pertinent to this research, are reported in this paper. Multiple regression was performed in an attempt to form a causal link between demand chain and firm performance as correlation does not indicate causality²¹. In the analysis variables such as share price, market capitalisation and dividends were not included as these are open to the vagaries of the market²². Company performance was operationalised through the enterprise value of the firm which takes into account total cash, total debt and short-term investments as this reduces the influence of market forces.

²¹ Kennedy, P. (2003) *A Guide to Econometrics: 5th Edition*. Maldon, Massachusetts: Blackwell Publishing.

²² Shiller, R.J. (1990) Market Volatility and Investor Behavior. *American Economic Review*, Vol. 80, No. 2, pp. 58-62.

In the regression analysis the change in enterprise value (EV) was selected as the regressor (dependent variable). Change in enterprise value was selected as initial analysis indicates that if the static value is used it is highly correlated to factors such as assets and employees. This is to be expected as it can be generalised that organisations with larger quantities of assets have a greater enterprise value. Change in EV was selected to examine whether a positive change in the supply chain proxy, analogous to an improvement in supply chain performance, contributes to a positive change in EV. In addition to using change in EV as the independent variable, change in the regressands was used for the same reasons as listed earlier. Total assets, ROCE, cash-to-cash and sales are all hypothesised to influence firm performance, thus are included in the regression model.

Industry sector can represent 19% of the aggregate variability in profits²³. Engineering companies were classified into eight different sectors - from SIC 28 to SIC 35 - and were coded as a dummy variable in the analysis. Power within supply chains was operationalised using the Herfindahl Index. This index is actually a proxy for market concentration but power and industry concentration are inversely related²⁴. The Herfindahl Index was calculated using the sales of all companies within the DataStream database with the same primary four-digit SIC code. The analysis hypothesised that there are further externalities, such as the rising costs of energy that influence enterprise value. Three were included in the regression model which were: input prices, output prices and consumer confidence. These were operationalised using data obtained from UK National Statistics.

In order to determine the affects that change in demand change ratios, RPI, input and output prices, industry power and type, total assets employed, ROCE, cash-to-cash cycle and total sales have upon company's financial performance the following regression model was used. The next section discusses the empirical testing of the model.

²³ McGahan, A.M. and Porter, M.E. (1997) How Much Does Industry Matter, Really? *Strategic Management Journal*, Vol. 18, No. S1, pp. 15-30.

²⁴ Hendricks, K.B. and Singhal, V.R. (2003)

Results

Appendix B shows the Pearson correlation coefficients of selected financial and operational information. Appendix D shows the estimated coefficients, with t -statistics, and p -values from the regression model using Enterprise Value - included in Appendix C - as the regressand.

Correlation analysis showed that change in the ratio is correlated, at a statistically significant level, with favourable changes in output prices (potentially due to efficiencies caused by better supply chain management), Herfindahl Index, creditor days, debtor days, enterprise value, funds generated from operations, net earnings per share (EPS), ROCE, inventory turns, Tobin's q (a comparison of the market value of the company and its assets) and cash-to-cash cycle.

Regression analysis indicated that the supply chain has a statistically significant ($p=0.001$), with positive coefficient, direct impact upon change in Enterprise Value. Thus: improving supply chain performance influences the value of the firm. Variables that also directly affect the rate of change of enterprise value at a statistically significant level are: the constant ($p=0.048$), input prices ($p=0.018$), industry sector (SIC30 $p=0.003$; SIC32 $p=0.003$), total assets employed ($p=0.000$) and total sales ($p=0.000$). The industry sectors SIC30 and SIC32 are, respectively, manufacturers of office machinery and computers and manufacture of radio, TV and communications equipment and apparatus. The R^2 and adjusted R^2 values of the regression model are, respectively, 12.1% and 10.3%, which are acceptable given that the model was based on cross sectional financial data^{25, 26}.

The statistical significance of the constant indicates the presence of industry specific factors such as the level of competition, the basis of competition, innovation rate, and cost of switching for customers²⁷. As should be expected, as the level of sales increases, the enterprise value of a firm increases. Also statistically significant is that

²⁵ Fama, E. & French, K. (2000) Forecasting Profitability and Earnings. *Journal of Business*, Vol. 73, No. 2, pp. 161-175.

²⁶ Hendricks, K.B. and Singhal, V.R. (2003)

²⁷ *ibid.*

an increase in the total assets within an organisation leads to an increase in enterprise value. This is due to two factors. The first of which is that larger companies (with greater enterprise value) often have more assets. The second of which is that total assets is a component of enterprise value.

Variables that did not have high levels of statistical significance will also influence enterprise value indirectly even if they are not significant in our model. For example; cash-to-cash is not statistically significant but improving the cash-to-cash time means that a company will need to finance its inventory for a shorter period of time: reducing its need to leverage debt, thereby increasing profit.

Conclusions

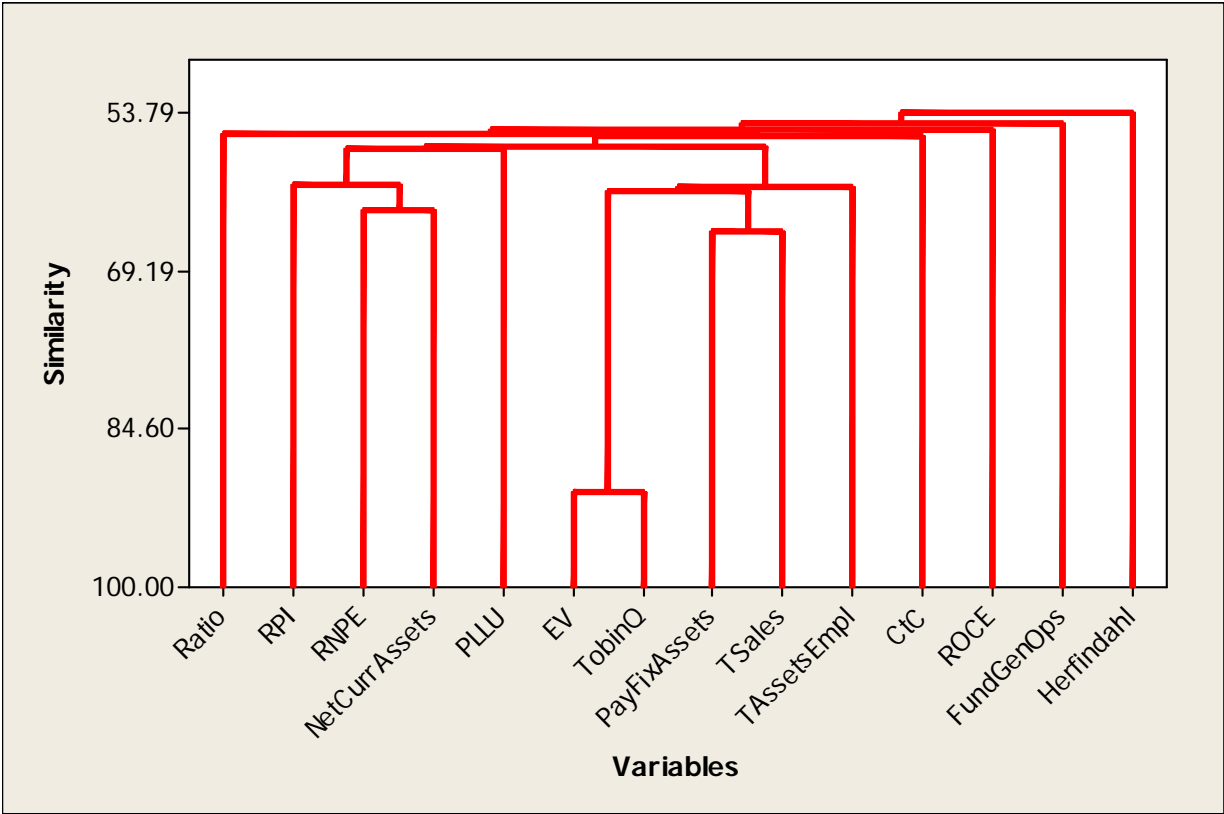
This work constructed a proxy that makes it empirically possible to test the efficacy of improved supply chain management. The results of our analysis indicate that improving supply chain performance has a statistically significant impact upon a company's financial performance, as do sales, total assets and, in certain cases, the sector in which a firm operates. These results are specific to a sector within the UK economy but may be generalisable to other sectors.

The originality of this research is that it uses secondary data to explain the relationships between supply chain and a company's financial performance. The findings of this research allow Supply Chain Directors and Managers to evaluate the relative merits of alternative strategies, technologies and approaches in terms of their impact on a company's overall financial performance and with confidence to advocate the supply chain as a critical driver of superior company performance.

Assumptions, limitations and extensions of the research

The next stages of the research are to analyse companies internally to determine whether the model is further validated by the analysis of specific supply chain performance. A further extension of the work is to test the proxy in other industry sectors to validate its general applicability.

Appendix A: Cluster analysis dendrogram



Clustering groups variables when they are initially unknown. Thus: the dendrogram shows the grouping of similar variables. In this case only Enterprise Value and Tobin’s Q can be considered similar.

Appendix B: Correlation table

	Ratio	Output prices	Herfindahl Index	Creditor days	Debtor days	Enterprise value	Funds generated from operations	Net EPS	ROCE	Inventory Turns	Tobin's q	Cash-to-cash
Ratio	1											
Output prices	-.197(***)	1										
Herfindahl Index	-.068(*)	-.061(*)	1									
Creditor days	.082(**)	.019	.000	1								
Debtor days	-.065(*)	-.083(**)	.017	.246(**)	1							
Enterprise value	.116(***)	-.014	-.024	.087(*)	-.043	1						
Funds generated from operations	.067(*)	-.008	-.062(*)	-.027	-.072(**)	.038	1					
Net EPS	.059(*)	-.053	.009	-.023	.018	-.018	.032	1				
ROCE	.107(***)	.057	-.012	.027	-.032	.035	.047	.216(***)	1			
Inventory Turns	-.123(***)	-.022	.062(*)	.170(***)	.433(***)	-.064(*)	-.042	-.020	-.109(***)	1		
Tobin's q	.104(***)	.047	.007	.091(***)	-.056(*)	.813(***)	.015	-.030	-.001	-.056	1	
Cash-to-cash	-.076(**)	-.048	.016	-.148(***)	.497(***)	-.087(**)	-.037	-.007	-.075(**)	.527(***)	-.098(***)	1

*** Correlation is significant at the 0.01 level (2-tailed).

** Correlation is significant at the 0.05 level (2-tailed).

* Correlation is significant at the 0.1 level (2-tailed).

Correlation measures the degree of linear relationship between two variables and assumes a value between -1 and +1. If one variable increases when the other decreases the correlation coefficient is negative.

Appendix C: Regression equation

$$EV_i = \beta_0 + \beta_1 \hat{d}cratio_i + \beta_2 RPI_i + \beta_3 input - price_i + \beta_4 output - price_i + \beta_5 herfindafl_i + \beta_6 industry_i + \beta_7 assets_i + \beta_8 ROCE_i + \beta_9 cash - to - cash_i + \beta_{10} sales_i$$

Appendix D: Regression table

Variable	Coefficient (t)	p
Constant	-4.241 (-1.98)	0.048
Ratio	0.7038 (3.49)	0.001
RPI	0.07824 (1.52)	0.129
Input prices	0.015928 (2.38)	0.018
Output prices	0.02374 (1.25)	0.211
Herfindahl Index	-0.0174 (-0.07)	0.946
Industry 1 (SIC28)	-0.0353 (-0.27)	0.785
Industry 2 (SIC29)	-0.0184 (-0.13)	0.895
Industry 3 (SIC30)	0.5427 (2.98)	0.003
Industry 4 (SIC31)	-0.0135 (-0.1)	0.922
Industry 5 (SIC32)	0.4327 (3)	0.003
Industry 6 (SIC33)	0.1561 (1.22)	0.224
Industry 7 (SIC34)	0.0735 (0.43)	0.67
Industry 8 (SIC35)	0.0667 (0.37)	0.709
Total Assets Employed	0.10238 (3.57)	0.000
ROCE	0.002802 (0.75)	0.451
Cash-to-cash	-0.08677 (-1.08)	0.278
Total Sales	0.5919 (5.45)	0.000
Model F value		6.56
R^2		12.1%
Adjusted R^2		10.3%

Regression is used to investigate and model the relationship between a response variable (in this case Enterprise Value) and one or more predictors. p-values of less than 0.05 indicate that the predictor has a statistically significant affect upon the response variable. Statistically significant variables are listed in bold.