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De-Risking as a Source of Supply Chain Value

by

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Abstract

This paper develops a framework for valuing the supply chain initiative of a 'supplier' firm. Three generic sources of value are identified; cost savings, revenue increases, and risk reduction. The central thesis of this paper is that de-risking (risk here is used in a capital asset pricing model sense) may be a significant source of value to the shareholders of a supplier firm. The contention is that a well-conceived supply chain initiative can so alter the relationship between a supplier firm and a customer, as to reduce risk. This reduced risk follows from customer stickiness, by which we mean that the market share of supplier firm may be higher when the industry faces an adverse economy.

A state-preference theory/capital asset pricing model framework is used to show that customer stickiness can indeed reduce risk and the cost of capital. Evidence from the Indian automobile industry supports the thesis of customer stickiness.

De-Risking as a Source of Supply Chain Value

This paper develops a framework for valuing the supply chain initiative of a 'supplier' firm. Three generic sources of value are identified; cost savings, revenue increases, and risk reduction. The central thesis of this paper is that de-risking (risk here is used in a capital asset pricing model sense) may be a significant source of value to the shareholders of a supplier firm.

The value to shareholders is computed by discounting a future stream of cash flows at a rate that reflects the risk appropriate to these cash flows. Thus, value can be enhanced either by increasing the numerator (through a combination of cost savings and revenue increases), or alternatively by reducing risk and, therefore, the denominator.

Broadly cost savings may be derived directly from a reduction in operating cost and indirectly from reduced asset levels (both current and fixed assets.) Revenue increases may be derived from volume increases and unit price increases, both facilitated by enhanced end-customer value derived in turn from the supply chain initiative.

Finally risk reduction may be derived from customer stickiness. By customer stickiness we mean the willingness of customers to maintain relationships with the supplier firm, whose supply chain initiative provides enhanced value to customers, even in adverse market conditions. By stickiness we do not mean that the supplier firm's revenues are more strongly correlated with the specific industry revenues. Instead, by stickiness, we imply an asymmetric relationship between supplier firm revenues and industry revenues. When industry revenues increase, the supplier firm's revenues go up proportionally. When industry revenues fall the supplier firm's revenues fall less than proportionally, with customers responding by reducing transactions with other suppliers, who offer lower value to them. This customer stickiness moderates revenue fluctuations and lowers the supplier firm's risk as measured by the capital asset pricing model beta. This lowers the firm's cost of capital and enhances firm value. When industry revenues increase, the supplier firm's revenue may even increase less than proportionally. This may occur if quality is of overriding importance and the supplier firm, while very responsive in the short run, does take time to scale-up. If the revenue in good times increases than proportionately, this further lowers the cost of capital.

This de-risking argument is valid for a 'normal industry whose revenues move in line with the overall economy. It is not valid for a counter-cyclical industry whose revenues move in opposition to the overall economy.

In a sense our valuation model is most appropriate for a business-to-business relationship with the supplier firm selling to another business and not to a final customer. It is also most appropriate for the first mover who introduces a significant supply chain initiative in a given industry. While it may be appropriate even for a firm selling to a final customer or one that is not the first mover, we will assume first mover status and business-to-business relationship. We contend that the horizon for cost savings is medium-term from the view point of firm value, as competitors launch their own initiatives such cost savings lead to a cost level that is 'normal' for the business. Down the line, no firm makes an 'abnormal' profit out of cost savings. The horizon for revenue savings may, if anything, be even shorter than the cost-savings horizon. However, the relationship with customers, that the first mover can build can possibly be a long-term source of value. That is, such a relationship may permanently reduce the risk of the supplier firm. It is even entire possible that the supply chain initiative may result in a cost increase (such an increase being anticipated at the start of the initiative) rather than a cost saving, however de-risking has the potential to more than offset any cost increase. We identify sources of such customer stickiness.

The rest of this paper is organized as follows. Section 1 summarizes the literature on performance measurement and risk related to supply chain initiatives. It also discusses briefly transaction-cost economics and the underpinnings of the capital asset pricing model beta. Section 2 provides a formal valuation model of a supply chain initiative. Section 3 focuses on customer stickiness, and Section 4 concludes the paper.

1. Literature Review

The literature review focuses three broad topics; performance related to supply chain management, transaction cost economics, and risk in a corporate finance sense.

Supply Chain

We will focus on two related strands of supply chain literature, that concerned with performance and that concerned with risk. Within supply chain many researchers have equated improving performance at chain level as equivalent to improving performance at firm level, and discussed how benefits of improvements should be distributed equitably. However, Cox (1999) argues that a firm should strive for a position in a chain that enables it to appropriate most of the value from supply chain improvements that occur within a chain. In this paper we focus on firm level performance and avoid such a strategic positioning issue.

Improving supply chain performance has been a main concern of both practitioners and researchers. Substantial work in the area of supply chain improvement has focused on information sharing, better coordination, and joint optimization (see Cachon & Fisher 1997; Chan et. al 2000; Clark & Hammond 1997; Fisher et. al, 1997; Hertz et. al 2001; Karabakal et. al 2000; and Lin et. al, 2000).

Beamon (1999) presents a framework for the selection of performance measurement systems for supply chain initiatives. This framework incorporates three types of performance measures; resources, output and flexibility. The first, resources, covers total cost, distribution cost, manufacturing cost, inventory cost (both in terms of value associated with investment in raw material, work-in process and finished goods inventory, and the cost of inventory obsolescence). An overall measure of resource use is the return on investment. Output measures include sales, profits, fill rate, on-time deliveries, backorder/stockouts, customer response time, manufacturing lead-time, shipping errors, and customer complaints. Flexibility includes volume flexibility, delivery flexibility, mix flexibility, and new product flexibility. These three type of measures help a supply chain simultaneously achieve a high-level of efficiency, a high level of customer service, and provides the ability to respond to a changing environment.

While this framework is comprehensive one could argue that return on investment, is not a measure of resource alone but a comprehensive overall measure that incorporates benefits, costs and investment in assets.

Walters (1999) addresses the issue of shareholder value. Drivers of shareholder value include the sales growth rate, operating profit margins, fixed and working capital investment, and the cost of capital. He discusses the possibility of using the capital asset pricing model beta as a measure of risk, and provides an illustration of the use of Economic Value Added.

Christopher (1998) also discusses the use of shareholder value, focussing on total logistics cost and customer profitability analysis as important inputs in assessing such a shareholder value. The Supply Chain Operations Reference framework developed by The Supply Chain Council covers the four major processes: plan, source, make and deliver. This model users four major metrics, customer satisfaction and quality, time, cost, and assets. Shah and Singh (2001) measures supply chain performance using publicly available financial information related to working capital constituents such as inventories, receivables, and payables.

Holmberg (2000) takes the interesting position that there is too much emphasis on financial metrics.

Risk, traditionally in the supply chain literature, has been viewed as uncertainty of supply and demand. Uncertainty of demand and supply is captured by the variance of demand and supply lead-time faced by a firm. Such uncertainty can be handled by holding higher safety stocks and failure to cope with uncertainty leads to higher stock out costs. In most supply chain work, the benefits of risk mitigation have been measured in terms of reduction in safety stock and reduction in stock out costs.

Fisher (1997) in his landmark paper has argued that products can be categorized as functional products or innovative products based on demand uncertainty faced by the products in the market place. Functional products, such as food products, have by and large predictable demand and the focus of the

supply chain should be on improving efficiency by improving physical logistics. While for innovative products, such as fashion products, demand is inherently unpredictable at the final customer end. Innovative products, like fashion products and technology products, have received considerable attention. Risk mitigation strategies involve buy-back contracts, postponement or innovations in supply chain design that enhance flexibility. Padmanbhan & Png (19995) show that under high uncertainty producers can improve supply chain performance by using buy-back contracts. Buy-back contracts such as found in the music and book industries help in mitigating the risk of the retailer, and allow the retailer to stocks more than what he would have otherwise stocked, resulting in improving the overall supply chain performance (Emmons & Gilbert, 1998; Lee et. al, 2000, Li, 1999) .

Postponement refers to the delay of product differentiation to a point closer to the time of sale of the product. Lee and Tang (1998) have shown that by postponing the point of differentiation, firms can manage their supply chain using aggregate forecast at product level rather than individual SKU level. Since the forecasting error at aggregate level is much lower than the forecasting error at individual variant level, firms are able to reduce forecasting error and this results in lower safety stock inventory and better customer service. A significant number of firms have used the ideas of product and process postponement to decrease overall variability in demand and have managed to improve their supply chain performance (Brown et. al, 2000; Shah & Avittathur, 1999; Lee et. al, 1993).

Designing flexible supply chain can be achieved by using a flexible supply contract (Lim 2001; Tsay, 1999) or by dividing an entire season into, say, two parts (Fisher et. al, 1994). Instead of making a single forecast for the entire season, if one divides the season into two parts, then one can observe the initial demand during the first part of the season and then revise the forecast for the second (later part of the season) period. This can improve forecast accuracy and reduce risk of stockouts or obsolescence. Investing in flexible production facilities and flexible contracts with supplier would be important requirements for building a flexible supply chain (Corbett & DeCroix 2001; Donohue, 2000; Tsay &Lovejoy 1999)

Even though Fisher argues that functional products should not face much demand uncertainty, in real life manufacturers in functional products, such as food products, do see a large variability at their end.

Lee et. al (1997a) in their landmark paper have introduced the concept of the bullwhip effect. An increase in demand variability as one moves down in chain is referred to as the bullwhip effect. In a typical supply chain as we move down from retailers to wholesalers and to manufacturers, each stage in the chain distorts demand and the variability in demand keeps increasing as we move down the chain. Thus, though variability is quite low at the final customer end, a manufacturer usually sees a high demand variability. They have identified four different causes of the bullwhip effect: multiple demand forecast update by various supply chain members, order batching at various stage in chain, price fluctuations within the chain, and shortage gaming by partners in the chain. They have suggested ways in which companies can avoid this bullwhip effect by information sharing and aligning incentives across the chain. Chen et. al (2000) have quantified the impact of forecast updating and information sharing in a supply chain situation. Better information sharing would result in lowering of production (a change in production level results in higher production cost— see Lee et. al, 1997b). Lee et. al (2000) and Li and Kouvelis (1999) look at issues related to price protection and risk sharing contracts under price uncertainty. To handle issues related to multiple forecast updating within the chain, it has been suggested that organizations in a supply chain should work towards collaborative forecasting (Aviv, 2001; Cachon and Lariviere, 2001).

Apart from demand and supply uncertainty, researchers have also looked at risk arising from exchange rate fluctuations and from implementation. In addition to uncertainty about the supply quantity, firms also face foreign exchange related uncertainties. Multiple plant locations spread over the globe can also help firms in reducing risk from exchange rate fluctuations (Kogut & Kulatilaka 1985). Cohen and Mallik (1997) have suggested that by shifting production allocation across units, MNCs which have multiple facilities across the globe can take advantage of changes in exchange rate. McGuffog and Wadsely (1999) suggest that functional integration with a firm can help firms in reducing risks entailed in adapting lean supply.

We contend that the literature has focused on a number of financial measures but has not quite addressed risk relevant to shareholders. Risk faced at operations level (such as demand and supply related risk) may not necessarily translate into risk at shareholder's level. This is the gap in the literature that we propose to address.

The next strand of literature that we will review is transaction cost economics. Transaction cost economics focuses on relationships between parties, this is important to us since we will subsequently argue then the intimate relationship between a supplier firm and customer can lead to customer stickiness. Transaction cost economics (TCE see Williamson: 1975, 1979 and 1983; Goldberg, 1976 and Klein et al. 1978) provides an explanation for shifting transactions from market to firm and vice-versa, on efficiency considerations alone (i.e. no monopolistic motives are imputed). A transaction refers to an exchange across a technologically separable barrier. Efficiency refers to minimization of associated transaction costs (assuming that production costs remain unaltered in shifting a transaction between market and firm). Transaction costs represent search and information, bargaining and decision, and policing and enforcement costs. TCE provides an organization failure framework in which one form of organization is said to have failed if transactions shift (or remain within) another form. The organizational failure framework is based on the existence of certain factors. The human factors are bounded rationality and opportunism. By the latter is implied something more than self-interest; individuals can make self-disbelieved threats and promises. The environment is characterized by uncertainty/complexity. Further, exchanges involve a small, rather than a large, number of parties. This is a critical assumption for our paper that many exchanges end up over time with a small, rather than a large, number of. parties.

With uncertainty/complexity, bounded rationality implies that a complete contingent claims market cannot exist. Again, while opportunistic behaviour will provide no advantages (in repeated exchanges) in a competitive situation; such behaviour may be profitably adopted in small number exchanges. Uncertainty, opportunism, and bounded rationality can also lead to information impactedness. This describes situations in which relevant information available, say with one party, cannot be costlessly disclosed to the other or obtained by the other. Even with a commonly shared information set, information impactedness can occur. One party may be encouraged to misrepresent if a third party (the arbitrator) cannot costlessly access the information. Thus, impactedness is the usual moral hazard and adverse selection problems, compounded by opportunism.

While vertical integration that brings a supplier-customer exchange within a single firm is one possible solution, a well-designed relationship between an 'arms-length' supplier and customer can also be a solution. A well functioning supply chain that meets customer needs effectively can enhance the relationship between customer and the supplier firm, the exchange is not a 'within firm' relationship but nor is it a 'spot market' relationship. Blois (1972) describes what he titles vertical quasi-integration relationship. In such a relationship a large customer and supplier reap the advantages of formal vertical integration (where activities of a large customer and supplier would be brought under a single ownership) without assuming the 'risks and rigidity of ownership.'

Central to TCE is the 'incomplete contract' view of exchanges between, say supplier and customer. Macaulay (1996) argues that a supplier and customer are explicit and careful about the definition of performance in a given transaction. They tend to be less explicit about the rights and obligations of the two parties in the event of a contingency, relying on tacit agreement. They make unilateral assumptions about the rights and obligations of the two parties over possible defective performance. Surprisingly, they tend to be unaware of legal sanctions. Given the absence, and indeed unfeasibility, of a complete contract that specifies the consequences of every possible contingency, reputation is important. Key to this reputation is that a party does not behave opportunistically in an unforeseen contingency, but can be trusted to behave with 'honour.' Kreps (1996) presents an analysis of reputation focussing on an inferior party (in a hierarchy sense) trusting a superior party because of the reputation built by the latter.

TCE also highlights the role of asset-specificity in an exchange. Asset-specificity refers to the investments involved in an exchange. Both the original parties to a transaction are better off in that relationship, than they would be with any other party (i.e. buyer and seller are `locked in').

We finally review risk in corporate finance. The capital asset pricing model beta is a formal measure of risk in finance theory (Copeland and Weston, 1992). Formally it is defined for security 'i' as:

$$\beta_i = \text{Cov}(R_i, R_m)/\text{Var}(R_m) \quad (1)$$

Where R_i and R_m are the returns of security 'i' and of the overall market 'm' respectively.

In the CAPM framework, the cost of equity of firm 'j' is given by:

$$k_e = R_F + (E(R_m) - R_F)*\beta_j \quad (2)$$

Where R_F is the risk-free rate and $E(R_m)$ is the expected return on the market.

The overall weighted average cost of capital (WACC) is given by:

$$WACC = D/(D+E)*(1-T)*k_d + E/(D+E)* k_e \quad (3)$$

Where D and E are the market values of debt and equity respectively, k_d is the cost of debt and T the corporate tax rate.

The WACC is the appropriate discount rate to be used on a firm's future cash flows, for valuing a firm. At the core of the firm's WACC is the riskiness of equity as measured by its beta. In finance theory it can be shown that maximizing the value of the firm is consistent with maximizing the utility of individuals shareholders (Copeland and Weston, 1992). Minimizing the WACC is consistent with maximizing the value of the firm. Hence, if a supply chain initiative can be shown to reduce risk, this would imply that the value of the firm is increased.

An understanding of beta, in terms of firm level operations, is provided in the Mandlekar and Rhee (1984) expression:

$$\beta_j = (DOL)*(DFL)*\beta_j^0 \quad (4)$$

DOL is the degree of operating leverage (a measure of the sensitivity of operating profits, as measured by earnings before interest and tax (EBIT), to changes in revenues), DFL is the degree of financial leverage (a measure of the sensitivity of net profits to changes in EBIT). DOL arises from the presence of fixed operating costs in addition to variable operating costs. DFL arises from the presence of interest costs from the use of debt. β_j^0 is the inherent risk of a firm with neither operating nor financial leverage (i.e. the risk of a firm that has no fixed operating costs and no debt). β_j^0 is given by:

$$\beta_j^0 = Cov[(\Pi_{jt-1}/S_{jt-1})*(S_{jt}/E_{jt-1}), R_{mt}]/Var(R_{mt}) \quad (5)$$

Where Π is the net profit and the S the sales of the firm, with E the value of equity as before. The current period is 't' and the immediate prior period is 't-1'. This risk β_j^0 depends on how sales revenues move with market returns, a relationship this paper will explore.

2. Valuing a Supply Chain

We assume a world with zero-inflation, so that all numbers (including the cost of capital) are in real terms. The firm has free cash flows of FCF that will stay level, perpetually, in the absence of a supply chain initiative. The corporate tax rate is 'T'. A supply chain initiative involves the following.

i) Reduces the cash cost of goods sold (we assume that all savings are reflected in the variable COGS, and not in a combination of COGS and fixed operating costs.) Reduces inventory levels and logistics-related fixed asset levels. The depreciation rate for tax purposes is 'd' (on a written-down value

basis over an infinite horizon.) The horizon for such cost reduction is 't1'. After this horizon, customer prices will alter to wipe out any cost savings.

ii) Increases sales revenues. This could follow from a combination of market share and price increases. The horizon for such an increase is 't2'.

iii) Reduces the β of the firm, permanently.

Table I contains the symbols for the possible items whose values change following a supply chain initiative.

Take in Table 1

The present value of cost savings if the firm's risk does not alter is given by:

$$V_1 = (C - C_0)*(1 - T)*PVA(k_0,t1)+ (I_0-I) +(F_0 - F) - d(F_0 - F)/(k_0+d) \quad (6)$$

Where

$PVA(k_0,t1) = \{1/ k_0-1/[(1+ k_0)^{t1}]\}$ is the present value of a level annuity for t1 years.

The first term is the present value of after-tax COGS savings. This would include distribution costs, manufacturing costs including rework, and inventory obsolescence cost. The second is the immediate release of investment in inventory. The third is the immediate release of investment in logistics related fixed assets. The final term is the present value of depreciation tax shields foregone following such reduction in fixed assets.

The present values of revenue increases if the firm's risk does not alter is given by:

$$V_2 = (S-S_0)*(1-C)*(1-T)* PVA(k_0,t2) \quad (7)$$

Where

$PVA(k_0,t1) = \{1/ k_0-1/[(1+ k_0)^{t2}]\}$ is the present value of a level annuity for t2 years.

Revenue increases reflect the impact of customer satisfaction and product quality, customer satisfaction in turn reflecting performance improvement on such output measures as failed rate, on-time deliveries, customer response time, backorder/stock out.

This expression ignores the impact of a change in receivables because of additional sales. The net impact of such an additional impact, assuming an investment in receivables at the existing receivables turnover of $R_{turnover}$ to support additional sales followed by the salvaging of this at t2, is $-(S-S_0)* C_0/R_{turnover} [1+ 1/(1+k_o)^{t2}]$.

The present value of value increase from risk reduction is given by:

$$V_3 = FCF/k - FCF/k_0 \quad (8)$$

This term reflects the change in the value of the firm on the assumption that risk has reduced and therefore the present value of free cash flows (without the supply chain initiative) has increased. This ignores 'second-order' effects that V_1 and V_2 will increase if k, rather than k_0, is used for discounting.

Some supply chain initiatives may require substantial investments in new technologies, or may require additional warehouses. For example, a better responsiveness to the customer might actually warrant a higher transportation cost because of the use of a faster mode of transportation, or a higher number of stock-points. These investments may not allow the customer to be charged a higher premium. As a result a

supply chain initiative may indeed have a negative impact on cash-flow. For example, a customer may decide to go lean and want the supplier to work with vendor managed inventory, and require the vendor to keep stock at a warehouse located at his plant. This results in additional costs to the supplier, but would also result in better customer satisfaction. Also shipping in containers or shipping on specific days may increase costs at the vendor end, but might result in lower costs at the customer end. However such investments may be worthwhile if the overall risk of the supplier firm is reduced.

3. Customer Stickiness

Customer Stickiness: Concept

By customer stickiness we mean, as stated at the outset, that market shares of a supplier firm are higher when an industry is in a bad state compared to normal or good states. We have usurped the phrase 'customer stickiness' fully aware that the e-commerce literature uses it with a different connotation. In order to estimate the impact of customer stickiness on risk we need to value the supplier firm. Valuing a firm requires a multi-period computation. We assume that the conditions of admissible uncertainty, consistent with the capital asset pricing model, are satisfied (Fama, 1977) so that the valuation exercise reduces to one of valuing each period's cash flow by a WACC appropriate to that period. We can then restrict ourselves to valuing the firm's first period's cash flow. Subsequent periods will follow from the same logic.

We will first use a state-preference framework and then summarize the results in a capital asset pricing model framework. The reason for this seeming redundancy of frameworks is to avoid the confusion that can arise when betas are used (Booth, 1982).

The state preference numbers are in Table II below. In this table there are three possible states of the world, normal, bad and good. The relevant industry is 'normal' with revenues moving with the overall economy. The supplier firm, before it makes a supply chain initiative, has revenues that respond symmetrically to the economy, with a fixed market share of 33.33%. The firm's cost of capital is in Table II (Panel C). However, once the supply chain initiative is in place, the response is asymmetric; with

downward movements attenuated. The market share in a bad economy moves up to 40%. As Table II (Panel D) shows this reduces WACC, corresponding to a reduction in the equity β. Table II, Panel E explores another alternative. While the supplier firm gains market share on the downside, it gains sales on the upside but cannot retain market share. This reduces equity β and reduces WACC somewhat more than the positive response to downside economy does.

Take in Table II

The issue we now address is whether such an asymmetric response can follow from a supply chain initiative. And if so, what are the critical elements of such an initiative that can de-risk the supplier firm.

We contend that this asymmetric response arises from three sources:

i) 'Lock-in' derived from 'rational' features of the product that is central to the supplier firm customer relationship.

ii) 'Lock-in' derived from the 'contractual' features of this relationship. This could be based on past on-time delivery record that has encouraged the customer to operate with low warehouse capacities, a quality record that in turn has influenced customers 'inspection' levels', electronic data interfaces, and so on.

iii) The third is a positive reputation that the supplier has built over the settlement of unanticipated contingencies.

These sources provide a value to customers that certainly contribute to market share of the supplier under normal conditions. When the going gets bad, customers do not cut purchases across-the-board, but reduce purchases from suppliers with lower 'lock-in' and lower reputation. This behavioural response is not without counter arguments. Such suppliers may indeed be lower priced, and may be what customers seek in troubled times. But we believe that the value provided by a firm with a well-functioning supply chain is of even greater significance to customers in such troubled times than when the market is

normal. Customers would not wish, for instance, to jeopardize relationships with their own end-customers. Hence the stickiness.

While the above paragraphs covers customer response in bad times, also of interest is how the supplier firm's revenues alter in good times. We would hypothesize that market share that prevailed in normal times will be maintained will prevail in good times. However, a supplier firm not only has to get its own act together, but also has to ensure that its own suppliers get their acts together. This is especially true in Indian conditions where quality and contractual assurance are often wanting. A supplier firm is not only a systems integrator of items supplied by its own set of suppliers, but is equally a 'quality' and 'contractual assurance' integrator as far as its customer is concerned. This is a challenging and critical role. Thus, while the supply chain initiative itself would enhance flexibility, scaling up in response to a major increase in automobile industry purchases may indeed take some time. Thus, although the customer is willing to purchase proportionately from the supplier firm, the supplier firm concerned about its own reputation may respond a little cautiously. This may, in part, explain why the revenues in good times may increase less than proportionately. A second reason for this possibly occurring is customer behaviour. From our empirical observations and discussions with purchase departments of some automobile companies we have observed that during difficult times they pay more attention to supply chain effectiveness and reward firms that invest in supply chain relations with a higher share of their purchases. But during good times they are more worried about short term issues in terms of ability to get the required quantity, with the result that they are less concerned about supply chain effectiveness. This could be one of the explanations, which needs to be investigated through more rigorous research.

Customer Stickiness: Illustration

As we stated at the outset, we intend to use some empirical evidence to support our thesis of customer stickiness. A potential candidate for this in India is the automobile industry. The automobile industry has a large base of suppliers, many of them listed on the stock exchange. We first asked a few senior purchase executives from the automobile majors to rate their suppliers. Ratings were not restricted to the supply chain initiative alone but to a whole set of issues such as willingness to work together on design, quality,

and supply chain processes. From those firms that received a high rating from a majority of automobile firms, we restricted our attention to supplier firms which were listed and whose financial data was, therefore available.

We studied customer stickiness over a ten-year period, with 1990 as the base year. We removed one company from our sample that had significant discontinuity during the period of study because of serious disruptions in that company's operations. Our purpose was to examine how the market share of each supplier firm (in our sample) was related to the changes in the fortunes of the automobile industry. We used sales of automobile majors as a measure of the industry performance (we also tested the results with purchases, the conclusions are similar), and compared supplier firm market shares with industry sales. Since both industry sales and market shares were not static over the years, we de-trended the data series using equations (9) and (10) below. We developed two indices: an Automobile Sales Index (for the aggregate industry) and a supplier firm Market Share index (for each individual automobile component supplier) for each year 't'.

$$\text{Automobile Sales Index}_t = \text{Automobile Industry Sales}_t * /(1+CG_A)^t * 100/(\text{Automobile Industry Sales}_0) \quad (9)$$

Where

CG_A Compounded growth rate of the automobile industry sales between base period '0' and terminal period 'T'.

$$\text{Supplier Firm Market Share Index}_t = (\text{Supplier Firm Sales}_t/\text{Industry Sales}_t)/(1+CG_i)^t * 100/(\text{Supplier Firm Sales}_0/\text{Industry Sales}_0) \quad (10)$$

Where

CG_i = Compounded growth rate of market share of the i^{th} supplier firm.

The results are in Table III for the industry and four supplier firms. The Indian automobile industry grew at compounded growth rate of 15.4% over the 10 years. The market shares of all the four supplier firms studied increased in the period, all for had sales growth in excess of the industry average.

Take in Table 3

The industry and supplier firm indexes are in Figure 1. The industry did relatively poorly in 1992 and relatively well in 1995. Supplier firm market shares, on the other hand, did relatively well in 1992 and not as well in 1995. While there is broad support for our thesis that supplier firms may acquire additional market share in bad times, the data (scanty as it is) would appear to point to a loss of market share in good times. In other words, Table II, Panel E, appears to be more descriptive of reality in this specific context compared to Panel D.

Take in Figure I

Conclusion

In this article, we have provided a generalized framework for valuing a supply chain initiative. The framework incorporates the impact of additional revenues, additional costs, and a possible reduction in risk. The central thesis of this paper is that a well-conceived supply chain initiative can so alter the relationship between a supplier firm and a customer, as to reduce risk. This reduced risk follows from customer stickiness, by which we mean that the market share of supplier firm may be higher when the industry faces an adverse economy.

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Table I: Supply Chain Initiative-Inputs

Item	Base	After Initiative	Period
Sales	S_0	S	t1
COGS	C_0	C	t2
Inventory	I_0	I	t2
Logistics Fixed Assets	F_0	F	t2
Cost of Capital	k_0	k	

Table II: Revenue Response and Supplier Firm Risk

Revenue Response	Market Share of Supplier Firm			Equity Beta	WACC
	Good State	Normal State	Bad State		
Symmetric	33.33%	33.33%	33.33%	1.13	8.63%
Positive in bad times	33.33%	33.33%	40.00%	0.80	7.16%
Positive in bad times Negative in good times	30.00%	33.33%	40.00%	0.66	6.53%

See Annex I for detailed computations. Based on risk-free rate of 5.00%, expected market return of 12.44%, debt of 40% and equity of 60%, and tax rate of 30%.

Table III: Indian Automobile Industry Sales and Supplier Firm Market Shares

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Compound
	0	1	2	3	4	5	6	7	8	9	10	Growth
Industry Sales Rs. crores	10971.18	11959.83	13451.65	17667.84	23370.22	29510.45	30648.57	32430.27	35438.33	43499.58	45508.84	15.29%
Auto Sales Index	100.00	94.56	92.25	105.09	120.58	132.07	118.97	109.20	103.50	110.20	100.00	
SUPPLIER FIRM												
1. Brakes India												
Sales Rs, crores	81	98.48	106.5	132.3	166.63	241.9	315.12	369.7	357.27	374.03	457.49	
Market Share	0.74%	0.82%	0.79%	0.75%	0.71%	0.82%	1.03%	1.14%	1.01%	0.86%	1.01%	3.13%
Brakes India MS Index	100.00	108.14	100.82	92.45	85.36	95.15	115.72	124.40	106.67	88.21	100.00	
2. MICO												
Sales Rs, crores	287.97	359.54	463.04	509.93	648.21	836.83	1065.37	1250.07	1194.6	1365.14	1473.8	
Market Share	2.62%	3.01%	3.44%	2.89%	2.77%	2.84%	3.48%	3.85%	3.37%	3.14%	3.24%	2.12%
MICO MS Index	100.00	112.15	125.75	103.24	97.15	97.26	116.75	126.77	108.56	98.96	100.00	
3. Sundaram Brakes												
Sales Rs, crores	10.34	17.21	25.84	27.7	30.69	41.19	51.66	57.98	58.91	68.31	84.2	
Market Share	0.09%	0.14%	0.19%	0.16%	0.13%	0.14%	0.17%	0.18%	0.17%	0.16%	0.19%	6.98%
Sundaram Brakes MS Index	100.00	142.72	178.10	135.88	106.39	105.70	119.32	118.30	102.82	90.80	100.00	
4. Sundaram Fasteners												
Sales Rs, crores	77.38	90.44	113.71	119.1	151.16	207.64	264.22	301.44	284.73	300.86	375.26	
Market Share	0.71%	0.76%	0.85%	0.67%	0.65%	0.70%	0.86%	0.93%	0.80%	0.69%	0.82%	1.57%
Sundaram Fasteners MS Index	100.00	105.55	116.17	91.20	86.15	92.26	111.29	118.13	100.53	85.20	100.00	

Annex I: Computation of Risks

Panel A: State-Contingent Prices								
	State			**Expected**	**Value**	**WACC**	**Covariance**	**Beta**
	a	**b**	**c**	**Payoff**				
State Probability $\pi(\theta)$	0.33	0.33	0.33					
Market: Scaled	18	13	4.72	11.91	10.59	12.44%	29.99	1.00
P	0.27	0.31	0.38					
R_f	1.05							
Panel B: Industry Revenues								
Revenues: Industry	2400	1800	1200	1800.00	1647.80	9.24%	2656.00	0.57
Panel C: Firm Cost of Capital without Supply Chain								
Firm market share without Supply Chain	33.33%	33.33%	33.33%					
Revenues: Firm	800	600	400	600.00	549.27	9.24%	885.33	0.57
Costs: Firm	-620	-490	-360	-490.00	-452.26	8.35%	-575.47	0.45
Profits: Firm	180	110	40	110.00	97.01	13.39%	309.87	1.13
Panel D: Firm Cost of Capital with Supply Chain-Downside Positive Response								
Firm Market share with Supply Chain	33.33%	33.33%	40.00%					
Revenues: Firm	800	600	480	626.67	579.45	8.15%	693.69	0.42
Costs: Firm	-620	-490	-412	-507.33	-471.88	7.51%	-450.90	0.34
Profits: Firm	180	110	68	119.33	107.58	10.93%	242.79	0.80
Panel E: Firm Cost of Capital with Supply Chain-Downside Positive and Upside Negative Response								
Firm Market share with Supply Chain	30.00%	33.33%	40.00%					
Revenues: Firm	720	600	480	600.00	558.12	7.50%	531.20	0.34
Costs: Firm	-568	-490	-412	-490.00	-458.01	6.98%	-345.28	0.27
Profits: Firm	152	110	68	110.00	100.11	9.88%	185.92	0.66

1. State contingent prices P derived from: $P(\theta) = \pi(\theta) / P_0 [1-2*vE(\theta)]/[1-2vE_0]$ where $\pi(\theta)$ are the state probabilities . Assuming $v=0.01$, $P_0=1$ and $E_0=10$ yields $P_a= 0.27, P_b= 0.31, P_c=0.38$.
2. $R_F = 1/\Sigma P(\theta) = 5\%$
3. Expected Payoff = $\Sigma \pi(\theta)$*State Payoffs
4. Value = $\Sigma P(\theta)$*State Payoffs
5. WACC = Expected Payoff/Value -1
6. Covariance = Covariance between Market and Security (revenues, costs, profits each constitute a security).
7. Revenues: Firm = Revenues: Industry*Market Share
8. Costs: Firm = Revenues: Firm *65% (Variable Cost %) + 100(Fixed Cost)

See Booth (1982) for the formulae

Figure 1: Customer Stickiness