

INFORMATION AND INCENTIVES IN A SUPPLY CHAIN

Togar M. Simatupang^{*}, R. Sridharan[^], Alan C. Wright^{*}

^{*}Institute of Technology and Engineering

[^]Institute of Information Sciences and Technology
Massey University
New Zealand

Abstract: Manufacturing and retailing companies tend to collaborate in a supply chain to effectively match demand with supply. Although partnership in a supply chain promises advantages in the gaining of mutual benefits, those benefits are rarely realised due to differences of interests among its chain members. Identifying differences of interests that may prevent channel members from gaining mutual benefits, and studying the extent to which they relate to the level of the conflict perceived by each of channel members appear to be very important research issues. Asymmetric information and incentive misalignment in a supply chain are believed to be responsible for differences of interests. Asymmetric information occurs because each member has its own private information that other members need to know in order to make decisions. A channel member who has a set of operative goals, which typically often differ from the channel goal, prioritises decisions relevant to its own benefits. This typical behaviour leads to incentive misalignment. This paper introduces the existence of asymmetric information and incentive misalignment in a supply chain that may result in possible discontent which can prevent a supply chain from functioning effectively as a team.

Keywords: supply chain management, incentive alignment, asymmetric information, manufacturer, and retailer.

1 INTRODUCTION*

Intensive competition to reach fragmented customers leads to faster product development, increasingly flexible manufacturing, and an unprecedented variety of products. End customers give credit only to companies, which are able to deliver products with excellent quality, and on time. However, the demand of customers for product variety, especially in the case of short life-cycle products such as food, apparel, toys, and computers, makes it difficult for manufacturers and retailers to predict which particular variety of the products the markets will accept. To be effective in matching demand with supply, manufacturers and retailers tend to collaborate in a supply chain in order to match demand with supply.

Wal-Mart, which is recorded as one of heavy weight champions in a supply chain, uses checkout scanners to transmit point of sales (POS) data via satellite to its suppliers' systems to reduce order cycle time and base stocking

decisions on observed early sales rather than pure hunches [1]. Wal-Mart focused on the creation of customer services and non-price benefits by transferring stocking authority decisions to its suppliers. Both parties receive several valuable outcomes. Wal-Mart gains a reduction in lost sales and stocking costs, while the suppliers are able to speed up inventory replenishments, minimise stockouts, and improve brand loyalty.

Although partnership in a supply chain promises advantages in the gaining of mutual benefits, those benefits are rarely realised due to differences of interests among its chain members. Partnership as formalised in a contract usually includes delegation of decision rights. Each chain member makes independent decisions based on the availability of information. Most chain members make decisions to maximise their own performance metrics. They usually prioritise solutions that provide incentives for attaining a set of operative goals that typically, differ from the channel goal, but at the expense of the others. This incentive misalignment leads to sub-optimisation solutions for a supply chain partnership, which can prevent it from attaining mutual benefits. It is important to identify differences of interests in a

* Published in *Proceedings of the 7th Annual New Zealand Engineering and Technology Postgraduate Conference*, Massey University, Palmerston North, New Zealand, 23-24 November 2000, pp. 269-274 (ISBN: 0-473-07224-6).

supply chain partnership as these differences cause inefficiencies as chain members' behaviour works against the overall goal of the system. Different interests also make the members not sharing their information completely and faithfully with all other chain members leading to asymmetric information in the chain. If there is no information sharing, then decisions are made based on the best estimations of the real situation. Such decisions can be biased and can prevent a chain member from attaining the optimal solution for the common good.

As every supply chain is subject to asymmetric information and incentive misalignment, it is contended that both of these are main factors causing differences of interests. Until chain members dismantle them, products or services are unlikely to flow swiftly to customers, and lower performance occurs as a result. Thus, it is important to identify the impact of asymmetric information and incentive misalignment on chain performance. Alternative mechanisms need to be developed in order to mitigate lower performance. Hence, this paper examines the existence of asymmetric information and incentive misalignment in a supply chain. It includes also the extent to which they relate to the possible discontent that prevent a supply chain from functioning effectively as a team.

In the next section, we elaborate on why asymmetric information and incentive misalignment occurs in a supply chain. Section 3 presents the case of information sharing as a mechanism to mitigate the effects of asymmetric information. Section 4 deals with the case of incentives where we discuss the issue of appropriate incentives for different chain members to share information in order to achieve optimal performance as a system. The last section provides concluding remarks and directions for future research.

2 CONTROVERSY IN A SUPPLY CHAIN

A supply chain consists of interdependent firms, which attempt to match supply with demand by delivering the right product in the right place at the right time at the right price. Mismatch between supply and demand becomes more costly as compared to production costs, especially in a supply chain with short life-cycle products such as food, toys, apparel, and computers. Losses due to supply and demand mismatch can be stockouts, markdowns, and overstocks. For instance, department store markdowns in the apparel industry have dou-

bled in about ten years [2]. One way to find an effective solution to the supply and demand mismatch problem is to scrutinise conflicting objectives among chain members, as they each have different incentives and information.

A supply chain is designed to achieve a set of common goals among which is the responsibility to maximise the profit achieved by the chain through functional differentiation and interdependence among its members. Multiple firms or multiple departments within a single firm that join in a supply chain are goal-seeking entities. Thus, a channel member also may have a distinct set of operative goals. For a supply chain to function effectively, a certain degree of preference congruity with respect to a set of common goals must be present amongst the members. However, total congruity is unlikely to be achieved because each party has its own business interests. Identifying this dilemma within a supply chain partnership and its relations to sources of discontent within a supply chain appears to be very important.

A common dilemma is a conflict between making decisions based on a local perspective and making decisions based on a global perspective. Figure 1 depicts the dilemma within a supply chain partnership (see [3] for various uses of evaporating cloud diagram).

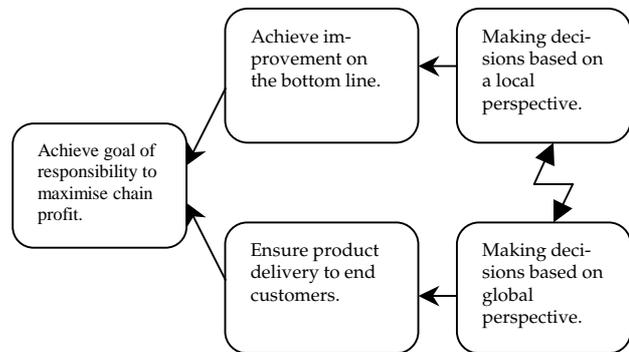


Figure 1: A dilemma within a supply chain partnership.

This problem occurs because multiple parties have misaligned incentives and private information. Incentive misalignment occurs when a player makes decisions considering only its own profit margin, and not the wider supply chain margin. For example, the retailer makes a decision on an order quantity which is less than the optimal supply chain quantity because she does not consider the supplier's profit margin. The phenomenon of each player

receiving only a portion of the total contribution margin is known as the classic double marginalisation [4]. From the supplier's perspective, the solution to double marginalisation relates to finding contracting mechanisms that motivate the retailer to choose the correct order quantity.

Asymmetric information refers to different parties having different states of information. In the presence of an information gap between two agents in the supply chain, one agent can take advantage to enhance his/her own benefits at the cost of other agents. The problem of asymmetric information can be illustrated as follows. The manufacturer requires the service of the retailers as agents to deliver his/her products to the end customers. The retailer's actions, which are not observable by the manufacturer, will affect the revenues from selling the products. The retailer possesses private information about the market demand of the products. The manufacturer very often does not know about the potential market during the pre-condition of the contract, whereas the retailer is required to disclose its knowledge about the markets, including future projections. The problem of the manufacturer is to devise incentives to induce the retailer to reveal her private information to him prior to the acceptance of the contracts. With the availability of this information the manufacturer can take optimal decisions at his end and also direct the retailer in marketing the product(s) and improving the level of service offered at the retail level. The contract might include the possibility of developing the idiosyncratic investment in an information sharing system between manufacturer and the retailer [5].

Breaking the dilemma depends on how the retailer and the supplier invalidate flawed assumptions about their business relationship. An analysis is very often carried out first to examine how conflicting incentives and private information affect supply chain performance. Alternative mechanisms of incentive alignments are then designed to mitigate the resulting inefficiencies. Since sharing private information can also enhance the effectiveness of designed mechanisms such as better knowledge of a parameter, it is also important to analyse the value of information sharing. Thus, analysing the perspective of each player in a supply chain can provide direction for solutions.

3 INFORMATION SHARING

The existence of asymmetric information on the part of a chain partnership means that its attention is focused on obtaining true revelations of a partner's private information. Information sharing, by definition, involves parties which seem to be diametrically opposed, i.e., those who create the data (who knows what) and those who need access to it. They are likely answer to separate management with differing agendas, perhaps separated by geography, and who may have varied incentives. Within this environment, embracing multiple decision-making authorities (who decides what, also referred as decision rights) is more productive than trying to eliminate them. Thus, chain members have to choose a co-ordination structure based on a joint design of decision right and information structure.

The chain members have to design a joint co-ordination structure that consists of who makes the quantity decisions for each market, and what information is available to each decision maker. The retailer, for instance, owns and controls how many items to stock, but the suppliers set the whole price. The retailer takes the price and determines the best of stocking levels to maximise her profits. In practice, this concept is known as a Retailer Managed Inventory (RMI). Similarly, a Vendor Managed Inventory (VMI) gives ownership and control of inventories to the supplier. The supplier decides the inventory level at the retail echelon. The retailer determines wholesale prices that are normally set to be a fixed margin for each unit sold in her store. Both choices of co-ordination structure require data sharing about demand and inventory level.

The traditional supply chain usually communicates through orders, and the retailer places orders based on her demand forecast. Because of limited capacity or product shortages downstream, the retailer tends to inflate order quantities. This ordering behaviour influences the escalation of demand variance within a supply chain that leads to unnecessary inventory at each level [6]. On the other hand, the supplier tends to deflate order quantities to smooth the production line and thereby to reduce costs. Research shows that the supplier can reduce his demand variance by offering incentives to the retailers to align their ordering policies with the supplier's capacity plan [6].

The contemporary supply chain uses information technology to gather, retain and transfer a massive amount of data. The retailer, for instance, captures customer data from online transactions, point of sales scanners, and sensor chips on shopping carts. The advancement of information technology does not automatically enable a supply chain to reap the potential advantages of serving customers better. Mismatch between supply and demand still occurs in the market place, especially for innovative products such as toys, food, fashion apparel, and electronics. Chain members should be able to capitalise on information for effective actions to cope with unpredictable demands.

Unpredictability of demand for products makes information sharing crucial in facilitating the collaboration among chain members, which enables them to make optimal decisions. Each chain needs to have the capability of ensuring the accuracy of data, and using them to match supply with demand. There are three tactics used to deal with demand uncertainties: reducing uncertainty with accurate forecasts, avoiding uncertainty with a responsive supply chain, and hedging against uncertainty with inventory on critical points along a supply chain [7]. To reduce uncertainty, the retailer has to regularly update her forecasts based on early sales data, and track and estimate forecast accuracy. This accurate forecast needs to be supported by a responsive supply chain with the fastest possible rate of order replenishment. Information sharing makes a supply chain able to replenish products with shorter lead times and smaller batch sizes. Thus, the retailers can reduce the stockout cost of popular items, and avoid markdowns of less popular items. In addition to information, inventory can be used also to encounter demand uncertainty on the critical points along a supply chain. Use of inventory should enable the manufacturer to buffer lead-time fluctuations and limited capacity to cushion demand variations.

Information sharing has several pitfalls that need to be resolved. Firstly, the chain members have to distinguish demand information into local knowledge that cannot be communicated (such as intuition for local market conditions) and data that can be transferred such as past sales and stocking levels [8]. Retailers receive a multi-dimensional signal about consumer demand such as sales information, location specifics, and other qualitative information. For example, innovative products usually have a

time demand according to their product cycle. In this case, the manufacturer needs to receive data of market signals of less reliable demand forecast before the season and then more reliable demand forecast during the early season in order to be able to make production decisions. However, many information systems transmit only a one-dimensional signal (which typically varies from warehouse information to point of sales data), and much qualitative information is lost in such transmission. Furthermore, the data transferred may not be as precise as the retailers' information if the retailers are unwilling to communicate full information. As a result, the manufacturer may not be able to interpret the data as well as the retailers do.

Moreover, although the easy availability of information lets supply chain managers react to changing events, that information access is meaningless if participants do not work together as a team. Lack of integration poses the biggest barrier to a well-run supply chain. A supply chain that is divided into firms such as manufacturer, wholesalers, and retailers does not work together as links in a single supply chain. The silo mentality is still prevalent in many supply chains. To break down silo mentality barriers, it is important to establish a single set of performance metrics and rewards that applies to every firm in a supply chain.

Finally, a chain member with superior information wants to ensure economic benefits from information sharing. A supply chain should jointly design incentives for information sharing that link to performance metrics. The next section explains how to use contracts to mitigate incentive problems.

4 INCENTIVE SCHEME

Incentive misalignment is a core problem of the channel inefficiency that stems from the choice of the appropriate reward (encouraging or enabling) or penalty (discouraging or constraining) framework that conditions certain behaviors between parties. Incentives are usually formalized in contractual relationships that ought to exist between economic agents. For example, if the supplier is a principal, then the supplier can offer a sophisticated type of contract to influence the optimal order quantities the buyer will purchase.

Alternative performance schemes are often used to realign incentives among chain members in order to improve the overall productiv-

ity of a supply chain. A performance scheme is a set of corporate rules such as accounting methods, transfer pricing schemes between sites, performance metrics for site managers, and/or various operational constraints [9]. A performance scheme specifies how sites are to pay each other for the transfer of goods, what performance metric should be applied to each individual manager, and by what constraints he or she should abide.

An intra-firm scheme uses internal rule and an inter-firm scheme uses contractual relationship to allow incentive alignment. There are four broad areas that require the design of contractual incentives to counter inefficiency due to demand uncertainty: **accurate response, supply chain speed, inventory, and transaction (i.e., transfer pricing)**. Firms have to choose which contractual agreement really encourages a supply chain to perform better than it did during the original relationship.

Relating to incentives for **accurate response**, the supplier requires the retailer to share past sales and inventory data to update his production planning. Both parties can obtain an advantage by ensuring continuous replenishment in the life cycle of an item.

Recently, incentives to improve **supply chain speed** have become a part of supply chain contracts. For example, the retailer who sells an innovative product requires the supplier to maintain spare capacity to anticipate the next surge of demand after observing strong early sales data. The supplier can gain potential revenues due to a shorter lead-time being required to restock a particular item within the season. Both parties have to invest in an information system to automatically reorder popular items and mark down slow sellers on a weekly, or even a daily, basis. Some retailers also apply lead-time dependent payments to provide incentives to their suppliers to achieve just-in-time delivery.

Another source of incentive misalignment is related to the use of an **inventory** to buffer demand uncertainties such as holding and stockout costs. The retailer and the supplier have different perspectives on stockout cost. For the retailer, the stockouts do not always lead to lost-sales as the customers could find a less preferred substitute. Retailers must then make ordering decisions, which will balance the holding cost of the final products and also the backorder cost. As a result, the retailer tends to hold a small quantity of final products

to balance backorder costs. For the supplier, the stockouts directly lead to lost-sales because she depends on retail sales for its products. Thus, the supplier wants the retailer to maintain a positive inventory of his products at all times. The problem for the supplier is how to offer incentives to the retailer to increase her service level above the level she would choose on her own.

Transfer price relates to how one partner makes payment to the others. For example, introducing a revenue-sharing contract can invalidate the traditional contract that uses the wholesale price only [10]. The retailer and the supplier agree to share the retailer's revenue by a particular fraction. Although the supplier sells each unit below its production costs, both parties can be better off than before. However, based on the retailer's perspective, this contract needs to resolve retail performance requirements such as price and service. The retailer has little incentive to improve sales if only a small fraction of the revenue can be generated. On the other hand, the supplier wants the retailer to buy the right quantity and to sell at a higher price. The revenue-sharing contract induces the retailer to buy the right quantities, but at the expense of her sales effort.

5 CONCLUDING REMARKS

Asymmetric information and incentive misalignment are two prevalent phenomena in a supply chain that serve as main reasons for supply chain discontent. Resolving supply chain discontent becomes crucial as many firms around the world embrace co-operative strategy to mitigate mismatch between supply and demand. This paper argues that resolving supply chain discontent should be carried out from the participants' perspectives. Solutions for supply chain discontent can be arranged within the co-ordination structure.

The co-ordination structure depends on how participants specify the choices of information structure, decision rights, and decision-makers' incentives. Policies and measures need to change to integrate different decision-makers with different information to optimise the global chain. Failure to do so, individual firms tend to be wary of getting too close to one another for fear of losing control, compromising trade secrets, and even losing revenue. A successful supply chain will develop joint strategies to ensure that each partner has a stake in success. If policies and measures are aligned

across the firms, then potential benefits can be reaped successfully from information sharing and aligned incentives. An empirical study to examine information sharing and incentive alignment in New Zealand supply chains is now being undertaken.

6 REFERENCES

- 1 Hammond, J.H., 1993, "Response in Retail/Manufacturing Channels", in Bradley, S.P., Hausman, J.A., Nolan, R.L., (Eds.), *Globalization, Technology, and Competition*, Harvard Business School Press, Boston, pp. 185-214.
- 2 Fisher, M.L., Hammond, J.H., Obermeyer, W.R., Raman, A., 1994, "Making supply meet demand in an uncertain world", *Harvard Business Review*, May-June, pp. 83-93.
- 3 Goldratt, E.M., 1994, *It's Not Luck*, North River Press, Great Barrington, MA.
- 4 Spengler, J., 1950, "Vertical integration and anti-trust policy", *Journal of Political Economy*, Vol. 58, No. 2, pp. 347-352.
- 5 Desiraju, R., Moorthy, S., 1997, "Managing a distribution channel under asymmetric information with performance requirements", *Management Science*, Vol. 43, No. 12, pp. 1628-1644.
- 6 Lee, H.L., Padmanabhan, V., Whang, S., 1997, "The bullwhip effect in supply chains", *Sloan Management Review*, Spring, pp. 93-102.
- 7 Fisher, M.L., Raman, A., McClelland, A.S., 2000, "Rocket science retailing is almost here: Are you ready?", *Harvard Business Review*, Vol. 78, No. 4, Jul-Aug, pp. 115-124.
- 8 Jensen, M.C., Meckling, W.H., 1992, "Specific and general knowledge, and organizational structure", in Lars Werin and Hans Hijckander, (eds.), *Contract Economics*, Basil Blackwell, Cambridge, MA, pp. 251-274.
- 9 Lee, H.L., Whang, S., 1999, "Decentralized multi-echelon supply chains: Incentives and information", *Management Science*, Vol. 45, No. 5, pp. 633-640.
- 10 Cachon, G.P., Lariviere, M.A., 2000, "Supply chain coordination with revenue sharing contracts: Strengths and limitations", *Working Paper*, The Wharton School, University of Pennsylvania, PA.