Challenges and Opportunities in Information Enabled Supply Chain Collaboration

K.S. Bhoon

Subhash Wadhwa

Professor, IIT, Delhi

swadhwa@mech.iitd.ernet.in

Abstract: Globalisation of the economy has accelerated the pace of mergers, acquisitions, collaborations and other forms of partnerships. This has thrown up new challenges in supply chain collaborations. While many consider collaboration to be a win-win proposition because of demand aggregation strategies, dynamics of supply chains make it extremely uncertain as to the marginal gain for each of the supply chain stakeholder. In this paper, we model two simple, two stage supply chains and simulate collaboration among them in three different modes to understand the dynamics. From the results, we conclude that there is generally an overall benefit of collaboration but these benefits are not uniform, across the board among the supply chain partners. We therefore advise caution in merging supply chains without detailed study of cost benefit analysis for each partner.

Key words: Supply Chain Management, Collaboration, Simulation Models, Information Sharing

Mr K.S. Bhoon, Research Scholor, IIT, Delhi.

Professor Subhash Wadhwa (Eur. Ing., C. Emg.) received his PhD from NUI, Ireland, while working on an ESPRIT project at CIM Research Unit, Galwai. He is currently Professor and Group In-charge (P&I) at the Indian Institute of Technology, Delhi. He has originated novel research themes: decision and information delays involving Decision-Information Synchronization (DIS) applications in CIM, Supply Chain, e-Business; DRIS architecture for Agile Manufacturing; SAMIN architecture in IMS context, etc. He is an active contributor to EC projects in the IT&C domain and has coordinated several EU workshops. He has been a Consultant/Contributor/National-Expert to many international bodies including EC, UNIDO, CW and APO (Tokyo). He is dedicated to the goal of bringing synergy between Academics, Industry and Research.

1. Introduction

Inventory costs constitute major component of expenditure for all manufacturing and marketing concerns and these can make or break a business unit. Over the past 30 years there has been much progress in developing an inventory theory for the multi-echelon supply chains with a view to arrive at the most optimal way of managing inventory which would, for obvious reasons, include consumer satisfaction by ensuring right goods of right quality at right time. For serials systems with stochastic demand, there are some optimal policies for both periodic review case (Clark and Scarf 1960, Federgruen and Zipkin 1984) and continuous review case (De Bodt and Graves 1985). For the systems with stochastic demand, there is a rich literature on models and algorithms for finding inventory policies for multiechelon systems, e.g. Sherbrooke (1968), Simon (1971), Muckstadt (1973), Graves (1985), Svoronos and Zipkin (1988), Axsater (1990). Batch or periodic ordering for more general problem of a network as a whole has proved to be much harder and progress here has been slow (Graves 1996). Most work is restricted to two echelon distribution system with identical retail sites and Poisson demand, and then perhaps develop an approximate model of system cost or performance as a function of stock levels; simulation is used to evaluate the approximate model. Noteworthy examples are the papers by Deuer-meyer and Shwarz (1981) and Svoronos and Zipkin (1988) for continuous review case and by Eppen and Schrage (1981) for periodic review case in which the central depot holds no stock. SCM models and simulation is presented by Wadhwa and Rao (2003) and Wadhwa et al (2004). This paper uses some of these concepts and proposes supply chain collaboration modeling.

2. Changing Business Models-Collaborations and Partnerships

Most of these models are oriented to single supply chains, invariably assumed to be part of the same business entity, except for the bull-whip effect studied by many including Padmanabhan(1997) and Chen(2000). The 1990s have witnessed a partial deconstruction of past organizational and structural arrangements as leading companies have vigorously pursued acquisitions, divestment, strategic alliances, joint ventures, partnerships, outsourcing and business swaps as they shift from vertically integrated mass production to less rigid, more flexible and responsive forms of operation. Without doubt, substantial corporate restructuring is taking place on an unprecedented scale. Achieving business success through relational effectiveness is an important competence in both organizational and individual terms. It will provide competitive and collaborative advantage. Significant changes are occurring worldwide in business-to-business relationships. As can clearly be seen in figure 1, a wider range of relational types is being considered and applied.

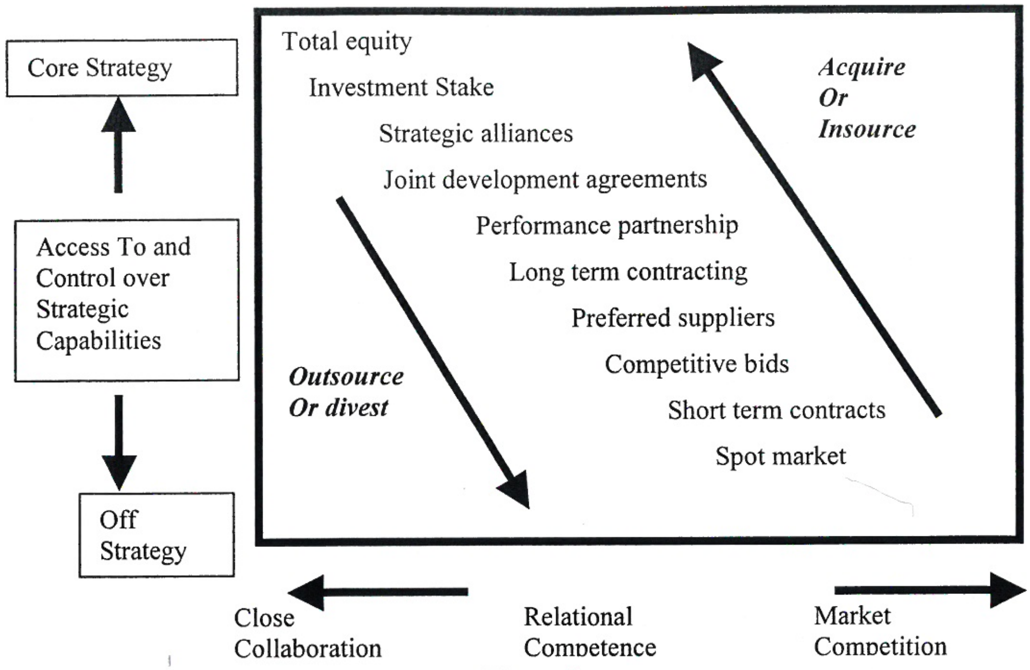

Figure 1.

The more value adding relationships, often associated with strategic alliances, joint ventures, collaborations and partnerships, are characterized by the building of fundamentally different ways of working with supplies, associates or even competitors. This usually involves radical changes in ways of operating for most companies. Achieving business success and competitive advantage through relational effectiveness is becoming an important competence in both organizational and individual terms. Attainment of such competence calls for the applications of innovative processes. However it needs little emphasis that there has to be a rigorous and balanced evaluation of the reasoning behind the relaxation of market competition and the adoption of more collaborative ways of working.

3. Web Enabled Synchronized Supply Chains

To achieve above objectives, synchronized Supply Chain strategy, with its inherent focus on web-enabled collaboration among supply chain partners, is emerging as a major driver of long-term competitive advantage. Success in designing and implementing a Synchronized Supply Chain strategy requires a coordinated set of actions involving all relevant supply chain partners. In collaborations, key performance indicators of acceptable performance must be clearly understood. Since partners are now collectively responsible for revenue growth, costs, asset utilization and service levels, stakeholder value must be defined in a "win-win" world where rewards are equitably shared and costs fairly distributed. If one participant feels that he is no winner in the game of partnership, then he will not be willing to move forward with the relationship. An analysis of supply chain economics is therefore essential to establish costs and benefits to different supply chain participants. The financial analysis suggests that collaborative planning can lead to inventory reductions of 10% to 50% for each of the supply chain participants. However, it is no easy task in the complex domain of dynamic supply chains. When one link in the chain overproduces relative to the market demand, inventory is accumulated. But when one link in the chain under produces, the end-to-end throughput of the whole supply chain suffers (Fraser 1997). The supply chain achieves its best throughput performance when each of the trading partners exactly matches the throughput of this system constraint.

4. Supply Chain Collaboration Research

Supply Chain Collaborations are still in a nascent stage. There has been some progress in developed countries (Wal-Mart, Sara Lee and Lucent Technologies). Very little by way of academic research appears to have been conducted in this domain. There are some papers on pooling in multi-location inventory distribution systems (Tagaras 1998) but these deal with effect of straight pooling of resources at one level (say retailer); not in a complete supply chain. We are seeing mega mergers but are mergers of supply chains profitable? *Despite acquiring a 7% stake in ACC, Gujarat Ambuja Cement continues to operate an independent supply chain for Cement. HLL took considerable time before the supply chains of erstwhile Brooke Bond and Lipton were integrated. There are obviously no easy solutions to collaborations where well-laid supply chains are already in place.*

5. Problem Definition

This paper studies the impact of collaboration among two independent supply chains. There are two web enabled supply chains with one manufacturer (M1& M2) and one retailer (R1&R2) each, as shown in Fig 2 below. Both chains are in the same business and are operating in the same market. It is assumed that both chains are operating under same parameters i.e. the manufacturing capacity, lead times, Inventory costs (Holding cost, shortage cost and transaction costs) are the same. Their maximum stock levels and reorder levels have also been kept the same for the purpose of simplicity. In essence, the manufacturing facilities of both chains are in one city and retailers in another city. Both chains face different demands. For the sake of easy understanding of the model, the demands are randomly fed to the simulator through a data file. The demands are processed via the web, hence no latency in receipt of demand exists. This should take care of the Bull-Whip effect.

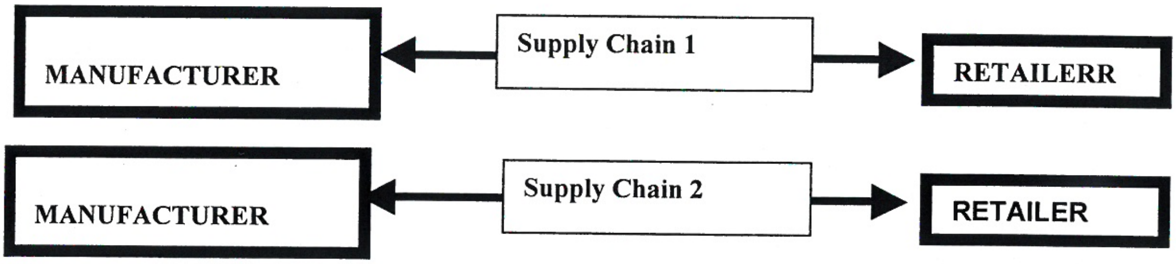

Figure 2.

Above model was investigated in the following modes by constructing a simulator using Access database and Visual Basic front end:

Model: Independent chains. The two chains continue to operate as competitors. However, their individual costs are compared keeping the different demand pattern in view. In this case there is no interaction among the chains. The total system costs are however calculated so that these can be compared with the other two Modes.

Mode2: Partial Collaboration. The two chains still operate independently but the retailers make up their shortfalls by buying goods from each other, which are paid for at holding cost rates. Similarly, the manufacturers buy from each other to make up for shortfalls in production to meet current demands.

Mode3. Full Collaboration. Both chains operate under one management. However the chains are retained in the original form i.e. no element is dismantled.

6. Simulation Parameters

The simulator is run for 40 days on demand given in Appendix 'A'. The production, stocking policy and cost parameters are given in Appendix "B". To enable focused investigation, only maximum stock levels, reorder points and lead times have been varied. While the results presented here pertain to seven different sets of data, the simulator was tested several times with different data and the results given here represent the general trends obtained in extensive testing.

7. Simulator Logic

Independent Chains.

Retailer End. The Retailer starts with maximum stock level. He meets the day's demand. After meeting the demand if the stock falls below reorder level, an order is placed on his manufacturer. After the lead-time is over, his stock is replenished. He incurs holding cost on the balance stock at the end of each day. If he cannot meet any demand upto full requirement, he incurs shortage costs for the unsatisfied demand.

Manufacturer's End. The manufacturer starts with stock equal to Capacity. He constantly revises his production targets in relation to the average demand on him. On any particular day if he finds that the order is more than the stock plus average production, he is able to produce to full capacity. One order must be supplied in one lot. If sufficient stock (including production) is not available, the whole order is delayed by one day and he incurs shortage cost on whole demand. His holding costs are calculated on the balance stock held at the end of each day. Both chains operate similarly.

Partial Collaboration.

Retailer End. Same logic except that, if the demand cannot be met, he checks up with the other retailer. The other retailer checks if there will be surplus stock left after he has met his demand, which is known by now. Whatever he can spare is passed on to the other retailer. The borrower incurs borrowing cost equal to holding cost (but he saves on shortage cost which is higher). The lender gets an additional income equal to the same amount.

Manufacturer End. Manufacturing decisions are still taken based on respective demands (It is to be noted that stock borrowed from the other retailer is actually reflected in the demand pattern of the other retailer to his manufacturer). However, the shortfall is met in the same manner as the retailers do i.e. paid borrowing and lending operations between manufacturers

Full Collaboration.

Retailer End. No change from Partial Collaboration except that borrowing and lending are gratis. However, the lender tends to optimize his holding cost and the borrower, the shortage cost.

Manufacturer End. The two chains are considered merged and production decisions are taken on one consolidated demand and one manufacturing facility although physically they may continue to work from two locations. The total manufacturing capacity is assumed to be doubled.

- **Investigation and Analysis.** Some useful results are presented below with analysis. The bar charts depict three bars in each simulation run. The first bar refers to operation of the two chains in independent mode, the second in partial collaboration mode and the third in full collaboration mode.
- **Collaboration as a Strategic Tool is Generally Beneficial.** Bar chart in Fig 3 depicts inventory cost behaviour under seven sets of operating parameters as defined by data given in Appendix "B". Collaboration is a win-win situation for the System except when it operates under R5 parameters. Except for R6 parameters, Full Collaboration (FC) is even better than Partial Collaboration (PC). Thus we see that Collaboration can be profitable arrangement for the combined system of two chains, provided the system parameters are fine-tuned to produce overall benefit. It is time yet to with-hold a verdict in favour of collaboration even if the system is fine tuned. We will investigate this shortly

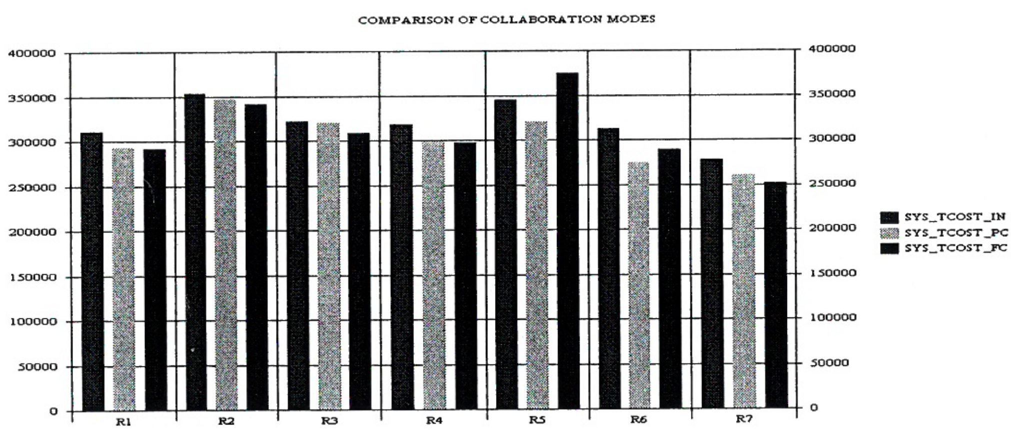

Figure 3.

- **Collaboration Benefits a Supply Chain Facing Higher Volatility in Demand.** Fig. 4 gives the result for Supply Chain 1 (SC1) and Fig 5 presents the same for Supply Chain 2 (SC2). SC1 will not be happy with collaboration if the system operates under parameters given in R3 or R5. In a set of seven parameters, this is a setback to the confidence a firm need to enjoy for partial or full collaboration. On the contrary, it is a win-win situation for SC2 under most parameters. In fact, the simulator was fed 20 different parameters and it was found that SC2 was always a gainer in collaboration. While there could be contrary cases, it is probable that a supply chain facing higher volatility in demand will generally be a beneficiary in collaborating with firms having more stable demand. Thus, unless the additional revenue generated by SC2 is shared by this chain with SC1 on some mutually agreed formula, the collaboration is bound to be failure in case SC1 starts loosing money.

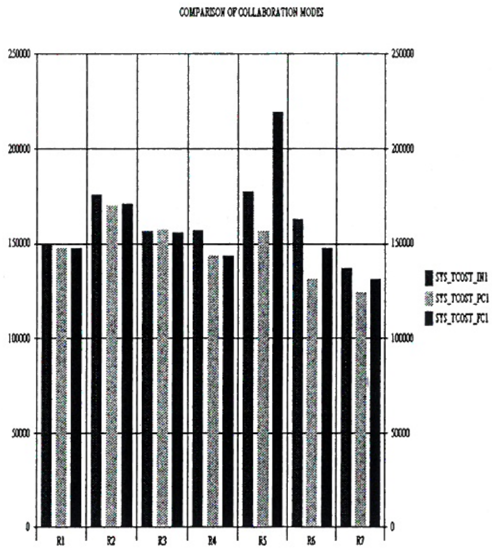

Figure 4 (Inventory costs Chain1).

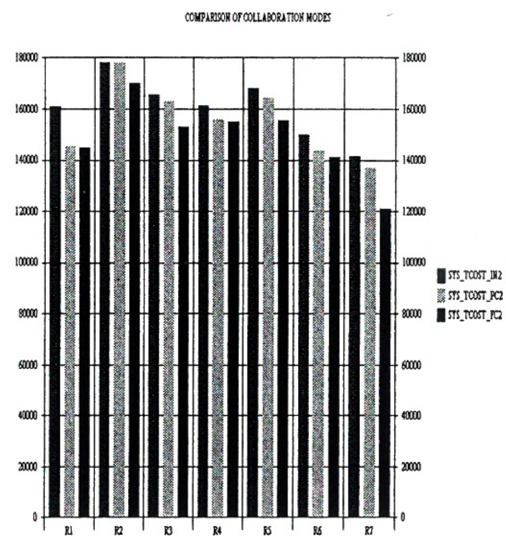

Figure 5 (Inventory costs Chain2).

- **Manufacturer-Retailer Relationship in an Existing Supply Chain may get disturbed by Collaboration with other Supply Chain.** So far we thought the problem is confined to inter-chain issues in collaborations. Fig.6 and Fig 7 throw up intra-chain problems. Fig 6 paints the cost picture of Manufacturer (M2) of SC2, which was shown to be beneficiary of collaboration. While the chain as a whole is a beneficiary under the specified parameters, its manufacturer loses money if the system operates under R5 parameters. In that case, how did SC2 benefit? Examine Fig. 7 to know that. As we can see, Retailer (R2) of SC2 is the real gainer and is literally laughing all the way to the bank. Detailed examination of the simulation revealed that R2 was able to keep his holding costs low by passing on part of his uncertainty of demand to Retailer1.

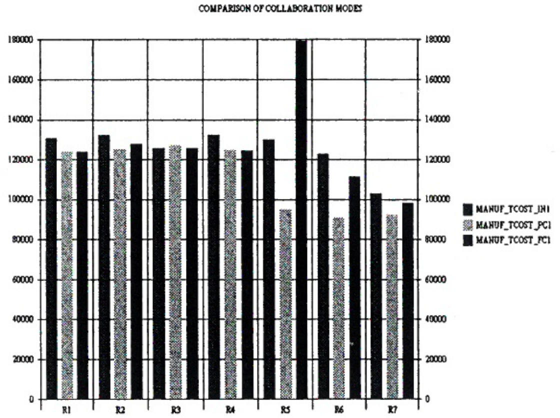

Figure 6 (Manufacturer 2).

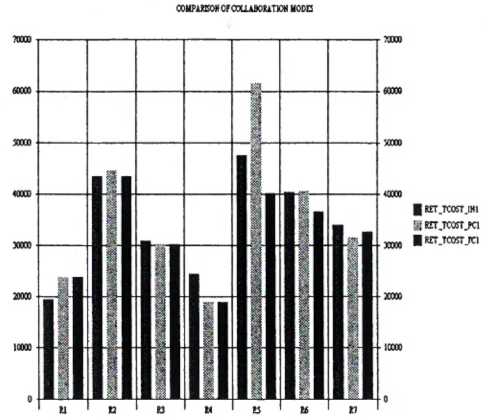

Figure 7 (Retailer 2).

- **The Challenge in Collaboration.** We have seen that SC1 could be a looser under certain operating parameters. If we examine the results for Manufacturer1 (M1) shown in Fig. 8 and Retailer1 in Fig 9, we find that M1 loses heavily in Full Collaboration (FC) under R5 conditions. While he is better off under PC in R5, he is a loser in PC under R3 conditions. Further analysis revealed that loss under R5 is not due to holding costs but shortage costs.

Holding costs are in fact down. Actual surprise comes from Fig 9. While SC1 and M1 lose out in FC when operating under R5 Parameters, Retailer1 actually gains. Similarly, while SC1 and M1 gain under R5, Retailer1 is a loser there. This is the real challenge in web enabled collaborating supply chains.

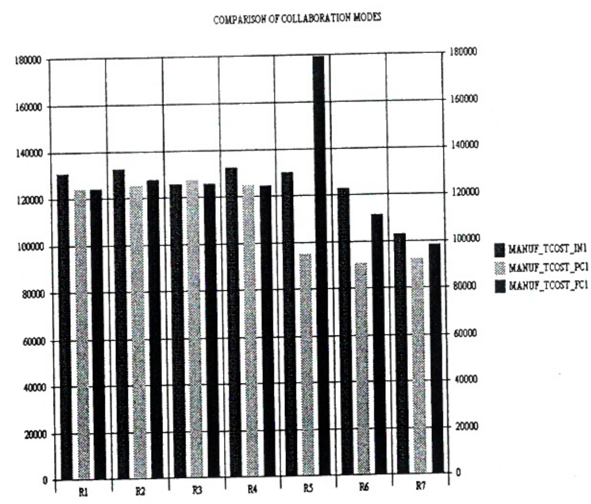

Figure 8 (Manufacturer1).

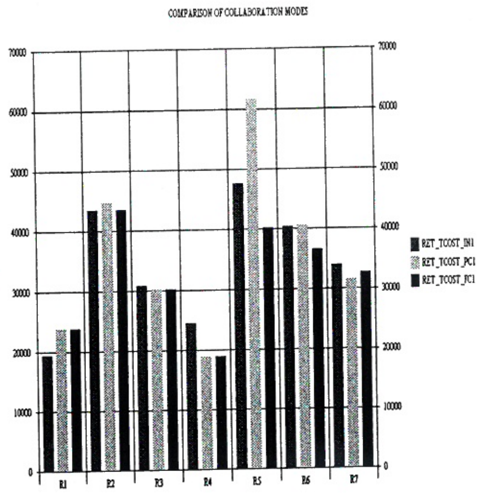

Figure 9 (Retailer1).

8. Deductions and Conclusions.

Results are laid out in a matrix given below. R1 to R7 represent the parameters of Appendix "B". PC and FC stand for Partial and Full collaboration Modes, respectively. Letter "Y' in a cell indicate that Supply Chain member will opt for collaboration because there is a gain for him. An "N" indicates rejection due to loss. A dash means no gain/loss.

	R1		R2		R3		R4		R5		R6		R7	
SC Partner	PC	FC	PC	FC	PC	FC	PC	FC	PC	FC	PC	FC	PC	FC
Retailer1	N	N	N	-	Y	Y	Y	Y	N	Y	N	Y	Y	Y
M1	Y	Y	Y	Y	N	-	Y	Y	Y	N	Y	Y	Y	Y
SC1	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y
Retailer2	Y	Y	-	-	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
M2	Y	Y	-	-	Y	Y	Y	Y	Y	N	Y	N	Y	Y
SC2	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Overall System	Y	Y	Y	Y	-	Y	Y	Y	Y	N	Y	Y	Y	Y

It can be seen from this table that unless the collaboration is operated under parameters R2 and R7, one or the other party will not participate in partnership.

9. Conclusion

The paper presented a SCM collaboration model involving transaction costs, delivery times etc apart from normal parameters. The demand information is transparent and is available almost instantaneously (e.g. web enabled supply chain). Generally, far too many variables make the supply chain complex. Thus, it is useful to model collaboration. The model here was tested for many different parameters than given in Appendix "B". It has not been possible to get a range of workable parameters under which everyone gains. A conclusion one can surely draw is that in a fine-tuned web enabled supply chain; collaboration will reduce inventory levels in the system because of aggregation. Since individual members of the collaboration may be hurt, there does not appear to be any option other than sharing benefits on mutual agreeable conditions. Simulation models can offer useful guidelines in this regard.

Appendix "A"

)emad Data (Demand 1 for Supply Chain 1 and Demand 2 for Supply Chain 2)

DAY	DEMAND1	DEMAND2
1	70	90
2	40	80
3	50	80
4	50	20
5	30	20
6	50	30
7	80	60
8	60	95
9	65	65
10	40	40
11	75	40
12	55	70
13	35	80
14	25	50
15	35	20
16	45	90
17	47	50
18	56	40
19	65	80
20	50	30
21	40	80
22	40	40
23	55	30
24	45	25
25	60	35
26	80	75
27	25	25
28	90	55
29	60	35
30	50	75
31	60	35
32	20	90
33	50	90
34	70	35
35	80	80
36	90	80
37	40	70
38	50	25
39	65	60
40	60	30

Appendix "B"

Cost Parameters for Both Supply Chains

Run Set	Retailer Max Stock Level (S)	Retailer Reorder Level (s)	Lead Time (Days)
R1	150	80	2
R2	240	180	2
R3	200	140	2
R4	160	100	2
R5	360	270	3
R6	300	210	3
R7	240	150	3

Transaction Costs per transaction = 50

Holding Cost per item per day = 10

Shortage Cost per item on occurrence = 30

Manufacturer's Capacity (each) =65

Dispatch Cost = 5000

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