Chapter 1

Introduction

Supply chain management deals with the management of product, information and resource flows between and among different stages in a supply chain (Chopra and Meindl, 2001). It generally consists of two or more than two stages. Different stakeholders at different stages are concerned about own profit targets. In case of a centralized supply chain the stages are vertically integrated and it consists of a central planner who coordinates the stakeholders of different stages. In case of a centralized supply chain the information flow is smooth. Hence, an optimal decision for the entire supply chain performance can be done. On the contrary, in case of decentralized supply chains, the parties involved are separate and each of them often considers its own profit. Information becomes close and private and information flow is no longer free. As a consequence, phenomena like double marginalization (Spengler, 1950) and bullwhip effect (Lee et al., 1997) take place and give rise to supply chain inefficiency. In order to minimize these inefficiencies, the supply chain members can form a partnership, cooperate together and involve in business by setting an appropriate contract. Different stakeholders in a supply chain may have different objectives and hence to achieve an efficient supply chain keeping in view the objectives and interests of all the stakeholders is important. In the literature, setting a supply chain contract between individual stakeholders has been proposed as a means to achieve supply chain optimisation and channel coordination. According to Tsay et al. (1999), much attention in recent years is devoted to research on supply chain contract between individual parties.

Supply chain contract is a topic currently explored by many researchers in the context of different supply chains. Supply chain contracts not only play a vital role in terms of creating supply chain coordination among different stages of the supply chain but also proper analysis of the impact of the contract on supply chain performances provides a direction for writer of the contract. It facilitates the decision making process for different stake holders of the supply chain. For example, the writer of the contract can decide which type of contract can maximise his profit and at the same time will be acceptable to the other stake holders. Given some other parameters such as demand distribution or the demand pattern, the decision variables become easy to be
determined leading towards overall improvement of the supply chain profit and simultaneously improving the absolute profit for each of the supply chain stages. Supply chain contracts involving different return policies belong to a particular category of supply chain contracts. The current study mainly focuses on different return policies viz. Buyback contract and Quantity flexibility contract.

Product warranty has received a great attention of different researchers from many disciplines and issues related to warranty have been highlighted with respect to diverse point of views including historical, economic, behavioural, marketing, statistical modelling, operations research etc. In this era of fierce competition in business warranty and after sales services play an important role to ensure reliability of the product. In order to signal better reliability to customers one can offer a longer period of warranty and provisions for after sales services. It is a well known fact that offering a longer warranty period from the manufacturer’s side signals his confidence about the product quality and it tends to boost sales. Hence, a longer warranty has a positive impact on the demand of the product. On the other hand, increasing the warranty period involves more cost incurred by the manufacturer towards replacing the product or fulfilling the warranty requirement. Therefore, setting an appropriate warranty period is a critical decision for the supply chain. Because, increase in the warranty period would increase the demand but would result in more warranty cost and on the contrary decrease in the warranty length would result in less demand but lessen the expected warranty cost. Hence, the manufacturer should carefully choose the length of the warranty period keeping in view the failure rate, the impact of the length of warranty on demand etc to best fulfil his business objectives and improve the performance of the overall supply chain.

Limited literature is available related to supply chain contract in conjunction with warranty (Hu, 2008; Ji et al., 2011; Sinha and Sarmah, 2011; Dai et al., 2012). However, there is no existing literature on the coordination mechanism with respect to buyback contract and quantity flexibility contract in conjunction with warranty; in this context risk dimension is also not considered by any researcher. When the manufacturer considers the length of the warranty period also along with other contract parameters to coordinate the supply chain, the situation becomes more complex compared to ordinary supply chain coordination at the time of designing supply chain contracts. The current research discusses the coordination of the supply chain with
respect to the quantity ordered and the length of the warranty period when buy back contract and quantity flexibility contract are implemented. The study also examines the quality improvement issues and its impact on the supply chain performance. It also considers a risk averse supply chain and provides necessary guidelines to the global coordinator to achieve mean-variance coordination satisfying the risk constraint of the entire supply chain as well as the parties of the supply chain.

1.1 Return Policies

The present study investigates the coordination mechanism with respect to two return policy contracts viz. buyback contract and quantity flexibility contract in conjunction with a free replacement warranty. Table 1.1 describes the contract parameters and the decision variables both for the manufacturer and the retailer in case of these two contracts.

**Table 1.1** Description of different decision variables for the manufacturer and the retailer in case of buyback contract and quantity flexibility contract in conjunction with warranty

<table>
<thead>
<tr>
<th>Name of Contract</th>
<th>Manufacturer’s Decision Variables</th>
<th>Retailer’s Decision Variables</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyback contract</td>
<td>Wholesale price (w), Buyback rate (b), Length of warranty (k)</td>
<td>Order quantity (q)</td>
<td>At the end of the selling season the manufacturer takes back all the unsold items at a buyback rate.</td>
</tr>
<tr>
<td>Quantity flexibility contract</td>
<td>Wholesale price (w), Fraction α (&lt;1), Length of warranty (k)</td>
<td>Order quantity (q)</td>
<td>At the end of the selling season the manufacturer takes back upto αq unsold items with full credit.</td>
</tr>
</tbody>
</table>

1.2 Business Context / Industry Applications

Different supply chain contracts have been mentioned in literature as a means of achieving channel coordination. Buyback contract and quantity flexibility contract are categorized as return policy contracts. These contracts are practised widely in different industries as a mechanism for achieving optimal supply chain profit as well as increasing the profit level of both the parties (upstream and downstream) in the supply chain. Buyback contract is adopted in different industries such as high-tech, fashion apparel etc. (Donohue et al., 2011). In a supply chain consisting of one manufacturer (supplier) and one retailer (buyer), the supplier is initially paid a
flush of cash according to the number of units purchased and the wholesale price per unit of the product. At the end of the selling season the unsold items are returned back by the supplier at a pre specified buyback rate. Quantity flexibility contract is widely applied in industries like consumer electronics, computer particularly in companies such as IBM, HP, Compaq etc. (Cao et al., 2009). This contract is useful because the retailer gets an opportunity to revise its ordering decision upto a certain level after having a close observation of the market demand. Therefore, this particular contract works on the basis of a predetermined fraction (α) such that at the end of the selling season at most αq number of unsold items are returned back by the manufacturer with full credit. Therefore, both of these contracts work as a mechanism which makes the individual decision of the parties in the supply chain similar to the optimal decision for the supply chain as a whole. It is also evident that in case of the products associated with the aforesaid industries where these two return policy contracts are adopted, warranty decision plays a very vital role. Selling of the products related to high-tech or apparel industry, computer industry or electronics industry generally involves offering a warranty which acts as a marketing element to signal better reliability of the product. Decision regarding the length of the warranty becomes important since it has an impact on the demand and at the same time cost is associated with it. Offering a longer warranty period may result in huge cost towards fulfilling warranty obligations. Therefore, choosing an appropriate warranty period is very important. On the other hand, the manufacturer as a coordinator of the supply chain has to design the contract parameters so that the retailer’s ordering decision coincides with the optimal decision of the supply chain. So, the coordinator requires a guideline in terms of the relationship among different variables to decide the contract parameters and the optimal warranty length in an appropriate manner. Therefore, the channel coordination problem in conjunction with warranty with respect to the aforesaid two return policy contracts is relevant to many industries.

High-tech consumer electronics appliances, computers are becoming products with short life-cycle characterised by short selling season, uncertain demand. The market for these products has become volatile because of continuous innovation in technology and frequent changes in customer needs. The retailer selling these particular products has to place its order long before the selling season and has got limited scope to replenish during the selling season. Since, the products with new technology tend to capture the market for old products, the retailers are keen to delay their purchases and reduce their purchasing quantities. On the other hand, suppliers use
different tools to induce retailers to purchase and stock greater quantities of products at an early stage by offering some transfer payment scheme or providing flexibility for ordering items in terms of the quantity ordered. Hence, it is necessary to develop an appropriate coordination mechanism that is beneficial to all parties in the supply chain. The supply chain is exposed to more risk with the life cycle of the product getting shrunk and uncertainty in demand pattern. This gives rise to the necessity for proper risk management for the parties in the supply chain and for the supply chain as a whole. Hence, it is important to understand the change in allocation of profit and risk with change in different variables and contract parameters. The challenge for the global coordinator is to design different contract parameters and set an appropriate warranty length in order to achieve channel coordination and satisfy the risk constraints of the individual channel member and the entire supply chain. So the problems discussed in the present study has got sufficient industry relevance and fit into the business context discussed above.

1.3 Organisation of Thesis

The thesis is organised in the following manner. Chapter 1 gives an introduction of the topic and describes its relevance and importance for business and different industries. Chapter 2 discusses the detailed literature review of the topic in three broad sections viz. literature on warranty, literature on supply chain contracts and literature on supply chain contract in conjunction with warranty. It discusses different channel coordination problems and provides the literature gap. Based on the literature gaps, research objectives are formulated in this chapter. Chapter 3 provides proofs of different results on channel coordination for buyback contract and quantity flexibility contract with warranty. It also states assumptions of the model. Chapter 4 performs an extensive numerical analysis with respect to uniform, normal and exponential demand distribution to investigate the dynamics of coordination. It performs sensitivity analysis to investigate the impact of change in different parameters on supply chain profit, supply chain risk, optimal order quantity and optimal warranty length. An analysis of risk borne by different parties is also carried out along with a discussion on achieving mean-variance coordination. Chapter 5 deals with the issues related to quality improvement and recoordination of the supply chain. A detailed numerical analysis is also performed in this chapter with respect to uniform and normal demand distribution. Chapter 6 provides summary, conclusions, contributions and future scope of the study.