Chapter 1

INTRODUCTION

1.1 Introduction

1.1.1 Supply Chain and its structure

Supply chain is a connected network in between some business entities/stages to perform an economic goal. Different stage of a supply chain may have different objectives but all together they perform a single goal. A supply chain performs procurement of raw materials; convert the raw materials into a finished product; distributes produced products and sells those products etc. For example, manufacturers (companies like Boeing, General Motors, Coca-Cola) assemble finished products and sell them to wholesalers or distributors, who then resell these products to retailers as their product orders are received. Retailers in turn sell these products to the end-product consumers. Each stage of a supply chain depends on others for smooth business. A number of definitions of supply chain are available in the literature but a few of those are provided here.

1 A supply chain to be a network of autonomous or semi-autonomous business entities collectively responsible for procurement manufacturing and distribution activities associated with one or more families of related product.

2 A supply chain is a network of facilities that procure raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system.

---

1 Jayashankar et al.[74]
2 According to Lee and Billington [89]
A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers.

A typical supply chain may involve a variety of stages. These stages include customers, retailers, wholesalers/distributors, manufacturers and Component/raw material suppliers. Practitioners/researchers are studied on supply chain for different type of channel structures on which two levels supply chains are mostly considered. Stages of a two-level supply chain are (i) manufacturer and (ii) retailer. Most researches on a two-level supply chains are considered single member in each stage. Some researchers are assumed multiple players in each stage to study the competitiveness or some other characteristics of the supply chain. A three levels supply chain may be consisting of manufacturer-distributor-retailer or supplier-manufacturer-retailer.

![Two-level Supply Chain](image1)

![Three-level Supply Chain](image2)

![Distribution-channel](image3)

\[\text{(a) Two-level Supply chain (b) Three-level Supply chain (c) Distribution-channel}\]

**Figure 1.1:** Different types of supply chain

Difference of it with two-level supply chain is due to consideration of intermediate stage. Most supply chains in real business scenario have some intermediate role and so three-level supply chain can be considered as more close to reality than the two levels. Practitioners have also addressed distribution channel to study supply chain which is closest to real business scenario. A typical distribution channel has a manufacturer, multiple distributors and multiple retailers under each distributor. Besides retail channel marketing, recent trends on online marketing motivates the managers to think about dual-channel supply chain, that is, the channel structure which is a combination of retail and e-tail channel. Although there are different types of channel structure for same type of product but the channel structure mainly depends on product category.

Traditionally, marketing, distribution, planning, manufacturing, and the purchasing organizations along the supply chain operate independently. These organizations have their own objectives and these are often conflicting. There is not a single, integrated plan for the organization rather there are as many plans as businesses. Clearly, there is a need for a mechanism through which different functions can be integrated together. Here comes necessity of supply chain management because supply chain management is a strategy through which such inte-

\[\text{According to Ganeshan and Harrison [49]}\]
CHAPTER 1. INTRODUCTION

1.1.2 Supply Chain Management

Supply chain management (SCM) is the management of a network of interconnected business involve in the ultimate provision of product and service packages required by the end customers. Supply chain management spans all movement and storage of raw material, work-in-process inventory and finished goods from point of origin to point of consumption. A number of definitions are available in the literature and among various professional associations. A few of these are provided here.

---

4 Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies. Supply Chain Management is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology.

5 The design and management of seamless, value-added processes across organizational boundaries to meet the real needs of the end customer.

---

The Council of Supply Chain Management Professionals (CSCMP) defines supply chain management

The Institute for Supply Management (ISM) describes supply chain management
The coordinated set of techniques to plan and execute all steps in the global network used to acquire raw materials from vendors, transform them into finished goods, and deliver both goods and services to customers.

Design, planning, execution, control, monitoring of supply chain activities with the object of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand and measuring performance globally.

The primary objective of SCM is to fulfill customer demands through the most efficient use of resources, including distribution capacity, inventory, and labor. In theory, a supply chain seeks to match demand with supply and does so with the minimal inventory. Supply chain management typically begins with the purchase of raw resources and ends with the delivery of the finished product to customers. SCM has the ability to communicate, negotiate and coordinate events with business partners and service firms in a variety of sectors, including manufacturing, transportation and warehousing. SCM is often considered as one of the key factors of companies success such as sales, marketing or finance. Managers are expected to master the ongoing challenges of effectively and efficiently managing limited resources by obtaining the best prices for raw materials and purchasing the necessary quantities without tying up valuable resources in inventory. A supply chain manager must ensure that there is always an optimal quantity of materials and supplies on hand for meeting production schedules and other needs of the organization. He or she also must ensure that an appropriate quantity of goods are stored in warehouses or delivered to retail outlets in a timely fashion so that customers’ demands can be met at all times. Thus, an efficient supply chain management must look forward for coordination among all business entities, involved in the supply chain.

### 1.1.3 Coordination

Each and every stage of a supply chain has different objectives/motives. These objectives often conflict each other. In a system where each member of a supply chain optimizes only their own decisions even not thinking about channel performance is called a decentralized/non-cooperative system. In a decentralized supply chain channel members maximize (minimize) their individual profit (cost) functions which leads to suboptimal solution. Inefficiencies in supply chain arise if channel members act independently for achieving own goals ignoring overall channel goals. On the other hand, in a system where the channel members act as a single entity for achieving overall channel goals ignoring own goals is called a centralized/cooperative system. A centralized channel maximize (minimize) total channel profit (cost) function which leads to benchmark solution. For example, suppose a dyadic channel consisting of a manufacturer and a retailer having respectively the following profit functions.

\[
\pi^m = (w^m - c)(a - bp^r) \quad (1.1)
\]

\[
\pi^r = (p^r - w^m)(a - bp^r) \quad (1.2)
\]

---

6 The Singapore-based Logistics & Supply Chain Management Society defines supply chain management.  
7 APICS Dictionary defines supply chain management.
Where, $p^r$, $w^m$ and $c$ respectively denote selling price of the retailer, wholesale price of the manufacturer and unit marginal cost of the manufacturer. $a - bp^m$ denotes the demand of the product where $a$ is the market potential and $b$ is the price elasticity parameter. Considering the manufacturer as leader of the channel, optimal solutions of the decentralized system can be found as follows.

\[
p^m = \frac{3a + bc}{4b} \quad (1.3)
\]

\[
w^m = \frac{a + bc}{2b} \quad (1.4)
\]

\[
\pi^m = \frac{(a - bc)^2}{8b} \quad (1.5)
\]

\[
\pi^r = \frac{(a - bc)^2}{16b} \quad (1.6)
\]

On the other hand, profit function of the centralized channel is

\[
\pi_c = (p_c - c)(a - bp_c) \quad (1.7)
\]

Optimal solutions of the centralized system are

\[
p^*_c = \frac{a + bc}{2b} \quad (1.8)
\]

\[
\pi^*_c = \frac{(a - bc)^2}{4b} \quad (1.9)
\]

Comparing channel profits between centralized and decentralized system, note that, $\pi^*_m + \pi^*_r = \frac{3(a - bc)^2}{16b} < \pi^*_c$. That is, centralized profit is higher than the sum of decentralized profit. This situation always happens because of the intension of individual profit maximization and is known as double marginalization. Due to double marginalization overall channel profit can not reach to the benchmark profit. As such, managers think about channel coordination to achieve channel profit equal to the centralized one. A supply chain is said to be coordinated if it achieves the same channel profit as in a centralized situation.

In the 21st century, changes in the business environment contributed to the modification of supply chain networks. First, as an outcome of globalization and the proliferation of multinational companies, joint ventures, strategic alliances and business partnerships, significant success factors were identified, complementing earlier Just in time, Lean manufacturing, and Agile Manufacturing practice. Second, technological changes, particularly the dramatic fall in information communication costs, which are a significant component of transaction costs, led to changes in coordination among the members of the supply chain network [31]. Organizations seek to achieve coordination through different approaches. The first step towards establishing coordination might be to share information between the entities in the supply chain. The sharing of information is indeed a necessary condition but may not be sufficient to achieve coordination and improve overall supply chain performance. Hence, besides sharing of information, organizations can use two main approaches to achieve coordination. The first approach is to modify the governance structure of the trading relationship, for example, by modifying the ownership (i.e., “who owns what”) and/or by modifying decision rights (i.e.,
“who decides what”). Modifying the governance structure works only when the process owner gets the decision rights over the functional people. This approach is the most difficult approach to implement, especially at the third level of supply chain management. The second approach for achieving coordination within the supply chain is to modify the terms of trade. The modification of the terms of trade can be achieved through incentive schemes or contracts over certain trade parameters (variables). This approach aims to achieve coordination among business entities by providing incentives to share risks and/or rewards. There are several contract mechanisms that can be designed and used to make sure that the independent decisions made by business entities optimize the overall performance of the whole chain (in such a case the mechanism coordinates the chain).

1.1.4 Contracts as coordination mechanism

A Supply Chain contract is an agreement among different organizations/entities with respect to different trade parameters such as pricing, order quantity commitment, periodicity of ordering, delivery commitment quality, and information sharing that together define the terms of trade. For example, the agreement with respect to the pricing parameter usually concerns: (i) how much is paid for each unit? (ii) what additional incentives are involved and how they are paid. This part can include agreement on incentives such as quantity discount, profit sharing, revenue sharing, credit for returned goods, etc. The choice of appropriate contract mechanism depends on several factors including product characteristics (demand uncertainty, life-cycle of the product, margin, etc.), balance of power and degree of dependency, and level of operational risk cost and risk averseness of the players in the supply chain. For example, for fashion products such as apparel and consumer electronics, the replenishment lead time is too long, demand tends to be more uncertain, the overstocking cost is high and hence the retailer typically responds by under-stocking. This situation is usually more expensive for the manufacturer as the margins for fashion products tend to be on the higher side. The manufacturer would therefore be interested to induce the retailer to buy more. The manufacturer can easily induce the retailer by providing incentives that minimize the overstocking risk for the Buyer. One such incentive mechanism is the buy-back incentive which allows the retailer to return the unsold products. Hence, the second approach would be more appropriate than the first in this case. On the other hand, for functional products such as milk, cereal, and juice, demand tends to be fairly stable; the margin tends to be low and can be replenished on a daily or weekly basis. For such types of products, the retailer could transfer the responsibility of the replenishment process to the manufacturer to ensure that products are supplied efficiently.

The format of supply chain contracts varies across industries. Some well known contracts discussed in the literature are the wholesale price contract, quantity discount contract, profit sharing contract, revenue sharing contract, two-part-tariff contract and the buy-back contract.

**Wholesale price contract**

With a wholesale price contract, manufacturer charges retailer a wholesale price \( w^m \) per unit purchased. Most studies on contracts start their analyses with the wholesale price contract, as
CHAPTER 1. INTRODUCTION

it is the most commonly used contract in practice. The wholesale price contract is very simple to administer. However, for the wholesale price contract to coordinate the supply chain, the manufacturer must be willing to supply the product at his marginal cost, which leaves his profit at zero. Spengler [130] was the first to identify the problem of “double marginalization” in a serial supply chain. He argued that a serial supply chain sees a coordination failure because there are two margins, and neither firm considers the entire Supply Chain’s margin when making a decision. Hirshleifer [62], and later Ronen & McKinney [119], Gerstner & Hess [51], Anupindi & Bassok[8], Van der Veen & Venugopal[141] looked at the effectiveness of a wholesale price discount in channel coordination.

Revenue sharing contract

A revenue sharing contract mechanism involves two parameters, namely \( w^m \) (the wholesale price per unit) and a percentage \( \gamma \) of the retailer’s revenue that goes to the manufacturer \((0 < \gamma < 1)\). Basic idea in this contract is, if the retailer share a percentage of its revenue then the manufacturer reduce its wholesale price. Reduction in wholesale price depends on how much the retailer share its revenue with the manufacturer. Dana & Spier [38], Pasternack (2001) [116], show that revenue sharing is valuable in vertically separated industries where the demand is either stochastic (unpredictable) or variable (e.g., systematically declining). Gerchak & Whang[50] analyzed the applicability of the revenue sharing contract in an assembly environment. Van der Veen & Venugopal [142] modeled a video rental supply chain to study pricing and replenishment decision making. They considered a linearly decreasing rental demand setting and illustrate that a revenue sharing contract can optimize the chain and provide win-win situations to the players in the industry. Cachon & Lariviere [22] studied the revenue-sharing contract extensively in more generalized settings. They looked at the ability of this contract to improve the overall supply chain performance. They also compare the revenue sharing contract to the buy-back and quantity flexibility contracts. They showed that only revenue sharing can coordinate systems with a traditional newsvendor setting with price-dependent demand. They also showed that revenue sharing can coordinate systems with multiple competing retailers. In another study, Koukamas [86] considered a standard newsvendor problem in a single manufacturer-retailer channel. This study showed that the conditions for win-win situations are dependent on the demand distribution.

Quantity discount

Quantity discount contract is most popular contract that is used for channel coordination. A manufacturer who offers the retailer a quantity discount varies the price charged to the retailer according to the quantity purchased by the retailer. The retailer obtains a discount for purchasing a larger quantity of the product from the manufacturer. The larger the quantity purchased, the lower the cost per unit for the retailer. Jeuland & Shugan [75], Monahan [99], Rosenblatt & Lee [120], Banerjee [11] have used quantity discounts as channel coordinating mechanisms. Burnetas et al. [17] investigate how a supplier can use a quantity discount schedule to influence the stocking decisions of a Buyer who faces a single period of stochastic demand. They show that the Supplier can earn larger profits with an all-unit discount compared to an incremental
discount.

Two-part tariff

A two-part tariff is a price discrimination technique in which the price of a product is composed of two parts - a lump-sum fee as well as a per-unit charge. Two-part tariff contract is actually a combination of all unit quantity discount and franchise fee. For channel coordination, assume that an upstream channel member provides all unit quantity discount to its immediate downstream channel member and charge a franchise fee. All unit quantity discount had been well studied and well applied to resolve channel conflict in supply chain literature. When all unit quantity discount is applied, a channel member provides discounts on the wholesale price to the other member anticipating centralized quantity to be ordered. Franchise fee is another contract that is used for cutting out channel conflict, where the upstream channel member supplies the product to the downstream channel member at its own marginal cost and charge a franchise fee for profit enhancement. Ingene and Parry [68] explored coordination of a channel consisting of a manufacturer and two competitive retailers, where manufacturer acted as a Stackelberg leader using two-part tariff contract. Zaccour [154] investigated under which conditions the manufacturer in a static marketing channel can reach the vertically integrated channel solution through the use of a two-part tariff.

Profit/cost sharing contract

As the manufacturer and the retailer are separate and independent economic entities, a key issue is to develop mechanisms that can align their objectives and coordinates their activities so as to optimize system performance. To obtain centralized channel profit the challenge, then, is to devise coordination mechanisms that are not only able to coordinate the activities but also able to align the objectives of independent supply chain members. As an incentive manufacturer can offer the retailer to share the surplus profit if the retailer adopt centralized decisions. Under profit sharing mechanisms, the system performance is first optimized and the resultant benefit is then shared between the manufacturer and the retailer. This solution can be considered as a cooperative solution. Its implementation, however, depends on the development of a profit sharing scheme that is acceptable to both parties. Goyal [58] proposed for the supplier and buyer to share the coordination benefit proportionally according to their costs.

Buyback contract

In buyback contract upstream channel partner offers to downstream partner a larger order quantity than its economic order quantity. Downstream partner accepts the offer under the condition that if it fails to sale all products during the selling season then at the end of selling season the upstream channel member will buy back all the remaining products from the downstream partner. With a buy back contract suppose the manufacturer charges the retailer \( w_m \) per unit purchased, but pays the retailer \( b_m \) per unit remaining at the end of the season, where \( b_m < w_m \). There is a extensive literature on buy back contracts. Padmanabhan and
Png [112] depict several motivations for return policies that are not included in the newsvendor model. In another work, Padmanabhan and Png [113] suggest that manufacturer uses a buy back contract to manipulate the competition between retailers. Emmons and Gilbert [44] and Taylor [136] use buy back contracts in a newsvendor problem. Anupindi and Bassok [8] show that buy back contracts can coordinate a two-retailer supply chain in which consumers search among the retailers to find inventory.

A supply chain is said to be coordinated if it achieves the same profit as in a centralized situation (or full partnership). Furthermore, win-win is said to be achieved if all the players make greater profit compared to the decentralized decision making situation. It is to be noted that one does not imply the other; a coordinated supply chain might fail to provide additional profit to one of the players. Also, even if all players gain from their collaboration, the supply chain is not necessarily optimized. Most of the literature seems to focus on achieving supply chain coordination while ignoring the win-win component. However, when the supply chain consists of autonomous organizations (which is assumed at Level 3), clearly, from an implementation point of view, win-win is probably more important than SC coordination. After all, the player is only willing to participate in joint actions if he will gain from the collaboration. Furthermore, since the SC as a whole is nobodys specific focus, the optimal SC result can be seen as less important from a practical point of view. In the next section, some game theoretical aspects related to supply chain are discussed.

1.2 Uses of Game theory in supply chain management

Game theory can be defined as the study of mathematical models of conflict and cooperation between intelligent rational decision-makers. Game theory provides general mathematical techniques for analyzing situations in which two or more individuals make decisions that will influence one another’s welfare [102]. Game theory has been extensively used as an important tool for managing supply chain. A board concept of game theory is essential for developing any supply chain model. The games like non-cooperative games, cooperative games, dynamic/differential games and games with asymmetric/incomplete information etc. are used in the recent supply chain management literature.

1.2.1 Non-cooperative Game

In non-cooperative static games are simultaneous move, one-shot games, i.e., the players choose strategies simultaneously and are thereafter committed to their chosen strategies. John Nash [104] formally introduced the solution concept for these games. A player can choose a particular strategy or a player can choose to randomly select from among a set of strategies. In the former case the player is said to choose a pure strategy whereas in the latter case the player chooses a mixed strategy. Due to problem of implementation, mixed strategies have not been used in supply chain management. So, players in supply chain always choose pure strategies instead of mixed strategies when involve in a game. In a non-cooperative game the players are unable to make binding commitments before choosing their strategies. A non-cooperative game is said to
be games of complete information, if the players strategies and payoffs are common knowledge to all players. Otherwise it is called games of incomplete information.

1.2.2 The equilibrium of the game

Best response function: Given an n-player game, player i’s best response (function) to the strategies $x_{-i}$ of the other players is the strategy $x_i^*$ that maximizes player i’s payoff $\pi(x_i, x_{-i})$:

$$x_i^*(x_{-i}) = \arg \max_{x_i} \pi(x_i, x_{-i})$$

Clearly, the best response is the best player i can hope for given the decisions of other players. Naturally, an outcome in which all players choose their best responses is a candidate for the non-cooperative solution. Such an outcome is called a Nash equilibrium of the game.

Nash equilibrium: An outcome $(x_1^*, x_2^*, \ldots, x_n^*)$ is a Nash equilibrium of the game if $x_i^*$ is a best response to $x_{-i}^*$ for all $i = 1, 2, \ldots, n$.

Nash equilibrium provides each and every players maximum achievable payoff and so no player wants to unilaterally deviate from it. That is, the Nash equilibrium has a self-enforcing property and it seems to be the necessary condition for the prediction of any rational behavior by players. Note that, the system optimal solution (i.e., a solution that maximizes the sum of players payoffs) need not be the Nash equilibrium. Hence, decentralized decision making where each player separately maximize their individual utility generally causes inefficiency in the supply chain. A set of strategies is Pareto frontier if each player can be made better off only if some other player is made worse off. A set of strategies is called Pareto optimal if they are on the Pareto frontier; otherwise it is called Pareto inferior. Hence, a Nash equilibrium can be Pareto inferior. Testing concavity of the players’ payoffs is the simplest and the most widely used technique for demonstrating the existence of Nash equilibrium. In this context, the following theorem of Debreu [39], widely used in the supply chain literature.

Theorem 1 Suppose that for each player the strategy space is compact and convex and the payoff function is continuous and quasi-concave with respect to each player’s own strategy. Then there exists at least one pure strategy Nash equilibrium in the game.

Now the question is whether the Nash equilibrium is unique or not. But, demonstrating uniqueness is generally much harder than demonstrating existence of equilibrium. There are several methods (such as Algebraic argument, Contraction mapping argument, Univalent mapping argument, Index theory approach etc.) for proving uniqueness but one may have to try all methods to find the one that works. Furthermore, one should have to show existence of Nash equilibrium separately. Cachon and Netessine [23] pointed out that uniqueness results are only available for games with continuous best response functions and there are no general methods to prove uniqueness of Nash equilibrium in super-modular games.
CHAPTER 1. INTRODUCTION

Stackelberg equilibrium

This concept was introduced by Stackelberg [131]. In a Stackelberg duopoly model, player 1, the Stackelberg leader, chooses a strategy first and then player 2, the Stackelberg follower, observes this decision and makes his own strategy choice. Since in many supply chain management models the upstream firm, e.g., the manufacturer, possesses certain power over the typically smaller downstream firm, e.g., the retailer, the Stackelberg equilibrium concept has found many applications in supply chain management literature. To find an equilibrium of a Stackelberg game, which often called the Stackelberg equilibrium, it’s needed to solve a problem via backwards induction. Note that, the first player chooses the best possible point on the second players best response function. Clearly, the first player can choose a Nash equilibrium, so the leader is always at least as well off as he would be in Nash equilibrium. Hence, if a player is allowed to choose between making moves simultaneously or being a leader in a game with complete information he would.

Subgame perfect equilibrium

In game theory, a subgame perfect equilibrium is a refinement of a Nash equilibrium. It is used in dynamic games. A strategy profile is a subgame perfect equilibrium if it represents a Nash equilibrium of every subgame of the original game. Nash equilibrium evaluates the desirability of a strategy only from the viewpoint of the start of the game. The optimality of actions proposed at unreached nodes is not tested if a strategy pair is in a Nash equilibrium. For each node of a bargaining game of alternating offers there is an extensive game that starts at this node is called a subgame.

A strategy pair is called a subgame perfect equilibrium of a bargaining game of alternating offers if the strategy pair it induces in every subgame is a Nash equilibrium of that subgame.

Backward induction method is commonly used to determine the subgame perfect equilibria of a finite game. Here one first considers the last actions of the game and determines which actions the final mover should take in each possible circumstance to maximize his/her utility. One then supposes that the last actor will do these actions, and considers the second to last actions, again choosing those that maximize that actor’s utility. This process continues until one reaches the first move of the game. The strategies which remain are the set of all subgame perfect equilibria for finite-horizon extensive games of perfect information [110].

1.2.3 Cooperative Game

Von Neumann and Morgenstern [107] first developed the concept of cooperative games in their work. The term cooperate means “to act together, with a common purpose.” In a cooperative game two or more individuals act together with a common purpose for determining their collective behavior. The analysis and application of cooperative game theory now becoming popular to study the behavior of the channel members under coordinated scenario. It helps to study the topics like bargaining and negotiations in supply chain. Cooperative game theory focuses on the outcome of the game in terms of the value created through cooperation of a subset of players but does not specify the actions that each player will take. Nash [105] argued
that cooperative actions are the result of some process of bargaining among the “cooperating” players, and in this bargaining process each player should be expected to behave according to some bargaining strategy that satisfies the same personal utility-maximization criterion as in any other game situation.

1.3 Bargaining

Bargaining/negotiations refer to situations where two or more players trying to reach an agreement regarding how to distribute an object or monetary amount. Each player prefers to reach an agreement in these games, rather than abstain from doing so; however, each prefers that agreement which most favors his interests. Some researchers in recent years considered bargaining theoretical model to expand the view of negotiation and coordination in supply chain. Bargaining theory deals with resolving bargaining situation between two players. Bargaining problem can be defined for the simplest case as “two individuals who have the opportunity to collaborate from mutual benefits in more than one way.” There are two main streams of research and application of bargaining theory. First, axiomatic approach, which requires resulting solution should posses a set of axioms. Second, strategic approach in which outcome is predicted by using concept of subgame perfect equilibrium. Nash [104] defines a classical bargaining problem as being a set of joint allocations of utility, some of which will correspond to what the players would obtain if they reach an agreement, and another which represents what they would get if they failed to do so. Nash [105] proposed that cooperation between players can be studied by using the same basic concept of Nash equilibrium. He argued that cooperative actions are the result of some process of bargaining among the “cooperating” players, and in this bargaining process each player should be expected to behave according to some bargaining strategy that satisfies the same personal utility-maximization criterion as in any other game situation. Gurnani and Shi [61] used a Generalized Nash Bargaining model to study a business-to-business supply chain. Summary of cooperative bargaining model can be found in review article of Nagarajan and Sosic [103]. Philosophers and economists used the Nash bargaining game to explain the appearance of human attitudes toward distributive justice ([5], [6], [15], [16]). These authors primarily use evolutionary game theory to explain how individuals come to believe that proposing a 50-50 split is the only just solution to the Nash bargaining game. Bargaining in practice is not merely a relationship in which upstream channel member makes take-it or leave-it offers to downstream channel member. Rather the relationship involves bargaining over the term of trade (such as bargaining for compensation of deteriorating products). Sucky ([132] & [133]) proposed several bargaining models for joint economic lot scheduling (JELS) with and without lot streaming under both complete and incomplete information for uniform demand. Ertogal and Wu [47] considered a supply chain contracting for wholesale price and order quantity in a price sensitive electric market under bargaining framework. They showed that in subgame perfect equilibrium the first best case is optimal for buyer and supplier. To achieve better coordination Hou et al. [63] used revenue sharing contract in a two-echelon supply chain and have used bargaining to divide the surplus between the parties.
1.3.1 Nash Bargaining Model

The Nash bargaining game is a simple two-player game used to model bargaining interactions. In the Nash bargaining game, two players demand a portion of some good (usually some amount of money). If the total amount requested by the players is less than that available, both players get their request. If their total request is greater than that available, neither player gets their request. Suppose two bargainers are faced with a set $A$ of alternatives. The rules are that, if they both agree on some alternative $a$ in $A$, then $a$ will be the outcome. Otherwise (i.e. if they fail to agree on an outcome) there is a fixed disagreement outcome $d$ which will be the result. Under these rules, each player may veto any outcome other than $d$. Let $u_1$ and $u_2$ be expected utility functions representing the preferences of players 1 and 2. Let $S$ be the set of feasible utility payoffs from an agreement, i.e. $S = \{ x = (u_1(a), u_2(a)) | a \in A \}$ Also suppose that $d$ be the utility payoffs to the players from a disagreement, i.e. $d = (u_1(d), u_2(d))$. Complete information about the bargaining outcome is available to both bargainers that is, the set $(S,d)$ is known to both bargainers and it provides all the information needed to solve the bargaining problem.

A **bargaining problem** is a pair $(S, d)$, where $S \subset \mathbb{R}^2$ is compact (i.e., closed and bounded) and convex, $d \in S$, and there exists $s \in S$ such that $s_i > d_i$ for $i=1, 2$. The set of all bargaining problems is denoted by $D$. The bargaining solution is a function $f : B \rightarrow \mathbb{R}^2$ that assigns to each bargaining problem $(S, d) \in B$ a unique element of $S$.

Nash characterized a particular solution $f$ of the bargaining problem via four axioms. Axioms are as follows:

(I) **Invariance to Equivalent Utility representation**: Suppose that the bargaining problem $(S', d')$ is obtained from $(S, d)$ by the transformations $s_i \rightarrow \alpha_i s_i + \beta_i$ for $i=1, 2$. Where $\alpha_i > 0$ for $i=1, 2$. Then $f_i(S', d') = \alpha_i f_i(S, d) + \beta_i$ for $i=1, 2$.

(II) **Independence of Irrelevant Alternatives**: if $S$ contains $S$, and $f(S,d)$ is in $S$, then $f(S, d) = f(S, d)$

(III) **Pareto optimality**: Suppose $(S, d)$ is a bargaining problem. $s \in S$, $l \in S$ and $l_i > s_i$, for $i=1, 2$. Then $f(S, d) \neq s$.

(IV) **Symmetry**: If $S$ is symmetric then $f_1(S, d) = f_2(S, d)$. That is, $S$ symmetric means $(x_1, x_2)$ is in $S$ iff $(x_2, x_1)$ is also in $S$.

Nash shows that there is one bargaining solution satisfying the four axioms above. Instead of the the four axioms there is an another axioms which is added in future to derive the unique Nash equilibrium and is as follows.

(V) **Individual rationality** $f(S,d) = v$ where $v$ is the disagreement payoff

To derive the equilibrium outcome of bargaining problem he proposed the following theorem.
Nash’s Theorem There is a unique bargaining solution \( f^N : B \rightarrow R^2 \) satisfying the axioms I, II, III and IV. It is given by

\[
f^N(S, d) = \arg \max_{(d_1, d_2) \leq (s_1, s_2) \in S} (s_1 - d_1)(s_2 - d_2)
\]

Nash’s theorem the bargaining solution selects the utility pair that maximizes the product of the players’ gains in utility over the disagreement outcome. Nash bargaining solution is an axiomatic approach to solve the bargaining problem. Alternative offer bargaining is an another approach to solve bargaining problem.

1.3.2 Alternating offer bargaining model

Alternative offer bargaining is a strategic approach because it finds an equilibrium of an explicit model of the bargaining process. The bargaining procedure is as follows. The players can take actions only at times in the set \( T = \{0, 1, 2, \ldots\} \). In each period \( t \in T \) one of the players, say \( i \) (a member of \( X \)), proposes an agreement and the other player (\( j \)) either accept it or reject it. Bargaining process end when the players accept an offer and then settle for an agreement. On the other hand if the players reject an offer then the game passes to the period \( t+1 \), in this period player \( j \) proposes an offer to the player \( i \). Obviously the player \( i \) may accept the offer or reject it. The game continues in this manner that is, when the players fail to reach an agreement the game passes to the next period otherwise game end. There is no limit on the number of periods. At all times, each players knows all his previous moves and all those of the other players. A bargaining game of alternating offers is an extensive game and can be represented as a tree. The structure of the tree is repetitive, but once a player accepts an offer the game ceases to be repeated.

The subgame perfect equilibrium strategy allows predicting the result of bargaining and the bargaining game will finish in one iteration when the players use the subgame perfect equilibrium strategy. Sutton [134], Binmore et al. [16] have considered in their work the extended alternating offer bargaining game, where three additional criterions are included. First, to make the iterations of the bargaining process independent assume that both players are equally likely to make an offer at any iteration of the game. Second, to depict the stability of the bargaining process, assume the negotiation may breakdown with a certain probability. Third, the players have the outside options. Wu [147] has indicated there are three reasons, which impel to apply strategic bargaining as an alternative to supply chain interaction. First, contract negotiation is generalized to a bilateral bargaining over the expected channel surplus. Second, instead of considering the contract would be accepted in one offer, an alternating offer bargaining process takes place before a final agreement is reached. Third, instead of the pre-determined contract, the channel members bargaining powers settle the division of the channel surplus.
1.3.3 Relation between Nash bargaining model and alternating offer bargaining model

The approach of Nash bargaining model is axiomatic because to solve the bargaining problem there is some axioms which is required to satisfy. It fails to reach any agreement of a bargaining model if axioms of Nash are not satisfied. On the other hand the model of alternating offers is strategic because it formulate the bargaining process as a specific extensive game. Contrary to Nash bargaining model, in this model players have opportunities to propose offers at various points in time until they could reached an agreement. Although the two approaches are different but they are complementary to each other, each helps to justify and clarify the other [106]. The set of outcomes that is, the set of agreement and disagreement events are the primitive element of Nash’s model. In the model of alternating offers in the players’ preferences over agreements reached at various points in time rather than their preferences over uncertain outcomes.

1.4 Important issues highlighted in the thesis

The thesis addresses the issue of channel coordination among different stages of supply chain under deterministic demand environment. For model formulation it incorporated some topics which are very much suitable in respect to the current business scenario. This section discussed those issues which are widely used in the thesis.

1.4.1 Corporate Social Responsibility (CSR)

We live in a society and every body have some responsibility to our society. Everyone support the intent of doing good work for society. Business firms, corporate sectors, members of supply chain or consumers all belongs to some society. If a business firm do some social work then it creates some positivity to the consumers mind and consumer will buy the firm’s product to support/participate in the good intent. Corporate social responsibility (CSR) refers to a business practice that involves participating in initiatives that benefit society. Corporate Social Responsibility (CSR) is a form of corporate self-regulation that currently does not has unique definition. Broadly CSR can be defined as a doctrine that promotes expanded social stewardship by businesses and organizations. Dyllick and Hockerts [42] have defined CSR as “meeting the needs of a firm’s direct and indirect stakeholders (e.g. shareholders, employees, clients, pressure groups, communities etc.), without compromising its ability to meet the needs of future stakeholders as well.” Dahlstrud [36] has analyzed 37 definitions of CSR and developed five dimensions of CSR: environmental; social; economic; stakeholder; and voluntariness. CSR suggests that corporations embrace responsibilities toward a broader group of stakeholders such as customers, employees etc. besides their regular financial obligations to stockholders [43].

In the current global business environment CSR is now a determining factor in consumer and client choice which companies cannot afford to ignore. Companies who fail to maximize their adoption of a CSR strategy will be left behind. Senior executives from 147 companies in a range of industry sectors across Europe, North America and Australasia were interviewed for the survey. The survey concluded that CEOs are failing to recognize the benefits of implementing Corporate Social Responsibility strategies, despite increased pressure to include ethical, social
and environmental issues into their decision-making processes. In a recent survey by KPMG, 74 percent of the top 100 U.S. companies by revenue published CSR reports last year, up from 37 percent in 2005. Globally, 80 percent of the world’s 250 largest companies issued CSR reports last year. Recent empirical evidence shows that customers are willing to pay a higher price for products with CSR attributes and CSR programs influence 70 percent of all consumer buying decisions ([32], [10]). Modern theoretical and empirical analysis suggests that firms can strategically engage in socially responsible activities to increase private profits. Thus, alongside business goals companies are under pressure to look after social and environmental issues though only 11 percent have made significant progress in setting up the CSR strategy in their organization [84]. On social issue, largest apparel retailer GAP admits to charge of its substandard working conditions in as many as 3000 factories worldwide [97]. Nike is often accused for inhuman labour and business practices in Asian manufacturing factories [7].

For environmental issues, in 2009 a group of 186 institutional investors having assets of 13 trillion US dollars have signed a statement. It suggests directions to deal with global warming and greenhouse gases [43]. Further, a 2004 Globescan CSR survey of more than 23,000 individuals in 21 countries have suggested that the public expects more from the corporate. Recent empirical evidence shows that customers are willing to pay a higher price for products with CSR attributes ([32], [9], [10]). Modern theoretical and empirical analysis indicate that firms can strategically engage in socially responsible activities to increase private profits. Given that the firms stakeholders may value the firms social efforts, the firm can obtain additional benefits from these activities, including: enhancing the firms reputation and the ability to generate profits by differentiating its product, the ability to attract more highly qualified personnel or the ability to extract a premium for its products. As a result many leading international brands like WalMart, Nike, Adidas, GAP have been impelled to incorporate CSR in their complex supply chains by a code of conducts [7].

Although there is a rich content on individual firms CSR consideration in a supply chain, application of CSR has emerged in the last two decades. Murphy and Poist [101] have considered a socially responsible supply chain and have suggested a total responsibility approach by adding social issues to traditional economy. Through a case study and survey research Carter and Jennings [26] have explained the necessity of CSR consideration in supply chain decision making. Ageron et al. [1] have analyzed a French sample data set and have derived several conditions for a successful sustainable supply chain management. Cruz [33] has traced equilibrium condi-
tion for an environmentally responsible supply chain network by using multi-criteria decision making approach. Cruz and Wakolbinger [35] have extended the model to multi-period setting for measuring long-term effects of CSR. Considering a socially responsible supply chain network Hsueh and Chang (2008)[64] have shown that the social responsibility sharing through monetary transfer leads to channel optimization. Savaskan et al. [126] have focused on identifying a socially responsible close loop supply chain that involved in product manufacturing and remanufacturing. Cruz [34] has developed a decision support system framework for modelling and analysis of a CSR supply chain network. Ni et al. [109] have developed a two-tire CSR supply chain by assuming the dominant upstream channel member’s CSR cost is shared by the downstream channel member through wholesale price contract. Ni and Kevin [108] have developed a two-echelon supply chain by assuming that each channel member has individual CSR cost. They have examined the effects of strategic interactions between the channel members under game theoretical setting.

1.4.2 Perishable Products

Product perishability has enormous impact on decision making. Deterioration is the result of various effects on stock, some of which are damage, spoilage, obsoletes, decay, decreasing usefulness and many more. While kept in store fruits, vegetables, etc suffer from depletion by decent spoilage. Through a gradual loss of potential or utility with the passage of time, electronic goods, grain, radioactive substances deteriorate. Gasoline, alcohol etc undergo physical depletion over time through the process of evaporation. Ghare and Schrader [52] have first proposed deterioration in inventory literature. They developed EOQ model for items with exponential decay and deterministic demand. Liu and Shi [95] have classified perishability and deteriorating inventory models into two major categories, namely decay models and finite lifetime models. Finite lifetime models assume a limited lifetime for each item. Blood cells, cans of fruit, foodstuffs, cosmetics, drugs, etc are examples of items having fixed lifetimes. Decaying products are of two types. Products which deteriorate from beginning and products which start to worsen after a certain time. For perishable products, disposal cost and salvage value have significant impact on order quantity.

![Figure 1.4: Example of perishable product](image)

Some products like fruits, vegetables have low disposal cost. On contrary electronic goods, radioactive substances have high disposal cost. For some products (eg. backed goods, books, etc.) there are salvage values because products can be used alternatively such as sale of the product
for scrap, recycling, donation of the product for charity, etc. However, researches addressing contract for supply chain coordination for perishable product are less. Jaggi and Verma [73] have developed a supplier-buyer chain for multiple items with time varying deterioration rate and have discussed about joint ordering policy aimed at coordinating the supply chain. Giri and Bardhan [53] have proposed a two-echelon supply chain for decaying product, whose demand varies with stock and price, and used revenue sharing contract to coordinate the supply chain. Recently Giri and Maiti [54] have developed a vendor-buyer supply chain model for a deteriorating product with time-varying demand and production rate. Production process of vendor is not reliable. It may shift from an in-control state to an out-of-control state during a production run and produce some defective items. Assuming vendor follows a lot-for-lot policy they have determined optimal production quantity. They have shown numerically that centralized production quantity is more favorable than decentralized production quantity. Sadigh et al [121] have used game theoretic approach to coordinate a seller-buyer chain where the on hand product of the seller deteriorates continuously, and the buyer purchases the product continuously. In all the models cited above disposal cost of deteriorated product is excluded. Also, either conventional specific side-payment contracts are used as a tool for coordination or integrated order quantities are used to improve supply chain performance. Further, the problems are analyzed in two-echelon environment rather than in three-echelon because of simplicity of analysis.

1.4.3 Imperfect Quality Products

Advances in science and technology, improved mechanization and automation for large-scale production have made outstanding contributions to improve the quality of product. But, the percentage of good quality products in any manufacturing system could not reach at 100%. Consequently, it is necessary to separate imperfect quality products from the whole lot by screening process to sustain the existence of a business sector in a competitive market.

![Figure 1.5: Imperfect quality product](image)

Imperfect quality product found at the delivery time to the customers causes bad impression/impact of the seller that loses goodwill with customers to some extent. Product quality risk is an inherent part of the supply chain risks. In other words, it tends to comprise some
or all of the risk elements, such as operational risk, disruption risk and reputational risk. For example, when lead was found in their toys, it tarnished Mattel’s reputation, and disrupted the supply of its products in the market. Perfection is so overrated. When manufacturers and retailers make mistakes or end up with less-than-perfect products, they can’t sell them at full price. Agnihotri and Kenett [2] showed how the impact of defects on system performance was measured in an imperfect production process with 100% inspection followed by rework. Lee et al. [90] developed a batch quantity model in a multi-stage production system, considering the proportions of defective items produced at each stage while ignoring rework. Eroglu and Ozdemir [46] developed an EOQ model in which each incoming lot contains some defective items and shortages are backordered. They assumed that each lot goes through a 100% inspection to separate good from defective items; the defective items are classified as imperfect quality and scrap items. At the end of screening process, imperfect-quality items are sold as a single lot and scrap items are disposed from inventory with disposal cost. Lin [94] proposed an inventory model for items with imperfect quality and quantity discounts where the buyer exerted power over the supplier. However all the models cited above examined the effect of imperfect quality items on pricing and replenishment policies in pure inventory scenario.

1.4.4 E-Business in supply chain

The rapid growth of internet based electronic commerce has attracted the manufacturers of several companies such as, IBM, HP, Sony, Kodak, Panasonic, Cisco, etc to introduce direct online channels to their existing brick-and-motor retail networks. Reduced cost for searching, increasing contact with the customers and detail specification and information of the products through the internet enable the manufacturer to enhance it’s market coverage. The growth of US online marketing is forecasted at 8% in 2010 and is set to reach 14% by 2012. Two third (2/3) of the marketers believe that online business must be complemented by traditional marketing activities [37]. As a result, manufacturers redesign their traditional channel structures by engaging in direct sales to reach different customer’s segments that cannot be reached by the traditional retail channel. This channel structure births to the dual channel. In fact, manufacturers who sell only through retailers are now considering the option of selling directly to end customers. Since, in dual-channel of same/substitutable product is sold through retail store as well as online channel, customers have alternatives to choose the channel that is better suited for their needs [135].

Various aspects of dual-channel supply chain, such as advantages and disadvantages of online channel in addition to brick-and-motor channel, when to open an online channel, pricing policies, replenishment policies, price competition, retail services, sales effort in retail channel, return policies, etc have been explored extensively in supply chain literature. Interestingly, there is no research till date that has discussed pricing and replenishment policies for the hi-tech products, whose unit costs decrease continuously in their short life span. Hi-tech products have high online compatibility and tech savvy customers that generally considers the specifications of the products through online channels and compare the retail prices with the products in online manufacturers’ suggested retail prices. In such situation there is a need for the manufacturer to identify online price and replenishment/production policy of a product that effectively reduces total channel cost and increases channel profit.

As indicated above, in addition to traditional brick-and-motor channel, a new channel directly
CHAPTER 1. INTRODUCTION

Figure 1.6: Online business

to the customers through internet is prevalingly in practice because of its intuitive advantages. As a result, dual-channel supply chain has got enormous attention and became in mainstream. Extensive researches have been done addressing variety of problems in dual-channel supply chain. For example, Levary and Mathieu [96] have examined the profits of retail store, online store and dual-channel, and have concluded that the dual-channel provides maximum profit. Ahn et al. [4] have discussed about the pricing decisions of a dual-channel supply chain, where the retail channel and the online channel operate in spatially separated markets. Huang and Swaminathan [67] have determined the optimal pricing strategies in a retail-e-tail supply chain by considering price dependent demand, a degree of substitution across the channel and the overall market potential. Yan [149] has developed a dual-channel supply chain by considering differentiated branding strategy. He has concluded that though differentiated branding strategy alleviates channel competition and conflict, it does not resolve full channel conflict. Dan et al. [37] have determined optimal retail service and prices in centralized and de-centralized dual-channel supply chain. Chen et al. [30] have determined the manufacturer’s pricing strategies in a dual-channel supply chain. They have also shown that the channel conflict can be resolved by applying two-part tariff or a price sharing agreement.

1.4.5 Coordination in multi-echelon multi-member supply chain

With increasing trend of globalization the current business practice is enormously competitive. An efficient way to survive in such environment is the members of a supply chain should take coordinated decision. Coordination through cooperation is imperative for improving channel wide performance because it offers the potential to realize substantial profit benefit. When the channel members opt independent self-interested decisions, the solutions become suboptimal. On the other hand, coordination among the channel members has the potential to create profit benefit. Channel coordination using coordination contract is the design of contract among the channel members that effectively neutralizes the difference between the centralized solution predicted by a single decision maker and decentralized solutions made by the channel members. The basic objective behind designing a contract is to incentivize decentralized channel members...
to act coherently with one another. Variety of contracts such as quantity discount ([99], [92]), quantity flexibility ([140], [93]), two-part tariff [57], revenue sharing ([50], [22], [118]), sales rebate ([137], [146]), buy back ([115], [40]), credit option [41], commitment to purchase quantity [155], price discount [29], delay in payment [71] etc. are used to resolve channel conflict in supply chains. These contracts are different in contractual clauses and are mainly concerned with quantity, time and price. But there is no universal coordination contract that cuts out double marginalization because of the diversity of supply chain characteristics. Also, a coordination contract cannot provide any idea about how the surplus created through coordination is divided among the channel members. There is a vast literature on supply chain coordination that may be noted in the review articles of Sarmah et al. [125] and Cachon [21].

Although use of coordination contract to cut out double marginalization in two-echelon supply chain has been explored extensively, models dealt with resolving channel conflict in three-echelon supply chain are notably fewer. In practice it is more difficult to cut out channel conflict in a three-tire supply chain by applying coordination contract than a two-tire supply chain. When the number of echelon increases, self cost minimizing/profit maximizing objectives increase. As a result dimension of the solution space increases and the channel coordination using contract becomes more complex. Also, many difficulties remain when it comes to carry out any coordination contract for channel members. For example geographical constraints, administrative problems, performance measurement and incentives at individual forms based on local perspective, dynamically interchanging products and the like [78]. Ingene and Parry [68] explored coordination of a channel consisting of a manufacturer and two competitive retailers where manufacturer acted as a stackelberg leader. Yang and Zhou [151] extended the work of Ingene and Parry [68] by considering duopolistic retailers, who compete it in three different ways. However, application of coordination contract to resolve channel conflict in a supply chain that has multiple retailers in downstream is notably fewer. Wang et al. [144] extended the work of Yang and Zhou [151] and explored channel coordination by applying price discount contract. Xiao et al. [148] has investigated the coordination mechanism for a supply chain with one manufacturer and two competing retailers when the demands are disrupted. They showed that the supply chain is to be coordinated by either a linear quantity discount schedule or an all-unit quantity discount schedule.

Focusing on multi-echelon supply chain Munason and Rosenblatt [100] have developed a supplier-manufacturer-retailer supply chain and have explored channel coordination using quantity discount. Jaber et al. [72] have extended Munason and Rosenblatt’s model by assuming profit function, discount dependent demand and profit sharing. Jaber et al. [69] have studied a three-echelon supply chain with learning based continuous improvement. Saha et al. [123] have considered a three-echelon supply chain coordination problem, where demand is linear in price. They have used mail-in-rebate and downward-direct-discount for channel coordination. Jaber and Goyal [70] have investigated the coordination of order quantities in a three-tire supply chain, where they have allowed more than one member at each echelon. Ding and Chen [40] have used flexible buy back contract to coordinate a three-level supply chain, where the profit is divided among the channel members freely. In practice it is more difficult to cut out channel conflict in a three-tire supply chain by applying coordination contract than a two-tire supply chain. When the number of echelon increases, self cost minimizing/profit maximizing objectives increase. As a result dimension of the solution space increases and the channel coordination
using contract becomes more complex. The problem further intensifies if there are multiple members in some echelons. Because of multiple members, there are several system and cost parameters in each echelon and one-to-one interactions between the members of different echelons are needed as each member has its own reservation. So, apart from the vertical coordination, horizontal coordination is essential for the channel best performance. Also, many difficulties remain when it comes to carry out any coordination contract for channel members. For example geographical constraints, administrative problems, performance measurement and incentives at individual forms based on local perspective, dynamically interchanging products and the like.

There are few papers in supply chain literature which are dealing with resolving channel conflict in a dual-channel supply chain. In a manufacturer-Stackelberg dual-channel supply chain, Chen et al. [30] have investigated that a contract with a wholesale price and a direct channel price offered by the manufacturer can resolve the channel conflict. They have also suggested that complementary agreements, such as two-part-tariff, negotiated profit sharing in some specific ranges coordinate the channel and the channel members' profits are win-win. Cai [24] has shown that hybrid revenue sharing and linear price relationship between the retail channel price and direct channel price coordinate a dual channel supply chain. Boyaci [18] has proposed that revenue sharing, wholesale price, buy back contracts can’t resolve channel conflict though a penalty contract coordinates the channel. Agarwal [3] has shown that sales effort resolves channel conflict when the channels compete. Cai et al [24] have proposed that it is possible to achieve win-win profits in a dual channel supply chain applying price discounting though they have not discussed channel coordination issues. Yao and Liu [152] have compared the profit gains under Bertrand and Stackelberg equilibrium pricing strategies but they have not discussed about double marginalization of the channel.

1.5 Organization of the thesis

This thesis depicts some real life supply chain models and analyzes coordination issues among the channel members under deterministic demand environment. Chapter 1 is introductory in nature. Besides introduction, the thesis consists of three more chapters.

Chapter-2 explores the effect of corporate social responsibility for supply chains with different channel structures. The issue of channel coordination is discussed for two-level and three-level supply chains those consist of one member in each level as well as for distribution channel, which consists of a single manufacturer, multiple distributor and multiple retailer assigned with each distributor. For two-level supply chain, concept of sub-game perfect equilibrium and extended strategic bargaining is used for channel coordination and profit division between the channel members. In three-level supply chain channel coordination issues are resolved by proposing a contract-bargaining process which consists of two wholesale price discounts and two Nash bargaining products. On the other hand, revenue sharing contract is used for coordinate the distribution channel.

Chapter-3 deals with managing perishable product in supply chains through two sections. One of them has considered a three-level supply chain consists of a manufacturer, a distributor and
a retailer and the second one has considered a distribution channel, which consists of a single manufacturer, multiple distributor and multiple retailer assigned with each distributor. For channel coordination a new coordination mechanism called, compensation on disposal cost, is used. Two new types of sequential contract bargaining processes namely, forward and backward are used for coordination and surplus profit division in distribution channel. On the other hand, the third section considering imperfect quality product a model is developed that consists of a manufacturer, a distributor and duopolistic retailers. The model considers all three( Cournot, Collusion and Stackelberg ) possible behaviors of the duopolistic retailers. It also explores the channel coordination and profit distribution for all the three game theoretical behaviors of the duopolistic retailers.

Chapter-4 investigates the issues like successful operations and coordination of dual-channel supply chains considering two different features. The first one considers the effect of decreasing feature of unit cost of the products in two-level dual-channel supply chain. While the second model considers a social responsible dual-channel supply chain. Both models have a retail channel as well as an online channel that is operated by the manufacturer for selling products. Models focus on successful operations of dual channel supply chain and develop efficient policies for profit maximization. The channel is coordinated through profit sharing mechanism in first model while to coordinate the second model, quantity discount with the agreement of franchise fee is used.