

Chapter 1

Overview of Chapters

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1 Background

The retail industry has emerged as a fascinating choice for researchers in the field of supply chain management. It presents a vast array of stimulating challenges that have long provided the context of much of the research in the area of operations research and inventory management. However, in recent years, advances in computing capabilities and information technologies, hyper-competition in the retail industry, emergence of multiple retail formats and distribution channels, an ever increasing trend towards a globally dispersed retail network, and a better understanding of the importance of collaboration in the extended supply chain have led to a surge in academic research on topics in retail supply chain management. Many supply chain innovations (e.g., vendor managed inventory) were first conceived and successfully validated in this industry, and have since been adopted in others. Conversely, many retailers have been quick to adopt cutting edge practices that first originated in other industries.

However, for every example of leading edge progressive thinking among retailers, there are numerous examples of archaic systems and planning processes. Moreover, there continue to be a host of open problems facing practitioners and academics. All of this is, of course, good news for academics engaged in research in retail supply chain management. The recent past has witnessed exciting new research—theoretical as well as applied—aimed at addressing some of the retail industry’s many pressing challenges. This book is an attempt to summarize some of this research, as well as a perspective on what new applications may lie ahead.

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The past 20 years have seen a revolution in retailer's computing capabilities. Circa 1990, retailers' information systems tracked and stored dollar receipts for their merchandise, but often retained only cumulative sales data, as opposed to the selling patterns for individual SKUs by time period. Merchandise planners had access to various kinds of product level financial and inventory count information through computer terminals connected to the corporate data base systems. But there was no computing technology capable of applying quantitative forecasting and inventory management methods to evaluate alternative strategies, analyze market sensitivity to assumptions or optimize buying, promotions and clearance markdown decisions.

Since that time, the technology required to implement these methodologies has become widely available to buyers and inventory control analysts, as retailers have greatly expanded the information captured in their data bases and have distributed networked PCs to their professional employees. Retailers today can choose from a variety of commercial products that perform sales forecasting, pricing and inventory management functions, integrated as modules in their corporate information systems. Networked personal computers allow access to detailed sales and financial information, as well as offering localized processing power to analyze certain types of decisions. While the analytical methods imbedded in today's commercial offerings may appear to be fairly simple by academic standards, retailers' increasing investment and reliance on these systems indicates that they are providing value to retail supply chain operations today.

There is a natural development path for academic research in supply chain management to find its way into general use by major retailers. A number of the authors of the chapters in this volume have been instrumental in the successful implementation of methodologies for retailers. For purposes of illustration, let us consider the typical steps leading the implementation of a new methodology developed at the Retail Workbench at Santa Clara University. First, working with a sponsoring retailer, a decision support prototype is designed and developed for testing by buyers or other analysts in the merchandise planning cycle. Successful decision support prototypes were then adapted into an operational system by a third party software company or consulting organization, that works in cooperation with the sponsoring retailer. Finally, if market demand is perceived to be large enough, the one of a kind operational system is transformed into a commercial software product to be sold by an independent software vendor. It is hoped that many of the methodologies presented in this volume will find their way into mainstream retail practice through such a process as well.

2 The Focus of Academic Research in this Volume

Despite the advances in analytical applications discussed in the preceding section, retailers today face many important unsolved problems in supply chain management. The chapters in this book focus on three crucial areas of retail supply chain management in which academic researchers have been very active recently: (1) empirical studies of retail supply chain practices, (2) assortment and inventory

planning and (3) integrating price optimization into retail supply chain decisions. There are clearly other important research areas related to retail supply chain management, but in these three areas, recent research has successfully addressed some problems, while significant challenges remain.

2.1 Empirical Studies of Retail Supply Chain Practices

Chapter 2 (Agrawal and Smith), begins with a description of supply chain practices and processes observed at two retailers in the home furnishing sector. Because of the large number of stock-keeping-units (SKUs), the inter-relationships among the SKUs, as well as use of multiple store formats and multiple marketing channels targeted to different customer segments, home furnishings is one of the most complex retail sectors. In addition to documenting the complex flows of materials and information in such multi-channel environments, we present details of key supply chain planning processes: product design and assortment planning, sourcing and vendor selection, logistics planning, distribution planning and inventory management, clearance and markdown optimization, and cross-channel optimization.

Due to its complexity, we believe that the assortment selection and supply chain management decisions for this sector pose many challenging problems, whose solutions extend beyond the current state of the art. At the same time, the challenges in this sector are relevant to many other retail sectors as well. Thus, we hope that documenting the practices for these supply chains will provide a foundation for future methodological research, some of which are identified in the chapter.

Product level inventory management has been the subject of numerous papers in the area of supply chain management. More recently, researchers have begun to evaluate empirical evidence regarding the relationship between inventory management and overall firm performance. Some past research shows that inventory turnover varies substantially across firms as well as over time. Gaur et al. (2005) demonstrate that a significant portion of this variation can be explained by gross margin, capital intensity, and sales surprise (the ratio of actual sales to expected sales for the year). Using additional data, in Chap. 3, Gaur and Kesavan confirm these previously published results. Extending the findings of Gaur et al. (2005), they investigate the effects of firm size and sales growth rate on inventory turnover using data for 353 public listed US retailers for the period 1985–2003. With respect to size, they find strong evidence of diminishing returns to size: inventory turnover increases with size at a slower rate for large firms than for small firms. With respect to sales growth rate, they find that inventory turnover increases with sales growth rate, but its rate of increase depends on firm size and on whether sales growth rate is positive or negative. Their results are useful in (1) helping managers make aggregate-level inventory decisions by showing how inventory turnover changes with size and sales growth, (2) employing inventory

turnover in performance analysis, benchmarking and working capital management, and (3) identifying the causes of performance differences among firms and over time.

In Chap. 4, de Horatius and Ton direct attention to store level performance. In order to ensure product availability in retail settings, most existing research in this area has focused on two factors—poor assortment and poor inventory planning. The authors' research with several retailers during the last few years highlights a third factor, poor execution, or the failure to carry-out an operational plan. Poor store execution leads to stock outs and distorts sales and inventory data that are important inputs to assortment and inventory planning.

In this chapter they focus on two common execution problems—inventory record inaccuracy and misplaced products. Drawing on well-researched case studies, they describe the magnitude and root causes of these problems. They also describe the findings of empirical studies that have identified factors that exacerbate the occurrence of these problems. These factors include product variety, inventory levels, employee turnover and training, employee workload and employee effort. They describe the effect of inventory record inaccuracy and misplaced products on inventory planning and summarize how researchers have incorporated these problems into existing inventory models. They also discuss future research opportunities for studying the impact of store execution on product availability, in particular, and on retail supply chains, in general.

In Chap. 5, Chen and Mersereau take a detailed look into the literature on two established streams of OM research that try to overcome one of the key shortcomings noted by de Horatius and Ton—lack of visibility into operational data. The first is demand estimation and inventory optimization in the presence of data censoring, where imperfect data may cause significant estimation biases and inventory cost inefficiencies. The second is inventory record inaccuracy, where intelligent replenishment and inspection policies may be able to reduce inventory management costs even without real-time tracking technologies like radio frequency identification (RFID). Common themes of these literatures are that lack of visibility can be costly if not properly accounted for, that intelligent analytical approaches can potentially substitute for visibility provided by technology, and that understanding the best possible policy without visibility is needed to properly evaluate visibility technologies. The authors include a survey of modern and emerging visibility technologies and a discussion of several new avenues for analytical research.

In recent years, the focus of retail operations and supply chain management literature has also begun to include practices and decision making tools that focus on a key element of any brick-and-mortar retail store—store associates. Retail store associates are frontline employees of retail organizations and are responsible for delivering superior in-store experience to its customers. Store associates provide customer service through direct interaction with customers as well as through indirect means such as maintaining a clean store and ensuring that the shelves are fully stocked. While labor is critical to drive store sales, it needs to be planned for carefully as it is one of the largest expenses for retailers. Therefore, retailers deploy workforce management solutions to balance their need for labor to drive sales against their need

to control store expenses to improve profitability. While labor planning is not a new decision for retailers, there continue to be considerable differences in the way labor planning is performed in the retail industry. These approaches differ in the level of sophistication used to manage the payroll and the degree to which different departments within a retail organization are involved in labor planning. In Chap. 6, Saravanan and Mani provide an overview of the literature on workforce management in the retail industry and survey the empirical research on this topic. They discuss some of the new technologies that have the potential to shape this aspect of the retail landscape, and conclude with directions for future research.

In addition to scientific inventory management and keen attention to execution of operational policies, leading edge retailers are resorting to other innovative management practices. In Chap. 7, Kurtulus and Toktay discuss one interesting example from the consumer goods sector, called category captainship. It is a form of manufacturer-retailer collaboration in which retailers rely on a leading manufacturer for management of items in a given category. There are reported success stories about category captainship, but also a growing debate about its potential for creating anti-competitive practices by category captains. The goal of this chapter is to provide an overview of the existing research on category captainship.

Despite a decade of implementation, there is limited academic research concerning category captainship. The existing research on captainship can be grouped into four broad categories that aim to answer the following questions: (1) What are the consequences of the retailer delegating the pricing decision to a category captain? (2) What are the consequences of the retailer delegating the assortment selection decision to a category captain? (3) When will category captainship emerge? What are the category characteristics that facilitate the emergence of category captainship? (4) What are the antitrust concerns that may arise as a result of using category captains for category management? What can be done to mitigate these antitrust concerns? The limited research in this field is due to challenges arising from the broad scope of implementation of category captainship programs. This chapter reviews the current research on category captainship and proposes some avenues for future research that could potentially overcome these challenges and improve our understanding of category captainship practices. The chapter also sheds light on how category captainship practices could potentially change the nature of the manufacturer-retailer relationships and the landscape in the retail industry.

2.2 Assortment and Inventory Planning

The assortment a retailer carries has a significant impact on sales, margins and customer traffic. Therefore, assortment planning has received high priority from retailers, consultants and software providers. The academic literature on assortment planning from an operations perspective is relatively new, but quickly growing. The basic assortment planning problem focuses on choosing the optimal set of products to be carried and the inventory level of each product. Decisions for products are

interdependent and complex, due to considerations such as shelf space availability, substitutability between products, and brand management by vendors.

An in depth review of the research on this topic is presented by Kok, Fisher and Ramnath in Chap. 8. This chapter is composed of four main parts. In the first part they discuss empirical results on consumer substitution behavior and present three demand models used in assortment planning: the multinomial logit, exogenous demand and locational choice models. In the second part, they describe optimization based assortment planning research. In the third part, they discuss demand and substitution estimation methodologies. In the fourth part, they present industry approaches to assortment planning by describing the assortment planning process at four prominent retailers. The authors conclude by providing a critical comparison of the academic and industry approaches and identifying research opportunities to bridge the gap between the two approaches.

One of the most fascinating recent developments in the apparel retail industry is the emergence of *fast fashion* retailers—companies such as H&M, Zara, Uniqlo, Mango, etc. These companies have thrived by offering fashionable designs at affordable prices, frequent assortment changes, and quick response to changes in their markets. In an industry that is often characterized by extremely long and inefficient supply chains—product concept to end of sales cycles of up to 18 months is not uncommon—these companies can introduce new products in a matter of days. What makes it even more impressive is the fact that these new designs are created in response to observed consumer choices.

Caro and Martinez-de-Albeniz examine the underlying business model of such companies from an operations perspective in Chap. 9. In particular, they describe the key operational competencies that such firms must develop, and present a survey of the literature on methodologies for making several important supply chain planning and control decisions. The paper also points to several open questions that are interesting opportunities for future research.

In Chap. 10, Anupindi, Gupta and Venkatraman present a specific optimization methodology for the rationalization of retail assortment and stocking decisions for retail category management. They assume that consumers are heterogeneous in their intrinsic preferences for items and are willing to substitute less preferred items to a limited extent if their preferred items are not available. The authors propose an objective function for a far-sighted retailer that includes not only short-term profits but also a penalty for disutility incurred by consumers who do not find their preferred items in the available assortment. The retailer problem is formulated as a constrained integer programming problem. They demonstrate an empirical application of their proposed model using household scanner panel data for eight items in the canned tuna category. Their results indicate that the inclusion of the penalty for disutility in the retailer's objective function is informative in terms of choosing an assortment to carry. They find that customer disutility can be significantly reduced at the cost of a small reduction in short term profits. They also find that the optimal assortment behaves non-monotonically as the weight on customer disutility in the retailer's objective function is increased.

Smith, in Chap. 11, considers an assortment planning model for retailers who sell multi-featured products such as consumer electronics and must tailor their

assortments to appeal to a diverse set of customer tastes. The assortment decision affects both the probability that customers choose a particular retailer and the demands for the various products in the retailer's assortment. By explicitly including diverse customer segments, this paper develops an operational methodology for optimizing retail assortments for heterogeneous product preferences. A multinomial logit model is used for computing customers' joint probabilities of retailer choice and product choice. An optimization problem is then formulated for determining the assortment that maximizes the retailer's expected profit. The relationship between the optimal assortment and the retailer's competitive strength is also analyzed. Limiting properties of the relationship are derived for the special cases of a monopoly retailer and perfect competition among retailers. A commercial data base of consumer preferences for DVD players is used to illustrate the assortment optimization methodology and the sensitivity to various input assumptions. It was found that including customer heterogeneity in the choice model had a significant impact on expected profits for this data set.

The assortment planning decision is tightly connected to the inventory planning decision, about which there is extensive literature in the field of operations management. However, much of this literature assumes that the assortment has already been specified, and focuses solely on the inventory management decision. In Chap. 12, Agrawal and Smith provide a review of some recent research on multi-location inventory that is related to retail supply chain management.

In order for the review to be meaningful, it is restricted in scope in a number of ways. First, the focus is on papers that model multi-level inventory systems, since virtually all retail supply chains are multi-level. Second, attention is restricted to papers after 1993, and the reader is referred to the reviews in other papers for articles prior to 1993. For example, Axsater (1993), Federgruen (1993), and Nahmias and Smith (1993) contain excellent reviews of the work up to that point. Third, certain model formulations that are not typical of retail inventory management are also excluded, such as serial systems, since they are not representative of typical retail chains, and are a special case of general multi-location multi-echelon systems. Also excluded are papers that assume deterministic demand, since demand uncertainty is a key aspect of most retail systems.

Finally, the primary focus is on periodic review systems. Most retail chains today employ technologies such as point-of-sale (POS) scanner systems that provide real time access to sales and inventory data. Consequently, in principle, continuous review models could be an appropriate construct for these retail systems. However, two issues limit the practical applicability of this assumption. First, due to contracts with vendors and shipping companies, shipments occur primarily on a pre-specified schedule, and often a variety of items are delivered simultaneously. Second, despite the real time access to sales information, the ERP databases and inventory allocation algorithms are typically updated periodically. Thus, strictly speaking, inventory decisions must be made by planners according to predefined cycles. Thus, periodic review systems are a better representation of the inventory management systems used by most retailers. They conclude with suggestions for future research in this area.

2.3 *Integrating Price Optimization into Retail Supply Chain Decisions*

In addition to more efficient operational decisions, recent research has shown that better designed incentive systems can also be very effective in improving the operational and financial performance of supply chains. These incentive systems are captured in the supply chain contracts that define the relationship between buyers and suppliers. Reviews of some of the supply chain literature that focuses on the design of these contracts are contained in Tsay et al. (1999) and Cachon (2003).

In Chap. 13, Aydin and Porteus study the effect of the type of rebate offered to customers on the performance of the supply chain, and on the preference of the manufacturer and the retailer for such rebates. Starting with a newsvendor model (single-product, single-period, stochastic demand), they build a single-retailer, single-manufacturer supply chain with endogenous manufacturer rebates and retail pricing. The demand uncertainty is multiplicative, and the expected demand depends on the effective (retail) price of the product. A retailer rebate goes from the manufacturer to the retailer for each unit it sells. A consumer rebate goes from the manufacturer to the consumers for each unit they buy. Each consumer's response to consumer rebates is characterized by two exogenous parameters: α , the effective fraction of the consumer rebate that the consumer values, leading to the lower effective retail price perceived by the consumer, and, β , the probability that a consumer rebate will be redeemed. The type(s) of rebate(s) allowed and the unit wholesale price are given exogenously. Simultaneously, the manufacturer sets the size of the rebate(s) and the retailer sets the retail price. The retailer then decides how many units of the product to stock and the manufacturer delivers that amount by the beginning of the selling season. Compared to no rebates, an equilibrium retailer rebate leads to a lower effective price (hence, higher sales volume) and higher profits for both the supply chain and the retailer. An equilibrium consumer rebate also leads to a lower effective price and higher profits for the retailer, but not necessarily for the chain. Under their assumptions, such a consumer rebate (with or without a retailer rebate) allocates a fixed fraction of the (expected) supply chain profits to each player: The retailer gets $\alpha/(\alpha + \beta)$ and the manufacturer gets the rest, leading to interesting consequences. However, both firms prefer a higher α and a lower β , even though the manufacturer gets a smaller share of the chain profits, the total amount received is higher. Neither the retailer nor the manufacturer always prefers one particular kind of rebate to the other. In addition, contrary to popular belief, it is possible for both firms to prefer consumer rebates even when all such rebates are redeemed.

Another important aspect of pricing that has received some attention in the operations management literature is markdown planning, i.e., the price charged by the retailer at the end of the season to clear leftover inventory. This is important financially for retailers, since studies by the National Retail Federation have found that over one third of merchandise is sold on markdowns in some retail chains. Clearance markdowns are the focus of Chap. 14 by Smith. In the basic newsvendor model, the salvage value (which is related to the markdown price) is assumed to be

fixed, but, in practice, this will depend upon the retailer's markdown pricing strategy. As the season draws to a close, sales rates depend upon price, seasonal effects and the remaining assortment of items available to customers. There is little time to react to observed sales, and pricing errors result in either loss of potential revenue or excess inventory to be liquidated. This chapter develops optimal clearance price trajectories and inventory management policies that take into account the impact of reduced assortment and seasonal changes on sales rates. Versions of these policies have been implemented and tested at a number of major retail chains and these results are summarized and discussed.

Finally, in Chap. 15, Whang extends the markdown strategy discussion by including the element of retailer competition, using a stylized model of markdown competition. He considers two retailers who compete in a market with a fixed level of initial inventory. The initial inventory level is known to one retailer, but not to the other. To maximize the profit, each retailer marks down at a time of his individual choice. The model assumes deterministic demands, a single chance of price change, and a prefixed set of prices. He considers a two-parameter strategy set where a retailer chooses the timing of markdown as a function of the current time, his inventory level and the other retailer's actions so far. The paper characterizes the equilibrium of the game and derives managerial insights.

Retail supply chain management is a relatively new but very exciting field of research. Fortunately, there is a substantial body of research in the areas of traditional inventory management, multi-echelon systems, channel coordination and pricing that can be applied in the field of retailing. The challenge, of course, is to develop and adapt methodologies that most accurately reflect the realities and constraints faced by retailers. As the practice of retailing evolves at increasing speed because of changes in the global competitive landscape, technology, and consumer expectations, we expect the array of research challenges facing academics and practitioners to expand as well. We hope that this book will serve as a useful reference for these researchers, and look ahead to the evolution of this field with much anticipation.

References

- Axsater, S. (1993). Continuous review policies for multi-level inventory systems with stochastic demand. In S. C. Graves, A. H. G. Rinnooy Kan, & P. H. Zipkin (Eds.), *Logistics of production and inventory* (Handbooks in operations research and management science, Vol. 4, pp. 175–197). Amsterdam, The Netherlands: Elsevier Science Publishing Company.
- Cachon, G. (2003). Supply chain coordination with contracts. In S. C. Graves & A. G. De Kok (Eds.), *Handbooks in operations research and management science: supply chain management* (pp. 229–340). The Netherlands: Kluwer Academic Publishers.
- Federgruen, A. (1993). Centralized planning models for multi-echelon inventory systems under uncertainty. In S. C. Graves, A. H. G. Rinnooy Kan, & P. H. Zipkin (Eds.), *Logistics of production and inventory* (Handbooks in operations research and management science, Vol. 4, pp. 133–173). Amsterdam: Elsevier. Ch. 3.

- Gaur, V., Fisher, M. L., & Raman, A. (2005). An econometric analysis of inventory turnover performance in retail services. *Management Science*, *51*(2), 181–194.
- Nahmias, S., & Smith, S. A. (1993). Mathematical models of retailer inventory systems: a review. In R. K. Sarin (Ed.), *Perspectives in operations management* (pp. 249–278). Norwell, MA: Kluwer Academic Publishers.
- Tsay, A. A., Nahmias, S., & Agrawal, N. (1999). Modeling supply chain contracts: a review. In S. Tayur, R. Ganeshan, & M. Magazine (Eds.), *Quantitative models for supply chain management* (pp. 299–336). Norwell, MA: Kluwer Academic Publishers.