Supply Chain Optimization in a Retail Environment

by

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Submitted to the Department of Civil Engineering and the Sloan School of Management
in Partial Fulfillment of the Requirements for the Degrees of

Master of Science in Civil Engineering and
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ABSTRACT

Many consumer products companies sell through retailers to consumers. Manufacturers lack visibility throughout the supply chain to ensure their products are reaching consumers. The retailer pulls product through the supply chain to the end distribution point. System inefficiencies occur whenever product supply is insufficient to meet consumer demand in a particular retail store.

In the case of Procter & Gamble (P&G), high out-of-stocks at local levels prompted inquiry into the cost to the supply chain, the accuracy of internal data and the impact that P&G could have on reducing these rates. Results found wide variation in out-of-stock rates across stores and across time that in aggregate confirmed internal data reports. In total, lost sales from out-of-stocks cost the company $10 million annually.

Out-of-stocks were affected by three events: the ongoing replenishment system, promotions, and product transitioning. System efficiency could be increased by tailoring supply to meet demand at the point of sale and aligning incentives within the supply chain to ensure product availability. In particular, this thesis examines out-of-stock data and recommends policies to improve supply chain coordination.

Research was conducted during a six and a half month internship with P&G's Product Supply group at the Cosmetics division in Hunt Valley Maryland. The internship was affiliated with the Massachusetts Institute of Technology's Leaders for Manufacturing Program.

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1 INTRODUCTION

One of the main issues confronting the consumer products industry is retail out-of-stocks. Over the last 20 years, the retail out-of-stock rate has not changed dramatically even though both retailer and manufacturer technology has improved.[1] Out-of-stocks reflect inefficiencies in the supply chain. Improving the efficiency of the entire supply chain also leads to improvement in the out-of-stock rate.

Some manufacturers have managed around the retailer by distributing directly to stores using their own employees and equipment. Some companies have bypassed the retailer by selling direct to consumer. As a manufacturer supplying through retail channels, P&G maintains control of product until it leaves the distribution center. The retailer controls the product through its own distribution centers to individual stores until purchased by the consumer.

Manufacturers that sell through retail channels attempt to minimize inefficiencies in the supply chain through policies like electronic data interchange and just-in-time distribution. Manufacturers monitor their supply chain effectiveness by measuring inventory and service levels in their distribution centers. However, even low inventories and high service levels in distribution centers are ineffective if the product is not on the shelf when the consumer wants to buy it. When designing supply chain systems, manufacturers need to optimize for the entire supply chain, including the retail outlet.

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[1] Thomas W. Gruen and Daniel S. Corsten, Retail Out-of-Stocks: *A Worldwide Examination of Extent, Causes and Consumer Responses* (Atlanta, GA: Emory University, 2002).

This thesis examines the nature of out-of-stocks and methods to improve supply chain efficiency. The rest of this chapter explains the current environment for the industry and company. Chapter 2 defines the problem and approach. In addition, there is a brief summary of statistical implications on out-of-stock rates. Chapter 3 reviews results from an audit conducted in the Baltimore area. Chapter 4 reviews additional findings from a national audit. In Chapter 5, I explore the system issues creating the results in Chapter 3 and 4. Finally Chapter 6 examines the product transition process more closely and recommends policy changes to increase supply chain efficiency.

1.1 PROCTER & GAMBLE

Procter & Gamble (P&G) is one of the largest consumer products companies in the world, selling $40 billion of products in fiscal year 2002 in the following categories: family care, fabric and home care, health and beauty care and food and beverage. Cosmetics is a $1 billion business within health and beauty care headquartered in Hunt Valley, Maryland that makes two brands: Cover Girl and Max Factor. Cover Girl is distributed primarily in the U.S. and Max Factor is a global brand.

1.2 THE COSMETICS INDUSTRY

The cosmetics industry is mature with stable niches. The industry is divided into prestige and mass segments with price being the primary differentiator. Prestige brands owned by companies like Esteé Lauder and Lancôme sell at high price points with high service through department stores. The mass market is dominated by a few large players including P&G, L'Oreal and Revlon. Dollar sales to mass consumers grew 2. 3% from

August 2002 to August 2003.[2] Most company growth is from market share gains taken from competitors. Other mass cosmetic companies like Mary Kay and Avon have pursued a direct-to-consumer strategy. The mass segment also has several smaller players and frequently experiences new brand introductions.

The industry is fashion-driven, with consumer preferences changing frequently. To cater to consumer tastes, each player frequently introduces new products and discontinues others. Companies with better intuition regarding consumer preferences will perform better in the long term as will companies with the best capability to respond to changing market preferences.

Since the rise of retailing giants like Wal-mart, retail customers have been increasing their power. At P&G, the top four customers account for more than 50% of the cosmetic business. P&G has three major categories of customers: Mass merchants like Target and Wal-Mart, drug stores like CVS and Rite Aid, and grocery stores like Albertsons and Stop and Shop. The highest sales volumes come from mass merchants while grocery stores experience much lower sales volumes. Altogether, P&G product reaches consumers through 30,000 retail outlets throughout the United States.

1.3 P&G Supply Chain

P&G manufactures its products in Maryland and outsources some product to contract manufacturers. All products are shipped out of one distribution center in Maryland to retailer distribution centers nationwide. To minimize transportation costs, products are

[2] "Cosmetics Category Performance Study." *MMR,* September 23, 2002, 19.

shipped on a sailing schedule. As part of the sailing schedule, each region of the country is assigned a day of the week. Each day, all products are shipped via truckload to one particular region. Each area of the country is served on the same day each week.

The P&G distribution center is capable of shipping in case quantities and less than case quantities. A typical case includes 72 units of one item. Products shipped in cases are stored at the retailer distribution center. Pickers aggregate orders in single units to send to the store. A less than case quantity, also called a shelfpack, includes two to four units of one item. Less than case shipments aggregate shelfpacks of different products together to ship to individual stores. Products shipped in less than case quantities arrive at the retail distribution center and are shipped via cross dock to the store without further manipulation.

2 PROBLEM STATEMENT

Executive management at P&G noticed high out-of-stock rates at local area stores that were inconsistent with internally-reported data. Because cosmetics are fashion trend items and rely heavily on trial purchases, out-of-stocks result in lost sales, P&G considers high in-stock rates to be both a source of incremental sales and a major advantage versus key competitors. Local area stores were exhibiting out-of-stock rates around 10%. P&G was concerned that out-of-stocks were costing the $1 billion business 10% of its sales. In addition, there was concern that internally reported out-of-stock rate of 5% was inaccurate. Finally P&G wanted strategies to reduce out-of-stocks and increase supply chain efficiency.

2.1 APPROACH

The approach included a survey of existing literature, store audits, customer interviews, and statistical and mathematical modeling. Existing literature on retail out-of-stocks was examined to determine the re-application to the cosmetics business. Store audits were conducted at top customers on a limited basis to quantify the perceived high out-of-stock rate and compare to existing data. The data was analyzed and an audit was conducted on a national basis for a larger sample. Statistical modeling was used to separate random out-of-stocks caused by demand variability and out-of-stocks caused by systemic issues. Interviews with customers confirmed and identified system issues.

2.2 EXISTING OUT-OF-STOCK LITERATURE

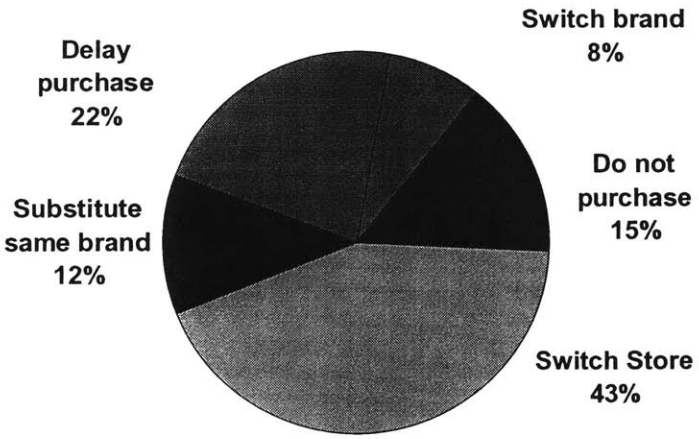
P&G funded a study on retail out-of-stocks.[3] The study found that the average out-of-stock rate worldwide is about 8%, higher for fast moving items and about twice that average for promoted items. The typical retailer loses about 4% of sales as a result of out-of-stocks. The study found that out-of-stock rates vary widely by retailer and by individual store by time of day and by day of week. The study also included extensive research on consumer response to out-of-stocks which was used to estimate lost sales for P&G. The cosmetics division was interested in examining category-specific issues since much of the research generated did not exclusively examine the cosmetics category.

[3] Thomas W. Gruen and Daniel S. Corsten, Retail Out-of-Stocks: *A Worldwide Examination of Extent, Causes and Consumer Responses* (Atlanta, GA: Emory University, 2002).

2.3 Cost of Out-of-Stocks[4]

An out-of-stock product does not result in a lost sale unless a consumer who was going to buy the product does not buy it. Figure 1 shows consumer responses to cosmetic out-of-stocks. About one-third of the time, the out-of-stock does not result in a lost sale for the manufacturer or the retailer because the consumer delays the purchase or substitutes the same brand. 15% of the time, both P&G and the retailer lose because the customer never buys the product. 8% of the time, the consumer will actually switch brands, which means lost sales for P&G, but not for the retailer. Over 40% of the time, however, the retailer will lose the sale because the consumer will go to another store in order to purchase the product. The retailer loses sales more than twice as often as the manufacturer when a consumer experiences an out-of-stock. Once consumer response is taken into calculating lost sales for P&G, lost sales are an estimated $25 million.

Figure 1: Consumer Responses to Cosmetic Out-of-Stocks

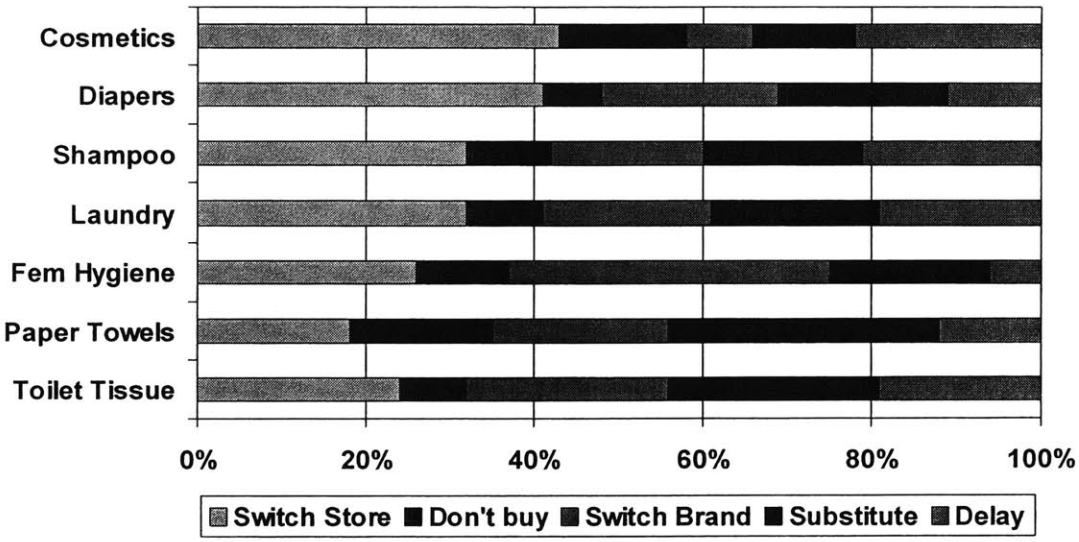


[4] Thomas W. Gruen and Daniel S. Corsten, Retail Out-of-Stocks: *A Worldwide Examination of Extent, Causes and Consumer Responses* (Atlanta, GA: Emory University, 2002).

2.4 MOST OF THE FOCUS IS AT THE STORE LEVEL

P&G established a division at corporate headquarters, the Retail Presence Network, to work with retailers on improving in-stock rates because there is widespread belief that the majority of out-of-stocks are attributable to store operations. Solutions focused on store processes like shelf replenishment and clerk training. The prevailing thought within P&G is that out-of-stocks are the result of poor store operations: the retailer is not ordering enough soon enough or replenishing the shelves. Because cosmetics is the most consumer loyal category, the efforts have been directed at P&G categories like toilet paper, paper towels, laundry and diapers. Figure 2 shows that cosmetics has the lowest percentage of customers buying another brand compared with diapers, shampoo, laundry detergent and toilet tissue.[5]

Figure 2: Consumer Responses by Category



[5] Thomas W. Gruen and Daniel S. Corsten, Retail Out-of-Stocks: *A Worldwide Examination of Extent, Causes and Consumer Responses* (Atlanta, GA: Emory University, 2002).

While store operations are the main cause of out-of-stocks for some categories of product, it is not the case for cosmetics. Cosmetics are low sales volume and occupy little space on retail shelves. Cosmetics sell at a slower rate through retail channels than toilet paper and paper towels. It is highly likely that a retailer would sell at least five units of toilet paper or paper towels in a day. In contrast, a cosmetic item in a store facing average demand sells two or three units a week. Even in high volume stores, it is rare for the product to sell more than two or three units in one day. At the other extreme, it is not unusual to have items that only sell one unit per store every eight weeks. Cosmetic products also require less space than other P&G products. Paper towels and toilet paper require lots of shelf space and one day's supply may exceed available shelf space. However, cosmetic products run very little risk of overflowing their shelf space beyond one days supply. Pegs are usually designed to accommodate 4 to 8 units of one stock keeping unit (SKU).

2.5 EXISTING DATA QUESTIONED

P&G has a system in place for measuring out-of-stock data. The P&G Retail Services Group (RSG) conducts visual audits throughout the year for particular customers. This data is reported on a brand level as an aggregate out-of-stock rate. Because it is reported as an aggregate number, there is no detail about which items in particular are out-of-stock.

In light of the discrepancy between internal reports and local store observation, P&G was concerned that the RSG audits were understated because of inaccuracy and

incentivization issues. In a store, items are often misplaced on the shelf. When an item is on the wrong place on the shelf, an item appears to be in stock. If the wall were arranged correctly so everything was in the correct place, there may be a significant increase in the number of out-of-stocks. There was also concern that RSG mistakenly thought their performance metrics included the results of the audits and thus were incentivized to understate the number.

2.6 STATISTICAL IMPLICATIONS OF SUB-100% SERVICE LEVELS

Out-of-stocks occur whenever demand exceeds supply. While supply can be predetermined, demand is a random variable. For each individual item, retailers determine a stocking level. The stocking level implies a given service level based on historical demand. Because inventory is costly, a retailer does not stock to a service level of 100%. Retailers typically stock between 90 and 95%. Because the service level is less than 100%, there will be times when an individual item is out-of-stock simply because demand is a random variable. Given the service level or stocking level for a group of items, statistical modeling is useful for determining effects caused by this effect. In particular, it is helpful for determining the likelihood of an out-of-stock rate on a particular number of items and for determining an out-of-stock rate for an individual item across stores.

2.6.1 Probability of out-of-stocks for a group of items

Statistical modeling can determine the likelihood of an out-of-stock rate on a particular number of items. On a wall of one hundred items given the same in-stock rate for each

individual item and independence of out-of-stocks, the probability that a k items are out-of-stock is binomial with the number of items n and the probability of out-of-stock p. In general,

$$P(X=k) = [n,k]\, p^k (1-p)^{n-k} \qquad \text{where } [n,k] = n!/(k!(n-k)!)$$

The probability that the out-of-stock rate is zero is the probability that none of the individual items are out-of-stock at the same time. The probability that the out-of-stock rate is 1% or that there is one out-of-stock is the probability that 99 items are in stock and one item is out-of-stock for any possible combination of one item out of 100.

For example:

Probability of out-of-stock for each individual item = 5%

Number of items = 100

X = Number of out-of-stocks

$P(X = 0) = [100,0] * 5\%^0 * 95\%^{100} = 1\%$

$P(X = 1) = [100,1] * 5\%^1 * 95\%^{99} = 3\%$

$P(X = 2) = [100,2] * 5\%^2 * 95\%^{98} = 8\%$

$P(X = 3) = [100,3] * 5\%^3 * 95\%^{97} = 14\%$

$P(X = 4) = [100,4] * 5\%^4 * 95\%^{96} = 18\%$

$P(X = 5) = [100,5] * 5\%^5 * 95\%^{95} = 18\%$

The cumulative probability can help determine the likelihood of an out-of-stock rate for the group of items. For example, the probability that there are 5 or less out-of-stocks on the wall is equal to the sum of the probabilities for each out-of-stock rate, or 62%. Given

a 5% out-of-stock rate on 100 individual items, there is still a 38% likelihood that the out-of-stock rate for the group of items will be higher than 5%.

Table 1 examines the probability of k or fewer out-of-stocks for up to 15 given different individual item out-of-stock rates for 100 items. There is still approximately a 40% probability that the out-of-stock rate for the group of items will be higher than the out-of-stock rate for items individually. Table 2 looks at probability of k or fewer out-of-stocks for an increasing number of items with individual out-of-stock rates of 5%. As the number of items increases, the likelihood that the out-of-stock rate for the group will be higher than the out-of-stock rate for the items individually also increases.

Table 1: Probability of Total Number or Fewer Out-of-Stocks for 100 Items

		Individual Item OOS Rate									
		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
Total number of OOS	0	37%	13%	5%	2%	1%	0%	0%	0%	0%	0%
	1	74%	40%	19%	9%	4%	2%	1%	0%	0%	0%
	2	92%	68%	42%	23%	12%	6%	3%	1%	0%	0%
	3	98%	86%	65%	43%	26%	14%	7%	4%	2%	1%
	4	100%	95%	82%	63%	44%	28%	16%	9%	5%	2%
	5	100%	98%	92%	79%	62%	44%	29%	18%	10%	6%
	6	100%	100%	97%	89%	77%	61%	44%	30%	19%	12%
	7	100%	100%	99%	95%	87%	75%	60%	45%	31%	21%
	8	100%	100%	100%	98%	94%	85%	73%	59%	45%	32%
	9	100%	100%	100%	99%	97%	92%	84%	72%	59%	45%
	10	100%	100%	100%	100%	99%	96%	91%	82%	71%	58%
	11	100%	100%	100%	100%	100%	98%	95%	90%	81%	70%
	12	100%	100%	100%	100%	100%	99%	98%	94%	89%	80%
	13	100%	100%	100%	100%	100%	100%	99%	97%	94%	88%
	14	100%	100%	100%	100%	100%	100%	100%	99%	97%	93%
	15	100%	100%	100%	100%	100%	100%	100%	99%	98%	96%

Table 2: Cumulative Probabilities of Out-of-Stocks for an Increasing Number of Items (p = 5%)

Total number of OOS	Number of Items							
	100	110	120	130	140	150	160	170
0	1%	0%	0%	0%	0%	0%	0%	0%
1	4%	2%	2%	1%	1%	0%	0%	0%
2	12%	8%	6%	4%	3%	2%	1%	1%
3	26%	19%	14%	11%	8%	5%	4%	3%
4	44%	35%	28%	22%	17%	13%	9%	7%
5	62%	53%	44%	36%	29%	23%	18%	14%
6	77%	69%	61%	52%	45%	37%	31%	25%
7	87%	81%	75%	67%	60%	52%	45%	38%
8	94%	90%	85%	80%	73%	66%	59%	52%
9	97%	95%	92%	88%	84%	78%	72%	65%
10	99%	98%	96%	94%	91%	87%	82%	77%
11	100%	99%	98%	97%	95%	93%	89%	85%
12	100%	100%	99%	99%	98%	96%	94%	91%
13	100%	100%	100%	99%	99%	98%	97%	95%
14	100%	100%	100%	100%	100%	99%	99%	98%
15	100%	100%	100%	100%	100%	100%	99%	99%
16	100%	100%	100%	100%	100%	100%	100%	99%
17	100%	100%	100%	100%	100%	100%	100%	100%
18	100%	100%	100%	100%	100%	100%	100%	100%
19	100%	100%	100%	100%	100%	100%	100%	100%
20	100%	100%	100%	100%	100%	100%	100%	100%

This analysis assumes independence. It is unlikely that items are independent given that they are shipped together from the same source. However, while it is unlikely the items are independent, the analysis is helpful as a proxy for understanding the dynamics of out-of-stocks for a group of items.

2.6.2 Probability of out-of-stocks for a given item

Statistical modeling also helps determine a reasonable number of stores at which the same item will be out-of-stock. Given an in-stock rate for an individual item at a group of stores and again the assumption of independence, the likelihood that an item will be out-of-stock at zero stores is the product of the in-stock rates for each individual store. The likelihood that an item will be out-of-stock at any one store is the product of the in-stock rates for all but one of the stores in any combination times the out-of-stock probability times the number of stores.

For example:

Average out-of-stock rate = 6%

Number of stores = 12

x = number of stores at which item out-of-stock

$P(x=0) = (.94)^{12} = 48\%$

$P(x=1) = [12,1] * (.94)^{11} = 36\%$

$P(x=2) = [12,2] * (.94)^{10} = 13\%$

$P(x=3) = [12,3] * (.94)^{9} = 2.7\%$

$P(x=4) = [12,4] * (.94)^{8} = 0.3\%$

Statistical modeling helps separate out-of-stocks caused by demand variation from out-of-stocks that arise from systemic issues. In this example, any item that is out-of-stock at four or more stores has a systemic issue associated with that individual item which is causing unusually high out-of-stock rates.

3 BALTIMORE AUDIT

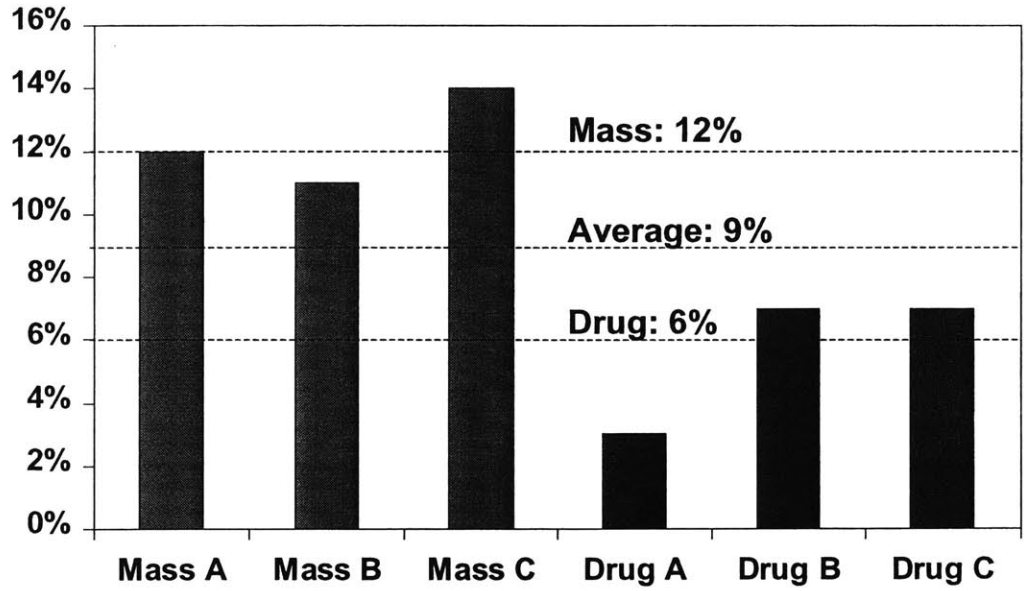
An initial audit was conducted in the local stores to quantify the perceived high out-of-stock rates and compare the results to existing RSG data. The audit was conducted on the same two or three stores for 6 major local retailers twice a week over a period of two and a half months, yielding a total of 20 data points. The auditor arranged items on the shelf in the correct place and identified and recorded out-of-stocks on an individual item basis.

The audit findings were characterized by high out-of-stock rates and high variation in out-of-stock rates.

3.1 OUT-OF-STOCK RATES HIGHER THAN NATIONALLY REPORTED NUMBERS

The average out-of-stock rate was 9%, far higher than the reported average of 5%, with mass stores averaging 12% and drug stores averaging 6% as shown in Figure 3. In this aspect, results were aligned with expectations regarding local area stores. Discrepancies between local stores and national averages remained unexplained.

Figure 3: Average Out-of-Stock Rates in Baltimore



3.2 HIGH VARIATION IN OUT-OF-STOCK RATES OVER TIME

Out-of-stock rates vary over time, even for the same store. Figure 4 shows one store that initially had out-of-stock rates averaging 20% that declined to an average of 10%. Within the same retail chain, different stores exhibited different patterns in their out-of-stock rates. Figure 5 shows the varying out-of-stock rates for stores. Even though local

stores in each chain have similar traits like promotions, order quantities, and order arrival days, they did not have similar patterns in their out-of-stock rates.

Figure 4: Single Retailer Out-of-Stock Rate Over Time

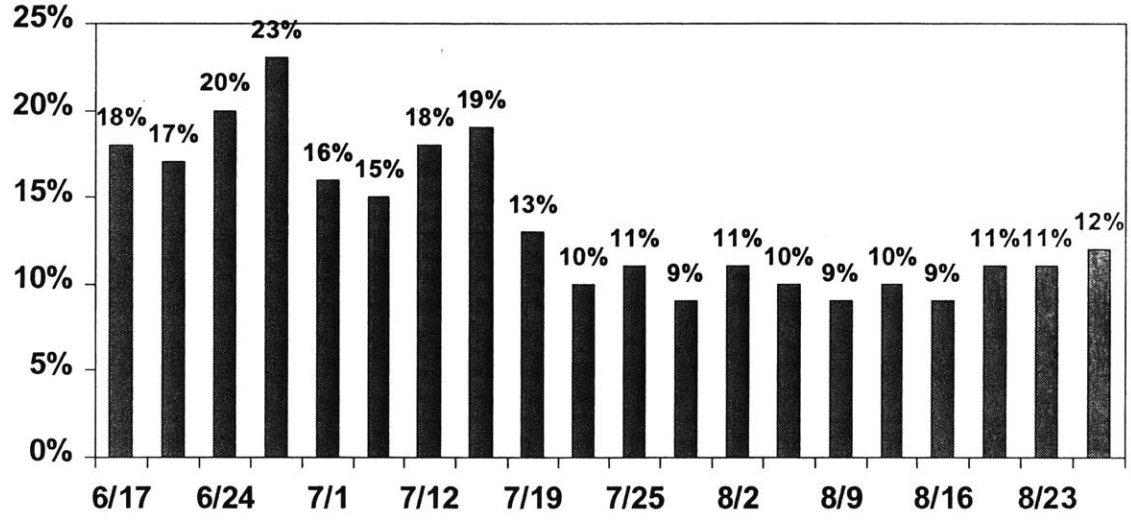
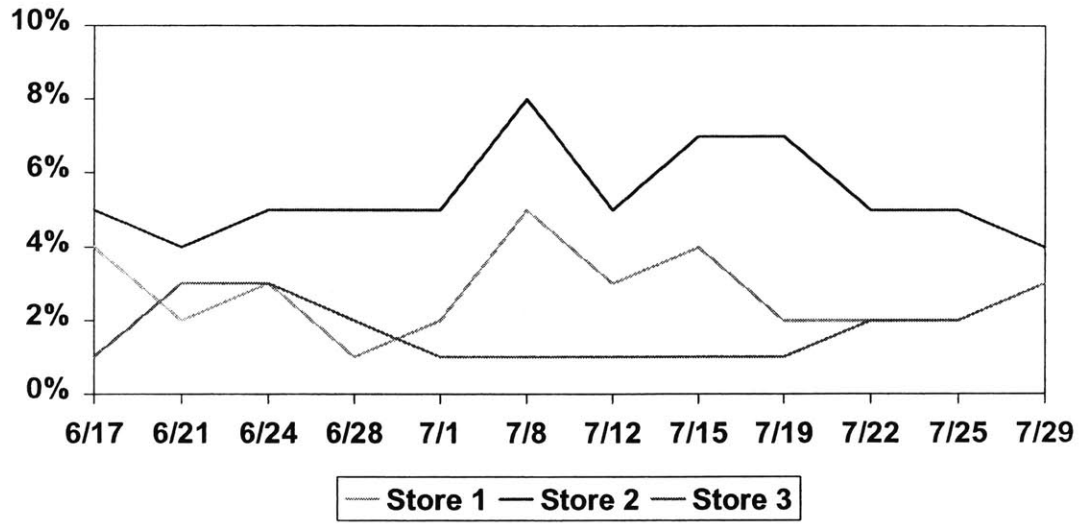


Figure 5: Out-of-Stock Rates for One Chain



3.3 RANDOM AND CONSISTENT OUT-OF-STOCKS

On an individual item basis, the audit revealed out-of-stocks for most individual items with some individual items experiencing consistent out-of-stocks over time and in multiple stores. Many items were out-of-stock at one or two of the stores audited. From statistical analysis, these items were likely out-of-stock because of variation in demand. However, the audit revealed that some out-of-stock items were frequently out-of-stock at particular stores and that some out-of-stock items were out-of-stock at multiple stores. For one individual item, the item would be out-of-stock for several weeks, in stock briefly and then out-of-stock again for several weeks.

3.4 LARGER SAMPLE SIZE NEEDED

The Baltimore audit did confirm that local mass merchant stores were experiencing out-of-stock rates upwards of 10%. However, because of the variation in out-of-stock rates over time and across different stores, it could not be determined that existing RSG data was understating the out-of-stock rate. Furthermore, there was suspicion regarding the accuracy of the data because of the small sample of stores. While the sample of 12 stores is a reasonable point estimate for the average out-of-stock rate nationally, the wide variation in the results means a very large confidence interval for the accuracy of the estimate. In addition, having only two or three stores to sample for each chain precluded the researcher from reaching chain-wide conclusions for major retail customers.

4 NATIONAL AUDIT

A national audit was planned to verify the existing data and for increased statistical accuracy. The audit was conducted on a larger sample of 40-60 stores for four large customers. Each store was audited once over a period of two weeks. The auditor would identify out-of-stocks, arrange the items so everything was in its proper place on the shelf, and then identify out-of-stocks again.

4.1 WIDE VARIATION IN OUT-OF-STOCK RATES ACROSS STORES

Out-of-stocks rates were consistent with RSG-reported data with wide variation in out-of-stock rates across stores. While most stores had out-of-stock rates below the mean, some stores had rates as high as three times the mean. This wide variation explains the discrepancy between local stores and the national mean. The stores local to P&G headquarters actually had higher out-of-stock rates around 10%, but the rates at these individual stores were less significant when averaged out with other stores throughout the nation. Table 3 summarizes major statistics for each individual retailer.

Table 3: Retailer Statistics on Out-of-Stock Rates from National Audit

	Retailer A	Retailer B	Retailer C	Retailer D
Minimum	1%	2%	0%	0%
Maximum	14%	33%	10%	16%
Mean	5%	7%	4%	5%
Median	5%	7%	3%	3%

Furthermore, the audit results indicated that even with more precise definitions of out-of-stocks, RSG data was an accurate reflection of reality. Defining out-of-stocks after ensuring items were in the correct place caused out-of-stocks to increase by 10%. In rate terms, this increased the out-of-stock rate by 0.5% at most. In some cases, the only item

left on the shelf was damaged and unlikely to be purchased. These cases contributed 2% of the total out-of-stocks.

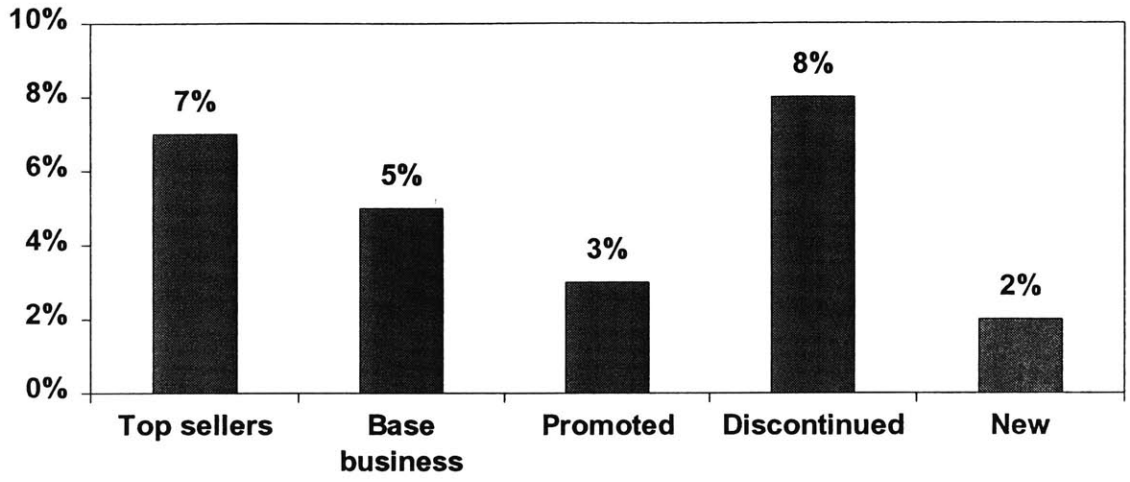
4.2 UNUSUALLY HIGH OUT-OF-STOCKS ACROSS STORES

Records of the individual items that were out-of-stock were examined for patterns in the data across stores within a chain. Certain items had unusually high out-of-stock rates across the chain. Fast movers, uncarded, discontinued and promoted items had out-of-stocks across several stores.

4.3 OUT-OF-STOCK RATES VARY ACROSS CATEGORIES OF ITEMS

Individual items were grouped into categories like top sellers, discontinued items, new items, promoted items, and base business, which incorporates all other items. Each of these categories has out-of-stocks associated with the SKUs that are in the category. Figure 6 shows out-of-stock rates for these categories of items. From the national audit, top sellers and discontinued items have above average out-of-stock rates, while base business is in line with the average and new and promoted items fall below the average.

Figure 6: Out-of-Stock Rates by Category

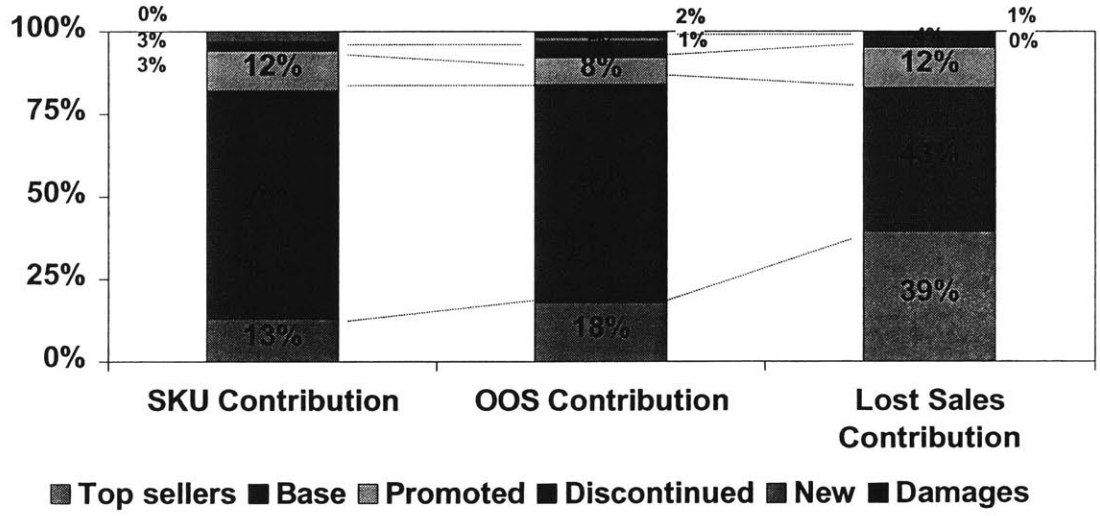


4.4 ESTIMATING LOST SALES

Utilizing store audit data and consumer response information, total sales lost from out-of-stocks are $8 - $12 million for P&G and $15 - $20 million for retail customers. Each category contributes differing amounts to lost sales because the products experience different consumption patterns and have different likelihoods of out-of-stocks resulting in lost sales. An out-of-stock for a top seller has a high likelihood that someone, or more than one person has actually encountered the out-of-stock, but a low likelihood that they would switch to another brand. In contrast, if a slow selling item is out-of-stock, there is a low likelihood that a person will encounter the out-of-stock since the item may sell only one unit every eight weeks. Furthermore, a new item is heavily promoted, and so has a high likelihood that someone has encountered the out-of-stock and a high likelihood that the encounter results in a lost sale, since new item sales rely on trial and repeat purchases.

Figure 7 shows the categories and their contributions to SKUs, out-of-stocks, and lost sales. Top sellers and base business are the largest portions of all three categories with the impact of top sellers magnified in contribution to lost sales. While top sellers contribute 13% of the SKUs, they contribute 18% of the out-of-stocks and almost 40% of the lost sales. Promotions are a small portion of the total SKUs because only three out of four retailers had promotions during the audit weeks. Of those three retailers, two had a small portion of the total product line on promotion. One had almost the entire product line on promotion. Discontinuations and new items are a small portion of the business, with only a small number of items transitioning in the second half of the year.

Figure 7: Contribution to SKUs, Out-of-Stocks, and Lost Sales



5 IDENTIFY SYSTEM ISSUES

The results of the audit are reflections of the policies that are currently being followed with regards to store operations and ordering. Out-of-stocks occur because stocking at service levels of 100% is prohibitively expensive. Patterns in the out-of-stock rates are

results of underlying system issues and not simply demand variation. Individual items go through different processes for entering the store. Top sellers and base business are part of the ongoing business. Promotions are events with special store policies. New and discontinued items are part of the product transition process.

5.1 ONGOING BUSINESS

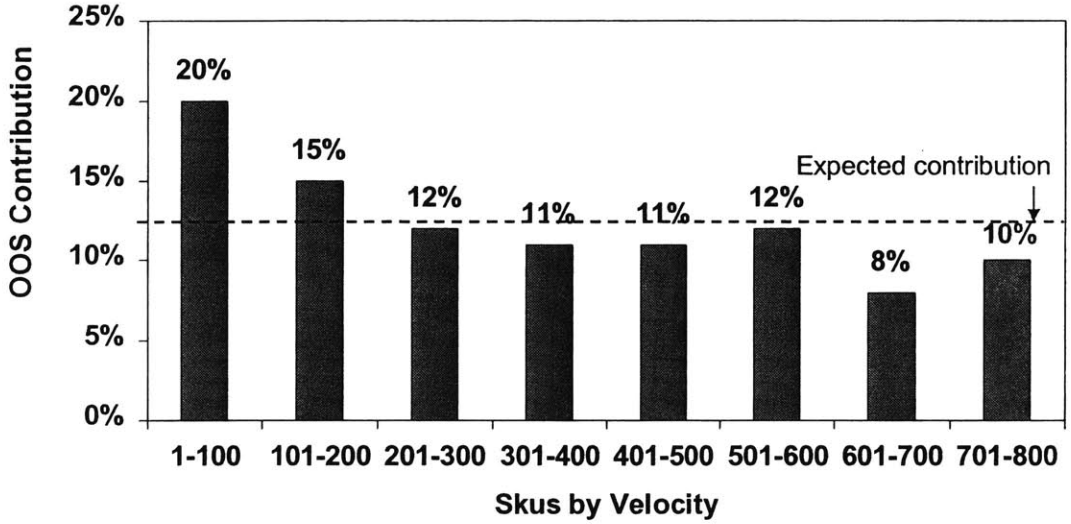
For ongoing business, out-of-stock patterns are results of mismatched supply and demand at each retail distribution point. Uniform supply policies for all stores result in high out-of-stock for some stores and some items and low out-of-stock rates for other stores. Economically, both P&G and the retailer encounter lost sales on products with unmet customer demand and excess inventory on products with nonexistent demand. Data from the audits, inventory theory and customer interviews support that distribution policies tailored to individual stores and dynamic for trends over time will result in higher sales and less excess inventory.

5.1.1 Fast selling items are experiencing high out-of-stocks

Audit data showed that the fastest selling items contributed disproportionately high out-of-stocks while slower selling items contributed disproportionately low out-of-stocks. At any one time there are 800 items on the wall. These items were grouped in terms of unit velocity beginning with the fastest selling 100 items. Each of these groups of 100 items comprises 12.5% of the total number of SKUs. If the out-of-stocks were random across the SKUs, each group would contribute approximately 12.5% of the out-of-stocks. In actuality, the fastest moving 100 SKUs contributed almost 20% to out-of-stocks. The top

25% of the SKUs contributed 35% to out-of-stocks. Furthermore, the slowest 200 SKUs contributed less than 20% to the out-of-stocks. Figure 8 shows the results graphically.

Figure 8: Out-of-Stock Contribution by Velocity



If fast selling items and slow selling item are stocked with the same inventory policy, specifically the same stock level and order quantity, fast selling items will experience greater out-of-stock levels compared to slow selling items. For an item at a particular store facing average demand and with the standard inventory policy, demand variation will cause that item to experience some out-of-stocks and some unit lost sales. That same inventory policy applied to an item facing higher than average demand, will experience out-of-stocks above average and may in fact seem to always be out-of-stock. Conversely, if that inventory policy is applied to an item facing lower than average demand that item will be in stock more than the average.

5.1.2 Retail policies regarding inventory

Most retail customers set the same ordering policies for every store in the system or for groups of stores in the system, even though the stores are likely to face different demand patterns. At major retailers, decisions regarding inventory are made at the corporate level.

Current retail philosophy among large clients has moved to automated ordering policies. Orders are triggered via scan data. When product inventory reaches its presentation minimum, an order is placed for a pre-determined level of product. Orders are placed weekly. At some retailers, inventory accuracy is verified by identifying product outages and confirming system accuracy. If the store employee identifies a discrepancy, he can adjust the inventory level in the system.

The presentation minimum and stock level implies a service level for goods. Slow selling items are often stocked with a presentation minimum that implies a high service level. If the presentation minimum is two items on a slow selling item, the likelihood that demand would ever reach two items in one week is almost zero. Therefore, that item will almost never encounter an out-of-stock. These items have service levels of almost 100%. For an item facing higher demand with a presentation minimum of two items, those two items may be purchased while the next order is on the way, resulting in an out-of-stock.

In determining the presentation minimum and order quantity, the retailer is also determining a service level for the item. By applying uniform policies to items facing different demand, retailers are choosing high service levels for slow-selling items and

lower service levels for faster-selling items. High service levels for slow-selling items result in low out-of-stock rates. Individual stores are supporting high inventory levels which are not actually resulting in higher sales. Low service levels for fast-selling items result in high out-of-stock levels and lost sales. Reallocation of inventory investment from slow selling items to fast-selling items could result in higher sales without investing in additional inventory.

Furthermore, retail chains rarely re-evaluate their ordering parameters. Fluctuations from fashion trends and seasonality result in further mismatches of supply and demand. Changes in fashion trends can result in changes in demand. For example, a formerly slow selling shade could experience an increase in demand because it is the new hot shade of the season. Some fluctuations from seasonality are predictable. Waterproof mascara is in higher demand in the summer because women are at the pool and beach. Black eyeliner sales rise during the Halloween season for children's costumes. Factoring in seasonal fluctuations also leads to higher sales and better return on inventory investment.

5.1.3 Match supply and demand to optimize profits

Lost sales from out-of-stocks are highest in the ongoing business. For the ongoing business, the main need is to match supply with demand not only on the aggregate level for the customer, but also for each customer's individual store. Tailoring ordering parameters to particular stores and particular items will result in increased sales and in fewer product returns. Setting service levels rather than ordering quantities leads to more clarity in decision-making. Finally, re-evaluating policies periodically or investing in the

ability to dynamically adjust order quantities based on historical demand would also improve return on inventory investment.

5.2 PROMOTIONS

Certain retailers often utilize promotions in order to boost sales. Whenever a customer orders a case, funds are given to the customer for the purpose of promoting P&G products. Promotions include coupons in the local newspaper, in-store coupons, price discounts, mail-in rebates or special pricing on bundled items. Promotions occur at different frequencies for different customers.

Promoted items actually had out-of-stock rates below average. This was counter to the intuition that promoted items would experience high out-of-stock rates. There could be two distortions in the data. The study was conducted on four major retailers. The audits were at a particular point in time and so not all customers had items on promotion. During the period of the audit, only two of the customers had items on promotion. However, the data was normalized for items on promotion in order to facilitate comparison. Furthermore, one customer had the majority of the product line on promotion and so the effect of the promotion on out-of-stocks was diluted by the sheer number of items on promotion.

In addition, many retailers have policies in place to increase supply in anticipation of higher demand during promotions. Before a promotion, store managers are given a list of the items with a recommended increased order quantity. The store manager chooses

whether to accept or reject the recommended increase. Similar to the ongoing business, stores are given standard suggestions. Because stores face different demand distributions, they will experience different consumer responses to promotions. While it is difficult to forecast customer response to promotion on new items, historical response to promotions is an indicator of the surrounding population's response level. The low out-of-stock rate on promotions suggests that retailers' policies to increase product supply during promotions is meeting increases in demand.

5.3 PRODUCT TRANSITIONING

Major players in the cosmetics industry introduce new product lines at least twice a year. Products have an average life of two to three years. The most popular products may last a decade or more while poor performers may be transitioned out in a year. Because retail space is limited, items must be discontinued in order for new items to be launched. As incentive for the retailer to carry the new item, manufacturers accept returns from customers, reimbursing in part or in full.

Prior to the audits, the prevailing opinion was that new items were out-of-stock and very little attention was given to discontinued items. In fact, audit results revealed that new products had lower than average out-of-stock rates while discontinuations had out-of-stock rates of almost twice the average.

5.3.1 New items had low out-of-stock rates

New products are less frequently out-of-stock because retailer headquarters push product into the stores. When a new product is introduced, retailer headquarters order a certain number of items for each store in the chain. In addition, throughout the supply chain, many parties are focused on the introduction of new items, resulting in better product availability at individual stores.

5.3.2 Discontinued items exhibited unusual patterns

Discontinued items were frequently out-of-stock across several stores and across several chains. If chains handled discontinuations similarly to the products in its ongoing business, discontinued items would have exhibited the same patterns as items in the ongoing business. In addition, because product return costs were rising, the expectation was that discontinued items were in-stock on the shelves. However, in aggregate, these items were experiencing both high out-of-stock rates and high product return rates. Chapter 6 investigates this dynamic.

6 DISCONTINUATIONS

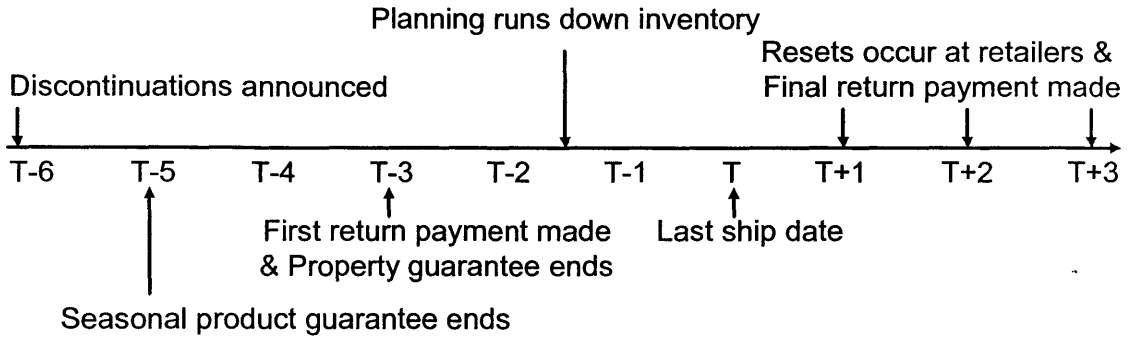
The current product transitioning process results in obsolete inventory at the end of a sales cycle as well as high out-of-stocks across national chains. Internal and external policies are misaligned and result in unusual behavior patterns from all parties in the supply chain. Optimizing the supply chain for product transitioning involves aligning internal and external parties.

6.1 P&G PRODUCT TRANSITION PROCESS

P&G introduces new product initiatives every six months in two waves, with its entire product line rolling over every 5 years. The larger wave is in January with about 80 to 100 items introduced and discontinued. In June this year, about 20 items were introduced and discontinued. The items are not always a one-for-one replacement.

Figure 9 shows the discontinuations process timeline. For each new product initiative, the finance department selects particular items to discontinue. P&G publishes the discontinued items list six months prior to the official last ship date so that customers can plan the changes into their store configurations. Three months prior to the last ship date, P&G pays the customer 50% of remaining inventory on discontinued items. P&G guarantees seasonal items until five months prior to the last ship date and property items until three months prior to the last ship date. Seasonal items are shades while property items are entire product lines. The planning department runs down inventory 1.5 months prior to the last ship date. At the last ship date, the distribution center stops shipping the discontinued products and begins shipping new products. For six months following the last ship date, customers reset their store configurations for new products. At the time of reset, P&G will pay the retailer for 50% of the remaining inventory.

Figure 9: Discontinuations Process Timeline (in months)



6.1.1 Policy costs at least $15 million

The product transition policy costs P&G more than $15 million. In addition to $1 million in lost sales from out-of-stocks, based on our computations, the company spends $3 million on internal obsolescence and $12 million on product return costs, based on their accounting records. With higher out-of-stock rates on discontinued items, there was an expectation that returns costs for those items would be lower. In fact, returns costs have been growing at a rate that outpaces declines in internal obsolescence. Over time, the total expense associated with discontinuations was increasing and was becoming a larger proportion of total sales.

Furthermore, lost sales from discontinued item out-of-stocks may be understated because fewer items were discontinued at the time of the audit. During the time of the audit, only 3% of the items were being discontinued, contributing 4% to lost sales. In January, four times as many items will be discontinued, contributing even more to items and out-of-stocks. In addition, while discontinued items were once part of rationing out poor-selling

items from stores, the improvement of the product portfolio has caused the need for P&G to discontinue items which sell at reasonable rates.

6.1.2 Internal misalignment leads to underproduction

Misaligned incentives within the organization resulted in underproduction of discontinued items. Within P&G, the product supply organization was responsible for minimizing total delivered costs. The planning division specifically was responsible for minimizing obsolescence costs. The sales organization is rewarded for maximizing shipments to the retailer. While the sales organization was nominally responsible for returns costs and lost sales, there was actually very little accountability within P&G for minimizing returns.

Because of the internal focus on reducing obsolescence costs and the control that product supply had over production, P&G was running out of discontinued items more than 1.5 months prior to the last ship date. During the June discontinuation, only 4 out of 19 items actually had inventory as of the last ship date. In October, 10 of the items with the last ship date for the following January were already out-of-stock.

6.1.3 External misalignment leads to abnormal retailer behavior

As a result of its policies, P&G was experiencing abnormal behavior from its retailers including overbuying, underbuying, and gaming. Retailers that experienced product shortages would overbuy discontinued items the next product transition cycle in an effort to guarantee product for their customers. Because of the return policy, retailers risked

little profit on carrying excess inventory. After wall resets, retailers marked the retail price down by 50% in order to increase sell-through. In overbuying, the retailer risked only the carrying cost of holding inventory.

Furthermore, some retailers simply removed the product from their shelves early in order to avoid additional manipulation. Because all the products were ceasing to be shipped on different days, retailers would need to make changes in their systems multiple times for one product transition cycle. During a product transition cycle, product supply would issue notices to retailers to take particular items off their order lists multiple times. The intention for the original policy design was for the retailers to take the item off the list at one time.

Finally, some retailers attempted to game the system and profit from P&G returns payments. The first payment of 50% of inventory is intended to be used to fund markdowns on the product and increase the sell-through. In reality, most retailers only discount the product after the last ship date. They try to sell the product at full price in order to take the returns money as profit.

6.2 INTERNAL AND EXTERNAL ALIGNMENT FOR SUPPLY CHAIN OPTIMIZATION

In the case of product transitioning, optimizing the supply chain involves changing policies to align the supply chain internally and externally. Rather than internal measures to keep costs down, P&G can use external policies to align behavior throughout the supply chain and maximize profit. Guaranteeing the product eliminates some of the

abnormal behaviors of over buying and under production. Furthermore, changing the returns policy creates behavioral changes in retailers to order optimally.

6.2.1 Product guarantees

The product supply organization is rewarded for minimizing internal obsolescence. In efforts to drive down internal obsolescence costs, the company stops production early and runs out of inventory. Customers are given notice that P&G has run out of the item and take the item off the ordering list. There is no measure of lost sales for the items that experience early shortages of product. After experiencing this, customers begin to overbuy in order to guarantee the product will be on store shelves until reset.

P&G should guarantee the product for its customers up to the last ship date. This would eliminate the need for the retailer to overbuy because it is trying to guarantee the product on its own. Furthermore, there would be forecast accuracy benefits because the guarantee is at the manufacturer level and not at the retailer level. This also results in less complexity for retailers because all products cease shipping on the same day, rather than on different days as they do currently. Finally, it builds trust and credibility with the retailer that P&G will supply the product. Repeated early run outs create disbelief that P&G will carry out plans to order the product. The return to common policy also eliminates the need for some retailers to keep manipulating their ordering systems to eliminate products that run out prior to the last ship date at different times.

6.2.1.1 Savings from aggregating demand at the manufacturer level

P&G guaranteeing the product for its retailers results in less waste than the retailer guaranteeing the product for its customers because of risk pooling. Assuming quick shipment to retail customers in small amounts, there will be lower inventory in the total system. For simplicity, assume a set of 10 retailers facing the same demand which is normally distributed with a mean $\boldsymbol{\mu}$ and standard deviation $\boldsymbol{\sigma}$. If each retailer were to attempt to have a service level of **x** for its customers, it would keep $\mu+z\sigma$ on hand, where $z=f(x)$. The inventory in the system would be equal to $10(\mu+z\sigma)$.

Now assume that P&G is guaranteeing the product for its retail customers and thus end customers. The demand at the aggregate level for all 10 stores is normally distributed with a mean 10μ and a standard deviation $\sqrt{10}\sigma$. If P&G were to attempt to have the same service level of **x** for its customers, it would stock $10\mu+\sqrt{10}z\sigma$, where $z = f(x)$. This results in fewer inventory of $(10 - \sqrt{10})\, z\, \sigma$. Dollar savings can be calculated by multiplying the results by the unit value. Inventory savings are a function of the number of retail outlets, the service level, and the variation of demand at each retail outlet.

6.2.1.2 Internal metrics changes to support product guarantees

This change in policy can be facilitated by a change in internal metrics. Rather than measuring the product supply organization on inventory obsolescence minimization, the key metric is delivering customer orders accurately and on time. In general, returns costs and obsolescence costs need to be tracked together instead of separately since decisions on obsolescence costs have a negative effect on returns costs. In this particular case,

decisions made by the product supply organization to minimize obsolescence costs resulted in greater costs further down in the supply chain.

6.2.1.3 Tailored product guarantees for supply chain length

In the ideal situation, the last product is purchased immediately before the new product is placed on the wall. At the extreme, product guarantees would not be the same day for each customer. Instead the guarantees would fit each individual customer according to the length of its supply chain and the timing of its reset.

P&G currently selects one day for all of the products to cease shipping from the distribution center. Retailers choose different reset dates as well as have different supply chain times. By ending product flow simultaneously for all customers, those customers with higher sell-through on the product will stock out while the customers with slower sell through will have excess inventory. By ending product flow from the origin at different times for different customers based on the shipment type, P&G can more readily manage the end distribution and allocation so that retailers with faster sales have product to sell and retailers with slow sales do not have excess. Figure 10 and 11 compares the two mental models.

Figure 10: Cease shipments simultaneously

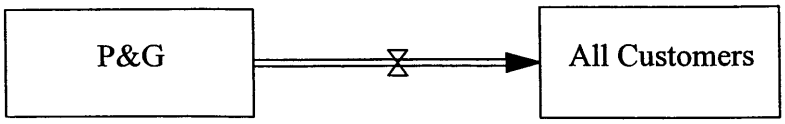
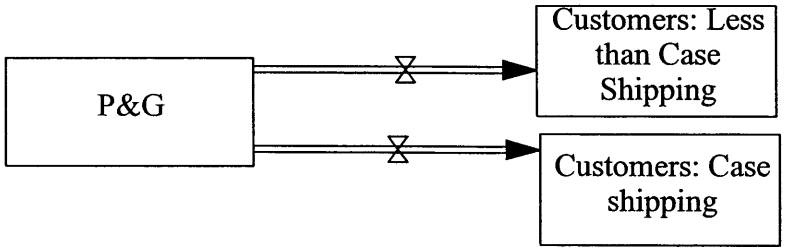


Figure 11: Cease shipments based on supply chain time



P&G has a built-in way to determine supply chain length. There are two methods of shipping to stores from the P&G distribution center: case and less than case. Some retailers receive product in full cases of 72 units. The product is stored in the distribution center and allocated to stores as individual units. Generally, the average time to reach the store from the distribution center is 8-10 weeks. Other retailers receive product in less than case size shipments of three or four units. Shipments are sent to the retailer distribution center and then directly to the store. The average time to reach the store from the distribution center is 3-4 weeks. The shipping method is an easy way to differentiate between customers based on supply chain time.

6.2.2 Restructuring returns

Restructuring its returns policy better aligns the retailer with P&G. In particular, P&G should adjust its returns policy by eliminating the first payment and giving a higher percentage return at the time of the second payment. The current policy was put into place in 1999 when the total length of the supply chain, from raw material to consumption was almost two years long. Since then, P&G has made incredible strides in reducing supply chain time and increasing supply chain capabilities. P&G can revise its returns policies to reflect these capabilities. This section examines changes in supply contracts in order to ensure coordination throughout the supply chain.

6.2.2.1 Allocation

For its January reset, P&G decided to put retailers on allocation in order to make sure inventory would be in the right place. The idea was to limit returns by limiting supply. In order to determine the proper amount to allocate to each customer, P&G asked top customers for historical demand information as well as inventory positions. Once a customer exceeded its allocation, it needed P&G to approve the order. Customers responded by ordering excess product early in the process and were upset by the delay in orders which exceeded allocation and by their lack of control to order what was desired.

Existing research demonstrates that allocation leads to gaming and manipulation. Furthermore, as the number of parties increases, allocation algorithms become too computationally complicated to use regularly. Allocation by the manufacturer induces competition between retailers and results in strategic behavior. According to Lee and

Whang, retailers will tend to inflate their orders, distorting the flow of information. [6] Cachon and Lariviere show that "Retailers will order more than they need to gain a more favorable allocation."[7] They further conclude that truth-telling mechanisms cause retailers to reveal private information. Furthermore, optimal allocation policy depends on the inventory levels of all items in the system, which makes the problem computationally complex.[8] Song and Zipkin remark that "premature obsolescence can be guaranteed if consumers cannot find the product." [9] They find that obsolescence should have substantial impact on inventory management.

6.2.2.2 Eliminating the first payment

P&G should eliminate the first payment because it is not used for the purpose it was intended and is an avenue for the retailer to game the system. The first payment is made three months prior to the last ship date. Its original intention was to fund the markdown of any remaining inventory in the store. Few retailers actually use the money to fund markdown of the product. In fact, most retailers wait until after the last ship date to discount the product. After the first payment, the retailer can continue to order more of the product from P&G. The result is simply more profit for the retailer and less for P&G.

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[6] Hau L. Lee and Seungjin Whang. "Decentralized Multi-Echelon Supply Chains: Incentives and Information," *Management Science* 45, no. 5 (1999) 633.
[7] Gérard P. Cachon and Martin A. Lariviere, "Capacity Choice and Allocation: Strategic Behavior and Supply Chain Performance," *Management Science* 45, no. 8 (1999): 1091.
[8] Andy A. Tsay, Stephen Nahmias and Narendra Agarwal, *Modeling Supply Chain Contracts: A review,* (MA: Kluwer Academic Publishers, 1999), 24.
[9] Jing-Sheng Song and Paul H. Zipkin, "Managing Inventory with the Prospect of Obsolescence," *Operations Research* 44, no 1 (1996), 215.

6.2.2.3 Literature review for returns

Padmanabhan and Png reviewed the strategic effect of returns policies on competition.[10] They found that a returns policy "subtly induces retailers to compete more intensely. Pasternack found that neither a policy of allowing for unlimited returns at full credit nor one which allows for no returns could be optimal for the total system.[11] Instead, Pasternack found that an optimal policy in the multi-retailer environment is only achievable if unlimited returns are permitted for partial credit. For the optimal policy, the costs must have the following relationship:

$c_1=(p+g) - ((p+g_2-c)(p+g-c_2))/(p+g_2-c_3)$

where

c= manufacturing cost

c_1= price per unit paid by the retailer to the manufacturer

c_2= credit per unit paid by the manufacturer to the retailer

c_3= salvage value per unit

p = selling price per unit

g= goodwill cost per unit due to stockout incurred by the retailer

g_1= additional goodwill cost per unit due to stockout incurred by the manufacturer

$g_2= g+ g_1$

[10] V. Padmanabhan and I.P.L. Png, "Manufacturer's Returns Policies and Retail Competition," *Marketing Science 16, no. 1 (1997) 81.*

[11] Barry Alan Pasternack. "Optimal Pricing and Return Policies for Perishable Commodities," *Marketing Science* 4, no. 2 (1985).

6.2.2.4 Partial credit for full returns at P&G

P&G was examined as a case study to apply Pasternack's theory to a multi-retailer environment. Policies were examined to determine optimal return policies for P&G discontinued products. P&G's largest customers are mass merchant and drugstore chains. These chains mark up products at different rates to sell to consumers. Mass merchants mark up their products 25% while drugstores tend to mark up their products by 40%. In order to develop general results, inputs were indexed as follows:

c= manufacturing cost = \$0.30; based on gross margins for all properties

c_1= price per unit paid by the retailer to the manufacturer = \$1.00

c_2= credit per unit paid by the manufacturer to the retailer = to be determined

c_3= salvage value per unit = 0

p = selling price per unit = \$1.40 for mass merchants, \$1.25 for drugstores

g= goodwill cost per unit due to stockout incurred by the retailer = \$0.10; estimated from consumer response

g_1= additional goodwill cost per unit due to stockout incurred by the manufacturer =\$0.05; half the goodwill cost to the retailer

g_2= g+ g_1= \$0.15

When Pasternack's model is applied to the parameters above, the return credit to optimize profits for the whole channel is 90% for the mass retailer and 88% for the case of the drug retailer. However, because indexed figures were available, the parameters were also

used to determine the impact of different return rates on profits for the manufacturer and retailer separately as well.

While Pasternack's model for the optimal return credit is independent of demand, the researcher used a particular demand profile in order to mathematically model the results for other return credits. The profile used was the average demand for discontinued items during the most recent wave of discontinuations. The item had normal demand with a mean of 800 and a standard deviation of 400. The model was also examined under other demand profiles which will be discussed later.

The author used numerical integration within Excel based on a given probability distribution. The model examined order quantities and profits for the retailer, manufacturer and in total for different return credits for the mass and the drug channel. The manufacturer sets a return credit. The retailer chooses the order quantity to maximize profit. The manufacturer produces the quantity ordered and gives credit to the retailer for anything unsold at the end of the season. Figure 12 and 13 show profits for both parties for the mass channel and the drug channel, respectively, along with markings for the current return credit, the optimal for P&G and the optimal for the channel.

Figure 12: Expected Profits in Mass Channel at Varying Return Credits

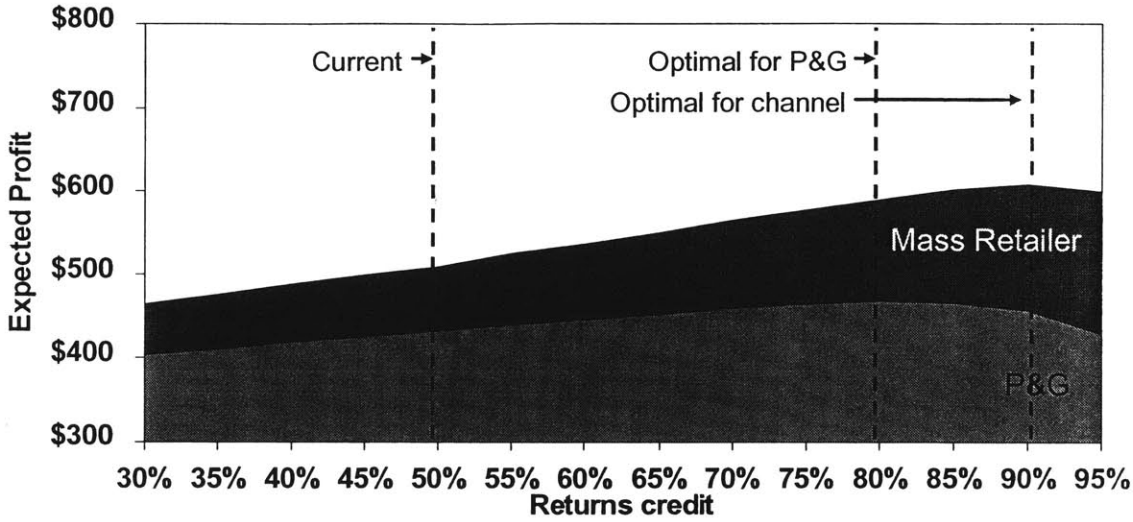
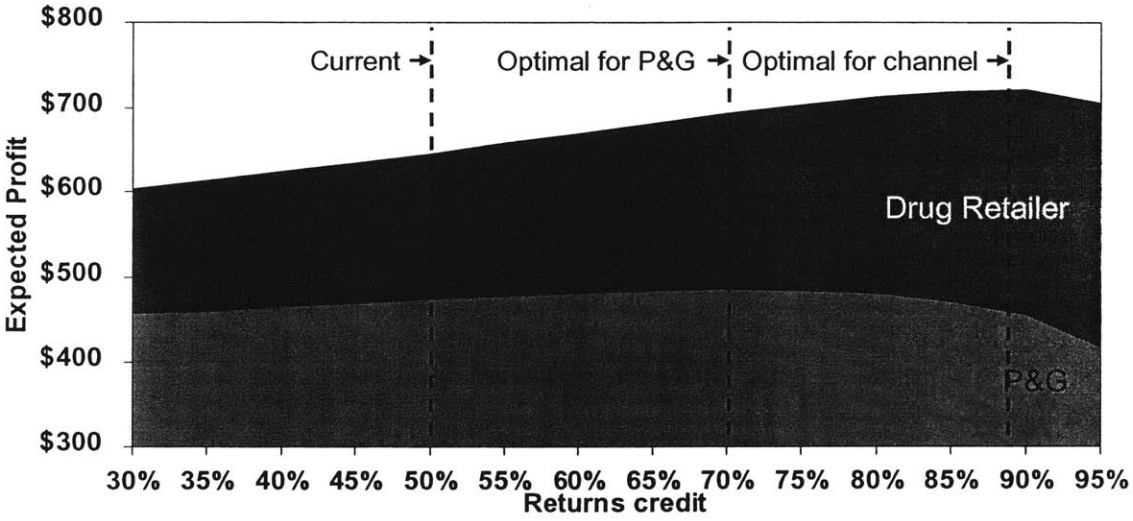


Figure 13: Expected Profits in Drug Channel at Varying Return Credits



Results for the mass channel and the drug channel followed similar patterns. As the return credit increases, the total channel profits increase up to a point. Retailer profits increase more than manufacturer profits as the return credit increases. After a certain

return credit, manufacturer profits decline with increases in the return credit while retailer profits continue to grow. When the return credit reaches 100%, the retailer receives all the profits in the channel while the manufacturer incurs a loss. However, since the total profits in the channel may go down, it is not in the retailer's interest to get 100% return credit.

Total channel profits reach their peak at returns of 90% in the mass retailer scenario and 88% in the drug retailer scenario. However, the policy to optimize for the entire supply chain is not necessarily the policy that optimizes for the manufacturer. The return credit that is optimal for the total supply chain results in lower profits to P&G because retailers insist on keeping margins the same. The P&G optimum is around 80% for the mass channel scenario and 70% for the drug channel scenario. For better return credit for all parties in the channel, P&G would want to offer 75% return credit for unsold product at the end of the product life to optimize P&G profits while increasing retailer profits. This optimizes (on average) P&G profit while still giving providing strong service to retailers.

The model was examined for different demand patterns, production costs, goodwill estimates and salvage value. The optimal return credit for the system overall is independent of demand. However, when demand variability is high there is a bigger payoff from using the optimal policy. In addition, the optimal return credit only varies slightly based on production cost, goodwill and salvage value estimates.

In implementing this return policy, P&G needs to consider for the following factors:

1. **Retailers may not make decisions based on the returns policies.** Implementing different return policies may have no impact on profits if retailers do not factor return policies into decision-making when determining their ordering parameters. Higher profits in the channel are the result of better product availability at the retailer which occurs as a result of increased ordering from reduced financial risk. A returns policy of 75% may not improve profits at all if retailers choose not to order any additional product as a result.

2. **Retailers may not make decisions to optimize profit.** The assumption underlying decision-making is that retailers choose to optimize profits. The driver for ordering more units is the ability to sell those units to consumers. If retailers do not make decisions to maximize profit, there is little motivation to order optimally. Schweitzer and Cachon found that decision makers frequently make choices that deviate from those that maximize expected profit.[12] They found that "subjects ordered too few of high-profit products and too many of low-profit products."

3. **Retailers may not use historical data in decision-making.** The decision to order a particular quantity is based on known information about the profile of demand. Using this information, the retailer makes decisions on the quantity to order. While many large retailers have demand information available, because of the number of items managed, few use actual demand profiles to determine order quantities.

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[12] Maurice E. Schweitzer and Gérard P. Cachon, "Decision Bias in the Newsvendor Problem with a Known Demand Distribution: Experimental Evidence," *Management Science* 46, no. 3 (2000): 404.

4. **Retailers may not allocate product to stores correctly.** As discussed in Chapter 5, many retailers apply similar supply policies to stores facing different demand. If customers are able to order more product, but allocate the product to stores incorrectly, many of the benefits of increased ordering will be lost.

5. **Higher return credits mean higher return costs.** P&G has made decisions to minimize returns, but this has often come at the expense of product availability. This recommended increase in return credits may also mean that expected returns will also increase. The tradeoff being made incurs higher returns and obsolescence costs in order to have higher sales. This is sometimes difficult for the product supply organization to accept because higher sales are often attributed to other functions within P&G while higher obsolescence costs are attributed solely to product supply. In addition, estimated lost sales are an invisible cost for the organization because they are not recorded through accounting while returns costs are visible to the organization. In a similar way, Fisher et al. expresses frustration that "companies can't quantify the value of a short lead time in reducing stockouts and markdowns." [13]

7 CONCLUSIONS

Many consumer products companies sell through retailers to consumers. Manufacturers lack visibility throughout the supply chain to ensure their products are reaching consumers. The retailer pulls the product through the supply chain to the end distribution

[13] Marshall L. Fisher, Ananth Raman and Anna Sheen McClelland, "Rocket Science Retailing is Almost Here – Are You Ready?" *Harvard Business Review,* July-August 2000, 120.

point. System inefficiencies occur whenever product supply is insufficient to meet consumer demand in a particular retail store.

In the case of P&G, high out-of-stocks at local levels prompted inquiry into the cost to P&G, the accuracy of internal data and the impact that P&G could have on reducing these rates. Results found wide variation in out-of-stock rates across stores and across time that in aggregate confirmed internal data reports. In total, out-of-stocks were costing the company $10 million in lost sales annually.

Out-of-stocks were affected by three events: the ongoing replenishment system, promotions, and product transitioning. System efficiency could be increased by tailoring supply to meet demand at the point of sale and aligning incentives within the supply chain to ensure product availability.

When faced with the complexity of managing hundreds of items for only one brand, the idea of matching supply to demand may seem onerous and overwhelming to retailers. However, information technology can be harnessed to incorporate this information into decision-making and adjust ordering parameters.

Supply chain optimization can also be achieved through internal and external alignment. Misaligned internal incentives at P&G were causing disruptions to product supply as well as abnormal retailer behavior. In addition, re-structuring the returns policy would allow

for increased profits for both P&G and the retailer with little need to constantly manage the product.

Finally, matching supply to demand require changes in actions performed by the retailer. The retailer controls the pull to the store and the allocation of total inventory between stores. As the manufacturer, P&G can also make a choice to shorten lead times to stores. In this way, P&G can pre-empt out-of-stocks based on existing system design by increasing the speed of replenishment to the store.

BIBLIOGRAPHY

Cachon, Gérard P. and Martin A. Lariviere, "Capacity Choice and Allocation: Strategic Behavior and Supply Chain Performance," *Management Science* 45, no. 8 (1999): 1091-1108.

"Cosmetics Category Performance Study." *MMR,* September 23, 2002, 19.

Fisher, Marshall L., Ananth Raman and Anna Sheen McClelland, "Rocket Science Retailing is Almost Here – Are You Ready?" *Harvard Business Review,* July-August 2000, 120.

Gruen, Thomas W. and Daniel S. Corsten. *Retail Out-of-Stocks: A Worldwide Examination of Extent, Causes and Consumer Responses.* Atlanta, GA: Emory University, 2002.

Lee, Hau L. and Seungjin Whang. "Decentralized Multi-Ecehlon Supply Chains: Incentives and Information." *Management Science* 45, no. 5 (1999) 633.

Padmanabhan, V. and I.P.L. Png. "Manufacturer's Returns Policies and Retail Competition." *Marketing Science 16, no. 1 (1997): 81-94.*

Pasternack, Barry Alan. "Optimal Pricing and Return Policies for Perishable Commodities," *Marketing Science* 4, no. 2 (1985): 166-176.

Schweitzer, Maurice E. and Gérard P. Cachon. "Decision Bias in the Newsvendor Problem with a Known Demand Distribution: Experimental Evidence." *Management Science* 46, no. 3 (2000): 404-420.

Song, Jing-Sheng and Paul H. Zipkin. "Managing Inventory with the Prospect of Obsolescence." *Operations Research* 44, no 1 (1996): 215-222.

Tsay, Andy A., Stephen Nahmias and Narendra Agarwal. *Modeling Supply Chain Contracts: A Review.* (MA: Kluwer Academic Publishers, 1999), 21-24.