SAS4400-2016

Leveraging Advanced Analytics in Pricing and Inventory Decisions at a Major Durable Goods Company

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ABSTRACT

As a result of globalization, the durable goods market has become increasingly competitive, with market conditions that challenge profitability for manufacturers. Moreover, high material costs and the capital-intensive nature of the industry make it essential that companies understand demand signals and utilize supply chain capacity as effectively as possible. To grow and increase profitability under these challenging market conditions, a major durable goods company has partnered with SAS to streamline analysis of pricing and profitability, optimize inventory, and improve service levels to its customers.

The price of a product is determined by a number of factors, such as the strategic importance of customers, supply chain costs, market conditions, and competitive prices. Offering promotions is an important part of a marketing strategy; it impacts purchasing behaviors of business customers and end consumers. This paper describes how this company developed a system to analyze product profitability and the impact of promotion on purchasing behaviors of both their business customers and end consumers.

This paper also discusses how this company uses integrated demand planning and inventory optimization to manage its complex multi-echelon supply chain. The process uses historical order data to create a statistical forecast of demand, and then optimizes inventory across the supply chain to satisfy the forecast at desired service levels.

INTRODUCTION

Market conditions, particularly in the United States, are challenging for most manufacturers because of increased competition that results from globalization. Supply chains are also constantly evolving and becoming more complex. A major durable goods company partnered with SAS to develop a new platform that uses SAS® Visual Analytics and SAS® Office Analytics to help it easily make data-driven pricing decisions. They also designed a scalable, streamlined process to evaluate stock keeping unit (SKU) profitability, based on a combination of Microsoft Excel spreadsheets and SAS technology. In addition, a SAS Visual Analytics reporting tool enables analysts to understand their large amount of historical invoice and retail data and to derive insights that can be incorporated into future pricing decisions.

The company also implemented SAS® Demand-Driven Planning and Optimization Foundation to make use of SAS® Analytics to improve demand forecast modeling and accuracy and to provide for more structured and efficient consensus planning and inventory optimization processes. The new approach eliminates the reliance on multiple processes that were based on Excel. SAS® Forecast Analyst Workbench creates a statistical forecast that is based on the historical data. The statistical forecast is fed into the SAS® Collaborative Planning Workbench, where the analysts can add value to the forecast based on market insights and real-time promotional information. This enhanced forecast is used by SAS® Inventory Optimization Workbench to calculate the inventory targets in the multi-echelon network in order to right-size the inventory and satisfy the desired customer service level.

PRICING ANALYTICS PLATFORM

The durable goods company sells their products to consumers through retailers. These retailers are the customers of the company. The transaction data between the company and their customers are called invoice data, and the transaction data between their customers and the end consumers are called retail sales data, as shown in Figure 1. The company uses both invoice data and retail sales data in their pricing decisions. The ability to visualize these transaction data and identify patterns from them is critical to designing a successful pricing strategy.

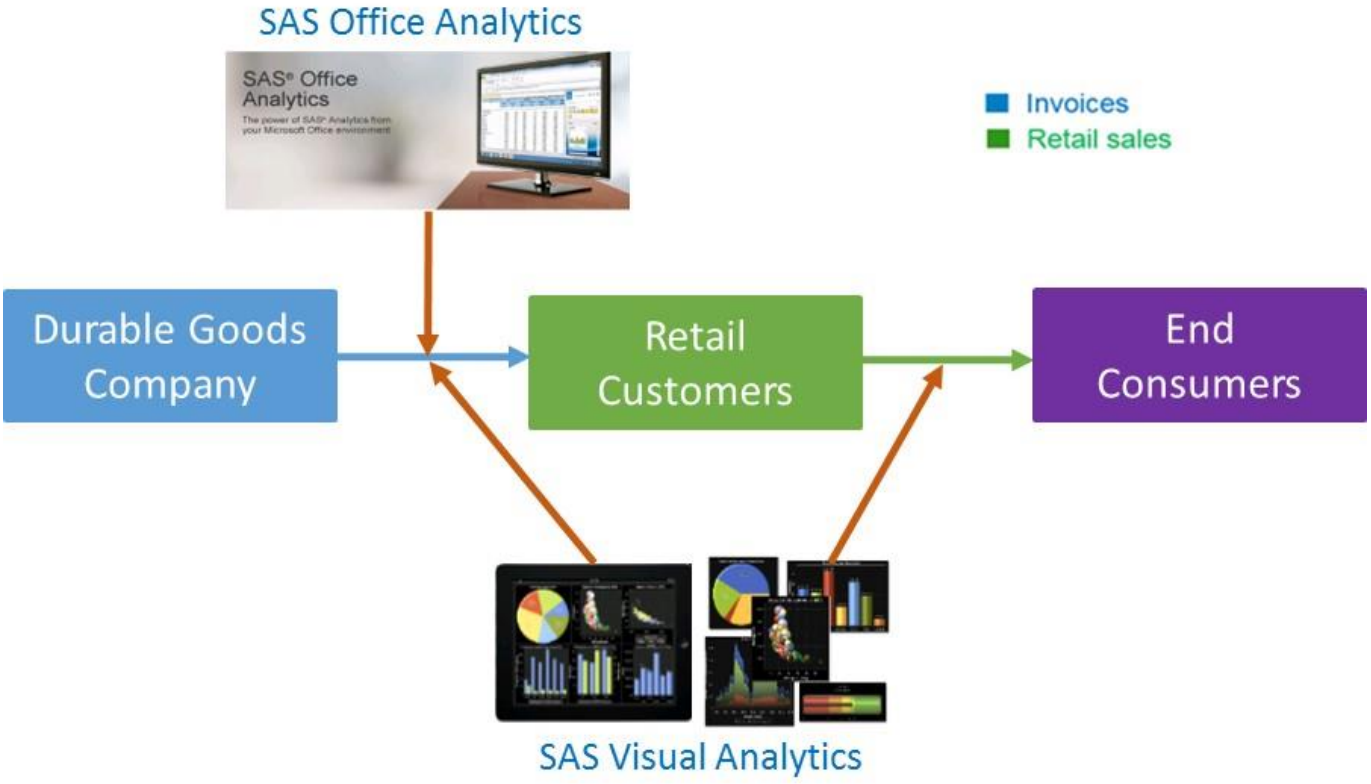

Figure 1. Transaction Data from Durable Goods Company to Consumers

Before the implementation described in this paper, the company was primarily using spreadsheets to design their pricing strategies and to visualize and create reports. Source data (such as forecast data) were downloaded first, and a lookup process was used to calculate the different cost components. Such analyses were often time-consuming and also error-prone. Because spreadsheets are not designed to handle large amounts of data, analysts often had to summarize the data when they created visual reports. In many cases, only a year's worth of data could be analyzed at a time, making year-over-year comparisons difficult.

The company and SAS joined hands to design a pricing analytics platform to overcome these challenges. The new analytical platform enables analysts to design their pricing and promotion strategies with the click of a button. The analysts can easily simulate many scenarios before finalizing the right pricing strategy. They can also monitor the performance in real time by using visual reports. SAS Visual Analytics now enables the company to visualize and create reports that use more than four years of data. Many new visualization options (such as waterfall charts, heat maps, and animation) are available. Analysts can easily make year-over-year comparisons and customer comparisons by different cost buckets and key performance metrics.

HISTORICAL PROFITABILITY REPORTS

The company breaks down the price and cost by item and customer into a number of different components such as the type of the promotion, discounts, and so on. Analyzing the historical performance of these promotions and their impact on net sales is critical to designing successful strategies. Real-time monitoring of SKU profitability by customer also helps to fine-tune the pricing strategies after they go live.

SAS and the company worked together and used SAS Visual Analytics to create a number of visual reports to gather insights from the historical invoice data. Time series plots that use more than four years of net sales and earnings before interest and tax (EBIT) data are created to understand the seasonality patterns. These plots can be easily filtered by product hierarchy, customer hierarchy, or brands. Pareto charts help identify any anomalies in pricing by customer and product lines. The discount and cost components are organized in easy-to-understand buckets in waterfall charts. Waterfall charts also help analysts easily visualize year-over-year comparisons.

An example of a historical profitability report is shown in Figure 2. Historical Profitability ReportsFigure 2, which consists of a heat map, a pie chart, and a time series plot. The heat map is based on product hierarchy, and the pie chart is based on brand hierarchy. Interactions between the heat map and the time series plot and between the pie chart and the time series plot enable analysts to understand the seasonality trends by product and brand hierarchy.

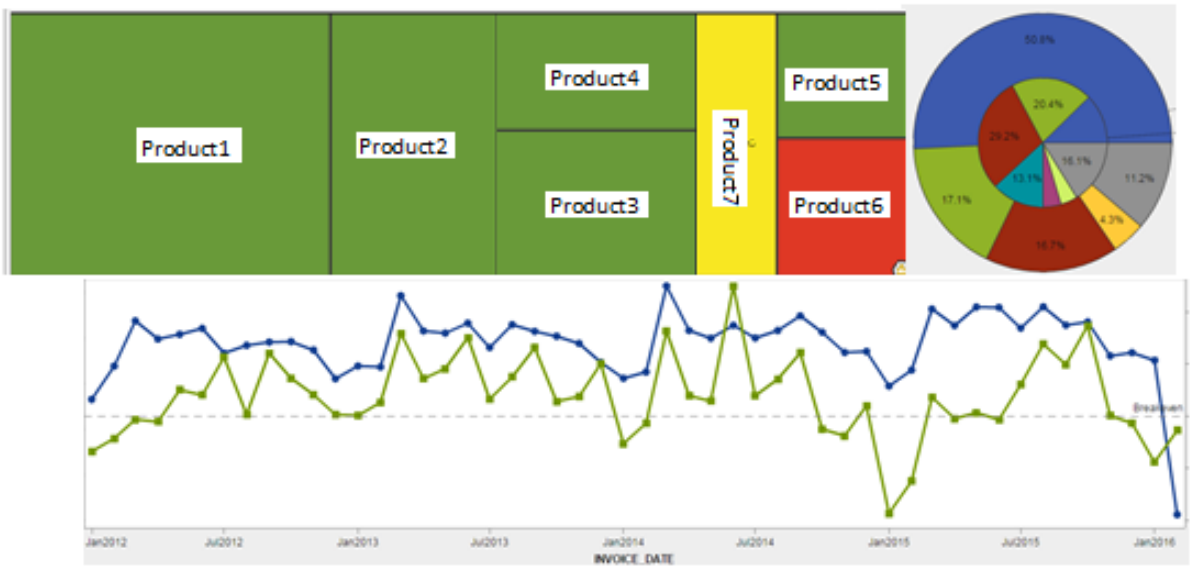

Figure 2. Historical Profitability Reports

RETAIL SENSITIVITY

The company receives weekly retail sales information from some of its larger retailers, who provide in-cart (or in-store) prices along with the quantity that they sold on a weekly basis by store. Retail data are used to estimate price sensitivity of consumers. Two demand models are developed: one is a hierarchical cumulative demand model, and the other is a hierarchical semi-log demand linear model. For the latter, seasonality at a weekly level is estimated by product line to account for buying seasons. The outputs from the two models are used to estimate potential benefits from retail promotions by different retail channels.

An example of retail win rate estimation by hierarchical cumulative demand model is illustrated in Figure 3. The plot on the left indicates the historical win rate at different price points, and the plot on the right indicates a piecewise linear fit of the historical win rate by using the hierarchical cumulative demand

model. The plot on the right demonstrates that the estimated retail win rate is a good approximation of the actual historical win rate.

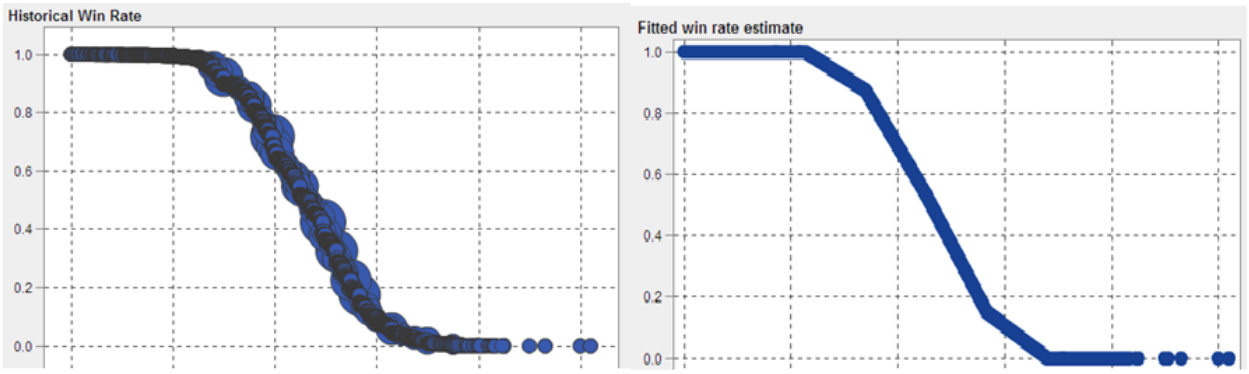

Figure 3. Retail Win Rate Estimation

PRICING STRATEGY AND SCENARIO ANALYSIS

The price of a product is determined by a number of factors, such as the strategic importance of customers, supply chain costs, market conditions, and competitive prices. Promotions are an important part of the marketing strategy at the company; they impact purchasing behaviors of both business customers, and end consumers. The company and their retail customers operate in a symbiotic relationship, and the price of a product is set such that there is sufficient profit margin for both the company and their retail customers. Supply chain is another important factor that needs to be considered. The retail customers can pick up the products at either the factory or regional distribution centers (RDCs). The product price needs to account for transportation cost and warehousing cost, depending on the delivery type.

SAS Office Analytics is used to design a SKU-profitability spreadsheet that enables analysts to analyze various scenarios. Analysts can select analysis time frames and retail customers at any level of hierarchy. SAS Office Analytics passes the analyst's selection to the computing server, where SKU profitability calculations are performed, and then streams the results back into the spreadsheet. These results act a baseline for the pricing strategy analysis. Figure 4 shows a screenshot of a SKU-profitability spreadsheet that is used to create the baseline data.

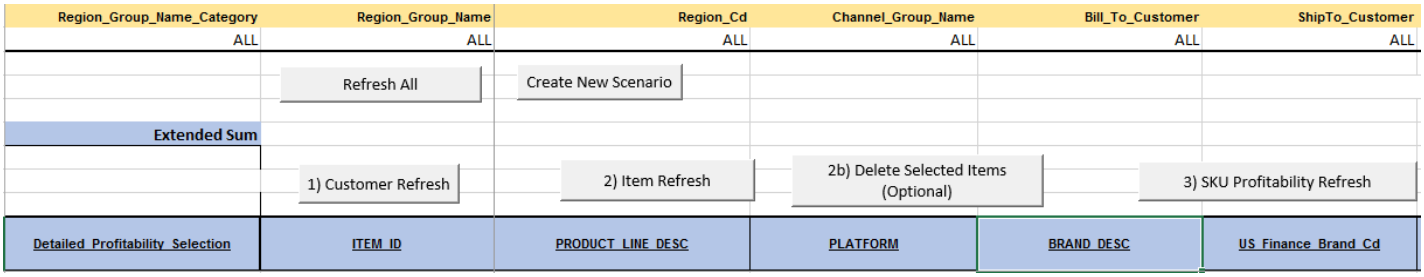

Figure 4. SAS Office Analytics Lookup

The company can use the baseline data to create multiple scenarios with different type of discounts and easily compare the profitability across these scenarios. Figure 5 shows a screenshot of the scenario analysis worksheet within the SKU profitability spreadsheet. Analysts can easily increase or decrease the different cost components by a fixed value or percentage and quickly evaluate the impact of these

changes on total EBIT. Analysts can also use SAS Office Analytics to quickly review the historical SKU profitability for the same customers during a similar period in the past.

Extended Sum			3,787	$1,430,608	$0	$3,095	$0
Change($)	$0		0	$0	$0	$0	$0
Change(%)	0%		0%	0%	0%	0%	0%
Item_id	MAP_Promo	Retail	Quantity	Gross_Price	Blems_Discontinued	Cash_Discounts	Flooring

Figure 5. SAS Office Analytics: Scenario Analysis

DEMAND-DRIVEN PLANNING AND OPTIMIZATION

The durable goods company licensed SAS Demand-Driven Planning and Optimization Foundation to take advantage of SAS Analytics to improve demand forecast modeling and accuracy, and to provide for more structured and efficient consensus planning and inventory optimization processes. SAS Demand-Driven Planning and Optimization Foundation provides the following capabilities for the company:

- delivers an enhanced, integrated platform for demand planning and inventory optimization, eliminating the reliance on multiple Excel-based processes
- interfaces with the SQL server-stage database to take advantage of existing master data
- produces reports to support exception-based management
- enables exception-based management to maximize planning productivity as facilitated by operational reporting
- delivers an inventory optimization platform to right-size finished goods inventory and increase customer service levels

This section focuses on how the company uses SAS Inventory Optimization Workbench to optimize inventory within its complex multi-echelon supply chain.

INVENTORY OPTIMIZATION

Like many manufacturers, this company has a complex supply chain for its two main product types: produced goods and sourced goods. Produced goods are manufactured in North America and have a short lead time, whereas sourced goods are manufactured primarily in Asia and have a long lead time. Produced goods can be picked up by customers either at the factory or at regional distribution centers (RDCs), whereas sourced goods can be picked up only at RDCs. So the supply chain network varies based on the product-customer combination.

The durable goods company uses SAS Inventory Optimization Workbench to compute weekly inventory targets of the multi-echelon network. These computations are executed in a batch mode. First, inventory optimization staging tables are created by preprocessing from the source tables. SAS and the company worked jointly to define the logic that is used in the preprocessing code. The weekly inventory optimization process uses data from the staging tables and forecasts in order to calculate optimal inventory target levels for each product-location combination. The optimal inventory target is the sum of the safety stock and forecasted demand over lead time. Safety stock represents the amount of inventory that is required to cover the uncertainty in demand data. The weekly forecast input data include the forecast mean and variance by product-location. The variance of forecast data and the desired service level for that particular product-location are the main drivers for the safety stock calculation.

TUNING AND VALIDATION

The following processes are run automatically each quarter:

- A tuning process optimizes the output of SAS Inventory Optimization Workbench by calibrating parameters such as the coefficient of variation (CV). Tuning is a simulation-and-optimization-based process that iterates across the feasible parameter space and determines the values of parameters that will optimize the key performance indicators (KPIs) of the supply chain network. The coefficient of variation (CV), which is defined as the ratio of the forecast's standard deviation and mean value, is a critical parameter that is used in calculating safety stock. CVs of SKU-location are usually in the range of 0.1 to 1. The simulation part of the tuning process iterates through discrete feasible values of the CV and calculates KPIs of the supply chain network at every step. The optimization part of the tuning process selects the CV that optimizes the KPIs while satisfying the business rules.
- A validation process quantifies the benefit that can be expected from using SAS Inventory Optimization Workbench. The validation process uses the parameters that are obtained from the tuning process and then runs a simulation process to determine the KPIs of the supply chain network. These KPIs can then be compared against historical KPI metrics during the same time frame to determine the benefits such as improvements in service level and reduction in inventory cost.

REPORTS

SAS worked with the company to design the following types of reports in SAS Visual Analytics to meet their business requirements:

- A future target and order report is based on the SAS Inventory Optimization Workbench output table. The primary use of this report is to analyze the inventory target and replenishment orders that are created across the time horizon. This report can be viewed at various levels of customer and location.
- A historical performance report keeps track of the performance of the supply chain network by using KPIs such as inventory turns, service level, backlog, and so on. Monitoring the KPIs such as inventory turns and backlogs plays a key role in the continuous improvement of supply chain. The company can use this report to quickly identify outliers and SKU locations that need improvement.
- Tuning and validation reports help quantify the value that is obtained by calibrating parameters during the tuning process. These reports compare tuning and validation results with the historical data, enabling the analysts to identify areas where their performance could be improved through optimization.

CONCLUSION

A major durable goods company has taken the next step in their analytic evolution by using advanced analytics in pricing and inventory decisions. A new pricing analytical platform, built using SAS Office Analytics and SAS Visual Analytics, enables analysts to design their pricing and promotion strategies with the click of a button. Analysts can simulate many scenarios before finalizing the right pricing strategy. The company can also use visual reports to monitor their performance in real time. SAS Visual Analytics enables the company to visualize and create reports that use more than four years of data. SAS Demand-Driven Planning and Optimization Foundation delivers an enhanced, integrated platform for demand planning and inventory optimization, eliminating reliance on multiple Excel-based processes. The company uses SAS Inventory Optimization Workbench to automatically compute weekly inventory targets of its multi-echelon supply chain network. Tuning and validation processes are run automatically every

quarter to calibrate inventory optimization parameters and quantify the benefits that could be expected from inventory optimization. Visual reports are also available to monitor the performance of the supply chain and identify areas of improvement.

CONTACT INFORMATION

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