Measurement and Evaluation of Retail Promotions

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Abstract

Promotions involve a complicated interplay of factors and are a result of a synchronized sequence of activities between manufacturers and retailers. The outcome of promotions pivot on several elements beyond the control of any one party in the supply chain. 'How' a promotion performed has a more straight forward answer than 'Why' a promotion performed a certain way. This research attempts to define a quantitative methodology to measure performance of promotions and reveal insights to consumer product manufacturers and retailers that will help answer the 'How' and the 'Why' of promotions. The measures used are simple, but the combination of analysis creates a complex structure of many dimensions that reveals intricate insights into the functioning of the supply chain, the most important asset in executing promotions. We present to you a three dimensional framework termed the 'Promotion Performance Cuboid' with structural elements consisting of three foundational supply chain measures, inventory, stock-outs, and performance of sales against target forecasts. The measures when viewed together through the Promotion Performance Cuboid, tell a revealing story of the underlying dynamics of promotions and the elements that actually control promotional performance become lucid.

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1 Introduction

Promotions attempt to generate incremental sales, popularize new products, or increase foot-traffic to stores. However, promotions also result in tremendous demand variations and place enormous stress on supply chains. The demand variations between promotions and non-promotions are a result of price discounts, predictability in promotion periods, and increase in associated advertising. Though the retailer is the face of a promotion, the planning and execution of a promotion is the result of collaborative investment and decision making between the retailer and manufacturer. Since the retailer is the touch point with end consumers the successful execution of promotions is highly dependent on the retailer’s distribution and store network. According to the USA Department of Commerce, retail sales in March 2015 were $441.4 billion. Bain and Company (2006) notes that large retailers spend 10 to 20 percent of their sales on promotions. In some cases this spending helps increase sales by 30 percent (Delaney & Blasberg 2006). However, only 18 percent of the promoted brands create increased store profits (Srinivasan, Pauwels, Hanssens, & Dekimpe, 2004). The low profitability of promotions is caused by low margins and inefficient execution. Therefore, measuring performance of promotions and improving them, is essential for the profitability and return on invested capital for retailers and manufacturers.

The main scope of our research is to understand how to better evaluate promotions. What important factors should be considered when evaluating promotions at retail stores? How do promotions impact store inventories? Are there some SKUs, stores or promotions that weigh down the overall revenue potential? These are some of the questions that this thesis aims to target. The evaluation of promotions includes three metrics store inventory levels, lost revenues and forecast error during promotions.
The remainder of this thesis is organized as follows. Chapter 2 presents a literature review that provides an overview of the recent research pertaining to evaluating promotions. Chapter 3 presents the methodology applied to the research and the metrics that will be used to analyze promotions. Chapter 5 examines the results of the methodology applied on a dataset and presents it as a case study. Chapter 6 concludes with generalized implications that may be used as a basis to evaluate promotions and suggestions for future research.
2 Literature Review

2.1 Introduction

The literature reviewed explores five main themes that recur across existing research in the area of evaluating promotions. The first theme is about how promotions are defined and organized. A second theme is the use of the Collaborative Planning, Forecasting, and Replenishment (CPFR) methodology between manufacturers and retailers to maximize the effectiveness of promotional planning, execution, and sharing of the resulting benefits. A third theme is the result of the CPFR process leading to the calculating and sharing of a competition index. A fourth theme that is central to research on promotions evaluation are optimization in order quantities and trade budgets.

The final theme has been forecasting models and suggested ways to measure forecast accuracy. Table 1 summarizes the themes and the Section 5 will summarize research findings of the literature review and present concluding remarks on gaps identified in existing research and how the research question may suitably address the gaps as part of the research effort. The final theme has been forecasting models and suggested ways to measure forecast accuracy.

The review of these five topics will identify methodologies used for solving problems analogous to the thesis problem. The themes may help identify possible sources of the current problems and suggest ways to solve them. The analysis of the literature will give information on how the current business processes at the CPG manufacturer differ from academic practices developed in the past. Moreover, they will provide a foundation for developing a solution for the thesis question. The literature review has confirmed that the current practices at the CPG manufacturer align with past research. However, further improvements are necessary in measuring the costs and effectiveness of promotions.
Promotions are a significant part of marketing expenditures in many industries (Blattberg, Briesch, & Fox, 1995). They increase short-term sales of products, popularize new products, and motivate brand switching. Promotions are executed by improving the visibility of the product in-store and through additional advertising, using free samples, or bundling the product and decreasing the price of the product. The execution of a promotion may include a mix of the previously mentioned activities, so that it motivates customers to make a purchase (Ashraf, Rizwan, Iqbal, & Khan, 2014).

The temporary retail price reduction is an essential part of most promotions. Setting the right price is the greatest contributing factor to the quantity sold during promotions. However, quantity sold should include only the quantity purchased by the end consumer and not the whole quantity ordered by the retailer from the manufacturer (Goodman & Moody, 1970).

The initial understanding and analysis of promotions and their organization at the CPG manufacturer shows that they comply with most of the guidelines described in the current
literature. The lack of a clear price estimate creates difficulties in forecasting demand during promotions.

2.3 Collaborative Planning, Forecasting and Replenishment

CPFR was actually designed to increase effectiveness of promotions rather than for daily business activities (Srinivasan, Pauwels, Hanssens, & Dekimpe, 2004). The highest leverage of sales and profits is in promotions but promotions generate the largest standard deviation in demand resulting in high forecast errors and therefore, possess the largest opportunity for improvement. When supply chain participants part of the CPFR group were evaluated as compared to supply chain participants not in the CPFR group, Wiehenbrauk (2010) claims that sales went up by 25% as compared to the non-CPFR group. Promotional stock service level for the CPFR group was at a high of 99.5% when compared to 94.7% for the non-CPFR group. End-of-promotion stock levels were lower by 50% for the CPFR group than for the non-CPFR group.

However, CPFR is a complex process requiring collaboration between supply chain participants that makes it cumbersome to implement (Srinivasan, Pauwels, Hanssens, & Dekimpe, 2004). Also, the data sets used by the manufacturers and retailers differ. The manufacturer’s forecast is based on market research data lacking information about regional prices or promotions. However, the retailer’s forecast is based on POS data that is highly reliable and displays actual trends.

The success of a promotion depends on the manufacturer’s and the retailer’s willingness to cooperate to capture all the profits from the demand increase (Gerstner & Hess, 1995). During promotions the main goal of the manufacturer is to increase demand and stimulate brand switching. On the other hand, the retailer suffers from the decreased margins and is trying to compensate for
them through increased visits to the store and increased purchases of complementary products and any other products at the store. Therefore, the manufacturer has to sacrifice part of its profits during promotions and pass them to the retailer as compensation for the lost margins (Srinivasan, Pauwels, Hanssens, & Dekimpe, 2004).

The increased usage of POS data and its sharing between retailers and manufacturers improves the transparency of the benefits distribution during promotions (Bemmaor & Mouchoux, 1991). Moreover, this information helps in assessing the elasticity of the demand during promotions and the type of customers who purchase the promoted items. Both retailers and manufacturers have higher revenue elasticity for national brands and products with a high frequency of promotions. However, the elasticity of the retail margins is lower for products with high frequency of promotions (Srinivasan, Pauwels, Hanssens, & Dekimpe, 2004). The manufacturer promotes its products frequently; therefore, it is important to diminish the difference between its interests and the retailer’s interests.

2.4 Sharing of Competitive Index Information between Manufacturer to Retailer

Wiehenbrauk (2010) has indicated that manufacturer and retailer collaboration through sharing of upstream information provides an opportunity to maximize the effectiveness of promotions. The article formulates an analytical model that jointly optimizes retailer promotion frequency and inventory decision about how much to order for a promotion. The model utilizes a combination of the newsvendor problem and the economic interpretation of demand through the calculation of a competition index.

Wiehenbrauk (2010) depicted the value of sharing upstream information by comparing two scenarios. In one scenario, no information is shared between manufacturer and retailer. In the
second, the competitive index information is shared by the manufacturer and the retailer running a promotion is able to adapt the promotion frequency and order quantity depending on the expected pressure from competition. The competitive index information reveals the level of competitiveness of a particular product across all the retailers. Using the competitive index information, Wiehenbrauk (2010) proposes that a retailer running a promotion is better able to match supply and demand and reduce inventory costs, and refers to this as the inventory effect. When retailers incur lower inventory costs, Wiehenbrauk (2010) suggests that the frequency of promotions are increased and refers to it as the frequency effect. Together, the inventory and the frequency effect result in an increased net profit effect for the retailer. Customers benefit with reduced prices. Manufacturers benefit from increased market share and sales.

Retailers and manufacturers each have important information which when shared can maximize the result from promotions. Retailers have a defined promotion schedule. Manufacturers can aggregate the schedule to a single set across retailers. Based on the aggregated schedule and future order quantities from individual retailers, Wiehenbrauk (2010) proposes a model that manufacturers can use to compile the competition index revealing the competitive pressure in the environment during a given period. Wiehenbrauk (2010) validates the model on a dataset consisting of two years sales volume and prices for six German retailers along with shipment data to these retailers for the category of diapers.

Sharing this information with retailers helps lower demand uncertainty and optimize inventory for the retailer. Wiehenbrauk (2010) claims that information sharing reduces inventory costs by 38% during promotions. The inventory effect and the corresponding frequency effect resulting from sharing of information increases retailer sales by 20%. The benefit to consumers is an average decrease in price by 0.2% to 5.3%. Finally, the manufacturer benefits through increased
market share, and smoothened production schedules resulting from less uncertain order quantities from retailers.

2.5 Optimizing order quantity using multi-item newsvendor with budget constraint

Kapur et al. (2007) address the major issues of accurately forecasting demand and holding sufficient inventory to control out-of-stocks during promotions. This has been addressed through the application of mathematical models to solve the multi-item newsvendor problem with a budget constraint. Optimal levels of inventory held during a promotion are calculated based on the forecast in the previous step and the profit maximization method described by Silver and Pyke et al. (1997). Additionally, a method to maximize revenue under a budget constraint is also suggested. Kapur et al. (2007) determine that a customer will permanently switch stores after 2.4 experiences of an out-of-stock situation. Thus, rate of stock-outs is an important factor that retailers will want to minimize. Kapur et al. (2007) recommend a scorecard approach at the retail store and distribution center level to track the true causes of out-of-stock situations. According to the study by Gruen, Corsten and Bharadwaj (2002) referenced by Kapur et al. (2007), 70% of stock outs are caused in the store while 30% are due to DC or suppliers upstream.

2.6 Promotion Forecasting and Measurement

Forecasting the demand during promotions and measuring the accuracy of the forecast and success of promotions is an essential part of improving the manufacturer's sales during promotions. The decisions about methods of forecasting will influence the demand for the product. Even though demand may be higher than forecast, the amount pushed to the retailer will be according to the forecast and some sales will be lost. Therefore, a too low forecast will result in
less sales than actually demanded and imply for the future that customer demand was lower (Silver, 1998). Promotion success can be measured by quantifying the net units and net profit at the retail level (Ailawadi, Harlam, César, & Trounce, 2006). Although this method is good for measuring the actual profits of the promotion, it does not include two major costs of the promotion: the holding cost of increased in-stock inventory and the cost of lost sales. Failing to include the lost sales in the performance of the promotions will also bias judgment of the actual demand generated by the promotions.

Therefore, the financial performance of the manufacturer and the more accurate measurement of its promotions can be improved by using more complete models. The new performance measurement model should include three components:

1. Changes of trade inventory levels during promotions. The inventory levels should be measured at all levels of the supply chain at which the promotion is run. Brown (1973) develops a model that includes the costs of inventory and sales at the different levels of the supply chain.

2. Return on investment for the promotion. When a promotion is organized, the manufacturer spends a bulk amount of money with the retailer or lowers the price of the products sold to the retailer. Therefore, a measure for assessing the profit from the additional promotional investment will indicate the performance of the promotion (Cuellar, 2012).

3. Assessment of the source of the increase in the units sold. The additional units sold during a promotion can be from brand substitution or store substitution (Kumar & Leone, 1988).
The other way to increase sales during promotions is to accurately measure the demand and thereby easily supply the required quantity. The forecast method of the product should be based on the product nature, the price decrease, base demand and components of the promotional mix (Kumar & Leone, 1988; Cuellar, 2012). The forecast of demand and performance measures of promotions are important components in determining the profit split for the promotions.

Koottatep (2006) presents time-series based forecasting models for promotions and validates the model using weighted mean percent error (WMPE) and weighted mean absolute error (WMAPE). Koottatep (2006) found forecast accuracy to be higher when demand is aggregated by location and product. The forecast was found to be highly correlated with historical demand patterns, length of product life cycles, holiday periods, promotion types, and advertisement layouts. However, Koottatep (2006) couldn’t establish a deterministic mathematical relationship between forecast accuracy and historical demand, length of product life cycles, holiday periods, promotion types, and advertisement layouts, because it is a stochastic process.

2.7 Conclusion

The key findings of the literature review reveal the current state of research related to retail promotions and evaluation. Wiehenbrauk (2010) has found that sharing of competition index information by manufacturer with retailers enhances the success of promotions. Kapur et al. (2007), Bell et al. (1998), Gruen et al. (2002) supported by concepts defined by Silver and Pyke et al. (1998) in Inventory Management, Production Planning, and Scheduling, determine that application of the single period multi-item newsvendor model with a budget constraint optimize the budget and order quantities for promotions. Wiehenbrauk (2010) and Kapur et al. (2007) validate that the involvement of a CPFR group in the promotions planning and execution process enhances the out of promotions. Finally Koottatep (2006) presented time-series based forecasting
models and showed that WMPE and WMAPE are suitable methods to measure forecast accuracy. However, Koottatep (2006) was unsuccessful in establishing a causal relationship between factors that were highly correlated with forecast and forecast accuracy. Additionally, measuring the profitability of promotions should include not only revenue, but also costs for investment and additional inventory. The big gap identified by the literature review is the lack of a structured methodology that considers a combination of supply chain metrics in light of one another rather than as standalone measures to evaluate the outcome of promotions. Researchers have covered areas focusing on demand forecasting methods, inventory and budget optimization models, collaborative techniques and the actual information that needs to be shared between manufacturers and retailers. However, there has been no research on specific metrics to measure the outcome of promotions beyond increase in sales and average inventory levels. As such, we address how to evaluate promotions.
3 Methodology

The methodology focuses on three primary dimensions to evaluate the success of a promotion: level of inventory by end of promotion; lost sales due to stock-outs, and forecast accuracy.

Promotions disturb the normal operations of stores and their supply chain. A promotion that performed better than expected may leave a store with insufficient inventory during the post promotion period. Conversely, a promotion that performed worse than expected leaves a store with excess inventory. Figure 1 captures how sales, price and inventory change for a SKU during a promotion. The graphic is a composite of 3 charts displaying data from all stores related to a distribution center for one SKU. The first, shows the total number of units sold on a given day. The second, shows the sum of the end-of-day inventory units. The third shows the average unit price. A promotion driven by a price reduction begins on Jul 27th and continues for the week until Aug 2nd. The figure shows the initial ramp-up of inventory before the promotion. The promotion create a spike in sales, with higher sales on the first (Sunday) and last (Saturday) days. Inventory depletes rapidly during the week as a result of increased sales. Replenishment during the week cause, the rises in inventory levels. In addition, the week after the promotion holds higher than average inventory for the SKU, because the promotion left the stores with excess inventory for the SKU. These observations lead to three dimensions for measuring promotions inventory by end of promotion; lost sales due to stock-outs, and forecast accuracy.
Figure 1. Displays a timeline of total inventory and sales, and price. On the x-axis is time for all the charts. On the y-axis of the first is the total number of units sold of the SKU on a given day across all stores in the supply chain. On the y-axis of the second is the sum of the end-of-day inventory units for the SKU across all stores. On the y-axis of the third is the average unit price for the SKU across all stores. The 3rd chart reveals that a price promotion began on Jul 26th and continues until Aug 2nd.

Measuring the inventory level at stores at the end of a promotions is important because it reveals the promotion performance during its period and its impact in the post-promotion period. However, the rate of sales is usually different for different SKUs and stores, this means that days of supply (DoS) is better metric than inventory level. Moreover, only observing DoS at the end of the promotion does not give proper indication whether the promotion ended with appropriate
inventory level. Therefore, a better metric is to measure the difference between DoS at the end of promotions and DoS of supply during non-promotion period.

The indicator for lost sales is the stock-out rate. This measure reveals how prepared a store was during a promotion. A low stock-out rate is usually preferred than a high one. However, a high stock-out rate is not necessarily detrimental because it may be caused by abnormally high sales.

The third dimension to evaluating the success of promotions is to measure the forecast error. The forecast for a promotion is assumed to be the target that the promotion aims to achieve. A positive difference between sales and forecast is preferred because sales exceeded the forecast during a promotion. A negative difference indicates that promotion sales did not achieve expectations.

The methodology for evaluating promotions rests on three pillars: inventory level at the end of a promotion measured by DoS at the end of promotion, lost sales measured by ‘Stock-out rate’, and the sales performance measured by the ‘forecast error’. This thesis aims to develop a framework for evaluating retail promotions that rests on these pillars.

3.1 Categories for metrics

The first step for creating a framework for evaluating promotions based on the three metrics is to identify categories for them. The categories of the metrics serve as dimensions for the framework. When using the framework the promotions will be evaluated based on their position within the categories of the metrics.
DoS Difference between end of promotion and average non-promotion period

DoS is categorized into three zones based on the difference between the end of promotion DoS and the average non-promotion DoS:

- SKU-Store-Promotions with high DoS difference
- SKU-Store-Promotions in an acceptable ‘Green Zone’
- SKU-Store-Promotions with low DoS difference

The distribution of SKU-Store-Promotions across the three zones was assessed. The ‘Green Zone’ implies that inventory levels by the end of promotions are within tolerable limits. High levels of inventory for a SKU with a high sales rate may be acceptable. However, high levels of inventory for a SKU with low sales rate implies excess inventory at stores. Thus, DoS is more suitable than inventory level for promotion evaluation. Figure 2 shows the distribution of SKU-Store Promotions by days of supply remaining by the end of promotions. On average at the end of promotions stores have between 2 and 3 weeks of inventory for the promotion participating SKUs.
Figure 2. Histogram of number of store-SKU-promotion records binned by DoS at the end of promotion. On the x-axis are displayed the lower boundaries of the bins and on the y-axis the number of records in each bin. The biggest portion of records has 3 weeks of DoS at the end of the promotion.

Although, DoS by the end of the promotion gives a normalized measure of SKU inventory levels in terms of sales, it does not provide information on whether inventory levels were high, acceptable or low. A comparison with average non-promotion DoS reveals the true nature of excess inventory by the end of promotions. Figure 3 shows the distribution of DoS Difference (the difference between DoS at the end of the promotion and the DoS during non-promotion periods) across the SKU-store-promotions for 7 day bins. Promotions appear to leave stores with lesser inventory than the average non-promotion inventory levels.
Figure 3. Distribution of DoS Diff across SKU-store-promotions binned by difference between DoS at the end of promotion and the DoS during non-promotion for a SKU-store. On the x-axis are displayed the lower boundaries of the bins and on the y-axis the number of records in each bin.

The DoS difference as a percentage of average non-promotion DoS is used as a metric to indicate excess, acceptable, or low inventories by the end of promotions. The plot of the DoS Diff % in bins of 20% reveals that on average, SKU-store-promotions fall into the ±20% band. This why this band is used to indicate the ‘Green Zone’ for DoS Diff % metric.
Figure 4. Distribution of DoS Diff % across the SKU-store-promotions binned by percentage difference between DoS at the end of promotion and the DoS during non-promotion for a SKU-store. On the x-axis are displayed the lower boundaries of the bins and on the y-axis the number of records in each bin. The ±20% boundary represents big number of records.

SO% (Stock-out rate)

Stock-out rate is categorized into 2 groups:

- SKU-Store-Promotions with high stock-out rate
- SKU-Store-Promotions with low stock-out rate

25
The distribution of stock-out rate for SKUs at stores during non-promotions is assessed and is estimated at 1.11%. Following from this, the SKU-Store-Promotions with stock-out rate greater than or equal to 1.11% are categorized as high and those below 1.11% are categorized as low.

**Forecast Error**

Forecast error metric is categorized into 3 zones:

- SKU-Store-Promotions with sales < forecast
- SKU-Store-Promotions with sales = forecast
- SKU-Store-Promotions with sales > forecast

This is a cornerstone metric and evaluates the actual sales with respect to the forecast. The forecast is used as indicator whether the sales met the goal for the promotion.

Figure 5 represents the framework for evaluating the performance of promotions. The framework is called Promotion Performance Cuboid with dimensions that represent the different categories of the three metrics. The cuboid is made up of 18 different cubes, each of which represents one of the categorized possibility of a metric. Each cube represents a certain combination of metric categories that reveals an insight for the performance of a promotion.
Figure 5. Promotion Performance Cuboid. The plot of possibilities that the three categorized metrics fall in three dimensional space forms the cuboid for evaluating promotion performance. Each individual element cube represents a category value for a metric. Together, multiple cubes reveal the true story of promotional performance.

The Promotion Performance Cuboid forms the cornerstone of the analysis conducted as part of this thesis.

3.2 Formulas for Calculating Metrics

This section details the metrics and the method by which they are computed across different levels of granularity. The analysis is conducted along three levels of granularity: SKU, Store, and Promotion. At the SKU level, the performance of SKUs during promotions are evaluated across stores. At the store level, the performance of stores is evaluated across promoted SKUs. At the promotion level, the performance of promotions is evaluated across SKUs and Stores. Each of the
metrics uses different formulas for calculation depending on the level of aggregation. Definition of variables used for the calculation of the metrics is represented in Table 2.

*Table 2. Description of parameters used to define formulas in methodology.*

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>Index for a store</td>
</tr>
<tr>
<td>S</td>
<td>Total number of stores in a subset</td>
</tr>
<tr>
<td>p</td>
<td>Index for a promotion event</td>
</tr>
<tr>
<td>P</td>
<td>Total number of promotion events in a subset</td>
</tr>
<tr>
<td>k</td>
<td>Index for a SKU</td>
</tr>
<tr>
<td>K</td>
<td>Total number of SKUs in a subset</td>
</tr>
<tr>
<td>pr</td>
<td>Promotion identifier of a value</td>
</tr>
<tr>
<td>npr</td>
<td>Non-promotion identifier of a value</td>
</tr>
<tr>
<td>A</td>
<td>Actual sales for a store-SKU-promotion</td>
</tr>
<tr>
<td>F</td>
<td>Forecast for a store-SKU-promotion</td>
</tr>
<tr>
<td>DoS</td>
<td>Days of supply for a store-SKU-promotion</td>
</tr>
<tr>
<td>SO</td>
<td>Stock-out count for a store-SKU-promotion</td>
</tr>
</tbody>
</table>

**Aggregate Days of Supply Difference Percentage (DoS Diff %)**

The objective of this metric is to analyze the inventory level at the end of a promotion. It compares days of supply (DoS) at the end of promotion to the average non-promotion days of supply. The Aggregate DoS Difference Percentage is a metric that is applied at the SKU, the Store and promotion levels separately.

**SKU Level:** The metric, described in Equation 1, captures the aggregate percentage difference between the end of promotion and non-promotion DoS for a SKU at the store-promotion level.

*Equation 1. SKU level DoS Difference as percentage of DoS during non promotions*

\[
\text{DoS Diff \%}_S = \left( \frac{\sum_{s=1}^{n} \sum_{p=1}^{m} (\text{DoS}_{pr} - \text{DoS}_{npr})}{\sum_{s=1}^{n} \sum_{p=1}^{m} \text{DoS}_{npr}} \right) \times 100
\]
**Store Level:** The metric, described in Equation 2, captures the aggregate percentage difference between the end of promotion and non-promotion DoS for a store at the promotion-SKU level.

**Equation 2. Store level DOS Difference as percentage of DoS during non promotions**

\[
\text{DoS Diff } \%_K = \left( \frac{\sum_{k=1}^{r} \sum_{p=1}^{m} (\text{DoS}_{pr} - \text{DoS}_{npr})}{\sum_{k=1}^{r} \sum_{p=1}^{m} \text{DoS}_{npr}} \right) \times 100
\]

**Promotion Level:** The metric described in Equation 3, captures the aggregate percentage difference between the end of promotion DoS and the average non-promotion DoS at the store-SKU level.

**Equation 3. Promotion level DoS Difference as percentage of non-promotion DoS**

\[
\text{DoS Diff } \%_p = \left( \frac{\sum_{s=1}^{n} \sum_{k=1}^{r} (\text{DoS}_{pr} - \text{DoS}_{npr})}{\sum_{s=1}^{n} \sum_{p=1}^{m} \text{DoS}_{npr}} \right) \times 100
\]

**Normalized Stock-out Rate**

The objective of this metric is to indicate the magnitude of lost sales by measuring the number of stock-outs occasions and normalizing along the lines of SKU, store, and promotion as necessary. This normalization is necessary because a larger store may have more stock-outs than a smaller store. At the same time, a SKU that is part of multiple promotions may have more stock-outs than another SKU part of only one promotion.

**SKU Level:** When stock-outs are analyzed at the SKU level, the SKU may be promoted across multiple promotions and multiple stores. Thus, the stock-out count needs to be normalized
across the number of stores and promotions. The formula for normalized stock-outs at the SKU level is in Equation 4.

**Equation 4. SKU level Stock-out percentage from total promotion days**

\[
SO\%_K = \left( \frac{\sum_{p=1}^{m} \sum_{r=1}^{n} SO}{7 \times P \times S} \right) \times 100
\]

Store Level: When stock-outs are analyzed at a store level, there are multiple promotions run at the store and each promotion consists of multiple SKUs. Thus, the stock-out count needs to be normalized across the number of promotions and SKUs. The formula for normalized stock-outs at the Store level is in Equation 5.

**Equation 5. Store level Stock-out percentage from total promotion days**

\[
SO\%_S = \left( \frac{\sum_{p=1}^{m} \sum_{k=1}^{r} SO}{7 \times P \times K} \right) \times 100
\]

Promotion Level: When stock-outs are analyzed at a promotion level, each promotion consists of multiple SKUs and the promotion is run across multiple stores. Thus, the stock-out count needs to be normalized by the number of SKUs as well as the number of promotions. The formula for normalized stock-outs at the promotion level is in Equation 6.

**Equation 6. Promotion level Stock-out percentage from total promotion days**

\[
SO\%_P = \left( \frac{\sum_{p=1}^{m} \sum_{k=1}^{r} SO}{7 \times S \times K} \right) \times 100
\]
Forecast Error

This metric may be applied at the SKU, store, and promotion levels. The metric assesses whether the sales met the forecasted target. The underlying assumption here is that the forecast is the goal of the promotion.

**SKU Level:** This metric in Equation 7 at the SKU level compares the aggregate sales across stores and promotions to the expected forecast for a promoted SKU.

*Equation 7. SKU level Forecast Error as a percentage of forecast*

\[
\text{Sales Accuracy}_K = \left( \frac{\sum_{i=1}^n \sum_{p=1}^m (A - F)}{\sum_{i=1}^n \sum_{p=1}^m F} \right) \times 100
\]

A negative value for this metric implies that actual sales was less than the expected forecast. A positive value for this metric implies that actual sales exceeded expected forecast.

**Store Level:** The metric in Equation 8 at the store level compares the aggregate sales across SKUs and Promotions run to the expected forecast for a store.

*Equation 8. Store level Forecast Error as a percentage of forecast*

\[
\text{Sales Accuracy}_S = \left( \frac{\sum_{k=1}^r \sum_{p=1}^m (A - F)}{\sum_{k=1}^r \sum_{p=1}^m F} \right) \times 100
\]

**Promotion Level:** The metric in Equation 9 at the promotion level compares the aggregate sales across SKUs and stores to the expected forecast for a promotion.

*Equation 9. Promotion level Forecast Error as a percentage of forecast*

\[
\text{Sales Accuracy}_P = \left( \frac{\sum_{i=1}^n \sum_{k=1}^r (A - F)}{\sum_{i=1}^n \sum_{k=1}^r F} \right) \times 100
\]
3.3 SKU Analysis

SKUs with high DoS Diff%

The first step in the analysis is identifying the SKUs with high aggregate DoS by the end of the promotion as compared to average non-promotion DoS for the same SKUs. The method to obtain the list of SKUs is by applying the ‘Aggregate Days of Supply Difference Percentage’ metric on the data set. Then, the SKUs are segregated into 3 categories. The first category of SKUs are those with the metric value greater than 20%. These SKUs represent those with high DoS by the end of promotions. The second category of SKUs are those with that fall between -20% to +20%. These SKUs represent those with tolerable DoS by the end of promotions. This is the green zone and implies that the inventory levels by the end of the promotion are within acceptable limits. The third category of SKUs are those with the metric value lesser than -20%. These SKUs represent those with low DoS by the end of promotions.

SO% analysis for SKUs with High DoS Diff %

This step goes one level deeper and follows the DoS analysis in the previous step and entails computing the stock-outs by day-of-week for the SKUs identified of having high DoS by the end of the promotion. The method involves applying the Normalized Stock-out Rate metric at the SKU level that gives the average stock-out rate of each SKU across stores and promotions. The result is sorted by the stock-out rate and reveals the SKUs with the high stock-outs and those with the low stock-outs.
Forecast Error for SKUs with High DoS Diff %

This step also goes one level deeper and follows the DoS analysis and entails identifying how the SKUs performed in terms of sales with respect to the target forecast. The forecast is assumed to be the goal of the promotion.

Connect the metrics

The SKUs with high DoS are analyzed through the lens of the Stock-out rate and the actual sales are compared to target forecasts. Each SKU with high DoS is evaluated using different metrics and each metric reveals different insights into the cause for the high DoS by the end of the promotion(s). In this step, the three metrics are tied together to reveal the underlying implications and explain what may be going on with the stores.
3.4 Store Analysis

Stores with high DoS Diff%:

The first step in the analysis is identifying the stores with high aggregate DoS by the end of promotions with the average non-promotion DoS, for the SKUs participating in the promotion(s). The first step in the method to obtain the list of stores is by applying the ‘Aggregate Days of Supply Difference Percentage’ metric on the data set at the store level. Then the Stores are segregated into the 3 categories. The first category of Store are those with the ‘Aggregate Days of Supply Difference Percentage’ metric value greater than 20%. These stores represent the ones with high aggregate DoS across the participating SKUs, by the end of promotions. The second category of stores are those with the metric value between -20% to +20%, in the green zone. These stores represent those with tolerable DoS by the end of promotions and implies that the aggregate inventory levels by the end of a promotion for the participating SKUs are within reasonable limits. The third category of stores are those for which the value of the metric is less than -20%. These stores represent the ones with low DoS, across the participating SKUs, by the end of promotions. The ±20% bandwidth is selected and calculated in the same way as for the SKUs.

SO% analysis for Stores with High DoS Diff %:

This step is the next level of analysis and entails computing the stock-outs by day-of-week for the stores identified to have high DoS by the end of the promotion. The method involves applying the Normalized Stock-out Rate metric at the store level that gives the average stock-out rate of each store across SKUs and promotions. The result is sorted by the stock-out rate and reveals the stores with high stock-outs and those with the low stock-outs, across the participating SKUs in the promotions.
Forecast Error for Stores with High DoS Diff %

This step involves identifying how the stores performed in terms of sales with respect to the target forecast. The forecast is assumed to be the goal of the promotion.

Connect the metrics

The stores with high DoS are analyzed through the lens of the stock-out rate and the accuracy of sales as compared to the target forecast. Each store with high DoS is evaluated using different metrics and each metric reveals different insights into the cause for the high DoS by the end of the promotion(s). In this step, the three metrics are tied together to reveal the underlying implications and explain what may be going on with the stores.
3.5 Promotion Analysis

Promotions with high DoS Diff%

The first step in the analysis is identifying the promotions that end with high aggregate DoS as compared to average non-promotion DoS, for the participating SKUs. The first step in the method is to obtain the list of promotions by applying the ‘Aggregate Days of Supply Difference Percentage’ metric on the data set at the promotion level. Promotions are segregated into 3 categories. The first category of promotions are those with the ‘Aggregate Days of Supply Difference Percentage’ metric value greater than 20%. These promotions represent the ones with high aggregate DoS across the participating SKUs, by the end of the promotion. The second category of promotions are those with the metric value between -20% to +20%. These promotions represent those that end with tolerable DoS. This is the ‘Green Zone’ and implies that the aggregate ending inventory levels for the promotions, across the participating SKUs, are within tolerable limits. The third category of promotions are those with the metric value lesser than -20%. These promotions represent those that end with low DoS across the participating SKUs. The ±20% bandwidth is selected and calculated in the same way as for the SKUs.

SO% analysis for Promotions with High DoS Diff %

This step entails computing the stock-outs by day-of-week for the promotions that end with high DoS. The method involves applying the Normalized Stock-out Rate metric at the promotion level that gives the average stock-out rate of each promotion across SKUs and stores. The result is sorted by the stock-out rate and reveals the promotions with the high stock-outs and those with the low stock-outs, across the participating SKUs of the promotions.
Forecast Error for Promotions with High DoS Diff %

This step involves identifying how promotions performed in terms of actual sales with respect to the target forecast. The forecast is assumed to be the goal of the promotion.

Connect the metrics

Promotions with high DoS by the end are analyzed through the lens of the stock-out rate and the sales actuals compared to the target forecast. Each promotion with high DoS is evaluated using different metrics and each metric reveals different insights into the cause for the high ending DoS. In this step, the three metrics are tied together to reveal the underlying implications and explain what may be going on with the promotions.

3.6 Conclusion

The proposed methodology for evaluating promotions is a powerful way to evaluate promotions because it applies a specific set of metrics at different levels of aggregations (SKU, Store, and Promotion). The categorization of the metrics places promotions into 18 possible different buckets. Moreover, the combined analysis of the metrics reveals a correlated story that has different insights than what the individual metrics may reveal. Analyzing promotions from the perspective of days of supply, stock-out rate, and sales accuracy relative to forecast implies conclusions on SKU sales, replenishments, and replenishment quantities between BoxCo’s distribution centers and stores. These aspects may further be evaluated at the field level of the store to improve performance of promotions.
4 Case Study Analysis and Results

This case study is based on ProdCo and BoxCo’s supply chain for product category ‘P’ in the United States. Product category ‘P’ consists of 418 SKUs of which 32% are promoted. ProdCo sells P through a network of retailers, one of which is BoxCo. ProdCo has 3 production facilities that manufacture SKUs of category ‘P’. BoxCo has 26 distribution centers serving 1820 stores. Product from ProdCo’s plants are shipped to BoxCo’s distribution centers, from where BoxCo’s stores are replenished periodically. Annually, 16.5 million units of category P are sold through BoxCo’s stores resulting in net revenues of $325 million. ProdCo and BoxCo collaborate to conduct 44 promotion events annually for category P. Each promotion event on average consists of 22 SKUs. SKUs may be part of multiple promotion events and on average, 35 percent of P’s sales across BoxCo stores come from promotions.

The dataset analyzed spans the point-of-sale data for product category P across BoxCo’s 1820 retail stores over the period September 1\textsuperscript{st}, 2013 to August 31\textsuperscript{st}, 2014. There are 937 SKU-promotions during this period and the level of granularity of the data is SKU-Store-Promotion which means there is one record for each SKU participating in a promotion at a store. For analysis purposes, the promotions in the dataset were categorized by the discount class associated with promotions. The most popular promotion category was the $10 gift card promotion ($10GC) and also accounted for the most amount of data. The Promotion Performance Cuboid framework is applied at 3 levels of analysis, SKU, Store, and Promotion.

The forecast model was developed by the team here at MIT. The dataset was divided into training and validation sets and the training set was used to develop the sales forecast and the validation set to validate the model.
4.1 Categorizing Dataset in the Promotion Performance Cuboid

Percentage Records of Dataset Categorized

The dataset consists of 1,573,937 rows of data representing SKU-Store-Promotions. The tree-map in Figure 6 summarizes the dataset against the various categories of metrics.

Each region in the tree-map represents a unique combination of the categorized metrics, DoS Diff % (High, Low, Green Zone), SO% (High, Low), and Forecast Error (Positive, Equals, Negative). The same regions are visualized using the Promotion Performance Cuboid in Figures 7 and 8. Each region from Figure 6 corresponds to a cube in Figures 7 or 8.
Figure 7. Cubes representing the low stock-out instances of SKU-store-promotions in the Promotion Performance Cuboid. The numbers in the cubes represents the percentage of the dataset that accounted for the combination of the metrics.
Each cube represents a unique combination of DoS Difference, Stock-outs, and Forecast Error describing the underlying performance and outcome of a promotion. Thus, each cube reveals a story behind how the promotion performed and what actually may have caused the promotions to perform in the way they did. The table in the appendix gives a comprehensive description of insights for the different cubes from Figures 7 and 8.

Figure 8. Cubes representing the high stock-out instances of SKU-store-promotions in the Promotion Performance Cuboid. The numbers in the cubes represents the percentage of the dataset that accounts for the combination of the metrics.
Four of the cubes represent the highest occurring scenarios in the data and these were analyzed further to study the underlying characteristics. The cubes are labeled A, B, C, and D for discussion purposes and are represented in Figure 9.

![Figure 9](image)

**Figure 9.** Cubes representing the highest occurring scenarios in the dataset. The 4 cubes are labeled A, B, C, and D for discussion purposes.

The implications behind the four cubes are discussed below. It is assumed that BoxCo’s distribution centers replenish stores on demand, when there is a pull for product from the stores.
**Cube A represents low DoS, low stock-outs, and sales < forecast**

The SKU-store-promotions in cube A don’t appear to be selling up to expectations because sales do not match forecast and stock-outs occurrences across stores are low. The low days of supply by the end of the promotion combined with the below par sales and low stock-outs reveal that stores may have been holding low levels of inventory. Replenishments to stores, if any, appear to be on time because there were low stock-outs. However, since sales were below forecast, there may be a lot of leftover inventory in the DC. Based on this information, the areas to focus on maybe related to understanding why the SKU is selling poorly and to additionally decide whether it is even suitable for promotions.

**Cube B represents low DoS, low stock-outs, and sales > forecast**

The store-SKU-promotions in cube B appear to be selling above expectations. The low stock-outs and the low days of supply by the end of the promotion imply that the store held appropriate amounts of inventory and that replenishments were on time. It appears that the DC may be holding high amounts of inventory since stores were able to be replenished despite sales exceeding forecast levels. Sales exceeding forecast may result in stock-outs during the post promotion week. Thus, inventory levels during the post-promotion week would need to be monitored.

**Cube C represents DoS in the Green Zone, low stock-outs, and sales < forecast**

The store-SKU-promotions in cube C appear to be selling below forecast. The DoS Diff % in the Green Zone indicates that just the right amount of inventory was remaining by the end of the promotion. Stock-outs during the promotion were low. Since the SKU did not sell well and stock-outs were low, it implies that replenishments may have been timely and stores held a low amount of inventory. This further indicates that a lot of inventory still stocked up at the distribution
centers. Based on this information, the areas to focus on maybe related to understanding why the SKU is selling poorly and to additionally decide whether it is even suitable for promotions.

**Cube D represents high DoS, low stock-outs, and sales < forecast**

The store-SKU-promotions that fall in cube D appear to be selling below expectations because the sales is below forecast. The low stock-outs and the high days of supply by the end of promotion indicate that replenishments may have been on time from retailer’s DC to stores, however, the replenishment quantities may have been large. Areas to focus on would be the replenishment quantities and why the SKU sales are below par. Alternatively, it could be that the forecast for the SKU was simply off and so this is also worth checking.

**Days of Supply (DoS) Difference Categories**

The DoS Diff % metric gives the difference between end-of-promotion and average non-promotion DoS. SKU-store-promotions may be classified into one of the three categories depending on the value the metric takes:

- SKU-Store-Promotions with high DoS Diff %
- SKU-Store-Promotions in an acceptable ‘Green Zone’
- SKU-Store-Promotions with low DoS Diff %

The pie chart in Figure 10 displays the distribution of the SKU-store-promotion combinations across the three DoS Diff % categories. The scope of this thesis are the SKU-store-promotions in the ‘Green Zone’ and in the ‘Above Green Zone’ (high DoS Diff %). The below green zone indicates those SKU-store-promotions in the dataset that sold well and ended promotions with a DoS below the average non-promotion DoS. However, stores may experience a higher stock-out rate during promotions for these SKUs.
As is evident from the above chart, majority of the SKU-Store-Promotions, 45.12%, fall in the ‘Below Green Zone’ (low DoS Diff %). There are another 28.06% of SKU-Store-Promotion combinations that fall in the acceptable ‘Green Zone’. This category represents the SKUs part of promotions run at stores that ended the promotion at around the same level as the average non-promotion inventory. In other words, this category of SKU-Store-Promotions may have sold as expected to forecast.

The SKU-Store-Promotion that fall in the ‘Above Green Zone’ (high DoS Diff %) account for 26.82%. This category represents the SKUs part of promotions run at stores that ended the promotion at a higher level than the average non-promotion inventory. In other words, this category of SKU-Store-Promotions has sales at expected forecast levels.
Categorizing Stock-out rates

Stock-outs reveal how often a SKU's inventory level reaches 0 at a store during a promotion. For the purpose of this analysis, they are categorized into 2 groups of high and low. A high stock-out rate is when the metric returns a percentage greater than the average non-promotion stock-out rate of 1.11%. A low stock-out rate is when the metric returns a percentage value lesser or equal to 1.11%. The distribution of stock-out rate for this dataset is assessed by measuring the percentage of SKU-store-promotions that had a stock-out rate greater than 1.11% over the total available promotion days across all stores and SKUs. This metric is referred to as SO%.

Table 3 shows that 6.44% of SKU-Store-Promotions fall into the high SO% category and 93.56% fall into the low SO% category. It is important to note that lost revenues from the 6.44% high stock-out SKU-store-promotion instances account for 23% of total promotional revenues.

Table 3. Spread of high and low SO% across the records of aggregated dataset.

<table>
<thead>
<tr>
<th>% Above Average Non Promotion SO</th>
<th>6.44</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Below Average Non Promotion SO</td>
<td>93.56</td>
</tr>
</tbody>
</table>

The histogram in Figure 11 shows the frequency distribution of SKU-Store-Promotion stock-outs in the dataset. Notice that the SKU-store-promotions that don’t stock-out, with SO% = 0 are excluded from the analysis because they are not problematic in terms of stock-outs. It appears that few SKU-store-promotions have high stock-out rates, but that also means that there may be a few SKUs or few store or few promotions that stock-out unusually high.
Figure 11. Frequency distribution of stock-outs for SKU-Store-Promotions. On the x-axis are plotted bins representing the number of stock-outs of a SKU at a store, during a promotion (the bin with 0 stock-outs is excluded). On the y-axis is the number of records that falls into each bin. While the majority of the SKUs stock-out only once at a store during a promotion, it may be noted that there are several instances when a SKU stocks-out at a store on multiple days of the promotion.

Forecast Error

The forecast that is referenced here is one developed and tested at MIT based on the dataset consisting of one year’s worth of point of sale data across 1820 BoxCo stores. It is assumed that the forecast is correct and the actual sales achieved per SKU-Store-Promotion is compared with the calculated forecast to assess how precise the promotion turned out to be. This metric is
technically the same calculation as the forecast error but it is important to note that we are assessing the accuracy of actual sales against the forecast.

The computation of sales accuracy to forecast can result in SKU-Store-Promotions falling into the previously classified three categories. When sales exceeds forecast, forecast error is positive, indicating that the SKU-Store-promotions sold above expectations. When sales falls short of forecast, forecast error is negative, indicating that the SKU-Store-Promotion sold below expectations. Then there is the category of SKU-Store-Promotions where sales is accurate against the forecast.

The chart in Figure 12 shows the distribution of the SKU-Store-Promotions across the three categories. 32.47% of the SKU-Store-Promotions sold beyond expectations while 46.34% sold below and 21.19% matched the forecast. This is a cornerstone metric that may be used to judge a promotion but we need to view this metric in light of the others to know what really happened behind the scenes, which is really the objective of this thesis.

Figure 12. Pie-chart showing the distribution of SKU-Store-Promotions across the three categories for Sales Accuracy: sales exceeding expectations, sales below expectations, and sales matching forecast. The forecast sales are according to sales over a 1 year period across 1820 stores. The forecast model is developed at MIT.
4.2 SKU Analysis

The goal of this section is to apply the performance evaluation framework towards SKUs in the dataset. After the analysis the underperforming SKUs will be identified and possible reasons for their failure will be identified.

SKUs with high DoS Diff %

The objective of this step is to identify the SKUs with a high DoS Diff % at the end of the promotions in the $10GC category. Figure 13 shows that three SKUs have DoS Diff % higher than 20%. This means that across all stores and promotions, the three SKUs had the highest inventory levels. In order to find possible reasons for the high DoS Diff %, analysis in light of the other two metrics in the framework is necessary. In the next step the SO% for these three SKUs will be analyzed.
Figure 13. Displayed is the list of SKUs with positive DoS. On the x-axis is plotted the SKUs and on the Y-axis, the average DoS Diff % aggregated across stores and promotions. Only the first three SKUs (82438, 86225, and 86223) fall in the High category because they are above the 20% DoS Diff % threshold.

SO% for SKUs with High DoS Diff %

Table 4 shows the stock-out percentages (SO %) of SKUs with positive DOS Diff %. All the SKUs have an SO % that is below the average non-promotion stock-out rate of 1.11%. The low SO % numbers for the high DoS Diff % SKUs reveal that on average across all stores and promotions, the three SKUs had low stock-outs. However, it is possible that certain stores and promotions had high SO%. The next level of analysis is to identify which stores and promotions cause the stock-outs of these SKUs.
Table 4. Stock-out % by day-of-week for SKUs with positive DoS Diff %. The numbers in the table represent SO % for the SKU in the row for each day-of-week aggregated across stores and promotions. The red color indicates the SKUs with higher SO %

<table>
<thead>
<tr>
<th>SKU</th>
<th>Day of Week</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>82438</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>26590</td>
<td>0.02</td>
<td>0.06</td>
</tr>
<tr>
<td>86225</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>86223</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>86224</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>85941</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>86268</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>86222</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td>86226</td>
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<tr>
<td>86616</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>86618</td>
<td>0.10</td>
<td>0.08</td>
</tr>
<tr>
<td>86617</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>86271</td>
<td>0.07</td>
<td>0.09</td>
</tr>
<tr>
<td>86362</td>
<td>0.18</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Figure 14 displays all the stores that had high SO% for SKUs 82438, 86225, and 86223. The figure shows that only seven stores out of 1820 had very high SO%. This means that across all promotions for the selected SKUs these stores had very high stock-outs. The stock-outs may be a reason for the high DoS Diff%. These stores may not have been replenished on-time and therefore, may have been left with excess inventory. The next step in analysis is to identify promotions with high SO% for the selected three SKUs with high DoS Diff%.
Figure 14. Stores with high SO % (above 1.11%) for selected SKUs with high DoS Diff %. On the x-axis are the stores and on the y-axis is plotted the SO % for the stores aggregated across promotions and selected SKUs with high DoS Diff %. This bar chart shows that very few stores caused the high SO % for the selected SKUs.

Figure 15 represents the promotions that had SO% higher than 0 for the three selected SKUs. There appear to be no promotions with a high SO%. There might be two reasons that caused the relatively low SO%. First, the metric is aggregated for the three SKUs across all stores and the good performance of some stores overlays the bad performance of other. Second, the sales of the displayed promotions may have been relatively low and this may have caused the stock-outs to be
low. The performance of the sales can be measured by the third metric in the framework. The metric compares sales to forecast and measures the error.

![Bar chart showing SO by Promotion for High DoS SKUs](image)

**Figure 15.** Promotions with high SO % for the selected SKUs with high DoS Diff %. On the x-axis is the list of promotions and on the y-axis is the plot of SO % for the promotions aggregated across stores and selected SKUs with high DoS Diff %. This bar chart shows that 6 out of the 18 GC10 promotions accounted for higher than usual SO%. The low levels of SO% indicate that all promotions accounted for a lesser than average SO% (1.11%).

**Forecast Error analysis for SKUs with high DoS Diff%**

The next step of the analysis is to compare the SKUs aggregate sales achieved across all stores and promotions to the forecast. The Forecast Error is measured only for records in the training dataset. In the promotion performance evaluation framework the relation between the SO% and Forecast Error is essential for identifying reasons for the high DoS Diff % at the end of
promotions. Therefore, Table 5 displays the recalculated SO% for the SKUs with positive DoS Diff%. Table 6 displays the Forecast Error metric for the same period.

Table 5. Stock-out % by day of week for SKUs with positive DoS Difference % that are part of the testing dataset. The numbers in the table represent % SO for the SKU in the row for each day of week aggregated across stores and promotions. The red colored cells show the SKUs with higher SO%.

<table>
<thead>
<tr>
<th>SKU</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>85941</td>
<td>0.03</td>
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<td>0.02</td>
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<td>0.02</td>
<td>0.02</td>
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<td>0.04</td>
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<td>0.20</td>
<td>0.05</td>
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<tr>
<td>86225</td>
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<td>0.05</td>
<td>0.05</td>
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<td>0.17</td>
<td>0.06</td>
</tr>
<tr>
<td>86224</td>
<td>0.01</td>
<td>0.03</td>
<td>0.02</td>
<td>0.03</td>
<td>0.05</td>
<td>0.08</td>
<td>0.27</td>
<td>0.07</td>
</tr>
<tr>
<td>86222</td>
<td>0.05</td>
<td>0.06</td>
<td>0.03</td>
<td>0.07</td>
<td>0.09</td>
<td>0.19</td>
<td>0.47</td>
<td>0.14</td>
</tr>
<tr>
<td>86616</td>
<td>0.09</td>
<td>0.07</td>
<td>0.04</td>
<td>0.08</td>
<td>0.08</td>
<td>0.14</td>
<td>0.46</td>
<td>0.14</td>
</tr>
<tr>
<td>86268</td>
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<td>0.03</td>
<td>0.05</td>
<td>0.06</td>
<td>0.09</td>
<td>0.19</td>
<td>0.59</td>
<td>0.15</td>
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<tr>
<td>86617</td>
<td>0.08</td>
<td>0.08</td>
<td>0.04</td>
<td>0.08</td>
<td>0.11</td>
<td>0.20</td>
<td>0.51</td>
<td>0.16</td>
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<td>86618</td>
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<td>0.10</td>
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<td>0.11</td>
<td>0.26</td>
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<tr>
<td>86226</td>
<td>0.09</td>
<td>0.09</td>
<td>0.06</td>
<td>0.11</td>
<td>0.17</td>
<td>0.29</td>
<td>0.72</td>
<td>0.22</td>
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<tr>
<td>86271</td>
<td>0.12</td>
<td>0.17</td>
<td>0.14</td>
<td>0.20</td>
<td>0.26</td>
<td>0.44</td>
<td>0.84</td>
<td>0.31</td>
</tr>
<tr>
<td>86362</td>
<td>0.44</td>
<td>0.40</td>
<td>0.52</td>
<td>0.54</td>
<td>0.63</td>
<td>0.87</td>
<td>2.09</td>
<td>0.78</td>
</tr>
<tr>
<td>Grand Total</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>0.11</td>
<td>0.14</td>
<td>0.23</td>
<td>0.59</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Table 5 and 6 reveal that out of the three SKUs with high DoS Diff% only two are part of the validation dataset. Both of the SKUs (86225, and 86223) have low SO% and a low negative forecast error. The results of the metrics imply that the high DoS Diff% might have been caused by the low sales of the two items, although the stores had sufficient inventory on hand and were replenished on-time.
Table 6. Forecast Error % for SKUs with positive DoS Difference %. The lower values of the error are highlighted in green and the higher in red. The two SKUs with high DoS have negative error but is it smaller for one of them.

<table>
<thead>
<tr>
<th>SKU</th>
<th>Error %</th>
</tr>
</thead>
<tbody>
<tr>
<td>86271</td>
<td>-13.3</td>
</tr>
<tr>
<td>86224</td>
<td>-30.4</td>
</tr>
<tr>
<td>86362</td>
<td>-39.8</td>
</tr>
<tr>
<td>86225</td>
<td>-48.8</td>
</tr>
<tr>
<td>86223</td>
<td>-53.1</td>
</tr>
<tr>
<td>86268</td>
<td>-53.7</td>
</tr>
<tr>
<td>86226</td>
<td>-109.2</td>
</tr>
<tr>
<td>86618</td>
<td>-141.2</td>
</tr>
<tr>
<td>86617</td>
<td>-165.2</td>
</tr>
<tr>
<td>86222</td>
<td>-168.2</td>
</tr>
<tr>
<td>85941</td>
<td>-223.8</td>
</tr>
<tr>
<td>86616</td>
<td>-461.4</td>
</tr>
</tbody>
</table>

The analysis at the SKU level is a useful tool in identifying underperforming SKUs across all stores and promotions and identifying ways to improve the performance. Further analysis of SO% at store and promotion levels helps identify specific elements of the supply chain that might be tweaked to improve future performance of the SKUs.
4.3 Store Analysis

The store analysis is analogous to SKU analysis and analyzes promotions from the perspective of how promotions performed at stores. The three metrics of the Promotion Performance Cuboid are aggregated at a store level. The metrics reveal insights into why stores perform the way they do.

Stores with high DoS Diff %

The DoS Diff % metric was applied to the dataset representing the $1OGC SKU-promotions. Figure 16 identifies the stores with a high DoS Diff % values, exceeding the 20% threshold. The next step in the analysis is to see how these stores with excess inventory by the end of the $1OGC promotions performed on the stock-out and Forecast Error metrics.
Figure 16. Stores with DoS Diff % > 20% across GC10 category promotions. On the x-axis is the stores and on the y-axis is the Aggregate DoS Diff % across SKUs and promotions. Only 4 out of 1820 stores have DoS diff % greater than 20%.

SO% for Stores with High DoS Diff %

Table 7 shows the SO% results for the four stores with high DoS Diff%. Only one of the stores (1194) exceeds the threshold stock-out rate of 1.11% by the end of the week, implying a high stock-out rate. Store 1128 stocked-out consistently, but at lower levels, starting from day 3 of the week. The two other stores barely stock-out.
Table 7. Stock-out % by day-of-week for stores with DoS Diff % > 20% that are part of the testing dataset. The numbers in the table represent the SO % for the Store aggregated cross SKUs and promotions, out of the total SKU-store-promotion days available. The cells in red color shows stores with higher SO% and those in darker shade of green show the stores with lower SO%.

<table>
<thead>
<tr>
<th>Store</th>
<th>Day of Week</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>1128</td>
<td>0.10</td>
<td>0.00</td>
<td>0.10</td>
<td>0.29</td>
<td>0.38</td>
<td>0.48</td>
<td>0.76</td>
</tr>
<tr>
<td>1194</td>
<td>0.10</td>
<td>0.21</td>
<td>0.19</td>
<td>0.29</td>
<td>0.29</td>
<td>0.67</td>
<td>1.14</td>
</tr>
<tr>
<td>1448</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.19</td>
<td>0.29</td>
<td>0.48</td>
<td>0.57</td>
</tr>
<tr>
<td>1940</td>
<td>0.10</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.19</td>
<td>0.29</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Figure 17 displays the SKUs that stock-out at a high rate at the four stores previously identified. There are only 6 SKUs that stock-out higher than the average of 1.11% (non-promotion average).
Figure 17. SKUs with high SO% for select stores with high DoS Diff%. On the x-axis is a list of SKUs and on the y-axis is the DoS Diff % for the SKUs aggregated across promotions and select stores with high SO%. This bar chart shows that very few SKUs cause the high SO for the select stores.

Promotions that experience high stock-out rate at the four stores previously identified are displayed in Figure 18. There are only four promotions out of eighteen in the $10GC category that experience a high stock-out rate. Promotion 24 experienced high stock-out rates.
Figure 18. Promotions with high SO % for select stores with high DoS Diff %. On the x-axis is the list of promotions id’s and on the y-axis is the SO % for the promotions aggregated across SKUs and select stores with high DoS Diff %. The chart shows that one promotion had a very high stock-out rate of 8% across the 4 stores. Overall, 4 promotions out of 18 GC10 promotions had high stock-outs at the 4 stores.

Forecast Error analysis for Stores with high DoS Diff %

The cornerstone Forecast Error metric reveals how the SKU-promotions performed at the stores. The aggregate % difference in sales and forecast for the positive DoS Diff % stores is calculated. Table 8 shows the forecast error for stores across all participating SKUs participating in the $10GC promotions. All the four stores record deviations around the -20% mark between actual sales and forecast.
Table 8. Sales vs. Forecast % difference for the stores with high DoS Diff %. The lower values of the error are highlighted in green and the higher in red. All the four stores have a deviation between actual sales and forecast of around -20%.

<table>
<thead>
<tr>
<th>store</th>
<th>% difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1448</td>
<td>-17.225</td>
</tr>
<tr>
<td>1940</td>
<td>-19.295</td>
</tr>
<tr>
<td>1128</td>
<td>-19.905</td>
</tr>
<tr>
<td>1194</td>
<td>-20.972</td>
</tr>
</tbody>
</table>

The metrics reveal two scenarios for stores with high DoS Diff %. The first scenario is when the stores have high SO % and sales is below forecast. This scenario indicates that there may be a problem with a delay in the last replenishment from the retailer DC to the store. The delay may have caused high stock-outs that resulted in stores missing the forecast. Due to a delay in the last replenishment, there was not sufficient time during the promotion to sell all the inventory.

The second scenario is when stores have low SO % and sales are below forecast levels. This scenario indicates that the promoted SKUs didn’t sell too well. While replenishments are timely and stock the stores, sales are below expected levels resulting in excess inventory by the end of the promotion. The stock-out rate is less because sales did not consume the available inventory at the store.
4.4 Promotion Analysis

Promotions with high DoS Diff %

The objective of this phase is to identify promotions that end with high days of supply. Figure 19 shows the promotions with positive aggregate DOS Diff %. On the horizontal axis are listed promotion id’s and on the vertical axis are plotted the actual aggregate DoS Diff % values. Only two promotions (9 and 41) have high DoS Diff % greater than 20%. The dataset consists of the $10GC promotions.

Figure 19. Promotions with positive DoS Diff %. On the x-axis is a list of promotions and on the y-axis is the average DoS diff % aggregated across SKUs and stores for the promotions. Only two promotions fall in the category of above the 20% threshold.
SO% for Promotions with High DoS Diff %

The next step is to evaluate stock-outs for promotions with high DoS Diff %. Table 9 shows the stock-out rate for the $10GC promotions with high DoS Diff %. Promotions 9 and 41 experienced very low stock-out rates. However, specific stores and SKUs may have had higher stock-out rates than others.

Table 9. Aggregated SO % for promotions with positive DoS Diff %. The numbers in the table represent SO % for the promotions aggregated by day-of-week, SKUs, and stores. The red color cells highlight promotions with higher than average SO %

<table>
<thead>
<tr>
<th>PromoEventID</th>
<th>0.23</th>
<th>0.23</th>
<th>0.28</th>
<th>0.30</th>
<th>0.30</th>
<th>0.37</th>
<th>0.39</th>
<th>0.46</th>
<th>0.47</th>
<th>0.49</th>
<th>0.75</th>
<th>0.78</th>
<th>1.31</th>
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<tr>
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<td></td>
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</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
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<td></td>
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<td>23</td>
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<td></td>
<td></td>
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</tbody>
</table>

Figure 20 shows the stores where promotions 9 and 41 had high stock-out rates. There are 28 stores out of 1820 that stock-out at a higher rate than usual. Store 0257 has the highest stock-out rate at 3.1% of total SKU-Promotion days.
Figure 20. Stores with high SO % for select promotions with high DoS Diff %. On the x-axis is the list of stores and on the y-axis is the SO % for the stores aggregated across SKUs and select promotions with high DoS Diff %. This bar chart shows that a lot of the stores cause the high SO % for the select promotions.

SKUs that have the greatest impact on SO% for promotions 9 and 41 are displayed in Figure 21. The top 4 SKUs (86283, 86371, 86373, and 86284) with the highest SO%, all belong
to promotion 9. Thus, the performance of promotion 9 seems to hinge on the four identified SKUs and further analysis on the performance of these SKUs may reveal more about promotion 9.

![Graph of SKU performance](image)

**Figure 21.** SKUs with high SO % for select promotions with high DoS Diff %. On the x-axis is the list of SKUs and on the y-axis is the SO % for the SKUs aggregated across stores and select promotions with high DoS Diff %.

**Forecast Error analysis for Promotions with high DoS Diff %**

The next step in the analysis is to compare aggregate sales to forecast, achieved across all SKUs participating in promotions 9 and 41, across the stores. Only promotion 41 is part of the
testing dataset and its forecast error is displayed in Table 10. Promotion 41, despite having high DoS Diff % and low SO%, ends up with sales matching the forecast.

*Table 10. Forecast error for promotions with high DoS Difference %. The lower values of the error are highlighted in green and the higher in red.*

<table>
<thead>
<tr>
<th>PromoEventID</th>
<th>Aggregated Forecast Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>0.7</td>
</tr>
<tr>
<td>29</td>
<td>0.0</td>
</tr>
<tr>
<td>41</td>
<td>0.0</td>
</tr>
<tr>
<td>39</td>
<td>-11.1</td>
</tr>
<tr>
<td>23</td>
<td>-17.6</td>
</tr>
<tr>
<td>25</td>
<td>-20.7</td>
</tr>
<tr>
<td>33</td>
<td>-34.8</td>
</tr>
<tr>
<td>27</td>
<td>-157.6</td>
</tr>
</tbody>
</table>

Promotions 41 is classified in the cube representing high DoS Diff %, low SO%, and sales meeting forecast. The high DoS by the end of promotion may be caused due to excess quantities replenished to the stores for the promoted SKUs. Stores may be carrying high levels of inventory for the promotion participating SKUs and thus, while stock-outs were low and sales met the forecast, the excess inventory were left behind by the end of promotion.
5 Conclusion

5.1 Promotion Performance Cuboid

The Promotion Performance Cuboid presents a framework for evaluating supply chain performance of promotions and their elements. Each cube in the Promotion Performance Cuboid is a combination of DoS Diff % (High/Green Zone/Low), SO % (High/Low), and Forecast Error (Negative/Sales=Forecast/Positive). Each cube tells a unique story about SKU-store-promotions that fall into the cube and reveal insights about replenishment frequencies, replenishment quantities, store inventory levels, and SKU sales performance.

For example, a promotion that falls into a cube representing low DoS Diff %, low stock-outs, and high sales accuracy to forecast zone reveals that end of promotion inventory levels were low, the promoted SKU sold beyond expectations and that stores may have held sufficient inventory levels to keep stock-outs low. This also implies that replenishments may have been on time and of the right quantities from DCs to stores. Additionally, it also reveals that the retailer is probably stocking higher inventories of the SKU at the DC than the sales forecast recommends, since the DC is able to meet the excess demand. With this information, the retailer may look into the forecast for the SKU and make adjustments to reduce DC inventory levels and at the same time achieve similar success. Similar insights and analysis may be derived for all the scenarios represented by the 18 cubes in the Promotion Performance Cuboid.

A key takeaway is that promotions do not perform evenly across all SKU’s. The SKU analysis section shows that there tends to be a small group of SKU’s that have tendencies towards high DoS by the end of a promotion or high stock-out rates during certain types of promotions or at certain stores. These SKUs when part of a promotion event, seem to have an effect that weighs-
down a promotion event at certain stores. Similarly, from the store analysis, it is evident that some stores exhibit poorer performance over a certain category of promotions and SKUs. Also similarly, from the promotion analysis section, it is evident that certain promotions do not perform too well at certain stores. It is also possible that certain SKUs part of a promotion weigh-down the promotion event at certain stores.

Thus, it is imperative to analyze SKUs, stores, and promotions that weigh-down promotional performance. The case study conducted as part of this thesis has identified the SKUs, stores, and promotions that have negatively affected promotional performance for the $10GC promotion event. A good starting point for ProdCo and BoxCo is maybe to experiment eliminating certain SKUs from the $10GC category of promotion events and analyze how performance improves. Other recommendations would be to closely monitor stores that tend to perform poorly on certain promotion categories or events. There might be two reasons for the poor performance: first, the distribution center serving the store is unable to replenish the store during promotions as effectively; second, the store policies on cycle times of replenishing shelves from backrooms may be effecting promotional performance. It is also possible that some SKUs just don’t sell well at certain stores considering the demographics of the region.

5.2 Future Work

This work lays a foundation for evaluating of promotions through the combined analysis of days-of-supply, stock-outs, and how sales performed with respect to forecasts. The Promotion Performance Cuboid helps categorize promotions and gives possible implications into how a promotion performed and why it performed a certain way. There are two areas for future research
on the topic. The first is to augment DC inventory and DC-Store replenishment data to the Promotion Performance Cuboid analysis to validate the implications related to inventory levels held at DCs and replenishment quantities and frequencies from DCs to stores. The second area of future research could include study on strategies to improve the execution of promotions and to also answer the million dollar question, ‘Are Promotions worthy of a strategy?’
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Retrieved November 26th, 2014
Appendix

Implications of the cubes in the Promotion Performance Cuboid.

<table>
<thead>
<tr>
<th>DoS Diff %</th>
<th>SO %</th>
<th>Sales Accuracy</th>
<th>Possible implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>High</td>
<td>+</td>
<td>• Promoted SKU(s) may not be selling too well.</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>=</td>
<td>• Replenishments may be on time from retailer’s DC to stores and stocking stores sufficiently.</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>-</td>
<td>• Nothing concrete may be concluded about the quantities replenished.</td>
</tr>
<tr>
<td>Green Zone</td>
<td>High</td>
<td>+</td>
<td>• Promoted SKU(s) sell as expected.</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>=</td>
<td>• Replenishments from retailer DC to stores may be on time.</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>-</td>
<td>• Replenishment quantities may be in excess.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Stores may be getting replenished only when inventory is necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Inventory of the SKU(s) may be low of non-existent at retailer DC by the end of promotion.</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>+</td>
<td>• Promoted SKU(s) sell beyond expected forecast.</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>=</td>
<td>• Replenishments from retailer DC to stores may be on time.</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>-</td>
<td>• Replenishment quantities may be in excess.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Retailer DC able to keep up with the spike in sales beyond expected forecast levels.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Stores may be getting replenished only when inventory is necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The retailer ordered more than forecast quantities of the promoted SKUs from the manufacturer.</td>
</tr>
<tr>
<td>DoS Diff %</td>
<td>SO %</td>
<td>Sales Accuracy</td>
<td>Possible implications</td>
</tr>
<tr>
<td>------------</td>
<td>------</td>
<td>----------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Green Zone</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| * Promoted SKU(s) may be selling well as expected.  
  * Last replenishments from retailer DC to stores may be delayed.  
  * Stores may be getting replenished only when inventory is necessary.  
  * Nothing concrete may be inferred about the replenishment quantities. |

| High       | High | +              | =                    |
| Green Zone | Low  |                |                      |
| Low        |      |                |                      |
| * Promoted SKU(s) sells well.  
  * Replenishments from retailer DC to stores may be frequently delayed.  
  * Replenishment quantities may be higher than necessary  
    Stores may be getting replenished only when inventory is necessary.  
  * Retailer may have ordered more than required inventory from the manufacturer because despite sales matching forecast, stores have a high DoS. |

| High       | High | +              | -                    |
| Green Zone | Low  |                |                      |
| Low        |      |                |                      |
| * Promoted SKU(s) sell beyond expected forecast.  
  * Replenishments from retailer DC to stores may be frequently delayed  
    Replenishment quantities may be in excess.  
  * Retailer DC able to keep up with the spike in sales beyond expected forecast levels.  
  * Stores may be getting replenished only when inventory is necessary.  
  * The retailer ordered more than forecast quantities of the promoted SKUs from the manufacturer. Despite sales exceeding forecast, stores still have a high DoS. |
<table>
<thead>
<tr>
<th>DoS Diff %</th>
<th>SO %</th>
<th>Sales Accuracy</th>
<th>Possible implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>High</td>
<td>+</td>
<td>• Promoted SKU(s) may not be selling too well.</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td>• Replenishments may be on time and as required at the stores from retailer DC stocking stores sufficiently.</td>
</tr>
<tr>
<td>Green Zone</td>
<td>Low</td>
<td>=</td>
<td>• Stores may be getting replenished only when inventory is necessary.</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>-</td>
<td>• Plenty of inventory may be still in stock for the SKU(s) at retailer DC.</td>
</tr>
</tbody>
</table>

*This is the perfect promotion*

- Promoted SKU(s) may sell as expected to forecast.
- Replenishments from retailer DC to stores may be on time.
- Replenishment quantities may be just right.
- Stores may be getting replenished only when inventory is necessary.

- Promoted SKU(s) sell beyond expected forecast.
- Replenishments from retailer DC to stores may be on time.
- Replenishment quantities may be just right.
- Retailer DC able to keep up with the spike in sales beyond expected forecast levels.
- Stores may be getting replenished only when inventory is necessary.
- The retailer ordered more than forecast quantities of the promoted SKUs from the manufacturer.
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</table>
| High      | High | +              | -
| Green Zone| Low  | =              | -
| Low       | Low  | -              | -
| High      | High | +              | -
| Green Zone| Low  | =              | -
| Low       | Low  | -              | -
| High      | High | +              | -
| Green Zone| Low  | =              | -
| Low       | Low  | -              | -

- **Promoted SKU(s) may not be selling too well.**
- **Replenishments from retailer DC to stores may be delayed during the promotion.**
- **Stores may be getting replenished only when inventory is necessary.**
- **Plenty of inventory may be still in stock for the SKU(s) at retailer DC.**

- **Promoted SKU(s) may sell well beyond expected rate.**
- **Replenishments from retailer DC to stores may or may not be delayed.**
- **Replenishment quantities may or may not be right.**
- **Stores may be getting replenished only when inventory is necessary.**

- **Promoted SKU(s) sell beyond expected forecast.**
- **Replenishments from retailer DC to stores delayed**
- **Replenishment quantities in excess**
- **Retailer DC able to keep up with the spike in sales beyond expected forecast levels.**
- **Stores may be getting replenished only when inventory is necessary.**
- **The retailer ordered more than forecast quantities of the promoted SKUs from the manufacturer.**
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<tr>
<td>High</td>
<td>High</td>
<td>+</td>
<td>- Sales not meeting the forecast along with low stock-outs by the end of the promotion implies that the promoted SKU may not be selling too well.</td>
</tr>
<tr>
<td>Green Zone</td>
<td>Low</td>
<td>=</td>
<td>- The low days of supply (low inventory) by the end of the promotion combined with the fact that there were low stock-outs and the SKU fell short of the forecast reveals that stores hold less inventory of the item since it doesn’t sell well.</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>-</td>
<td>- The DoS falls low by the end of the promotion due to stores carrying very little inventory and the promotion period being sufficient to sell the inventory held.</td>
</tr>
<tr>
<td>Replenishments appear to be on time.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inventory levels at the store appear to be low.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>+</td>
<td>- Sales match the forecast and combined with the fact that there were low stock-outs indicates that the SKU sold well during the promotion and the stores held the right amount of inventory.</td>
</tr>
<tr>
<td>Green Zone</td>
<td>Low</td>
<td>=</td>
<td>- The low DoS and low stock-outs during the promotion indicate that replenishments were of the right quantity and on time to the stores.</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>-</td>
<td>- The low DoS by the end of the promotion combined with the fact that sales matched the forecast reveal that the store held just the right inventory levels.</td>
</tr>
<tr>
<td>Sales exceeding the forecast implies that the promoted SKU is selling beyond expectations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The low stock-outs and the low DoS by the end of the promotion imply that the store held the right amounts of inventory and the replenishments were on time.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It appears that the DC holds high amounts of inventory since it is able to replenish stores despite sales exceeding forecast.</td>
<td></td>
<td></td>
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<td>Inventory levels at the store appear to be just right.</td>
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<td>High</td>
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<td>+</td>
<td>- Sales are less than expected and stock-outs are high indicates SKU may be selling well but could not achieve the forecast levels due to other reasons.</td>
</tr>
<tr>
<td>Green Zone</td>
<td>Low</td>
<td>=</td>
<td>- The high stock-outs and the low DoS by end of promotion indicate that either replenishments were delayed or the quantities replenished were too low.</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>-</td>
<td>- The low DoS, sales not meeting forecast, along with the high stock-outs indicates that inventory levels held at the store were low.</td>
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<td>High</td>
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<td>Green Zone</td>
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<td>- The low DoS, high stock-outs and sales yet able to meet forecast implies that inventory levels held at stores were reasonable but below what is required.</td>
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<tr>
<td>High</td>
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<td>+</td>
<td>- Sales exceed forecast and as a result, there are increased stock-outs. Reveals that SKU sells well.</td>
</tr>
<tr>
<td>Green Zone</td>
<td>Low</td>
<td>-</td>
<td>- Stock-outs are high due to the increased sales beyond forecast levels and yet the store is able to sell beyond forecast implies that replenishments are on time.</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>-</td>
<td>- DoS is low and stock-outs are high implies that the stores are not holding the required inventory to meet demand.</td>
</tr>
</tbody>
</table>