

Evaluating Sales Promotion Effects Using Scanner Panel Data



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We pledge on our honor that we have not given or received any unauthorized assistance on this assignment.

Executive Summary

In our research to optimize the retailer's gross profit amongst the 4 liquid laundry detergent brands, our team analyzed data from Information Resources, Inc. (IRI). Scanner panel data for 178 households over 135 weeks was analyzed. The study conducted by our team included a Binary Logit model for purchase incidence, Multinomial Logit model for brand choices, and Semi-log Regression models for purchased quantity of each brand. The highest gross profit of \$1505.6 is predicted for the retailer with a price cut and feature advertisement for Tide at a 70% pass through rate. Gross profit increases to \$3846.1 for the retailer when price cuts are offered to all 4 brands simultaneously.

Introduction and Background

Information Resources, Inc. (IRI) provided our team with scanner panel data of liquid laundry detergents: Unilever brands - Wisk and All, and Procter & Gamble brands - Tide and Cheer. Scanner panels are a special type of purchase panels, wherein purchase data from retail stores are automatically captured for participants enrolled in the program. Scanner panels overcome the limitation of requiring participants to manually input information. This study aggregated data from 178 households during a span of 135 weeks, from 4 stores belonging to the same supermarket chain located in close proximity. All the stores have identical pricing and promotional activities over this period.

Our team is hired to analyze

1. Effects of display and in-store feature promotions on sales quantities and profitability
2. To assess the profitability of price cuts for the retailer and manufacturer.

Thereafter, provide recommendations optimizing overall profit margins for the retailer.

Data and Methodology

Table 1 is a description of the variables referenced throughout this research. The primary focus in this analysis is the effect of promotional offers - price cut, in-store display and feature advertising on customer purchase incidence, brand choice, and purchase quantity.

The models used are:

1. Binary Logit Model (Eq.1): the distribution of Y follows binomial distribution meaning the data is either 0 or 1. This is also called the logistic regression model, and helps to accurately infer the attractiveness of the liquid detergent category. This implies, calculating the probability of a household purchasing liquid detergent in a given week, and how it is affected by change in price or promotional offers.
2. Multinomial Logit Model (Eq.2): is the extension of the Binomial distribution to model multiple binary outcomes simultaneously. It assumes that each independent variable has a single value for each case; data is multinomial. MNL is the most commonly used model for analyzing the behavior of an individual decision maker. In our research, MNL is used to study consumer behavior in purchasing a particular brand with respect to the other available brands; the various factors of price cuts and promotional offers are taken into account.
3. Semi-log Regression Model (Eq.3): this model defines a nonlinear relationship of an independent and dependent variable. The dependent variable is calculated as the exponential function of the linear independent variable. For our analysis, the quantity of liquid detergent of the purchased brand is the dependent variable, with average price, promotional offers, price cuts, as the independent variable.

The assumptions made during our analysis are:

1. The price cut offered for each brand is the average regular price in the data
2. Price cut offered remains constant in all scenarios
3. Only one brand has sales promotions in a given week
4. In-store displays and feature advertising cannot be applied at the same time
5. The retail margin is 20% while the manufacturer margin is 45%
6. The retailer pass through at 100% and 70% of price cut to customers is predicted (100% pass through rate means that the retailer passes the entire discount that they receive from manufacturer to the customer, whereas 70% implies that the retailer increases their profit margin)
7. Promotions did not result in category purchase ($lbpromot = 0$)

We briefly delved into the implications of having in-store displays and feature advertising simultaneously.

Statistical Analysis Systems (SAS), is a software used for a vast range of statistical analysis, including in this analysis. It is easy to use and interpret, due to its data visualization and a statistical analytical suite.

Key Findings

From Table 2 we infer the statistical significance of average regular price, average price cut, in-store display, and feature advertising as their p-values are less than 5%. All parameters affect the purchase incidence positively except the average price.

- If the average regular price *decreases* by \$1, the odds of purchase *increases* by 53.6%
 - If the average price cut *increases* by \$1, the odds of purchase *increases* by 190%
 - If there exists in-store display in the category, it *increases* the odds by 63.17%
 - If there are featured promotions in the category, it *increases* the odds by 74.49%
- Customers exhibit a higher chance of purchasing with a price cut, when compared to other promotional offers.

In terms of the brand attractiveness, Table 4 depicts the statistical significance of price cut, in-store display, and feature ads as their p-value is less than 5%. Regular price is not statistically significant as per the Pearson coefficient; however, we continue to include it, as modelling without price is redundant. Table 3 gives the ordinal values of the different brands.

- Cheer is the baseline in Table 4, from the intercepts it is evident that Cheer has the highest utility when all the conditions are identical, and Wisk has the lowest utility
 - The brand attractiveness *increases* by 0.71 as the price cut *increases* \$1
 - In-store display *increases* the brand utility by 1.03
 - Feature advertisements increases brand utility by 0.39
- The choice of brand is most impacted by in-store displays.

Table 5 describes how promotional tools influence customer's purchase quantity for each brand. Price cuts for all 4 brands are statistically insignificant as p-values are greater than 5%; however, it is integral to include it to do a comparative study between the effects of price-cuts, and other promotional tactics.

- In-store displays *increase* purchase quantity for Wisk and Cheer.
- Feature ads for Tide *increases* purchase quantity

- All promotional tactics for ‘All’ are statistically insignificant; however, price cuts are effective in increasing purchase quantity

From Table 6, we infer the various gross profit implications for the retailer and manufacturer from price cut and differing pass-through rates.

- For the retailer at 100% pass through rate - Tide has the largest gross profit increase at 35.5% and Cheer shows the least gross profit increase at 20.14% in these conditions
- For the retailer at 70% pass through rate - Tide has the largest gross profit increase at 59.50% and Wisk shows the least gross profit increase at 26.4% in these conditions
- For the manufacturer at 100% pass through rate - Wisk has the largest gross profit increase at 35.89% and ‘All’ has the least at 13.62%
- For the manufacturer at 70% pass through rate - Wisk has the largest gross profit increase at 14.30%. With these conditions, ‘All’ predicts gross *loss* at 34.30%

Table 7 tabulates the brand choice behaviour when no price cut, or/and promotional offers exist. From this we infer, Customers tend to buy the same brand that they bought previously.

Figure 1 shows the effect of different promotional tactics on total gross profit. A combination of price cut with display or price cut with feature ads for one brand at a time predicts a higher gross profit for the retailer with that brand when compared to only one promotional tool being offered. A combination of price cut with display and feature ads for one brand at a time predicts the highest gross profit for both retailer and manufacturer. Figure 2 shows a very high increase in gross profits when all brands have price cuts simultaneously for the retailer.

Conclusions and Recommendations

From the detailed analysis on the effects of different sales promotions, the following conclusions are drawn for retailer:

1. Price cut is not as effective compared to, display and feature advertising in terms of gross profits. However, it is an important factor with customer purchase incidence.
2. From the perspective of individual brands, there is a tremendous gross profit increase of 513.35% if Wisk has price cut and display promotions.
3. Price cut with feature and display ads for each brand at a time increases gross profit for the retailer
4. The Brand choice is impacted most by the in-store display

The recommendations to the retailer are:

1. The retailer should apply the 70% pass-through rate on price cut
2. Price cut and feature ads for Tide predict the highest gross profit increase to \$1505.6
3. If possible, applying price cuts for all 4 brands will increase the gross profit by 630.6% for the retailer. The gross profit will be \$3846.1

The limitation of the analysis is that costs for display and feature advertising promotions are unknown to us. To calculate the total gross profits when there is/are sales promotion(s) more accurately, average costs of each promotional tool should be considered. Also, the size of the households is not specific since quantity purchased is a dependent variable.

Appendices: Tables, Exhibits, Figures

Table 1. Descriptions of the variables. This table summarizes different variables and their definitions.

<i>Table1: variable definitions</i>	
<i>Variable</i>	<i>Definition</i>
CASEID	An ID number for each choice occasion.
PANID	An 8-digit ID number for a household in the IRI panel.
WEEK	A numerical number representing the week according to IRI's system. (It ranges from 906 to 1040 in the data.)
BRAND	1 = Wisk; 2 = All; 3 = Tide; 4 = Cheer
DECISION	1 = the brand (as indicated by BRAND) is chosen; 0 = otherwise
REGPR	Regular price for the brand (as indicated by BRAND), in cents/ounce.
PCUT	Amount of price cut for the brand (as indicated by BRAND), in cents/ounce.
DISP	1 = there was an in-store display promotion for the brand (as indicated by BRAND); 0 = otherwise
FEAT	1 = there was a feature advertising promotion (i.e., Free Standing Insert) for the brand (as indicated by BRAND); 0 = otherwise

Table 2. Binary Logit Model for Category Purchase Incidence =1. This table displays the parameter estimates of variables on customer purchase incidence.

Analysis Of Maximum Likelihood Parameter Estimates							
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Wald Chi-Square	Pr > ChiSq	
Intercept	1	1.2006	0.9234	-0.6093 3.0105	1.69	0.1936	
avg_rp	1	-0.7629	0.1444	-1.0459 -0.4798	27.90	<.0001	
avg_pc	1	1.0659	0.3720	0.3367 1.7951	8.21	0.0042	
cat_disp	1	0.4896	0.1401	0.2150 0.7642	12.21	0.0005	
cat_feat	1	0.5567	0.1051	0.3507 0.7627	28.04	<.0001	
Ibpromot	1	-0.5240	0.0841	-0.6889 -0.3591	38.80	<.0001	
Scale	0	1.0000	0.0000	1.0000 1.0000			

Table 3. Table of Brand Names and corresponding Ordinal Values

<i>Table2: Brands</i>	
<i>Brand Name</i>	<i>Ordinal Value</i>
Wisk	1
All	2
Tide	3
Cheer	4

Table 4. Multinomial Logit Model for Brand Choice. This table displays the parameter estimates of variables on 4 brand choices (Wisk=1, All=2, Tide=3, Cheer=4).

Analysis of Maximum Likelihood Estimates						
Parameter	DF	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
intcpt1	1	-0.43509	0.22097	3.8769	0.0490	0.647
intcpt2	1	0.01602	0.51238	0.0010	0.9751	1.016
intcpt3	1	0.44451	0.21794	4.1600	0.0414	1.560
regpr	1	0.06285	0.25312	0.0616	0.8039	1.065
pcut	1	0.71178	0.23680	9.0347	0.0026	2.038
disp	1	1.30738	0.12124	116.2794	<.0001	3.696
feat	1	0.39064	0.11213	12.1368	0.0005	1.478

Table 5. Semi-log (conditional) purchase quantity model for Brand 1(Wisk), 2(All), 3(Tide), 4(Cheer). This table displays the parameter estimates on purchase quantity of 4 brands.

	Semi-log (Conditional) Purchase Quantity Models: Estimates							
	brand 1		brand 2		brand 3		brand 4	
	Estimates	P- values	Estimates	P- values	Estimates	P- values	Estimates	P- values
Intercept	3.543	<.0001	4.231	<.0001	3.751	<.0001	3.756	<.0001
avol	0.007	<.0001	0.007	<.0001	0.007	<.0001	0.003	<.0001
regpr	0.020	0.751	-0.094	0.211	0.021	0.632	0.086	0.074
pcut	0.059	0.480	0.212	0.178	0.001	0.990	0.063	0.239
lbpromot	0.091	0.092	0.088	0.117	0.007	0.843	0.002	0.958
disp	0.226	0.000	0.042	0.506	-0.032	0.433	0.112	0.031
feat	-0.109	0.020	0.037	0.548	0.078	0.033	-0.102	0.085

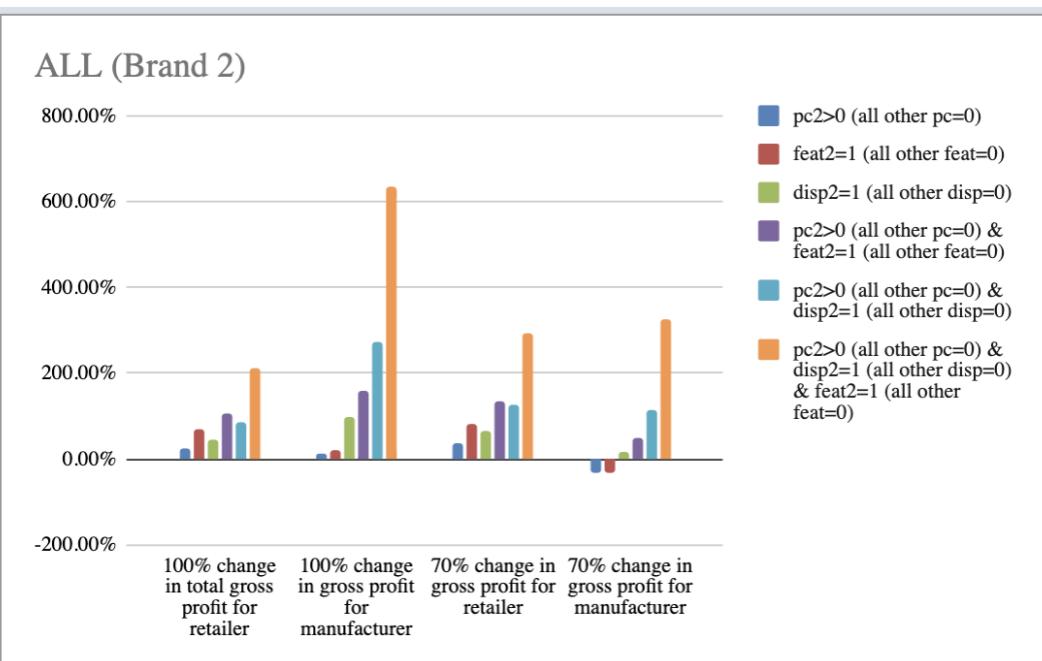
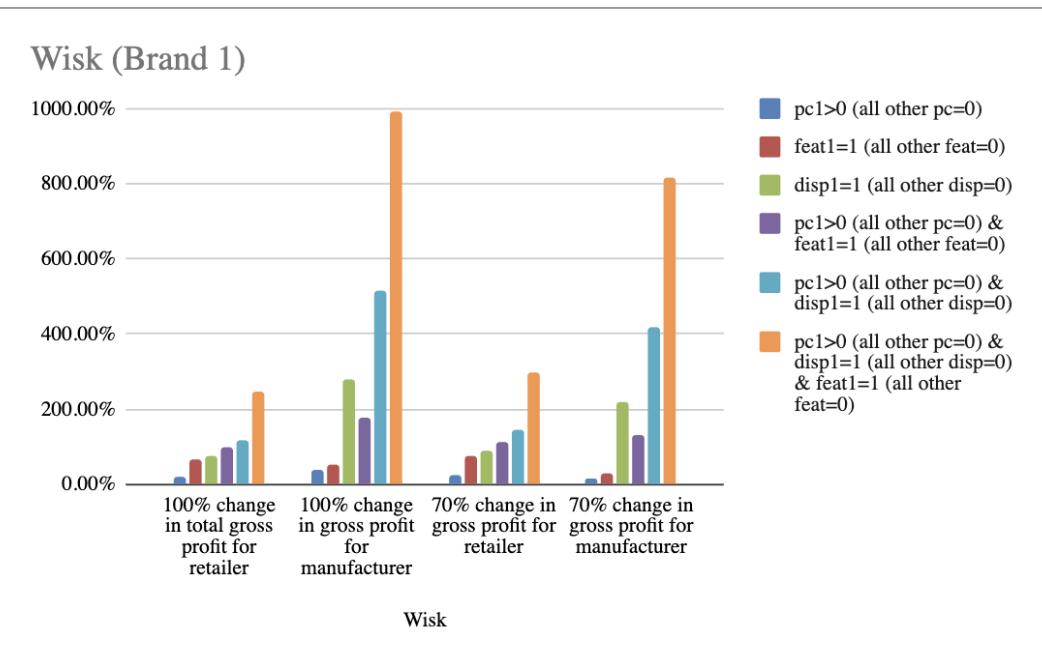
Table 6. Effect of Price Cut on the Gross Profit for Retailer and Manufacturer. This table displays the effect of price cuts on gross profits for both retailer and manufacturer when the pass-through is 100% or 70%.

Effect of Price Cut on the Gross Profit for Retailer and Manufacturer			
Retailer	change in gross profit (100% pass-through)	change in gross profit (70% pass-through)	change when pass-through is 100%/70%
pc1>0 (all other pc=0)	20.47%	26.40%	29%
pc2>0 (all other pc=0)	23.14%	35.70%	54%
pc3>0 (all other pc=0)	35.50%	59.50%	68%
pc4>0 (all other pc=0)	20.14%	28.90%	44%
pc1=2=3=4 >0	541.59%	630.26%	16%
Manufacturer	change in gross profit(100% pass-through)	change in gross profit (70% pass through)	change when pass-through is 100%/70%
pc1>0 (all other pc=0)	35.89%	14.30%	-60%
pc2>0 (all other pc=0)	13.62%	-34.30%	-352%
pc3>0 (all other pc=0)	16.68%	-12.60%	-176%
pc4>0 (all other pc=0)	24.35%	4.00%	-84%
pc1=2=3=4 >0	323.30%	216.94%	-33%

Table 7. Table of brand choice made on the previous category purchase occasion and choice made on this time. This table displays the relationship of brand choice made on the previous purchase and choice this time.

The FREQ Procedure							
Frequency	Table of Ichoice by choice						
	Ichoice	choice					
Percent		0	1	2	3	4	
Row Pct	1	2933 15.31 94.98 15.96	83 0.43 0.13 50.61	25 0.21 0.81 14.53	40 1.30 1.30 12.35	7 0.04 0.23 5.79	3088 16.12
Col Pct	2	4777 24.94 96.37 26.00	34 0.18 0.69 20.73	103 0.54 2.08 59.88	28 0.15 0.56 8.64	15 0.08 0.30 12.40	4957 25.88
Frequency	3	8000 41.76 96.26 43.54	29 0.15 0.35 17.68	32 0.17 0.39 18.60	231 1.21 2.78 71.30	19 0.10 0.23 15.70	8311 43.38
Percent	4	2666 13.92 95.18 14.51	18 0.09 0.64 10.98	12 0.06 0.43 6.98	25 0.13 0.89 7.72	80 0.42 2.86 66.12	2801 14.62
Row Pct	Total	18376 95.92	164 0.86	172 0.90	324 1.69	121 0.63	19157 100.00

Figure 1. Change in total gross profit for retailer and manufacturer. This table shows the percentage change in total gross profit for retailer and manufacturer by each brand.



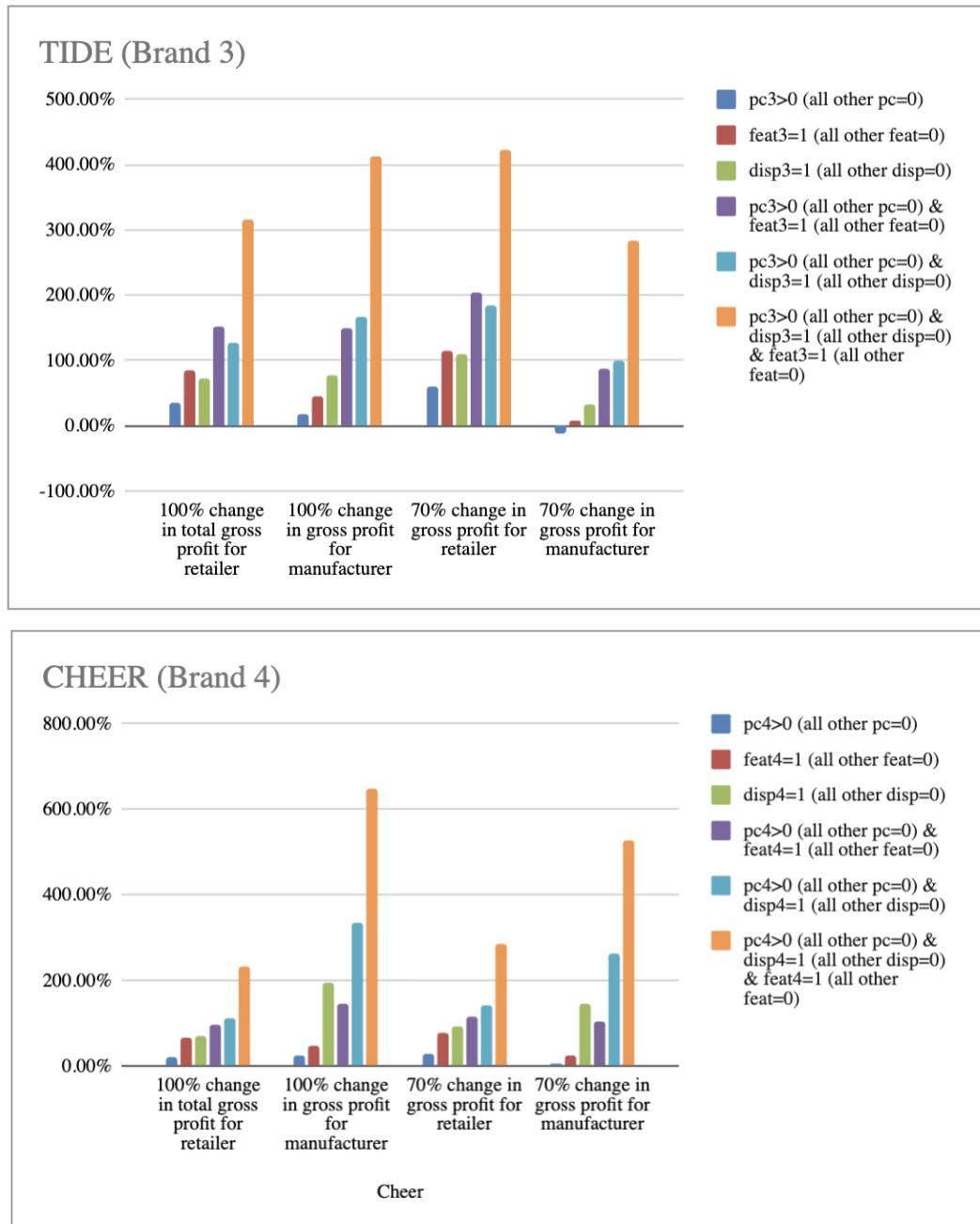
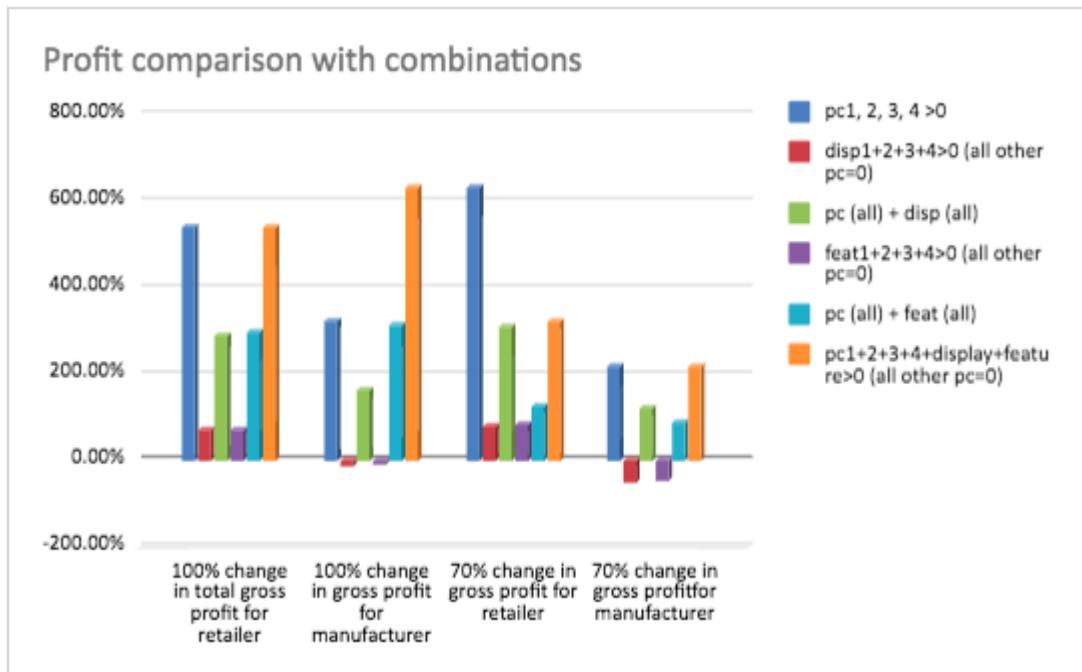


Figure 2. Change in Gross profits when there are multiple promotions. This graph shows the percentage change in gross profits when there are multiple promotions.



Equation 1. Binary Logit Model

$$\Pr(I_{i,t} = 1) = \frac{\exp\left(a + \sum_{p=1}^P b_p X_{p,i,t}\right)}{1 + \exp\left(a + \sum_{p=1}^P b_p X_{p,i,t}\right)}$$

Equation 2. Multinomial Logit Model

$$U_{i,k,t} = a_i + b_1 X_{1,k,t} + b_2 X_{2,k,t} + \dots + b_P X_{P,k,t} = a_k + \sum_{p=1}^P b_p X_{p,k,t}$$

Equation 3. Semi-log Regression Model

$$\ln(S_{i,k,t}) = a_k + \sum_{p=1}^P b_p X_{p,i,k,t} + \varepsilon_{i,k,t}$$