# Analyzing Concession Pricing Strategies at Soldier Field: Insights and Recommendations for the Chicago Bears

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## Question 1: Price Elasticity of the 7 Promotional Items

To calculating price elasticity, we aggregated the UseCount of each promotional item at each price level for each week, and then fitting a regression model with the log of UseCount as the dependent variable and the log of actual price as the independent variable, controlling for non-season ticket holder revenue (nonSTH_rev).

We made some assumptions before modeling:

- ✓ **Linear Relationship in Log-Log Model:** The model assumes a linear relationship between the log-transformed dependent variable (UseCount) and the log-transformed independent variables (Actual Price and nonSTH_rev).
- ✓ **Constant Elasticity Across Price Range:** The elasticity calculation assumes that the price elasticity of demand is constant across the price range considered.
- ✓ **Independence:** The model assumes that each observation (transaction) is independent of others and UseCount of one item is independent of the promotion of other items.
- ✓ **Dependence of Sales on Price and Discount:** The sales in a particular game are dependent on the price and discounts on different item.

Here are detailed steps we did for the modeling:

1. Aggregate the UseCount of each promotional item at each price level for each week
2. Since General Admission (GA) season ticket holders takes 80% of all ticket holders and they are eligible for 10% discount and Club Level (CL) season ticket holders takes the other 20% and eligible for 20 % discount while the 50 % discount is available for all the STH holders. So, to have the same effect on GA and CL STH , we multiply the UseCount at 10% discount level by 1.25 and UseCount at 20% discount level by 5, ensuring that they are all based on the whole population size.
3. For each item, fit a log-log linear regression. Mathematically, the model is:

$$log(UseCount) = beta_0 + beta_1 * log(ActualPrice) + beta_2 * log(nonSTH_rev)$$

where the **value of beta_1**, the coefficient of log(ActualPrice), represents the price elasticity

of demand for each item. The elasticity is interpreted in the following way: With increase in log(price) by 1 unit, the demand increases or decreases by the beta_1 depending on its sign. If it is positive, then demand increases otherwise decreases.

| | bag_of_peanuts | bavarian_pretzel | bottled_water | hot_dog | nachos | souv_popcorn | souv_soda |
|---|---|---|---|---|---|---|---|
| **const** | -9.3066 | -23.5499 | 37.5866 | -21.3572 | -19.8468 | 14.4199 | 1.1133 |
| | (22.5361) | (13.3488) | (13.9801) | (28.9000) | (32.6726) | (7.5002) | (9.4883) |
| **actual_price** | 0.0790 | -1.3452 | -4.1444 | -2.6079 | -0.7236 | -3.8445 | -1.4216 |
| | (2.4041) | (0.7210) | (1.5430) | (0.6897) | (2.6502) | (0.8957) | (0.3578) |
| **nonSTH_rev** | 1.4038 | 2.9927 | -2.6067 | 2.9104 | 2.7212 | -0.3289 | 0.6853 |
| | (2.2610) | (1.1989) | (1.3260) | (2.6403) | (3.4682) | (0.7735) | (0.9211) |
| **R-squared** | 0.0491 | 0.7621 | 0.4513 | 0.7744 | 0.0891 | 0.6692 | 0.6570 |
| **R-squared Adj.** | -0.1886 | 0.7189 | 0.3669 | 0.7242 | -0.0930 | 0.6090 | 0.5807 |
| **R2** | 0.05 | 0.76 | 0.45 | 0.77 | 0.09 | 0.67 | 0.66 |

The results for the items are as follows:

- Bag of Peanuts: 0.0790
- Bavarian Pretzel: -1.3452
- Bottled Water: -4.1444
- Hot Dog: -2.6079
- Nachos: -0.7236
- Souvenir Popcorn: -3.8445
- Souvenir Soda: -1.4216

This indicates that Bottled Water and Souvenir Popcorn are the most price elastic and cause most decrease in demand.

### Question 2: Effects of 50% Discounts on Other Items

To determine the effects of a 50% discount on Item A on the sales of Item B, we used a regression model similar to the first question but added a variable to indicate whether there was a 50% discount on Item A. The coefficients for this variable represent the causal effect of the discount on the use count of other items.

We made some assumptions before modeling:

✓ The model assumes that the UseCount of one item depends not only on its price and nonSTH_rev, but the promotion of other items.

Here is the detailed step for modeling:

1. For Item B, fit a regression with its actual price, nonSTH_rev, and whether Item A is the "Item of the Week". Mathematically, the model is:

$$log(UseCountofItemB) = beta_0 + beta_1 * log(ActualPrice)$$

$$+beta_2 * log(nonSTH_rev) + beta_3 * whether50\%discountofitemA$$

Where beta_3 represents the causal effect of the discount on the UseCount of other items.

2. Fit the model for all combinations of Item A and Item B for the seven promotional items

Here are results of the coefficients. Rows represent items, and columns represent the effect of different items discount cause on row items.

| | bag_of_peanuts | bavarian_pretzel | bottled_water | hot_dog | nachos | souv_popcorn | souv_soda |
|---|---|---|---|---|---|---|---|
| **bag_of_peanuts** | NaN | -0.106148 | -0.970703 | -0.634657 | 11.718912 | 1.025803 | 0.870149 |
| **bavarian_pretzel** | -0.269597 | NaN | 0.197502 | 0.354961 | -0.269597 | -0.466081 | -0.154797 |
| **bottled_water** | 1.936534 | 1.001202 | NaN | -1.488080 | 1.936534 | -0.826349 | 0.562857 |
| **hot_dog** | 0.020914 | -0.199088 | 0.098387 | NaN | 0.020914 | 0.080532 | 0.006391 |
| **nachos** | 11.830687 | -0.660907 | 0.056660 | 0.054161 | NaN | 0.595731 | -0.244724 |
| **souv_popcorn** | -0.425092 | 0.625487 | -0.034845 | -0.308547 | -0.425092 | NaN | 0.124681 |
| **souv_soda** | -0.436772 | 0.292123 | 0.218236 | -0.021451 | -0.436772 | 0.063424 | NaN |

Table 1. Summary of effect of the discount on the UseCount of other items

The results show that discounts on certain items can significantly impact the sales of others. Notably, a 50% discount on nachos leads to a substantial increase in the sale of Bag of Peanuts. Conversely, a 50% discount on Bottled Water negatively impacts its sales but positively affects the sale of Bag of Peanuts and Bavarian Pretzel.

**Question 3: Improving Concessions Pricing Strategy**

Based on insights from the elasticity analysis and the effects of discounts on sales of other items, the Bears could consider:

- From Question 1, we see that Nachos has price elasticity of -0.72 which means that on increasing the price of nachos, the demand will not be much reduced as compared to

increasing price of other items. Therefore, bears can experiment with increasing the price of the nachos and observe the demand and revenue generated.

- Choose items for which the 'Item of the Week' discount has maximum positive impact on the promotion of other items. Nachos and Bag of Peanuts are two good choices.

**Question 4: Weaknesses of the Analysis and Future Data Collection**

The main weaknesses of the analysis include:

- Limited Observations: With only data from a single season, the analysis may not fully capture variations across different times and conditions.
- Potential Confounders: The analysis may not account for all factors influencing sales, such as unobserved events or changes in consumer preferences.
- Simplification of Elasticity Models: The models may oversimplify the complex interactions between price changes, demand, and external factors.

To generate more effective data for future analysis, the Bears could:

- Extend Data Collection: Collect data over multiple seasons to capture a wider range of conditions and events.
- Detailed Tracking: Include more detailed tracking of attendance, weather conditions, and specific promotions to better control for these factors in the analysis.
- Consumer Surveys: Conduct surveys to understand the motivations behind concession purchases and the impact of promotions or price changes on consumer behavior.