BUMK758: Advanced Marketing Analytics



**OPTIMAL PRICE FOR TROPICANA**

**Group Number: #3**

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**Honor Pledge:**

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

**Executive Summary**

The study is to determine the optimal price of Tropicana 64 ounces by developing a model with multiple key variables that predicts the volume of sales in a retail company. Based on the semi-log model which included the influence of season, in-store display and feature advertisements, psychological pricing, and stores, we obtained the relation between price and sales of the product. As general rules, we suggest retailers improve current design of promotions and set prices ending with nine. With this relation and these rules, we determined the profit-maximizing price to be $3.19.

**Introduction and Background**

Nick’s, a grocery retailer who owned 15 stores in the Midwest, was encountering some business problems with one of their best-selling products – Tropicana 64 ounces – a refrigerated orange juice. At each store location, every store manager set their own price and decided on their sales promotion individually and without a unified strategy, causing inconsistent sales and unstable profit. Each store had a different location, some are in rural areas and some are urban, meaning each store will have totally different quantity in sales. Moreover, some managers use feature advertising to stimulate the sales of orange juice. Nick’s wants to know the effect of the featured advertising and whether they need to increase the advertising or displays. They would like to find an optimal price that can maximize its profit and allow them to gain a unified pricing among their 15 stores. Therefore, it is important for Nick’s to know each store’s predicted sales under the same price, so that the manager can make various advertising or promotional adjustments for each store and help the store that has relative low profit numbers to increase sales.

**Data and Methodology**

Provided with independent variables including retail price and sales promotion for the orange juice in each of the 15 stores from January 2009 to December 2010, we were able to build pricing models, which include linear, semi-log, and log-log model, to find the best fit for the relationship between these independent variables and sales volume.

By using the linear model, we could merely explain under thirty percent of the data because the relationship between price and sales is nonlinear. We then decided to put other variables in the semi-log and log-log model. To see how promotions impact sales volume, we created a dummy variable called “Deal” which represents sales promotion into our model, because we would like to see how the previous in-store display and feature advertisements stimulated the sales. In addition to this variable, we assumed that psychological pricing will have a positive effect on sales, we added End9, a dummy variable showing if the price ends with figure 9.

Seeing the descriptive statistics of each store, we found that the sales vary a lot among different stores, and thus created dummy variables for each store in hopes of making a more accurate prediction. Based on the observation on the sales trend regarding time, we created dummy variables for quarters, assuming that the sales will vary significantly in each quarter. Nevertheless, after putting quarter into the model, we found that the adjusted R-square value did not have any apparent increase, and the coefficient of each quarter did not have a significant difference, so we removed the quarter variable. Moreover, in order to see if there was any seasonality effect, we added the variable “summer” to the model, and this time we found the results showed a slightly higher adjusted R-square.

In the end, after we put the same variables, including Price, Deal, Store, End9, and Summer in the semi-log and log-log model, we finally decided to use the semi-log model to regulate the optimal price. Our decision was because the semi-log model has a higher adjusted R-square than the log-log model does, which is used to explain the percentage to represent the real situation in semi-log model. Most of the variables in the model have the p-value under 0.05, meaning that those variables have significant effect on the model. The variable ‘deal’ is the only one that has a 0.06 p-value, which is just higher than the 0.05 significance point. This difference is extremely minor however, and this variable is an essential element which the manager uses to provoke the sales. Thus, we justify that it still could be considered statistically significant and. we decide to keep it in our model. In conclusion, because of the highest adjusted R-square, and significant effects in variables, including price, stores, end9 and summer, we decided to use the semi-log model to generate the optimal price and increase the profit.

*log(Sales)=a+b1Price+b2Deal+b3End9+b4Summer+b5Store1+...+b19Store15*

We will explain the findings and recommendations based on the semi-log model as below.

**Key Findings**

Basic descriptive statistics: The mean of the Quant is 40914.54 and the mean of the Price is 3.602. The range of the Quant is from 2112 to 1186496 and the range of the Price is from 2.74 to 4.18. The standard deviation of Quant is 49216.14, while that of Price is 0.35.

According to the t-values generated by SAS (Table 2), we could tell that most of our variables are significant, such as Price, End9, Summer and the stores. The coefficient of Price indicates that a unit increase in price results in a 1.57 ounce decrease in sales, the coefficient of End9 indicates that an End9 price setting causes a 0.16 ounce increase in sales, and the coefficient of Summer indicates that the summer season brings a 0.18 ounce increase in sales. On the other hand, the variable Deal, which has a t-value of 0.35, appears to have no significant influence on sales.

The semi-log model we made comparing to the log-log model and linear model with the same variables has a relatively large adjusted R square, 0.4703. The higher adjusted R square shows that this model has a greater predictive ability, meaning that it is more reasonable to use the model’s coefficient to determine the future retail price.

  To set the optimal price, we could use the coefficient of price generated by SAS. The formula is listed below.

*P\*=Ct-(*1*/b)*

Given that *Ct*, which stands for the cost per bottle charged by the manufacturer to the retailer, is $2.57 and *b* (coefficient of price) is -1.57024, the optimal price *P\** is about $3.21 per bottle.

*P\**=2.57-(1/-1.57024)=3.20684532

However, the End9 was proved to be significant in our model and is likely to increase sales since its coefficient is positive. In order to gain the benefit of End9 effect, we would suggest that the optimal retail price be adjusted to a price ending with figure “9”, which would be either $3.19 or $3.29. To choose between the two prices, we calculated the profits respectively, adding the calculated price $3.21 (Table 3). According to the result, $3.19 creates better profit; thus, we would recommend the optimal retail price for week 105 be adjusted to $3.19/bottle.

**Conclusions and Recommendations**

The semi-log model showed 46% accuracy of predicting the sales volume with Price, Stores, Deal, End9, and Summer. After examining the significant level for each variable, we found that whether or not the stores provided deals on the products did not influence the sales, however having the prices end with nine could in fact stimulate customers’ purchase.  Each store impacted sales differently. Summer sales had distinguishing performance from other seasons.

Based on the observation we concluded that the retailers should improve the current promotions. We found that setting prices ending with nine could stimulate customers’ purchase better than deals, so we suggest the price to be $3.19 instead of $3.21 which is the optimal price we generated from the model directly. With the ending nine effect, $3.19 can boost larger sales.  The profit generated from it will be $653,977.51 (in Summer).

The model can only reflect less than 50% of the reality; loose measurement on store and time variables are the essential reasons for the poor approximation.  Further study can add measurements on competitiveness around each store, and track sales on a daily basis to see a clearer seasonality.  Setting prices for stores separately can be more beneficial than using a uniform price, but we conclude that for setting the retail price for the Tropicana 64 ounces, retailers should improve their current deals and set their price to our optimal price point of $3.19 per bottle.

**Appendices**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Adj R-Square | Insignificant Variables | Significant Variables | Pr > F |
| log-log | 0.3933 | Deal | Price | <.0001 |
| log-log | 0.3946 | Deal | Price, Quarter 1 & 3 | <.0001 |
| semi-log | 0.4049 | Deal | Price | <.0001 |
| semi-log | 0.4074 | Deal | Price, All Quarters | <.0001 |
| log-log | 0.446 | N/A | Price, Deal, All Stores | <.0001 |
| semi-log | 0.4576 | Deal | Price, All Stores | <.0001 |
| log-log | 0.4504 | Deal | Price, All Stores,  End9 | <.0001 |
| semi-log | 0.4625 | Deal | Price, All Stores,  End9 | <.0001 |
| log-log | 0.4475 | Deal, Quarter2 | Price, All Stores,  End9, Quarter 1 & 3 | <.0001 |
| semi-log | 0.4602 | Deal | Price, All Stores, All quarters, End9 | <.0001 |
| log-log | 0.451 | Deal, Quarter 1 & 2 | Price, All Stores, Quarter 3, End9 | <.0001 |
| semi-log | 0.451 | Deal, Quarter 1 & 2 | Price, All Stores, Quarter 3, End9 | <.0001 |
| semi-log | 0.4621 | N/A | Price, All Stores,  End9 | <.0001 |
| semi-log | 0.4703 | Deal | Price, All Stores,  End9,  Summer | <.0001 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table 2. Coefficient of the semi-log model    Table 3. Comparing profits to determine the optimal Price | | | | | | |
| The prediction of quant and profit Spring, Fall & Winter | | | | | | |
|  | Optimal price 3.19 | | Optimal price 3.21 | | Optimal price 3.29 | |
| Store | Quant | Profit | Quant | Profit | Quant | Profit |
| 1 | 43315.87175 | 26855.84049 | 35574.33038 | 22767.57144 | 37021.36287 | 26655.38127 |
| 2 | 55040.49137 | 34125.10465 | 45203.49112 | 28930.23432 | 47042.20234 | 33870.38569 |
| 3 | 72912.4292 | 45205.7061 | 59881.30309 | 38324.03398 | 62317.05355 | 44868.27855 |
| 4 | 65089.23152 | 40355.32354 | 53456.29056 | 34212.02596 | 55630.69521 | 40054.10055 |
| 5 | 58485.51525 | 36261.01946 | 48032.81009 | 30740.99846 | 49986.60757 | 35990.35745 |
| 6 | 53395.10745 | 33104.96662 | 43852.17511 | 28065.39207 | 45635.91978 | 32857.86225 |
| 7 | 50746.82838 | 31463.0336 | 41677.20435 | 26673.41078 | 43372.47924 | 31228.18505 |
| 8 | 57932.53368 | 35918.17088 | 47578.65903 | 30450.34178 | 49513.98332 | 35650.06799 |
| 9 | 58586.1969 | 36323.44208 | 48115.49762 | 30793.91848 | 50072.65852 | 36052.31414 |
| 10 | 40709.81105 | 25240.08285 | 33434.03259 | 21397.78086 | 34794.00567 | 25051.68408 |
| 11 | 54339.37602 | 33690.41313 | 44627.68119 | 28561.71596 | 46442.97059 | 33438.93883 |
| 12 | 62177.24651 | 38549.89283 | 51064.74416 | 32681.43627 | 53141.86953 | 38262.14606 |
| 13 | 51636.0009 | 32014.32056 | 42407.46131 | 27140.77524 | 44132.44036 | 31775.35706 |
| 14 | 53457.61629 | 33143.7221 | 43903.51218 | 28098.2478 | 45689.34506 | 32896.32844 |
| 15 | 100414.7512 | 62257.14576 | 82468.32836 | 52779.73015 | 85822.83566 | 61792.44168 |
|  | SUM-P | 544508.1846 | SUM-P | 461617.6135 | SUM-P | 540443.8291 |
|  | AVERAGE-P | 36300.54564 | AVERAGE-P | 30774.50757 | AVERAGE-P | 36029.58861 |
|  |  |  |  |  |  |  |
| The prediction of quant and profit in Summer | | | | | | |
|  | Optimal price 3.19 | | Optimal price 3.21 | | Optimal price 3.29 | |
| store | Quant | Profit | Quant | Profit | Quant | Profit |
| 1 | 52024.20656 | 32255.00807 | 42726.2857 | 26490.29713 | 44464.23335 | 27567.82468 |
| 2 | 66105.974 | 40985.70388 | 54291.3178 | 33660.61704 | 56499.68828 | 35029.80674 |
| 3 | 87570.93241 | 54293.97809 | 71919.99503 | 44590.39692 | 74845.43505 | 46404.16973 |
| 4 | 78174.93884 | 48468.46208 | 64203.28137 | 39806.03445 | 66814.83395 | 41425.19705 |
| 5 | 70243.59439 | 43551.02852 | 57689.45038 | 35767.45923 | 60036.04435 | 37222.3475 |
| 6 | 64129.79785 | 39760.47467 | 52668.32973 | 32654.36443 | 54810.68304 | 33982.62349 |
| 7 | 60949.10191 | 37788.44319 | 50056.09722 | 31034.78028 | 52092.19456 | 32297.16063 |
| 8 | 69579.43997 | 43139.25278 | 57143.99561 | 35429.27728 | 59468.4025 | 36870.40955 |
| 9 | 70364.51734 | 43626.00075 | 57788.76161 | 35829.0322 | 60139.3952 | 37286.42503 |
| 10 | 48894.21667 | 30314.41434 | 40155.69691 | 24896.53208 | 41789.08249 | 25909.23115 |
| 11 | 65263.90461 | 40463.62086 | 53599.74556 | 33231.84225 | 55779.98543 | 34583.59097 |
| 12 | 74677.52084 | 46300.06292 | 61330.93231 | 38025.17803 | 63825.64833 | 39571.90196 |
| 13 | 62017.03597 | 38450.5623 | 50933.16693 | 31578.5635 | 53004.94023 | 32863.06294 |
| 14 | 64204.87363 | 39807.02165 | 52729.98774 | 32692.5924 | 54874.84907 | 34022.40643 |
| 15 | 120602.3923 | 74773.48325 | 99047.97424 | 61409.74403 | 103076.8804 | 63907.66582 |
|  | SUM-P | 653977.5173 | SUM-P | 537096.7112 | SUM-P | 558943.8236 |
|  | AVERAGE-P | 43598.50116 | AVERAGE-P | 35806.44742 | AVERAGE-P | 37262.92158 |