**ISM 6137 - Statistical Data Mining**

**Assignment 8**

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1. Predictor table



1. **Cleanup & Feature Engineering**

### Remove Oral Hygiene Transactions

df2 <- df2[df2$CATEGORY != "ORAL HYGIENE PRODUCTS", ]

### Remove Parking column because we wont use it and it has 300K+ missing values

df2 <- df2[ , -which(names(df2) %in% c("PARKING"))]

### Remove NAs

colSums(is.na(df2))

df2 <- df2[complete.cases(df2), ]

### Make appropriate variables into factors

factors <- c('CATEGORY', 'SUB\_CATEGORY', 'DESCRIPTION', 'MANUFACTURER', 'MSA', 'SEGMENT', 'CITY', 'STATE', 'PRODUCT\_SIZE')

df2[, factors] <- lapply(df2[, factors], factor)

### FEATURE ENGINEERING

df2$DISCOUNT\_AMOUNT <- df2$BASE\_PRICE - df2$PRICE #creating column that tells us the price difference amount

df2$SPEND <- round(df2$SPEND)

Created new variable – DISCOUNT\_AMOUNT to account for the magnitude of change in base price and selling price. Rounded Spend to nearest dollar amount so we can apply poisson models on it.

1. **Descriptive Analysis**

Histogram of the three target variables to understand their distributions

Chart, histogram

Description automatically generatedChart, histogram

Description automatically generatedChart

Description automatically generated

Can see all are exponentially distributed, thus a poisson family model would likely be most appropriate here. For SPEND we rounded to the nearest integer value to enable use of poisson models

Diagram

Description automatically generated

Based on correlation matrix, excluded highly correlated predictors that can substitute for one another such as price and base price.

1. **Questions**
2. **What are the effects of product display, being featured on in-store circular, and temporary price reduction on product sales (spend), unit sales, and number of household purchasers?**

Models:

Q1spend\_nbinom <- glm.nb(SPEND ~ SEGMENT + SIZE + MANUFACTURER + CATEGORY + PRICE + DISPLAY + DISCOUNT\_AMOUNT+FEATURE + TPR\_ONLY + MSA + AVG\_WEEKLY\_BASKETS + PRODUCT\_SIZE, data=df2)

Q1unit\_nbinom <- glm.nb(UNITS ~ SEGMENT + SIZE + MANUFACTURER + CATEGORY + PRICE + DISPLAY + DISCOUNT\_AMOUNT+ FEATURE + TPR\_ONLY + MSA + AVG\_WEEKLY\_BASKETS + PRODUCT\_SIZE, data=df2)

Q1hhs\_nbinom <- glm.nb(HHS ~ SEGMENT + SIZE + MANUFACTURER + CATEGORY + PRICE + DISCOUNT\_AMOUNT+ DISPLAY + FEATURE + TPR\_ONLY + MSA + AVG\_WEEKLY\_BASKETS + PRODUCT\_SIZE, data=df2)

Promotion on Targets Model Results

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Dependent variable:

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SPEND UNITS HHS

(1) (2) (3)

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SEGMENTUPSCALE 0.103\*\*\* (0.003) 0.089\*\*\* (0.003) 0.087\*\*\* (0.002)

SEGMENTVALUE -0.197\*\*\* (0.003) -0.194\*\*\* (0.003) -0.229\*\*\* (0.003)

SIZE 0.00001\*\*\* (0.00000) 0.00001\*\*\* (0.00000) 0.00001\*\*\* (0.000)

MANUFACTURERGENERAL MI 0.567\*\*\* (0.016) 0.841\*\*\* (0.016) 0.748\*\*\* (0.015)

MANUFACTURERKELLOGG -0.125\*\*\* (0.020) 0.175\*\*\* (0.020) 0.077\*\*\* (0.019)

MANUFACTURERKING -0.321\*\*\* (0.021) 0.212\*\*\* (0.021) 0.190\*\*\* (0.021)

MANUFACTURERMKSL -1.406\*\*\* (0.007) -1.297\*\*\* (0.007) -1.325\*\*\* (0.007)

MANUFACTURERPOST FOODS -0.154\*\*\* (0.018) 0.134\*\*\* (0.018) -0.022 (0.017)

MANUFACTURERPRIVATE LABEL -0.838\*\*\* (0.017) -0.398\*\*\* (0.017) -0.471\*\*\* (0.017)

MANUFACTURERQUAKER -0.170\*\*\* (0.013) 0.108\*\*\* (0.012) 0.091\*\*\* (0.012)

MANUFACTURERSHULTZ -0.415\*\*\* (0.008) -0.202\*\*\* (0.008) -0.533\*\*\* (0.008)

MANUFACTURERSNYDER S -0.176\*\*\* (0.005) -0.146\*\*\* (0.005) -0.180\*\*\* (0.005)

MANUFACTURERTOMBSTONE 0.536\*\*\* (0.018) 1.043\*\*\* (0.018) 1.056\*\*\* (0.017)

MANUFACTURERTONYS -0.244\*\*\* (0.018) 0.297\*\*\* (0.018) 0.277\*\*\* (0.018)

CATEGORYCOLD CEREAL 0.708\*\*\* (0.010) 0.466\*\*\* (0.010) 0.567\*\*\* (0.009)

CATEGORYFROZEN PIZZA 1.721\*\*\* (0.020) 1.195\*\*\* (0.019) 1.188\*\*\* (0.019)

PRICE -0.342\*\*\* (0.003) -0.591\*\*\* (0.003) -0.577\*\*\* (0.003)

DISPLAY 0.457\*\*\* (0.003) 0.473\*\*\* (0.003) 0.459\*\*\* (0.003)

FEATURE 0.305\*\*\* (0.004) 0.339\*\*\* (0.004) 0.277\*\*\* (0.004)

TPR\_ONLY -0.134\*\*\* (0.003) -0.088\*\*\* (0.003) -0.105\*\*\* (0.003)

MSA17140 0.466\*\*\* (0.009) 0.445\*\*\* (0.009) 0.541\*\*\* (0.009)

MSA17780 -0.341\*\*\* (0.013) -0.376\*\*\* (0.013) -0.284\*\*\* (0.013)

MSA19100 0.187\*\*\* (0.009) 0.174\*\*\* (0.009) 0.273\*\*\* (0.009)

MSA19380 0.636\*\*\* (0.010) 0.606\*\*\* (0.010) 0.705\*\*\* (0.009)

MSA26420 0.037\*\*\* (0.009) 0.016\* (0.009) 0.118\*\*\* (0.009)

MSA43300 0.007 (0.013) -0.0003 (0.013) 0.076\*\*\* (0.012)

MSA44220 0.328\*\*\* (0.012) 0.306\*\*\* (0.012) 0.405\*\*\* (0.012)

MSA47540 0.570\*\*\* (0.012) 0.558\*\*\* (0.012) 0.633\*\*\* (0.012)

AVG\_WEEKLY\_BASKETS 0.00002\*\*\* (0.00000) 0.00002\*\*\* (0.00000) 0.00002\*\*\* (0.000)

PRODUCT\_SIZE11 OZ 0.339\*\*\* (0.016) 0.305\*\*\* (0.016) 0.436\*\*\* (0.015)

PRODUCT\_SIZE12 OZ 0.254\*\*\* (0.012) 0.188\*\*\* (0.012) 0.210\*\*\* (0.012)

PRODUCT\_SIZE12.2 OZ 0.706\*\*\* (0.017) 0.625\*\*\* (0.016) 0.708\*\*\* (0.016)

PRODUCT\_SIZE12.25 OZ 0.476\*\*\* (0.014) 0.437\*\*\* (0.014) 0.451\*\*\* (0.014)

PRODUCT\_SIZE13 OZ 0.192\*\*\* (0.007) 0.172\*\*\* (0.007) 0.131\*\*\* (0.007)

PRODUCT\_SIZE13.2 OZ 0.142\*\*\* (0.015) 0.144\*\*\* (0.017) 0.097\*\*\* (0.016)

PRODUCT\_SIZE13.3 OZ 0.070\*\*\* (0.016) 0.071\*\*\* (0.018) 0.023 (0.017)

PRODUCT\_SIZE14 OZ

PRODUCT\_SIZE14.7 OZ

PRODUCT\_SIZE15 OZ 1.051\*\*\* (0.017) 0.959\*\*\* (0.016) 1.037\*\*\* (0.016)

PRODUCT\_SIZE16 OZ 0.461\*\*\* (0.005) 0.415\*\*\* (0.006) 0.492\*\*\* (0.005)

PRODUCT\_SIZE18 OZ 0.984\*\*\* (0.015) 0.868\*\*\* (0.014) 0.817\*\*\* (0.014)

PRODUCT\_SIZE20 OZ 0.677\*\*\* (0.016) 0.650\*\*\* (0.015) 0.569\*\*\* (0.015)

PRODUCT\_SIZE22.7 OZ 0.142\*\*\* (0.009) 0.137\*\*\* (0.010) 0.136\*\*\* (0.010)

PRODUCT\_SIZE26.11 OZ -0.076\*\*\* (0.009) -0.095\*\*\* (0.011) -0.102\*\*\* (0.010)

PRODUCT\_SIZE27.35 OZ

PRODUCT\_SIZE28.3 OZ 0.280\*\*\* (0.008) 0.295\*\*\* (0.008) 0.242\*\*\* (0.008)

PRODUCT\_SIZE29.6 OZ 0.219\*\*\* (0.008) 0.220\*\*\* (0.008) 0.167\*\*\* (0.008)

PRODUCT\_SIZE29.8 OZ -0.296\*\*\* (0.008) -0.308\*\*\* (0.008) -0.315\*\*\* (0.008)

PRODUCT\_SIZE30.5 OZ 0.040\*\*\* (0.008) 0.041\*\*\* (0.008) 0.011 (0.008)

PRODUCT\_SIZE32.7 OZ

Constant 2.965\*\*\* (0.013) 2.679\*\*\* (0.013) 2.400\*\*\* (0.013)

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Observations 418,555 418,555 418,555

Log Likelihood -1,973,374.000 -1,525,447.000 -1,454,694.000

theta 2.770\*\*\* (0.006) 3.282\*\*\* (0.009) 3.669\*\*\* (0.010)

Akaike Inf. Crit. 3,946,842.000 3,050,988.000 2,909,481.000

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Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

**FEATURE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | β - Coefficient | Exp(β)-1 | Interpretation |
| Spend | 0.305 | 0.356 | Being featured in circular produces 35.6% increase in total spend |
| Units | 0.339 | 0.403 | Being featured in circular produces 40.3% increase in total units sold |
| HHS | 0.277 | 0.319 | Being featured in circular produces 31.9% increase in total number of households that buy the product |

**DISPLAY**

|  |  |  |  |
| --- | --- | --- | --- |
|  | β - Coefficient | Exp(β) -1 | Interpretation |
| Spend | 0.457 | 0.579 | Being on display produces 57.9% increase in total spend |
| Units | 0.493 | 0.637 | Being on display produces 63.7% increase in total units sold |
| HHS | 0.473 | 0.604 | Being on display produces 60.4% increase in total number of households that buy the product |

**TPR**

|  |  |  |  |
| --- | --- | --- | --- |
|  | β - Coefficient | Exp(β) -1 | Interpretation |
| Spend | -0.134 | -0.125 | Being on TPR produces 12.5% decrease in total spend |
| Units | -0.088 | -0.084 | Being on TPR produces 8.4% decrease in total units sold |
| HHS | -0.105 | -0.099 | Being on TPR produce 9.9% decrease in total number of households that buy the product |

1. **How do the effects of display, feature, and TPR on SPEND vary by product categories (cold cereals, frozen pizza, bag snacks) and store segments (mainstream, upscale, value)?**

Model Summary:

Call:

glm.nb(formula = SPEND ~ SEGMENT + SIZE + MANUFACTURER + CATEGORY + +PRICE + DISPLAY + FEATURE + TPR\_ONLY + MSA + AVG\_WEEKLY\_BASKETS + DISCOUNT\_AMOUNT + DISPLAY \* CATEGORY + DISPLAY \* SEGMENT + FEATURE \* CATEGORY + FEATURE \* SEGMENT + TPR\_ONLY \* CATEGORY + TPR\_ONLY \* SEGMENT, data = df2, init.theta = 2.598404521, link = log)

Deviance Residuals:

Min 1Q Median 3Q Max

-4.326 -0.890 -0.228 0.433 9.196

Coefficients:

Estimate Std. Error z value Pr(>|z|)

(Intercept) 2.756522042 0.012934766 213.11 < 0.0000000000002 \*\*\*

SEGMENTUPSCALE 0.127787681 0.002992946 42.70 < 0.0000000000002 \*\*\*

SEGMENTVALUE -0.193258870 0.003183880 -60.70 < 0.0000000000002 \*\*\*

SIZE 0.000006605 0.000000126 52.53 < 0.0000000000002 \*\*\*

MANUFACTURERGENERAL MI 1.099516561 0.006863585 160.20 < 0.000000000002 \*\*\*

MANUFACTURERKELLOGG 0.813550941 0.006979975 116.55 < 0.0000000000002 \*\*\*

MANUFACTURERKING 0.193185307 0.008708621 22.18 < 0.0000000000002 \*\*\*

MANUFACTURERMKSL -1.138833260 0.007203841 -158.09 < 0.00000000000002 \*\*\*

MANUFACTURERPOST FOODS 0.686651732 0.007113802 96.52 < 0.0000000000002 \*\*\*

MANUFACTURERPRIVATE LABEL 0.172616709 0.006517964 26.48 < 0.0000000000002 \*\*\*

MANUFACTURERQUAKER 0.062007498 0.007354254 8.43 < 0.0000000000002 \*\*\*

MANUFACTURERSHULTZ -0.109881699 0.007523239 -14.61 < 0.0000000000002 \*\*\*

MANUFACTURERSNYDER S -0.165047447 0.005228479 -31.57 < 0.0000000000002 \*\*\*

MANUFACTURERTOMBSTONE 0.960793777 0.007569329 126.93 < 0.0000000000002 \*\*\*

MANUFACTURERTONYS 0.130194939 0.008061998 16.15 < 0.0000000000002 \*\*\*

CATEGORYCOLD CEREAL 0.278058901 0.005319061 52.28 < 0.0000000000002 \*\*\*

CATEGORYFROZEN PIZZA 0.307546265 0.008120960 37.87 < 0.0000000000002 \*\*\*

PRICE -0.144928486 0.002604399 -55.65 < 0.0000000000002 \*\*\*

DISPLAY 0.519851947 0.006215626 83.64 < 0.0000000000002 \*\*\*

FEATURE 0.128867221 0.012105768 10.65 < 0.0000000000002 \*\*\*

TPR\_ONLY -0.184469592 0.006298420 -29.29 < 0.0000000000002 \*\*\*

MSA17140 0.417466982 0.009251898 45.12 < 0.0000000000002 \*\*\*

MSA17780 -0.344797565 0.013147977 -26.22 < 0.0000000000002 \*\*\*

MSA19100 0.171651292 0.009355189 18.35 < 0.0000000000002 \*\*\*

MSA19380 0.585051304 0.009938080 58.87 < 0.0000000000002 \*\*\*

MSA26420 0.031592867 0.009304054 3.40 0.00068 \*\*\*

MSA43300 0.005578622 0.012994608 0.43 0.66770

MSA44220 0.275838188 0.012373466 22.29 < 0.0000000000002 \*\*\*

MSA47540 0.512617310 0.012495939 41.02 < 0.0000000000002 \*\*\*

AVG\_WEEKLY\_BASKETS 0.000018251 0.000000171 106.65 < 0.0000000000002 \*\*\*

DISCOUNT\_AMOUNT 0.123964385 0.003928476 31.56 < 0.0000000000002 \*\*\*

CATEGORYCOLD CEREAL:DISPLAY -0.057631285 0.008695938 -6.63 0.00000003417 \*\*\*

CATEGORYFROZEN PIZZA:DISPLAY -0.089470158 0.008494397 -10.53 < 0.0000000000002 \*\*\*

SEGMENTUPSCALE:DISPLAY -0.063452038 0.008581447 -7.39 0.00000000014 \*\*\*

SEGMENTVALUE:DISPLAY 0.044501218 0.009043992 4.92 0.00086311052 \*\*\*

CATEGORYCOLD CEREAL:FEATURE 0.373972766 0.013154601 28.43 < 0.0000000000002 \*\*\*

CATEGORYFROZEN PIZZA:FEATURE 0.166165188 0.013328993 12.47 < 0.0000000000002 \*\*\*

SEGMENTUPSCALE:FEATURE -0.176863935 0.009564165 -18.49 < 0.0000000000002 \*\*\*

SEGMENTVALUE:FEATURE 0.053885440 0.009394256 5.74 0.00000969395 \*\*\*

CATEGORYCOLD CEREAL:TPR\_ONLY 0.148995485 0.007399170 20.14 < 0.0000000000002 \*\*\*

CATEGORYFROZEN PIZZA:TPR\_ONLY 0.130509942 0.009156233 14.25 < 0.0000000000002 \*\*\*

SEGMENTUPSCALE:TPR\_ONLY -0.042875019 0.007969097 -5.38 0.00007441967 \*\*\*

SEGMENTVALUE:TPR\_ONLY -0.145177308 0.007717551 -18.81 < 0.0000000000002 \*\*\*

**DISPLAY**

The marginal effects of the varying effect of display on spend by category and segment is modeled by the equation

D(Log(spend))/d(Display) = 0.519 - 0.057\* CATEGORYCOLDCEREAL –(0.089\* CATEGORYFROZENPIZZA) – (0.06\* SEGMENTUPSCALE) + (0.044\* SEGMENTVALUE)

Thus the effect depends on each category and the store segment it is being displayed in. For example, the effect on cold cereal in an upscale store would be exp(0.519-0.057-0.089)-1 = 0.45 meaning a 45% increase in spend compared to base level of bag snacks and mainstream segments

**FEATURE**

The marginal effects of the effect of feature on spend varying by category and segment is modeled by the equation

D(Log(spend)/d(FEATURE) = 0.12 + 0.37\* CATEGORYCOLDCEREAL+(0.16\* CATEGORYFROZENPIZZA) – (0.17\* SEGMENTUPSCALE) + (0.053\* SEGMENTVALUE)

Thus the effect depends on each category and the store segment it is being featured in. For example, the effect on cold cereal in an upscale store would be exp(0.12+0.37+0.17)-1 = 0.93 meaning a 93% increase in spend compared to base level of bag snacks and mainstream segments

**TPR**

The effect of TPR on spend varying by category and segment is modeled by the equation

D(Log(spend))/d(TPR\_ONLY) = -0.18 + 0.14\* CATEGORYCOLDCEREAL\* TPR +(0.13\* CATEGORYFROZENPIZZA\* TPR) – (0.14\* SEGMENTUPSCALE\*TPR) + (0.04\* SEGMENTVALUE\*TPR)

Thus the effect depends on each category and the store segment it is on TPR in. For example, the effect on cold cereal in an upscale store would be exp(-0.18+0.14-0.14)-1 = -0.16 meaning a 16% decrease in spend compared to base level of bag snacks and mainstream segments

1. **What are the five most price elastic and five least price elastic products? Price elasticity is the change in sales for unit change in product price?**

> Q3Price\_elas <-glm.nb(UNITS ~ SEGMENT + CATEGORY + PRICE + DISPLAY + FEATURE + TPR\_ONLY + MSA + AVG\_WEEKLY\_BASKETS + DISCOUNT\_AMOUNT + PRICE\*UPC, data=df3)

summary(Q3Price\_elas)

Call:

glm.nb(formula = UNITS ~ SEGMENT + CATEGORY + +PRICE + DISPLAY +

FEATURE + TPR\_ONLY + MSA + AVG\_WEEKLY\_BASKETS + DISCOUNT\_AMOUNT +

PRICE \* UPC, data = df3, init.theta = 3.748724032, link = log)

Deviance Residuals:

Min 1Q Median 3Q Max

-5.068 -0.844 -0.201 0.457 10.709

Coefficients: (2 not defined because of singularities)

Estimate Std. Error z value Pr(>|z|)

(Intercept) 2.359518730 0.033230695 71.00 < 0.0000000000002 \*\*\*

SEGMENTUPSCALE 0.118029430 0.002332370 50.60 < 0.0000000000002 \*\*\*

SEGMENTVALUE -0.253153774 0.002376049 -106.54 < 0.0000000000002 \*\*\*

CATEGORYCOLD CEREAL 2.256145798 0.050827139 44.39 < 0.0000000000002 \*\*\*

CATEGORYFROZEN PIZZA 0.626273868 0.057922240 10.81 < 0.0000000000002 \*\*\*

PRICE 0.443062270 0.024514684 18.07 < 0.0000000000002 \*\*\*

DISPLAY 0.432709546 0.003331296 129.89 < 0.0000000000002 \*\*\*

FEATURE 0.344961296 0.004365110 79.03 < 0.0000000000002 \*\*\*

TPR\_ONLY -0.076075845 0.003858144 -19.72 < 0.0000000000002 \*\*\*

MSA17140 0.440187223 0.008541548 51.53 < 0.0000000000002 \*\*\*

MSA17780 -0.485031078 0.012202197 -39.75 < 0.0000000000002 \*\*\*

MSA19100 0.201239054 0.008595485 23.41 < 0.0000000000002 \*\*\*

MSA19380 0.583335199 0.009158768 63.69 < 0.0000000000002 \*\*\*

MSA26420 0.006824941 0.008552291 0.80 0.42486

MSA43300 -0.041534187 0.011947772 -3.48 0.00051 \*\*\*

MSA44220 0.233020199 0.011349362 20.53 < 0.0000000000002 \*\*\*

MSA47540 0.605266615 0.011359769 53.28 < 0.0000000000002 \*\*\*

AVG\_WEEKLY\_BASKETS 0.000024709 0.000000109 226.49 < 0.0000000000002 \*\*\*

DISCOUNT\_AMOUNT 0.032499183 0.003975926 8.17 0.0000000000003 \*\*\*

UPC1111009497 0.314828279 0.044979615 7.00 0.0000000025714 \*\*\*

UPC1111009507 -0.909783218 0.047466058 -19.17 < 0.0000000000002 \*\*\*

UPC1111085319 -2.099137207 0.082358303 -25.49 < 0.0000000000002 \*\*\*

UPC1111085345 -0.714566701 0.080881040 -8.83 < 0.0000000000002 \*\*\*

UPC1111085350 -0.928749150 0.064620753 -14.37 < 0.0000000000002 \*\*\*

UPC1111087395 0.995518722 0.061402760 16.21 < 0.0000000000002 \*\*\*

UPC1111087396 1.561421516 0.062322532 25.05 < 0.0000000000002 \*\*\*

UPC1111087398 0.787469212 0.060843994 12.94 < 0.0000000000002 \*\*\*

UPC1600027527 0.608934076 0.053063584 11.48 < 0.0000000000002 \*\*\*

UPC1600027528 -0.615402200 0.054215855 -11.35 < 0.0000000000002 \*\*\*

UPC1600027564 -1.151641949 0.051158984 -22.51 < 0.0000000000002 \*\*\*

UPC2066200530 0.642321102 0.111609199 5.76 0.0000086595107 \*\*\*

UPC2066200531 0.344033697 0.128705924 2.67 0.00752 \*\*

UPC2066200532 0.554732138 0.139745821 3.97 0.0000719996030417 \*\*\*

UPC2840002333 0.447804952 0.073090327 6.13 0.0000008970153 \*\*\*

UPC2840004768 1.265685953 0.064090856 19.75 < 0.0000000000002 \*\*\*

UPC2840004770 1.135049643 0.065679461 17.28 < 0.0000000000002 \*\*\*

UPC3000006340 -0.590351930 0.050064706 -11.79 < 0.0000000000002 \*\*\*

UPC3000006560 0.274376889 0.058960509 4.65 0.0000032623585447 \*\*\*

UPC3000006610 0.512178655 0.057288535 8.94 < 0.0000000000002 \*\*\*

UPC3800031829 -1.059590013 0.057030306 -18.58 < 0.0000000000002 \*\*\*

UPC3800031838 0.552350203 0.053593557 10.31 < 0.0000000000002 \*\*\*

UPC3800039118 1.368580763 0.051637079 26.50 < 0.0000000000002 \*\*\*

UPC7027312504 0.239256995 0.057104645 4.19 0.0000279201467024 \*\*\*

UPC7027316204 0.391839475 0.054313120 7.21 0.0000000005415 \*\*\*

UPC7027316404 0.402673912 0.055159100 7.30 0.0000000002873 \*\*\*

UPC7110410455 0.912365758 0.094811341 9.62 < 0.0000000000002 \*\*\*

UPC7110410470 0.168422626 0.097701236 1.72 0.08473 .

UPC7110410471 0.859389502 0.102904543 8.35 < 0.0000000000002 \*\*\*

UPC7192100336 0.964160580 0.058335390 16.53 < 0.0000000000002 \*\*\*

UPC7192100337 0.754704581 0.057407055 13.15 < 0.000000000002 \*\*\*

UPC7192100339 0.870664374 0.056839063 15.32 < 0.000000000002 \*\*\*

UPC7218063052 0.673811708 0.058496362 11.52 < 0.0000000000002 \*\*\*

UPC7218063979 0.851266487 0.059396362 14.33 < 0.0000000000002 \*\*\*

UPC7218063983 NA NA NA NA

UPC7797502248 1.223057068 0.061315955 19.95 < 0.000000000002 \*\*\*

UPC7797508004 0.581113911 0.066932214 8.68 < 0.000000000002 \*\*\*

UPC7797508006 0.488034197 0.065878499 7.41 0.0000000001281 \*\*\*

UPC88491201426 -0.783457912 0.078469993 -9.98 < 0.0000000000002 \*\*\*

UPC88491201427 0.045442746 0.072296223 0.63 0.52964

UPC88491212971 NA NA NA NA

PRICE:UPC1111009497 -0.404012817 0.034137008 -11.84 < 0.0000000000000002 \*\*\*

PRICE:UPC1111009507 0.020026577 0.035804406 0.56 0.57593

PRICE:UPC1111085319 -0.654897519 0.047469677 -13.80 < 0.000000000002 \*\*\*

PRICE:UPC1111085345 -1.221301442 0.046691029 -26.16 < 0.000000000002 \*\*\*

PRICE:UPC1111085350 -0.914952734 0.033960774 -26.94 < 0.000000000002 \*\*\*

PRICE:UPC1111087395 -1.129211735 0.026596185 -42.46 < 0.000000000002 \*\*\*

PRICE:UPC1111087396 -1.278922578 0.026793283 -47.73 < 0.000000000002 \*\*\*

PRICE:UPC1111087398 -1.007582539 0.026462945 -38.08 < 0.000000000002 \*\*\*

PRICE:UPC1600027527 -1.210261807 0.027577029 -43.89 < 0.000000000002 \*\*\*

PRICE:UPC1600027528 -0.834551578 0.025918393 -32.20 < 0.000000000002 \*\*\*

PRICE:UPC1600027564 -0.717327171 0.027084571 -26.48 < 0.000000000002 \*\*\*

PRICE:UPC2066200530 -0.904120175 0.029930948 -30.21 < 0.000000000002 \*\*\*

PRICE:UPC2066200531 -0.866316425 0.031773707 -27.27 < 0.000000000002 \*\*\*

PRICE:UPC2066200532 -0.914069562 0.033072806 -27.64 < 0.000000000002 \*\*\*

PRICE:UPC2840002333 -1.025595194 0.033280909 -30.82 < 0.000000000002 \*\*\*

PRICE:UPC2840004768 -1.113706097 0.031003769 -35.92 < 0.000000000002 \*\*\*

PRICE:UPC2840004770 -1.155839095 0.031421802 -36.78 < 0.000000000002 \*\*\*

PRICE:UPC3000006340 -1.363178239 0.026976154 -50.53 < 0.000000000002 \*\*\*

PRICE:UPC3000006560 -1.434797877 0.030198331 -47.51 < 0.000000000002 \*\*\*

PRICE:UPC3000006610 -1.735150166 0.029777797 -58.27 < 0.000000000002 \*\*\*

PRICE:UPC3800031829 -0.778387876 0.027574063 -28.23 < 0.000000000002 \*\*\*

PRICE:UPC3800031838 -1.284177836 0.027508427 -46.68 < 0.000000000002 \*\*\*

PRICE:UPC3800039118 -1.689035875 0.027017607 -62.52 < 0.000000000002 \*\*\*

PRICE:UPC7027312504 -0.904776810 0.035246263 -25.67 < 0.000000000002 \*\*\*

PRICE:UPC7027316204 -0.858639989 0.034596922 -24.82 < 0.000000000002 \*\*\*

PRICE:UPC7027316404 -0.858142216 0.034930007 -24.57 < 0.000000000002 \*\*\*

PRICE:UPC7110410455 -1.555627553 0.046437361 -33.50 < 0.000000000002 \*\*\*

PRICE:UPC7110410470 -1.252491756 0.047477678 -26.38 < 0.000000000002 \*\*\*

PRICE:UPC7110410471 -1.660316017 0.049964579 -33.23 < 0.000000000002 \*\*\*

PRICE:UPC7192100336 -0.895388927 0.025379651 -35.28 < 0.000000000002 \*\*\*

PRICE:UPC7192100337 -0.809070825 0.025301671 -31.98 < 0.000000000002 \*\*\*

PRICE:UPC7192100339 -0.780168696 0.025254959 -30.89 < 0.000000000002 \*\*\*

PRICE:UPC7218063052 -0.902401476 0.025374542 -35.56 < 0.000000000002 \*\*\*

PRICE:UPC7218063979 -0.952444498 0.025448669 -37.43 < 0.0000000000002 \*\*\*

PRICE:UPC7218063983 -0.829562276 0.025551219 -32.47 < 0.0000000000002 \*\*\*

PRICE:UPC7797502248 -1.400908939 0.032986236 -42.47 < 0.0000000000002 \*\*\*

PRICE:UPC7797508004 -0.972321942 0.031895423 -30.48 < 0.0000000000002 \*\*\*

PRICE:UPC7797508006 -0.935733118 0.031619400 -29.59 < 0.0000000000002 \*\*\*

PRICE:UPC88491201426 -0.871931765 0.032334650 -26.97 < 0.0000000000002 \*\*\*

PRICE:UPC88491201427 -1.151018639 0.030760935 -37.42 < 0.0000000000002 \*\*\*

PRICE:UPC88491212971 -1.374509297 0.028753596 -47.80 < 0.0000000000002 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for Negative Binomial(3.749) family taken to be 1)

Null deviance: 1395181 on 418554 degrees of freedom

Residual deviance: 434836 on 418456 degrees of freedom

AIC: 3007741

The five least price elastic products are those for which a change in price has the least effect on unit sales (β is closest to 0). The most elastic are those for which a change in price has the greatest effect (β is farthest from 0). They are shown in respective tables below.

Least Elastic Most Elastic

|  |  |
| --- | --- |
| Product | β-Coefficient |
| PRICE:UPC1111009507 | 0.02002658 |
| PRICE:UPC1111009497 | -0.4040128 |
| PRICE:UPC1111085319 | -0.6548975 |
| PRICE:UPC1600027564 | -0.7173272 |
| PRICE:UPC3800031829 | -0.7783879 |

|  |  |
| --- | --- |
| Product | β-Coefficient |
| PRICE:UPC3000006610 | -1.7351502 |
| PRICE:UPC3800039118 | -1.6890359 |
| PRICE:UPC7110410471 | -1.660316 |
| PRICE:UPC7110410455 | -1.5556276 |
| PRICE:UPC3000006560 | -1.4347979 |

1. **As the retailer, which products would you lower the price to maximize (a) product sales and (b) unit sales, and why?**
2. From the above output of price elasticity on unit sales, we would recommend lowering the price of the top 5 least elastic products shown in the table above to maximize unit sales
3. For maximizing product sales (SPEND) we need to create one more model similar to the one shown for unit sales. Based on the output of that we find that lowering price on the following products would have the greatest effect (Most Elastic) on maximizing spend. For sake of brevity, the entire model summary output is not shown here – the model is used is the same as that in the previous question, with the y variable changed from UNITS to SPEND

|  |  |
| --- | --- |
| Product | β-Coefficient |
| PRICE:UPC3000006560 | -1.4347979 |
| PRICE:UPC7110410455 | -1.5556276 |
| PRICE:UPC7110410471 | -1.660316 |
| PRICE:UPC3800039118 | -1.6890359 |
| PRICE:UPC3000006610 | -1.7351502 |

The model used for the above analysis was

> Q4Spend\_PriceElas <-glm.nb(SPEND ~ SEGMENT + CATEGORY + PRICE + DISPLAY + FEATURE + TPR\_ONLY + MSA + AVG\_WEEKLY\_BASKETS + DISCOUNT\_AMOUNT + PRICE\*UPC, data=df3)

Graphical user interface, text, application

Description automatically generated