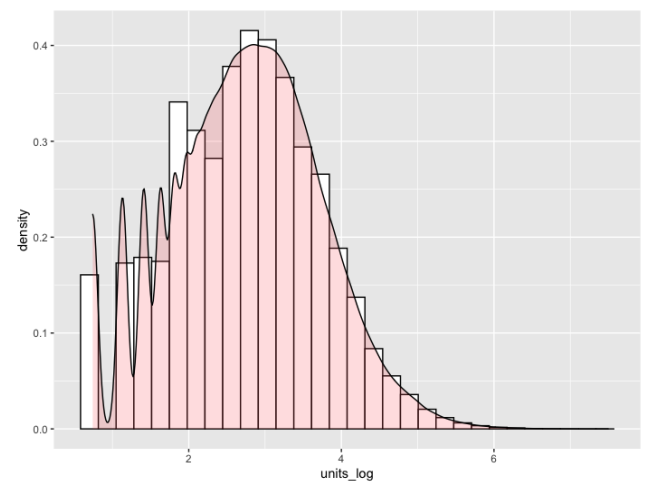
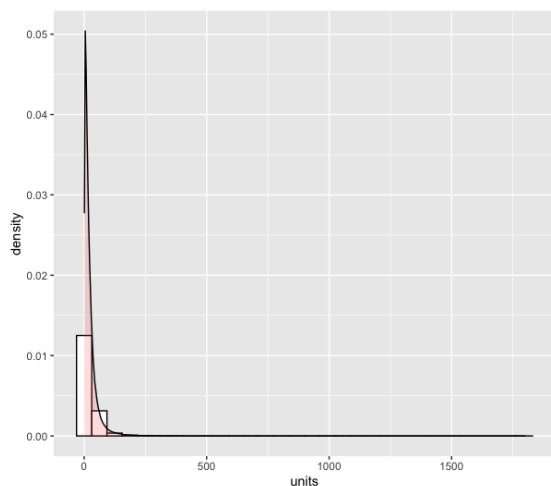
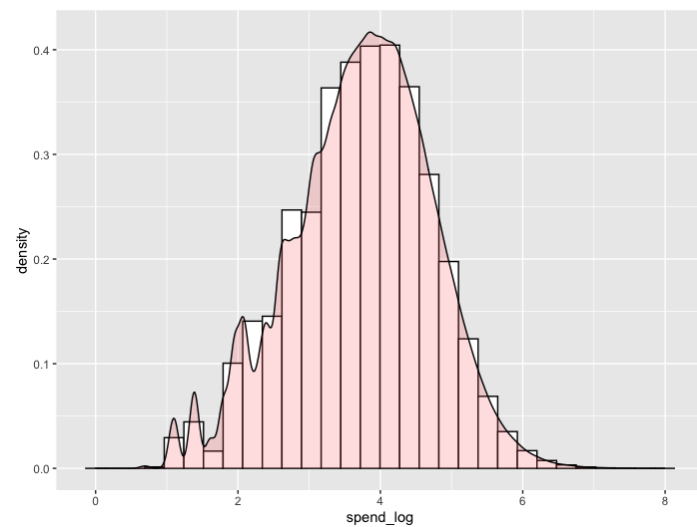
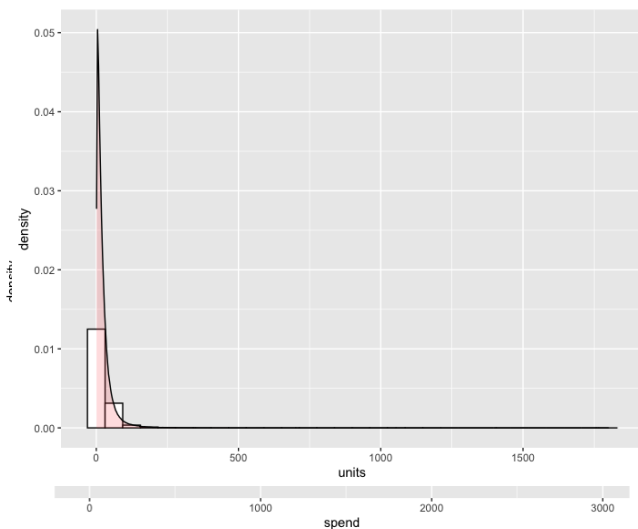


## Feature Engineering

I removed, NAs, and zeros from the dataset. I created a product column to denote the product names. I then created a yes | no version of the categorical columns in the dataset to create graphics. I transformed the following columns and added \_char to the new column name for feature, display, and tpr\_only. I then factored the following columns: description, product, manufacturer, category, and segment.

## Descriptive Statistics

I took the log +1 of the dependent variables spend, units, hhs supporting information will be found below. I used a log to bring the dependent variable to a 'somewhat normal' distribution. **I chose to use lmer models for units because of the long right tail does not fit Poisson Distribution.**



Predictor Table for A8. Snack Chain						
predictor	effect	rationale				
Target (y)			Question1	Question2	Question3	Question4
spend	dv	total spend (i.e., \$ sales)	DV M1	DV		DV M1
units	+	More units sold the more spend.	DV M2			DV M2
hhs	+	May show the level of price elasticity of products.	DV M3			
Predictors						
store_id	NA	Will use store_id for some models	levels			
state	NA	Will use state for some models	levels			
segment	+/-	Segment may effect which products do well with different level income customers.		levels+interaction		
category	Need	Need this variable to understand price elasticity of display effects.		levels+interaction		
product	Need	Will use product for some models				levels+interaction
display	Need	product was a part of in-store promotional display	Used IV #1	Used IV #1		
feature	Need	product was in in-store circular	Used as IV #2	Used as IV #2		
tpr_only	Need	temporary price reduction only	Used as IV #3	Used as IV #3		
price	Need	actual amount charged for the product at shelf				Used IV #1
store_num	NA	Need for the join.				
upc	NA	Need for the join.				
Excluded						
parking	??	Data looks incomplete; I will remove this variable.				
store_name	NA	Nice to use to see which stores are doing well for my report.				
base_price	NA	base price of item				
upc	NA	Data appears to be multi-level. I plan on using upc for some of my extra models.				
city	NA	Nice to see which cities are doing well for my report.				
msa	NA	Seems there are 3 different levels within msa.				
sub_category	NA	sub_category is not in scope for this project.				
size	NA	The larger the store the more items the store sells thus more convenient it becomes.				
manufacturer	NA	I will keep in my dataset for exploration purposes				
product_size	+/-	May help show what size product people purchase				
visits	NA	visits have a close relationship with hhs				
week_end_date	+/-	Will be good to add to my model for seasonal sales. Out of scope.				

What are the effects of product display, being featured on in-store circular, and temporary price reduction on product sales (spend) DV, unit sales DV, and number of household purchasers DV? (3 points)

```

A8. Snack Chain Model Output
=====
                                Dependent variable:
-----
                                spend_log    units_log    hhs_log
                                (1)          (2)          (3)
-----
display                        0.518***    0.677***    0.664***
                                (0.005)    (0.005)    (0.005)
feature                        0.737***    0.583***    0.536***
                                (0.005)    (0.005)    (0.005)
tpr_only                       -0.076***  0.186***    0.133***
                                (0.004)    (0.004)    (0.004)
Constant                       3.622***    2.593***    2.475***
                                (0.091)    (0.081)    (0.075)
-----
Observations                   418,554    418,554    418,554
Log Likelihood                 -528,509.500 -533,731.100 -518,984.400
Akaike Inf. Crit.             1,057,033.000 1,067,476.000 1,037,983.000
Bayesian Inf. Crit.           1,057,110.000 1,067,553.000 1,038,059.000
=====
Note:                          *p<0.1; **p<0.05; ***p<0.01
> |

```

model name - DV	display	feature	tpr_only	display marginal effects by 1000	feature marginal effects by 1000	tpr_only marginal effects by 1000
question1a - spend	52%	74%	-8%	520	740	-80
question1b - units	68%	58%	19%	680	580	190
question1b - hhs	66%	54%	13%	660	540	130

The chart above shows the beta coefficients and the marginal effects are in green. Most product promotions will have a positive effect on spending, units sold, and hhs. TPR does reduce spending as customers are purchasing products at a reduced price.

**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)? (3 points)**

A8. Snack Chain Model Output			
Dependent variable:			
spend_log			
display	0.792*** (0.008)	segmentVALUE	-0.324* (0.196)
categoryCOLD CEREAL	0.912 (1.940)	display:categoryCOLD CEREAL	-0.197*** (0.011)
categoryFROZEN PIZZA	0.337 (1.940)	display:categoryFROZEN PIZZA	-0.101*** (0.011)
feature	0.202*** (0.015)	categoryCOLD CEREAL:feature	0.385*** (0.017)
tpr_only	-0.060*** (0.007)	categoryFROZEN PIZZA:feature	0.487*** (0.017)
segmentUPSCALE	0.253 (0.196)	categoryCOLD CEREAL:tpr_only	0.141*** (0.009)
segmentVALUE	-0.324* (0.196)	categoryFROZEN PIZZA:tpr_only	0.297*** (0.011)
display:categoryCOLD CEREAL	-0.197*** (0.011)	display:segmentUPSCALE	-0.018 (0.011)
display:categoryFROZEN PIZZA	-0.101*** (0.011)	display:segmentVALUE	0.050*** (0.012)
categoryCOLD CEREAL:feature	0.385*** (0.017)	feature:segmentUPSCALE	-0.209*** (0.012)
categoryFROZEN PIZZA:feature	0.487*** (0.017)	feature:segmentVALUE	0.053*** (0.012)
categoryCOLD CEREAL:tpr_only	0.141*** (0.009)	tpr_only:segmentUPSCALE	-0.008 (0.010)
categoryFROZEN PIZZA:tpr_only	0.297*** (0.011)	tpr_only:segmentVALUE	-0.142*** (0.010)
display:segmentUPSCALE	-0.018 (0.011)	Constant	3.137** (1.379)
		-----	
		Observations	418,554
		Log Likelihood	-508,891.500
		Akaike Inf. Crit.	1,017,829.000
		Bayesian Inf. Crit.	1,018,081.000
		=====	

effect variable	FROZEN PIZZA	COLD CEREAL	BAG SNACKS compared to cereal	FROZEN PIZZA marginal effects by 1000	COLD CEREAL marginal effects by 1000	BAG SNACKS marginal effects by 1000
display	-10%	-19%	19%	-100	-190	190
feature	49%	39%	-39%	490	390	-390
tpr_only	30%	14%	-14%	300	140	-140
effect variable	UPSCALE	VALUE	MAINSTREAM compared to value	UPSCALE marginal effects by 1000	VALUE marginal effects by 1000	MAINSTREAM marginal effects by 1000
display	-2%	5%	-5%	-20	50	-50
feature	-21%	5%	-5%	-210	50	-50
tpr_only	-1%	-14%	14%	-10	-140	140

Product categories - impulse food purchases like snacks do well while on display. Product categories that may of been a surprise to the customer to see for example pizza or cereal on sale with a TRP or a feature do better than bag snacks.

Store Segments - Any product promotion has a negative effect on spend in upscale stores. Value stores do well with features and displays, but TPR has a negative effect. For Mainstream stores feature and display have a negative effect on spend while TPR has a positive effect.

**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? (3 points)**

TOP 5		BOTTOM 5	
DIGIORNO PEPPERONI PIZZA	59.73	SNYDR SOURDOUGH NIBBLERS	-66.97
DIGIORNO SUPREME PIZZA	45.79	SNYDR PRETZEL RODS	-63.69
DIGIORNO THREE MEAT	35.84	SNYDR FF MINI PRETZELS	-38.67
FRSC BRCK OVN ITL PER PZ	24.71	SHURGD PRETZEL STICKS	-33.76
NWMN OWN 4 CHEESE PIZZA	22.42	SHURGD PRETZEL RODS	-28.29

As the retailer, which products would you lower the price to maximize (a) product sales and (b) unit sales, and why? (1 points)

A8. Snack Chain Model Output		
	Dependent variable:	
	spend_log (1)	units_log (2)
price	-0.414*** (0.007)	-0.495*** (0.007)
productDIGRN PEPP PIZZA	0.181 (1.371)	0.310 (0.912)
productDIGRN SUPREME PIZZA	0.030 (1.371)	0.107 (0.912)
productFRSC 4 CHEESE PIZZA	-1.086 (1.371)	-1.020 (0.912)
productFRSC BRCK OVN ITL PEP PZ	-0.449 (1.371)	-0.426 (0.912)
productFRSC PEPPERONI PIZZA	-0.321 (1.371)	-0.342 (0.912)
productGM CHEERIOS	-1.910 (1.370)	-1.079 (0.911)
productGM HONEY NUT CHEERIOS	0.044 (1.371)	1.055 (0.912)
productKELL BITE SIZE MINI WHEAT	-2.431* (1.371)	-1.732* (0.912)
productKELL FROOT LOOPS	1.047 (1.371)	1.984** (0.912)
productKELL FROSTED FLAKES	0.326 (1.371)	1.274 (0.912)
productMKSL DUTCH PRETZELS	-3.848*** (1.374)	-3.057*** (0.915)
productMKSL MINI TWIST PRETZELS	-3.713*** (1.373)	-2.921*** (0.915)
productMKSL PRETZEL STICKS	-3.742*** (1.374)	-2.940*** (0.916)
productNWMN OWN 4 CHEESE PIZZA	-1.671 (1.377)	-1.529* (0.919)
productNWMN OWN PEPPERONI PIZZA	-1.620 (1.375)	-1.434 (0.917)
productNWMN OWN SUPREME PIZZA	-1.582 (1.378)	-1.486 (0.921)
productPL BT SZ FRSTD SHRD WHT	-2.065 (1.531)	-0.681 (1.108)
productPL HONEY NUT TOASTD OATS	-4.063*** (1.384)	-2.975*** (0.928)
productPL MINI TWIST PRETZELS	-3.232** (1.370)	-2.042** (0.911)
productPL PRETZEL STICKS	-3.140** (1.370)	-1.952** (0.911)
productPL RAISIN BRAN	-3.509** (1.405)	-2.434** (0.955)
productPL SR CRUST 3 MEAT PIZZA	-1.861 (1.371)	-1.404 (0.911)
productPL SR CRUST PEPPRN PIZZA	-2.308* (1.371)	-1.778* (0.911)
productPL SR CRUST SUPRM PIZZA	-2.149 (1.371)	-1.646* (0.911)
productPL TWIST PRETZELS	-3.933*** (1.370)	-2.742*** (0.911)

## A8. Snack Chain | Dalton Anderson

productPOST FM SZ HNYBNCH OT ALM	-1.115 (1.372)	-0.628 (0.913)	productSNYDR SOURDOUGH NIBBLERS	-3.145** (1.371)	-2.454*** (0.912)
productPOST FRUITY PEBBLES	-2.226 (1.371)	-1.468 (0.911)	price:productDIGRN PEPP PIZZA	0.074*** (0.010)	0.043*** (0.009)
productPOST HNY BN OTS HNY RSTD	-1.164 (1.375)	-0.565 (0.917)	price:productDIGRN SUPREME PIZZA	0.049*** (0.010)	0.030*** (0.009)
productQKER CAP N CRUNCH	-0.835 (1.371)	0.028 (0.911)	price:productFRSC 4 CHEESE PIZZA	0.075*** (0.011)	0.078*** (0.010)
productQKER CAP N CRUNCH BERRIES	-0.959 (1.371)	-0.090 (0.912)	price:productFRSC BRCK OVN ITL PEP PZ	-0.0003 (0.010)	0.005 (0.010)
productQKER LIFE ORIGINAL	-1.520 (1.371)	-0.536 (0.911)	price:productFRSC PEPPERONI PIZZA	-0.040*** (0.011)	-0.024** (0.010)
productRLDGLD BRAIDED HONEY WHT	-3.421** (1.372)	-2.602*** (0.912)	price:productGM CHEERIOS	0.421*** (0.009)	0.254*** (0.008)
productRLDGLD PRETZEL STICKS	-2.376* (1.371)	-1.638* (0.912)	price:productGM HONEY NUT CHEERIOS	-0.132*** (0.019)	-0.353*** (0.018)
productRLDGLD TINY TWISTS PRTZL	-2.137 (1.371)	-1.396 (0.912)	price:productKELL BITE SIZE MINI WHEAT	0.550*** (0.018)	0.415*** (0.016)
productSHURGD MINI PRETZELS	-3.786*** (1.371)	-2.579*** (0.912)	price:productKELL FROOT LOOPS	-0.739*** (0.018)	-0.944*** (0.017)
productSHURGD PRETZEL RODS	-3.726*** (1.372)	-2.498*** (0.912)	price:productKELL FROSTED FLAKES	-0.353*** (0.019)	-0.564*** (0.018)
productSHURGD PRETZEL STICKS	-3.586*** (1.371)	-2.377*** (0.912)	price:productMKSL DUTCH PRETZELS	0.385*** (0.047)	0.315*** (0.044)
productSNYDR FF MINI PRETZELS	-2.947** (1.371)	-2.306** (0.912)	price:productMKSL MINI TWIST PRETZELS	0.347*** (0.045)	0.274*** (0.042)
productSNYDR PRETZEL RODS	-2.727** (1.371)	-2.058** (0.912)	price:productMKSL PRETZEL STICKS	0.227*** (0.050)	0.170*** (0.046)

price:productQKER LIFE ORIGINAL	-0.170*** (0.015)	-0.346*** (0.014)
price:productRLDGLD BRAIDED HONEY WHT	0.398*** (0.023)	0.272*** (0.021)
price:productRLDGLD PRETZEL STICKS	0.098*** (0.021)	-0.006 (0.019)
price:productRLDGLD TINY TWISTS PRTZL	0.108*** (0.021)	-0.006 (0.019)
price:productSHURGD MINI PRETZELS	0.838*** (0.028)	0.617*** (0.026)
price:productSHURGD PRETZEL RODS	0.687*** (0.033)	0.450*** (0.030)
price:productSHURGD PRETZEL STICKS	0.758*** (0.029)	0.532*** (0.027)
price:productSNYDR FF MINI PRETZELS	0.321*** (0.018)	0.249*** (0.016)
price:productSNYDR PRETZEL RODS	0.023 (0.027)	-0.013 (0.025)
price:productSNYDR SOURDOUGH NIBBLERS	0.387*** (0.018)	0.301*** (0.017)
Constant	6.404*** (0.969)	5.262*** (0.645)
-----		
Observations	418,554	418,554
Log Likelihood	-480,471.000	-447,990.600
Akaike Inf. Crit.	961,110.100	896,149.200
Bayesian Inf. Crit.	962,029.400	897,068.600
-----		
Note:	*p<0.1; **p<0.05; ***p<0.01	



DV	FROOT LOOPS	FROST ED FLAKES	MINI TWIST PRETZELS	FROOT LOOPS marginal effects by 1000	FROSTED FLAKES marginal effects by 1000	MINI TWIST PRETZELS marginal effects by 1000
spend	104.70 %	32.60%	107.00%	1047	326	1070
units	198.40 %	127.40%	91.60%	1984	1274	916

These products give the highest return on promotion within our product selection when it comes to sold units and total spend.