Price Elasticity

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IS 6813-001 Spring 2023 MSBA Capstone Completion

SWIRE COCA-COLA

What is Price Elasticity

- Price elasticity refers to the degree to which the demand for a product or service changes in response to a change in its price.
- In other words, it measures the sensitivity of consumers' purchasing behavior to changes in the price of a good or service.
- The price elasticity of demand is calculated as the percentage change in quantity demanded divided by the percentage change in price.
- A product or service is considered to be price elastic if a small change in its price leads to a significant change in the quantity demanded, and price inelastic if a large change in price leads to only a small change in the quantity demanded.

The need..

- Understanding price elasticity is important for businesses in making pricing decisions and predicting consumer behavior.
- Knowing the price elasticity can help Swire decide optimal price points of products to:
  - maximize sales volume
  - maximize gross margin
  - maybe maximize both

  The optimal price point can vary across product types, geographies, and channels.

The data..

Sample 5 rows..

MARKET_ID_BLINDED	PRODUCT_ID_BLINDED	WEEK_ENDING_FRIDAY	PRICE	EQUIVALENT_VOLUME	UNITS	STD_PHYSICAL_VOL	NUMBER_OF_STORES	NUMBER_OF_STORES_SELLING
M00217	P002496971635	1/1/21	88.23	17.25	23	11.5	21	3
M00513	P002496971635	1/1/21	24.28	4.5	6	3	52	3
M00207	P011171232793	7/23/21	4961.504	951.229	2701.715	337.714	566.353	441.526
M00517	P010091774557	1/22/21	5.91	0.75	1	0.5	154	1
M00320	P144910371587	8/27/21	73.58	13.866	221.85	18.487	1887.004	36.975

Size

~ 853k rows

9 columns

Markets

20

Products

1,827

Duration

~ 1 year

10 months

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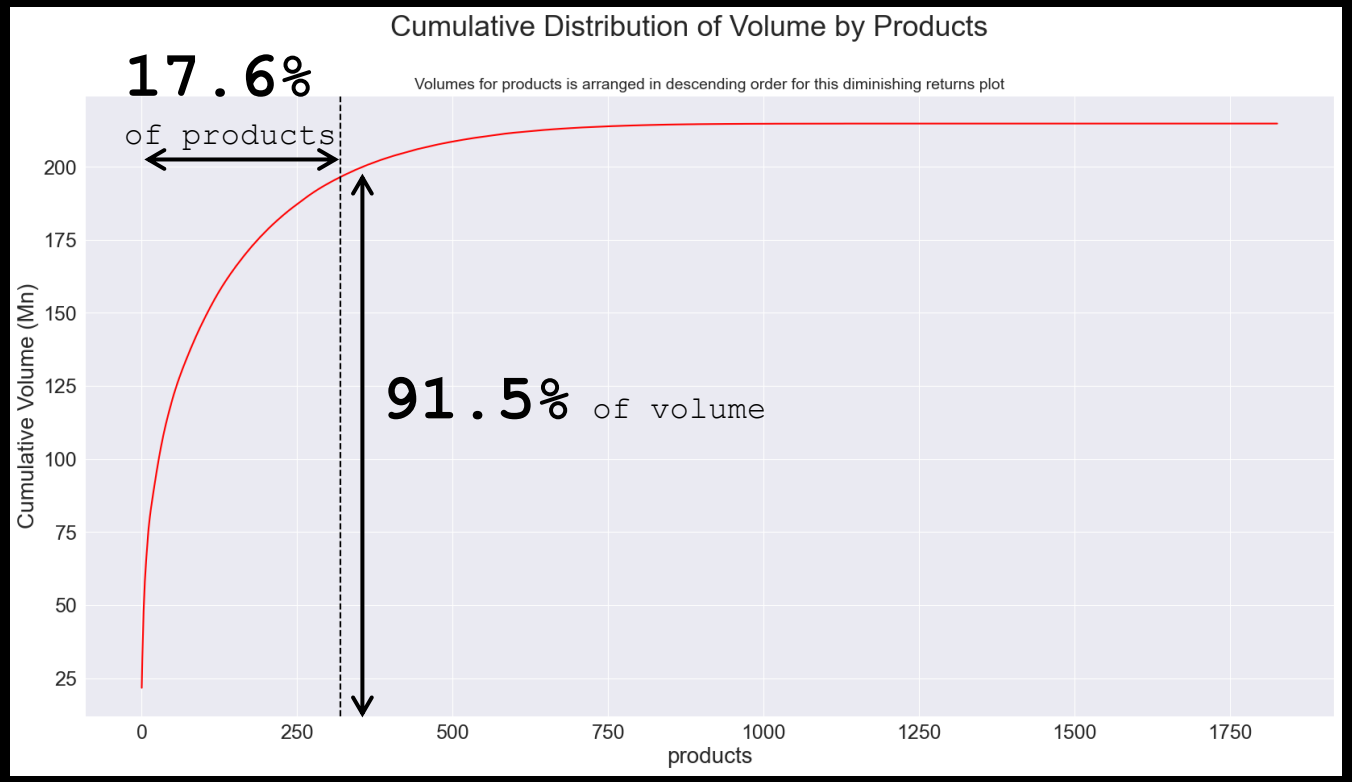
Which volume column to use for the analysis..

- **EQUIVALENT_VOLUME:** This is the normalized volume based on the volume of liquid in a product. Swire's standard definition for this is 1 Equivalent Volume = 24 servings or 192 American standard ounces.
- **UNITS:** This is the count of individual/lose units of a product within a STANDARD_PHYSICAL_CASE. For example, a 2-12pack STANDARD_PHYSICAL_CASE contains 2 units where each unit is a 12pack.
- **STD_PHYSICAL_VOL:** This is the raw physical case. It is the unique combination of beverage products and package sizes used for deliveries to customers.

I have decided to go ahead with **STD_PHYSICAL_VOL** to be consistent with most of the analytics projects in Swire.

17.6 % of products [321 out of 1,827] account for 91.5% of the volume



We will focus on these 321 products only for any further analysis

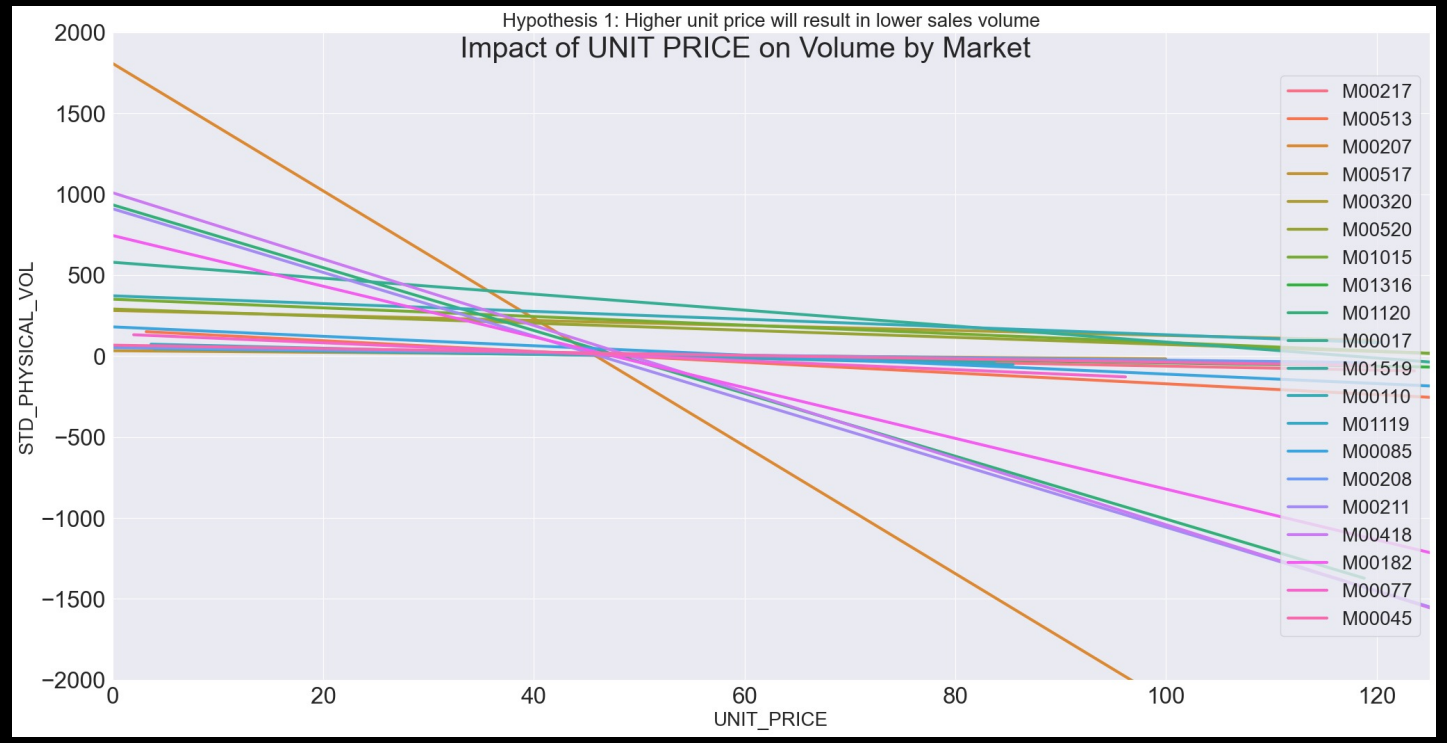
The hypothesis..

The general hypothesis for price elasticity is that ..

as the price of a good or service increases, the quantity demanded for that good or service will decrease, and vice versa.

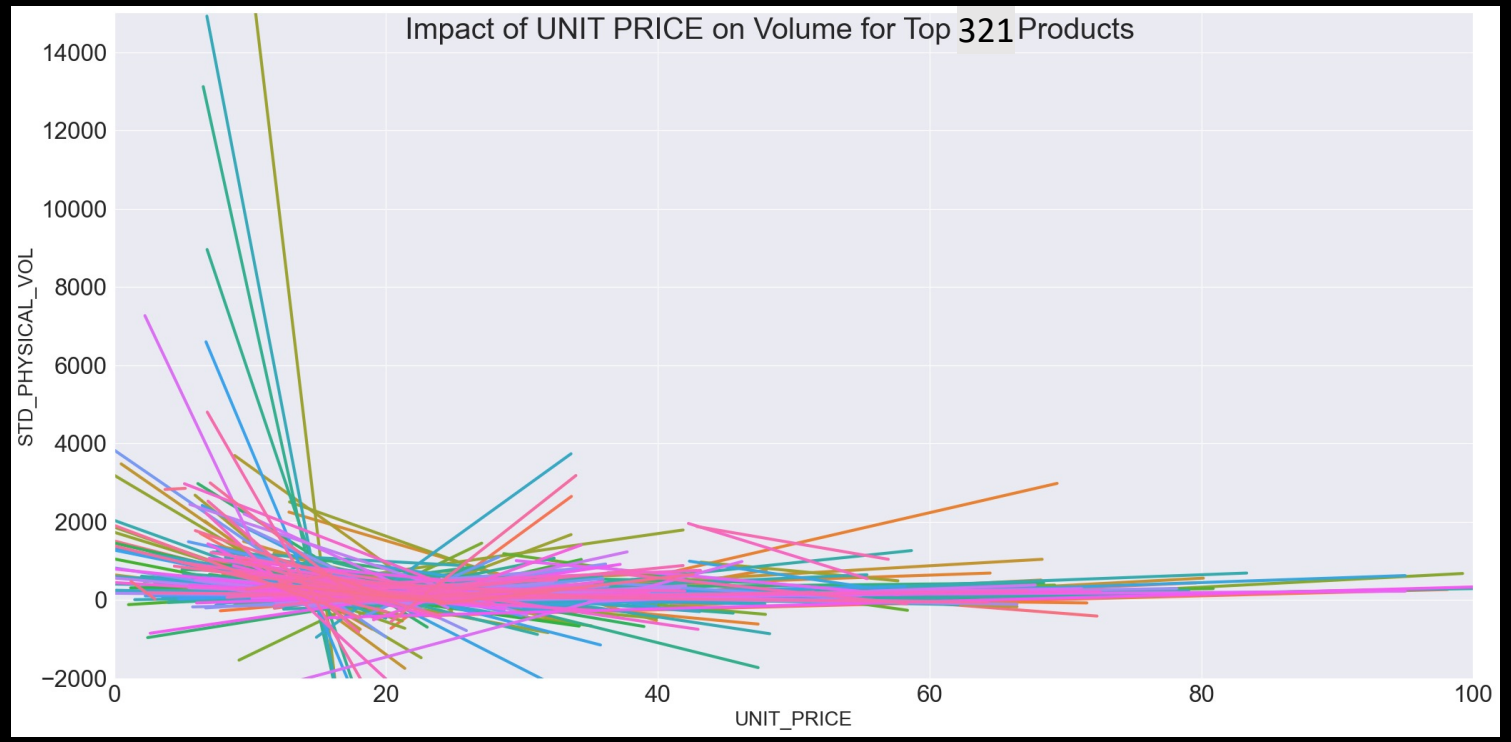
This means that there is an inverse relationship between the price of a product and the quantity of that product that consumers are willing and able to purchase.

The hypothesis appears to be true for all the markets..



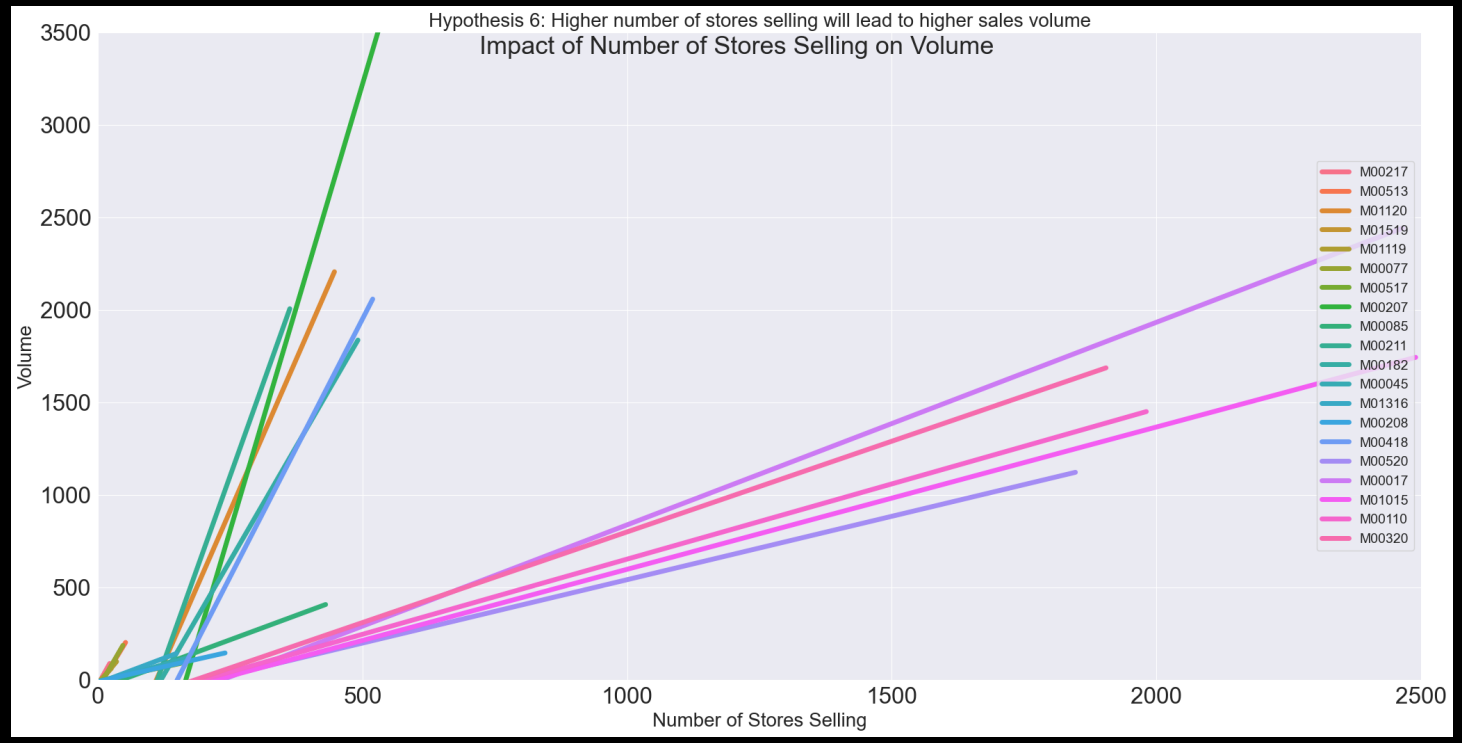
- The slope of each line is the price elasticity or degree of relationship between the unit price and the demand
- The slope of the line measures the responsiveness of quantity demanded to changes in price

…however, its not true for all the top 321 products



- Most of the products have **Positive price elasticity** i.e. demand of a product increases in response to a decrease in price or decreases in response to an increase in price.
- Some products have **Negative price elasticity** i.e. demand of a product decreases in response to a decrease in price or increases in response to an increase in price.

A high number of stores selling in a market always lead to higher sales volume



It's interesting to see how certain markets have high velocity stores where fewer stores sell much higher volume [compared to other markets with low velocity stores].

In order to determine 'True' price elasticity, its important to isolate unit price as the single factor driving the sales

The modeling process follows the following steps:

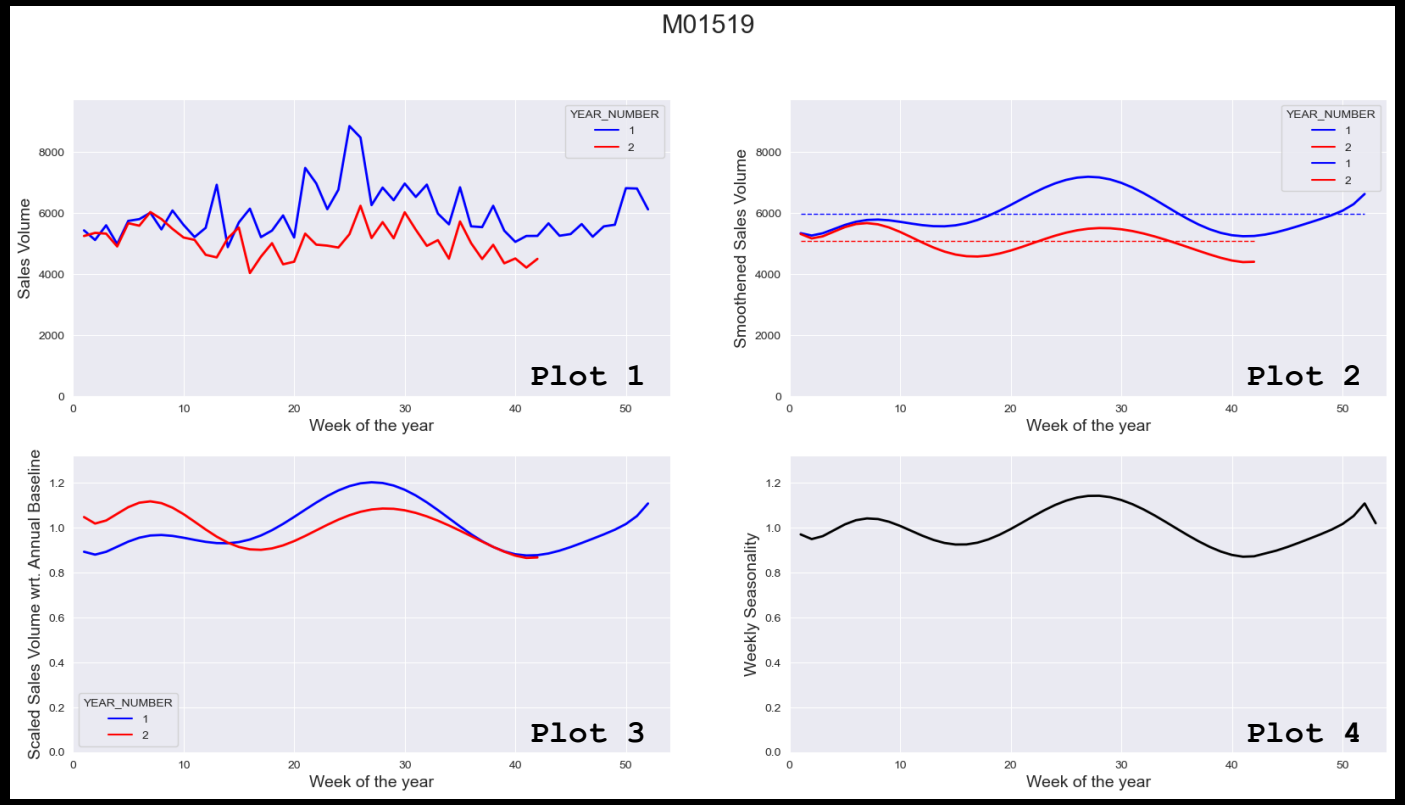
Step 1: Determine ***seasonality***

Step 2: Remove the effect of ***seasonality*** from the sales to obtain ***adjusted sales***

Step 3: Determine relationship of ***adjusted sales*** with ***unit price*** and ***number of stores selling***

Step 4: Isolate the effect of ***unit price*** on ***adjusted sales*** by keeping ***number of stores selling*** constant

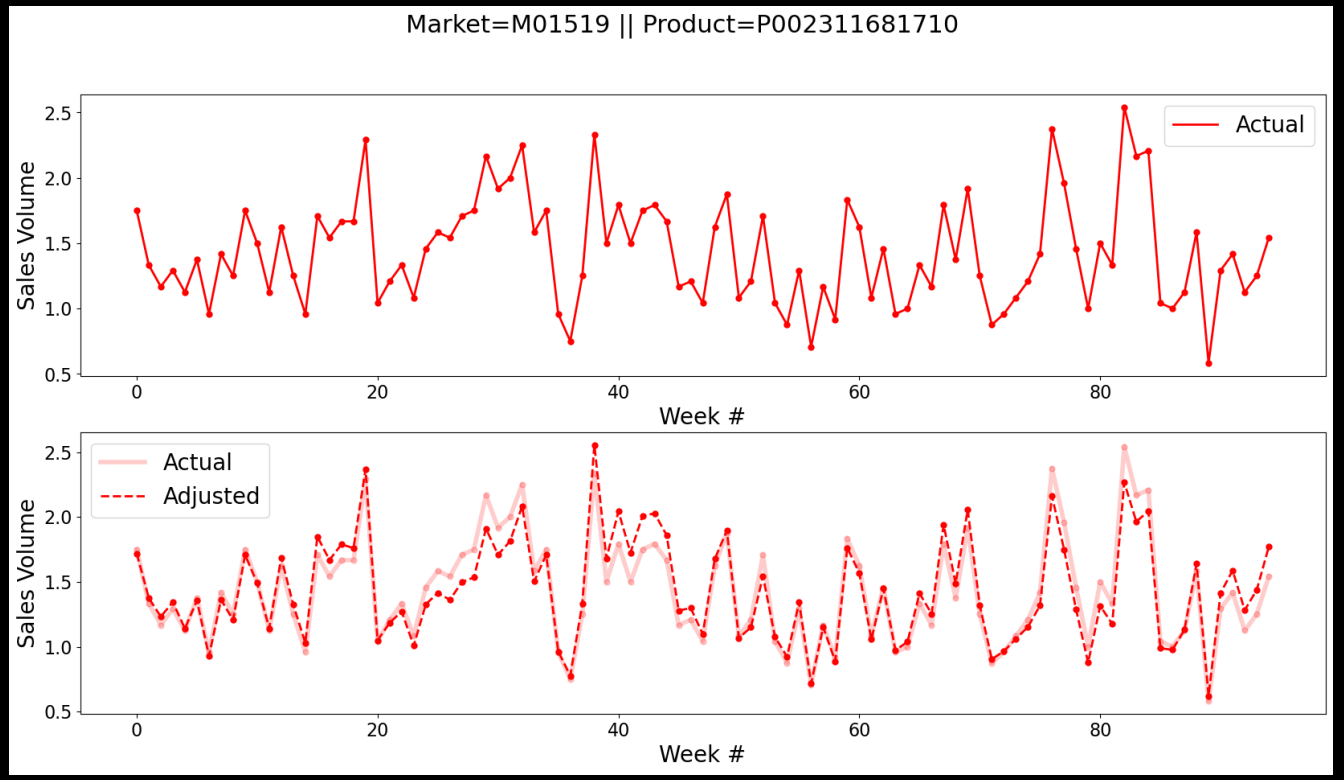
We derive average seasonality factors [at market level] by aggregating yearly seasonality trends



The plot on the left shows four phases of seasonality calculation for one market:

1. **Original/raw sales volume**
2. **Smoothened sales volume**
3. **Scaled sales volume**
4. **Average**

Then we remove the effect of seasonality from the sales..



We can now assume that the only significant factor affecting this adjusted sales is **Unit Price***

* **Number of stores selling** also effects the sales volume but that factor does not fluctuate as much as **unit price**

Now we can build the price elasticity model..

- The idea behind modeling is to determine this relationship :

  Adjusted Sales Vol = f(unit price, number of stores selling)

- Modeling techniques used:
  - Linear Regression
  - Random Forest Regression

- Models built : 4,734 [for all the 20 markets and 321 key products]

- Only a few models appear to be mathematically solid [see appendix for details]

- However, we can still use these models for directional guidance

Using the price elasticity model, we can isolate the impact of unit price on the sales volume

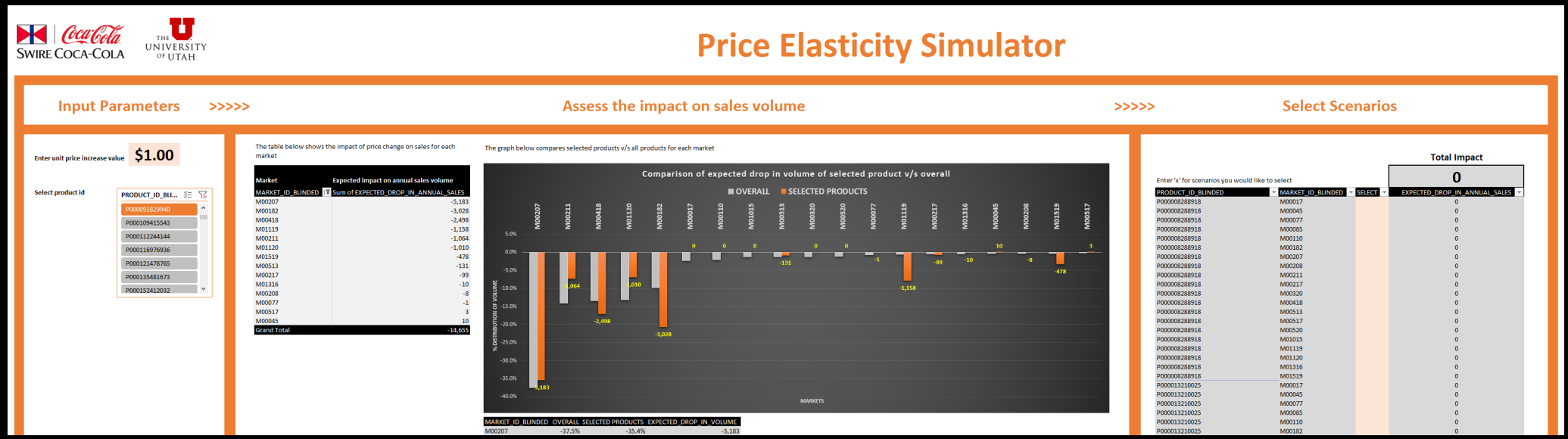
$$\text{Adjusted Sales Vol} = f(\text{unit price}, \text{number of stores selling})$$

Effect of Change

Change

Keep constant

Here's a demo of the price elasticity simulator tool



Click here ->

Price Elasticity Simulator Tool

Top insights from the model..

1. **81%** market and product combination demonstrate positive price elasticity

   Its nearly certain that increase in price will lead to decline in demand

2. In **57.2%** cases [market and product] , price appears to have significant relationship with sales volume

   Price is a crucial factor that affects demand. There are other factors as well.

3. **9** out of **20** markets account for **91%** of the sales volume

   We can get great returns if we decide on pricing considering these high impact markets

4. **17.6%** of products account for **91.5%** of sales volume

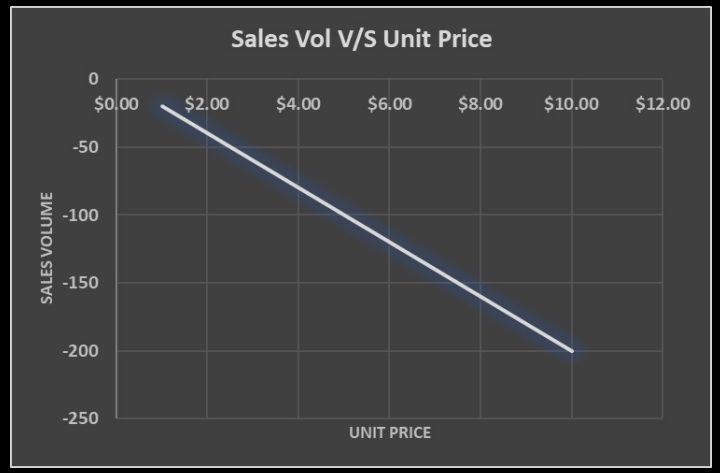
   We can get great returns if we decide on pricing considering these high impact products

5. There is **NO one size fits all** price elasticity. It varies by markets and products

   Some markets and some products are more price sensitive than others

A good next step would be to develop a price optimization engine with the following logic

Sales volume decline as unit price increases

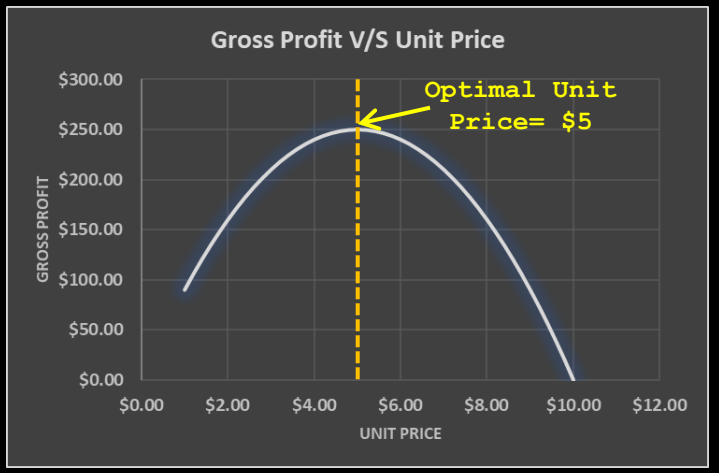


X

Profit **per unit** increases as unit price increases

=

Gross profit [volume x profit per unit] will start to tank at certain threshold of unit price



Need COGS and Cost-to-serve **for this graph**

Appendix

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Model Performance- Linear and Random Forest Regression on training and test set

Random forest models perform better on training set but performance of both linear and RF appears to be equivalent in the test set

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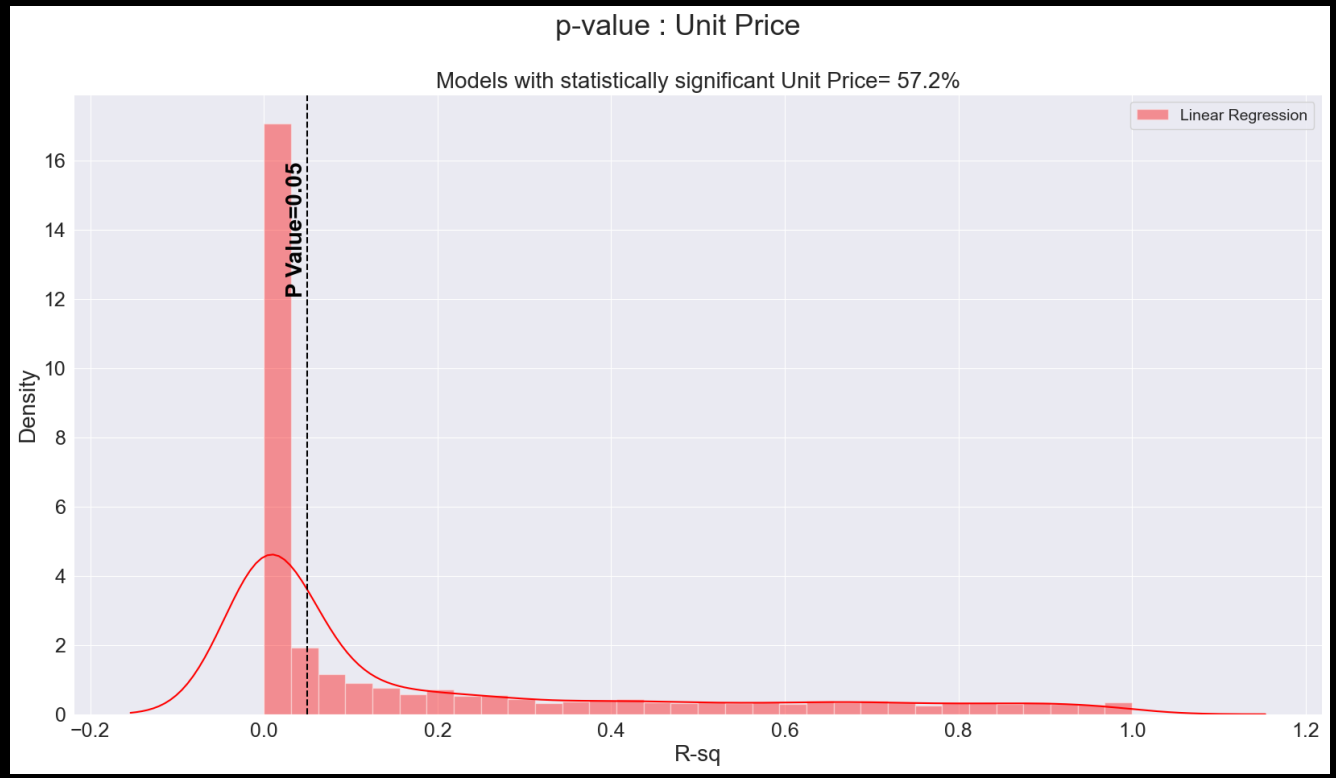
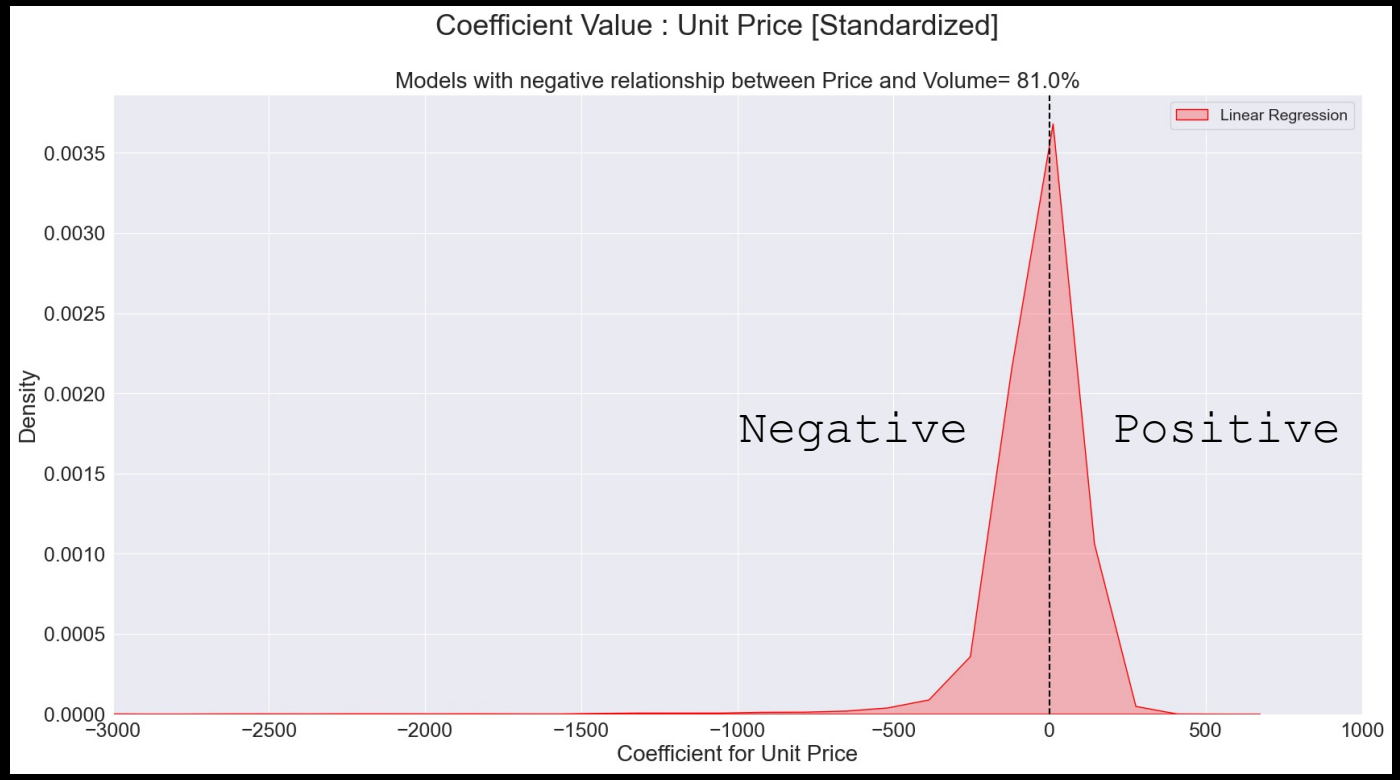
P-value of 'unit price' from linear regression model



In **57.2%** cases [market and product] , price appears to have significant relationship with sales volume

Coefficients of 'unit price' from linear regression model



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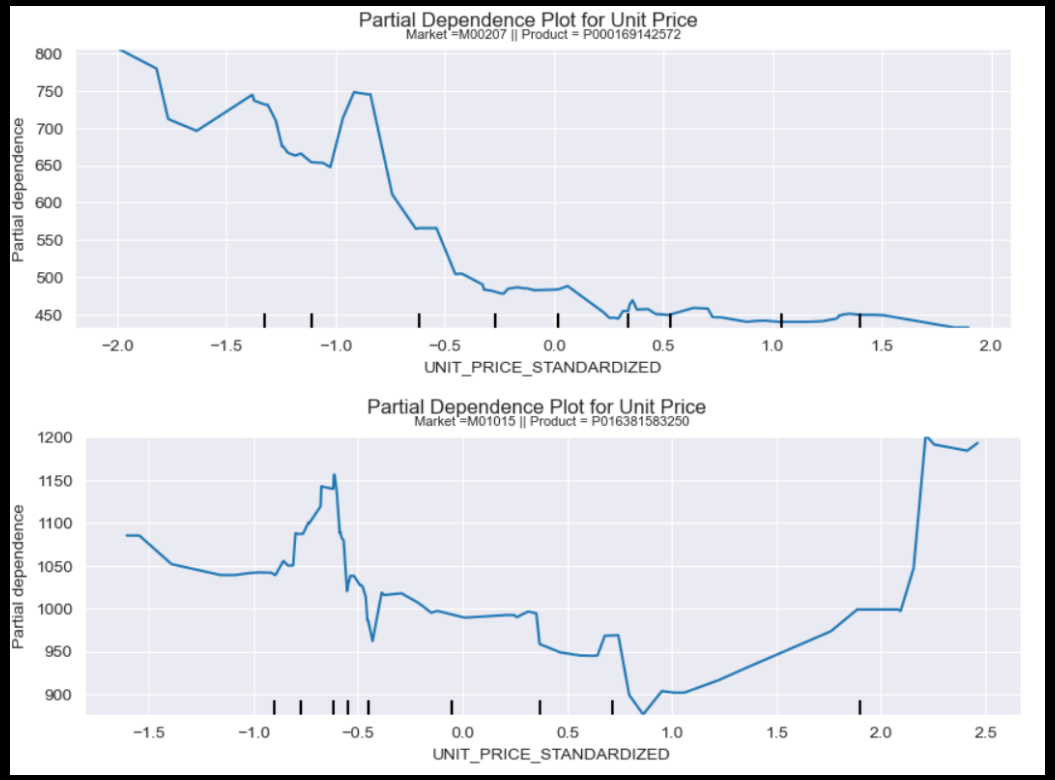
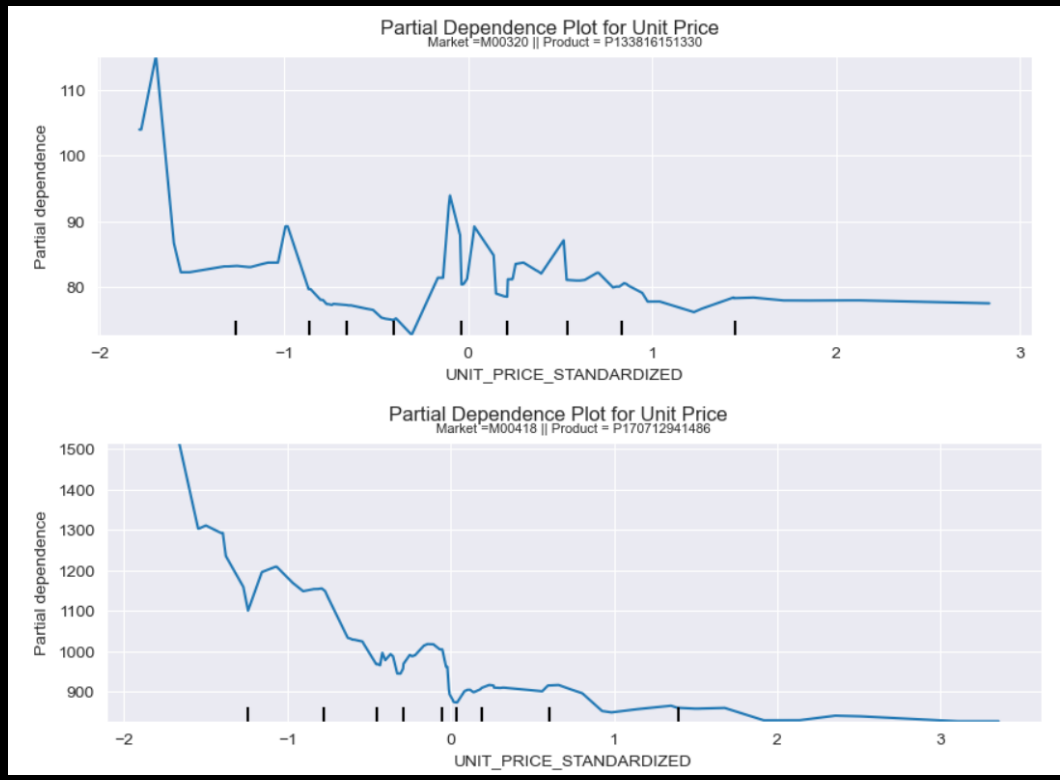
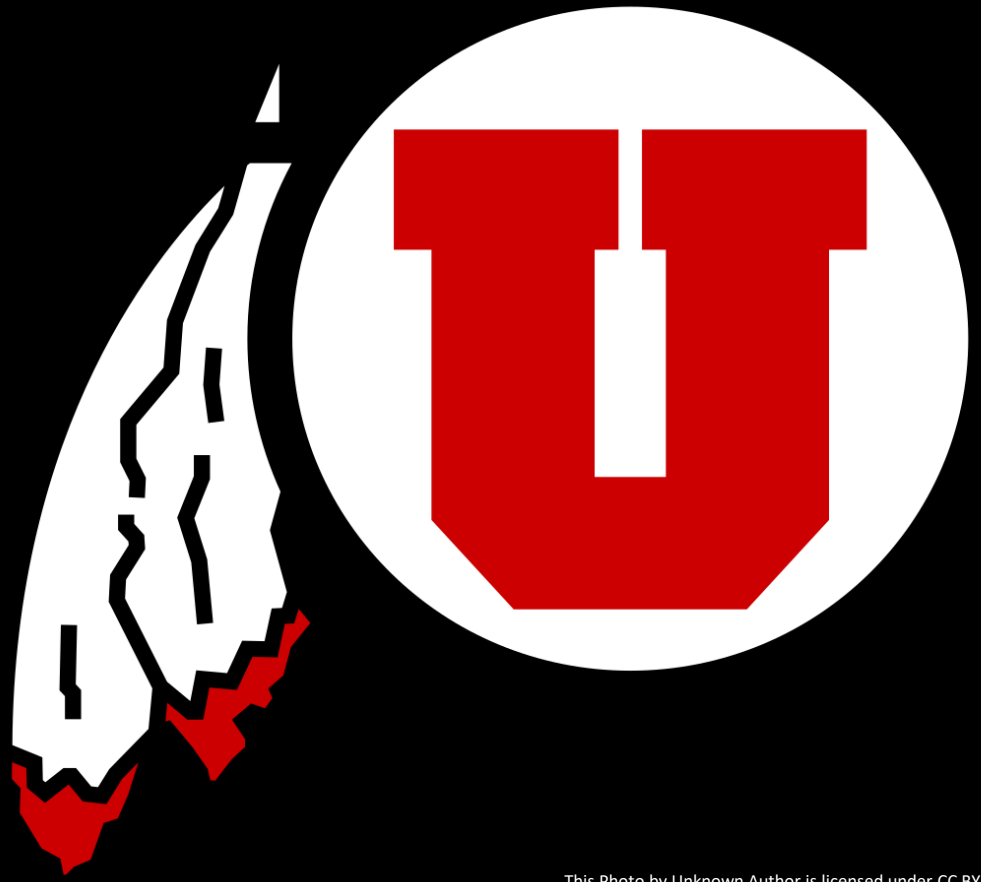
Partial dependence plot of 'Unit Price' from Random Forest Models





Thank You !!



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