Promotional Effectiveness Case

May 19, 2024

[1]:
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.linear_model import LinearRegression
from statsmodels.formula.api import ols
import statsmodels.api as sm
from scipy.stats import ttest_ind
from sklearn.preprocessing import MinMaxScaler
```

[2]:
```python
data = pd.read_excel('data - Promotional Effectiveness Case Study.xlsx')
print(data.head())
```

```
   Year  week number  Product  Price On Flyer?  Discount  Units    Sales $  \
0  2021            1  Pantene   7.99        No      0.00   8630   68953.70
1  2021            2  Pantene   7.29       Yes      0.10  10183   74234.07
2  2021            3  Pantene   5.49       Yes      0.30  21568  118408.32
3  2021            4  Pantene   7.49       Yes      0.05   9309   69724.41
4  2021            5  Pantene   7.99        No      0.00   8462   67611.38

   Gross Margin $  # Transactions that contained the product
0        33570.70                                        8460
1        32483.77                                        9983
2        29979.52                                       17117
3        31557.51                                        9038
4        32917.18                                        8379
```

[3]:
```python
#Split the dataset by product
aussie_data = data[data['Product'] == 'Aussie']
pantene_data = data[data['Product'] == 'Pantene']
```

Question 1: What price point is most effective at maximizing sales?

[4]:
```python
aussie_sales_data = aussie_data.groupby(['Product', 'Price']).agg({'Sales $':
 ↪'mean'}).reset_index()
aussie_sales_data
```

[4]:

	Product	Price	Sales $
0	Aussie	2.49	192228.000000
1	Aussie	2.99	170709.066667
2	Aussie	3.29	152944.580000
3	Aussie	3.49	124416.948889
4	Aussie	3.99	89367.022500
5	Aussie	4.29	66224.730000
6	Aussie	4.49	56708.700000
7	Aussie	4.79	55223.910000
8	Aussie	4.99	54437.630690

[5]:
```
aussie_sales_data.loc[aussie_sales_data['Sales $'].idxmax()]
```

[5]:
```
Product       Aussie
Price           2.49
Sales $     192228.0
Name: 0, dtype: object
```

[6]:
```
pantene_sales_data = pantene_data.groupby(['Product', 'Price']).agg({'Sales $':␣
↪'mean'}).reset_index()
pantene_sales_data
```

[6]:

	Product	Price	Sales $
0	Pantene	3.99	224121.791250
1	Pantene	4.49	184342.936667
2	Pantene	4.79	156176.034000
3	Pantene	5.29	147813.180000
4	Pantene	5.49	113200.662857
5	Pantene	6.49	92408.946667
6	Pantene	6.79	87472.660000
7	Pantene	7.29	74234.070000
8	Pantene	7.49	70188.790000
9	Pantene	7.99	69003.352143

[7]:
```
pantene_sales_data.loc[pantene_sales_data['Sales $'].idxmax()]
```

[7]:
```
Product          Pantene
Price               3.99
Sales $     224121.79125
Name: 0, dtype: object
```

For Aussie, 2.49 will maximize the sales.For Pantene, 3.99 will maximize the sales.

Question 2: What price point is most effective at maximizing gross margin?

[8]:
```
aussie_margin_data = aussie_data.groupby(['Product', 'Price']).agg({'Gross␣
↪Margin $': 'mean'}).reset_index()
aussie_margin_data
```

[8]:

```
  Product  Price  Gross Margin $
0  Aussie   2.49   -23932.000000
1  Aussie   2.99    10847.733333
2  Aussie   3.29    22778.980000
3  Aussie   3.49    24598.193333
4  Aussie   3.99    26653.322500
5  Aussie   4.29    23264.139503
6  Aussie   4.49    21339.947228
7  Aussie   4.79    22942.710000
8  Aussie   4.99    23891.465172
```

[9]:

```python
aussie_margin_data.loc[aussie_margin_data['Gross Margin $'].idxmax()]
```

[9]:

```
Product                Aussie
Price                    3.99
Gross Margin $     26653.3225
Name: 4, dtype: object
```

[10]:

```python
pantene_margin_data = pantene_data.groupby(['Product', 'Price']).agg({'Gross␣
↪Margin $': 'mean'}).reset_index()
pantene_margin_data
```

[10]:

```
   Product  Price  Gross Margin $
0  Pantene   3.99    -6178.796250
1  Pantene   4.49    16011.970000
2  Pantene   4.79    22497.174000
3  Pantene   5.29    33250.980000
4  Pantene   5.49    28661.005714
5  Pantene   6.49    34030.413333
6  Pantene   6.79    34654.117143
7  Pantene   7.29    32483.770000
8  Pantene   7.49    31767.690000
9  Pantene   7.99    33594.873571
```

[11]:

```python
pantene_margin_data.loc[pantene_margin_data['Gross Margin $'].idxmax()]
```

[11]:

```
Product                Pantene
Price                     6.79
Gross Margin $    34654.117143
Name: 6, dtype: object
```

For Aussie, 3.99 will maximize the gross margin. For Pantene, 6.79 will maximize the gross margin.

Question 3: Is Shampoo seasonal (influenced by time of year)? Explain why or why not.

[12]:

```python
#Create year week column
aussie_data['Year-Week'] = aussie_data['Year'].astype(str) + '-' +␣
↪aussie_data['week number'].astype(str)
```

```
#Select columns to focus on sales impact without discount and flyer influence
analysis_aussie_data = aussie_data[['Year', 'Year-Week', 'Product', 'Price',␣
 ↪'Units', 'Sales $']]

#Initialize MinMaxScaler
scaler = MinMaxScaler()

#Scale the Sales data
analysis_aussie_data['Normalized_Sales'] = scaler.
 ↪fit_transform(analysis_aussie_data[['Sales $']])

analysis_aussie_data
```

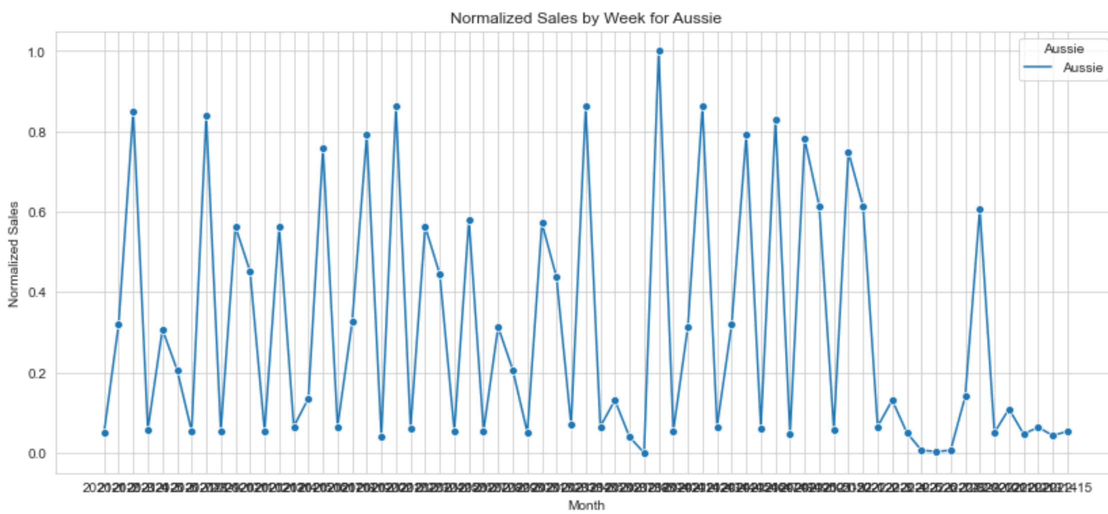
```
/var/folders/v9/_qnmdykd79g5g0_rs7scxqxr0000gn/T/ipykernel_19272/1083329218.py:2
: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  aussie_data['Year-Week'] = aussie_data['Year'].astype(str) + '-' +
aussie_data['week number'].astype(str)
/var/folders/v9/_qnmdykd79g5g0_rs7scxqxr0000gn/T/ipykernel_19272/1083329218.py:1
1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  analysis_aussie_data['Normalized_Sales'] =
scaler.fit_transform(analysis_aussie_data[['Sales $']])
```

[12]:

	Year	Year-Week	Product	Price	Units	Sales $	Normalized_Sales
67	2021	2021-1	Aussie	4.99	10980	54790.20	0.050471
68	2021	2021-2	Aussie	3.99	23510	93804.90	0.320016
69	2021	2021-3	Aussie	2.99	57084	170681.16	0.851137
70	2021	2021-4	Aussie	4.99	11195	55863.05	0.057883
71	2021	2021-5	Aussie	3.99	23058	92001.42	0.307556
..	…	…	…	…	…	…	…
129	2022	2022-11	Aussie	4.29	14757	63307.53	0.109316
130	2022	2022-12	Aussie	4.99	10873	54256.27	0.046782
131	2022	2022-13	Aussie	4.49	12630	56708.70	0.063726
132	2022	2022-14	Aussie	4.99	10767	53727.33	0.043128
133	2022	2022-15	Aussie	4.79	11529	55223.91	0.053468

[67 rows x 7 columns]

[13]:
```python
sns.set_style("whitegrid")

plt.figure(figsize=(14, 6))
sns.lineplot(data=analysis_aussie_data, x='Year-Week', y='Normalized_Sales',␣
 ↪hue='Product', marker='o')
plt.title('Normalized Sales by Week for Aussie')
plt.xlabel('Month')
plt.ylabel('Normalized Sales')
plt.legend(title='Aussie')
plt.show()
```



[14]:
```python
#ANOVA Test by week for Aussie to see if there is seasonality
week_model = ols('Normalized_Sales ~ Year-Week', data=analysis_aussie_data).
 ↪fit()
week_anova = sm.stats.anova_lm(week_model, typ=2)
print(week_anova)
```

```
           sum_sq    df         F    PR(>F)
Year      0.57612   1.0  6.555519  0.012788
Residual  5.71241  65.0       NaN       NaN
```

Since the P-value is 0.012, if we set the confident interval is 95%, then the P-value is still large than 0.05 so we reject the hypothesis, there is no seasonlity for Aussie

[15]:
```python
#Create year week column
pantene_data['Year-Week'] = pantene_data['Year'].astype(str) + '-' +␣
 ↪pantene_data['week number'].astype(str)

#Select columns to focus on sales impact without discount and flyer influence
```

```python
analysis_pantene_data = pantene_data[['Year', 'Year-Week', 'Product', 'Price',␣
↪'Units', 'Sales $']]

#Initialize MinMaxScaler
scaler = MinMaxScaler()

#Scale the Sales data
analysis_pantene_data['Normalized_Sales'] = scaler.
↪fit_transform(analysis_pantene_data[['Sales $']])

analysis_pantene_data
```

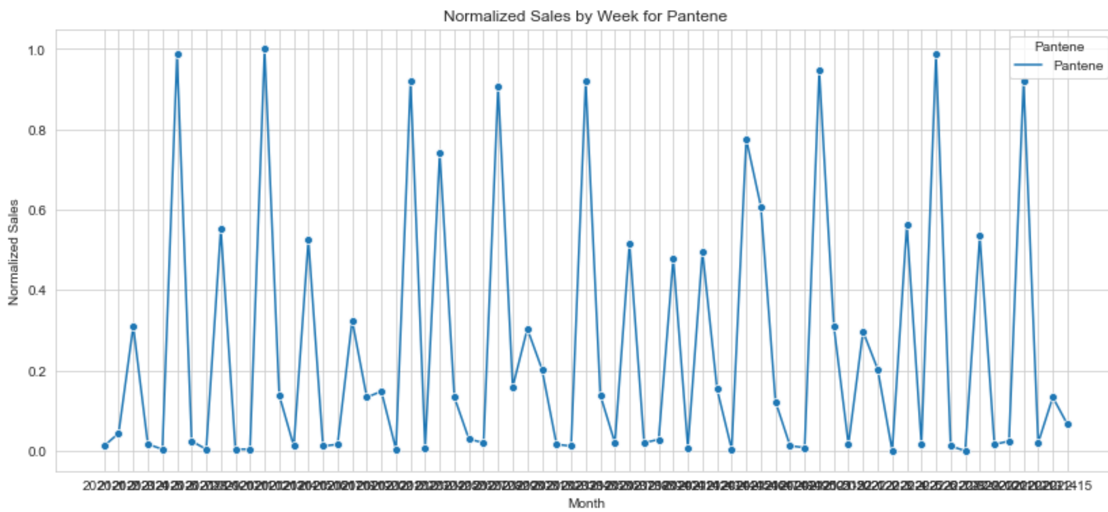
```
/var/folders/v9/_qnmdykd79g5g0_rs7scxqxr0000gn/T/ipykernel_19272/2315148616.py:2
: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  pantene_data['Year-Week'] = pantene_data['Year'].astype(str) + '-' +
pantene_data['week number'].astype(str)
/var/folders/v9/_qnmdykd79g5g0_rs7scxqxr0000gn/T/ipykernel_19272/2315148616.py:1
1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  analysis_pantene_data['Normalized_Sales'] =
scaler.fit_transform(analysis_pantene_data[['Sales $']])
```

[15]:

	Year	Year-Week	Product	Price	Units	Sales $	Normalized_Sales
0	2021	2021-1	Pantene	7.99	8630	68953.70	0.012011
1	2021	2021-2	Pantene	7.29	10183	74234.07	0.043889
2	2021	2021-3	Pantene	5.49	21568	118408.32	0.310576
3	2021	2021-4	Pantene	7.49	9309	69724.41	0.016664
4	2021	2021-5	Pantene	7.99	8462	67611.38	0.003907
..	…	…	…	…	…	…	…
62	2022	2022-11	Pantene	7.99	8883	70975.17	0.024215
63	2022	2022-12	Pantene	3.99	55008	219481.92	0.920774
64	2022	2022-13	Pantene	7.99	8798	70296.02	0.020115
65	2022	2022-14	Pantene	6.79	13118	89071.22	0.133464
66	2022	2022-15	Pantene	6.79	11477	77928.83	0.066195

[67 rows x 7 columns]

[16]:
```
#Set the aesthetic style of the plots
sns.set_style("whitegrid")

plt.figure(figsize=(14, 6))
sns.lineplot(data=analysis_pantene_data, x='Year-Week', y='Normalized_Sales',␣
 ↪hue='Product', marker='o')
plt.title('Normalized Sales by Week for Pantene')
plt.xlabel('Month')
plt.ylabel('Normalized Sales')
plt.legend(title='Pantene')
plt.show()
```



[17]:
```
#ANOVA Test by week for Pantene to see if there is seasonality
week_model = ols('Normalized_Sales ~ Year-Week', data=analysis_pantene_data).
 ↪fit()
week_anova = sm.stats.anova_lm(week_model, typ=2)
print(week_anova)
```

```
            sum_sq    df         F    PR(>F)
Year      0.000125   1.0  0.001153  0.973016
Residual  7.043296  65.0       NaN       NaN
```

Since the P-value is 0.97 large than 0.05 so we reject the hypothesis, there is no seasonlity for Pantene

Question 4: What is the cost per unit of each product?

[18]:
```
#Calculate the cost per unit for Pantene and Aussie
data['Cost per Unit'] = (data['Sales $'] - data['Gross Margin $']) /␣
 ↪data['Units']
```

```
#Separate cost per unit data for Aussie and Pantene
aussie_cost_per_unit = data[data['Product'] == 'Aussie'][['Year', 'week␣
↪number', 'Cost per Unit']]
pantene_cost_per_unit = data[data['Product'] == 'Pantene'][['Year', 'week␣
↪number', 'Cost per Unit']]
```

[19]:
```
aussie_cost_per_unit['Cost per Unit'].unique()
```

[19]:
```
array([2.8       , 2.8       , 2.8       , 2.8       , 2.8       ,
       2.7829624 , 2.8       , 2.7829624 , 2.80037631])
```

[20]:
```
round(aussie_cost_per_unit['Cost per Unit'],1).unique()
```

[20]:
```
array([2.8])
```

[21]:
```
#Display the cost per unit data
round(pantene_cost_per_unit['Cost per Unit'],1).unique()
```

[21]:
```
array([4.1])
```

There are typo error for Aussie, how ever if we round to 1 decimal, the cost will be same

So the cost for Pantene is consistenly 4.1, and cost for Aussie is consistenly 2.8

Question 5: How would Pantene perform for units, sales and margin with a 25% discount?

[22]:
```
#Take a look for Pantene's perfomance when discount rate is 20%
pantene_data[pantene_data['Discount'] == 0.2]
```

[22]:
```
    Year  week number  Product  Price On Flyer?  Discount  Units   Sales $  \
19  2021           20  Pantene   6.49       Yes       0.2  14099  91502.51
28  2021           29  Pantene   6.49       Yes       0.2  14378  93313.22
42  2021           43  Pantene   6.49       Yes       0.2  14239  92411.11

    Gross Margin $  # Transactions that contained the product Year-Week
19        33696.61                                      12691   2021-20
28        34363.42                                      12691   2021-29
42        34031.21                                      12447   2021-43
```

[23]:
```
pantene_data[pantene_data['Discount'] == 0.2].describe()
```

[23]:
```
         Year  week number         Price      Discount         Units  \
count     3.0     3.000000  3.000000e+00  3.000000e+00      3.000000
mean   2021.0    30.666667  6.490000e+00  2.000000e-01  14238.666667
std       0.0    11.590226  1.087792e-15  3.399350e-17    139.500299
min    2021.0    20.000000  6.490000e+00  2.000000e-01  14099.000000
25%    2021.0    24.500000  6.490000e+00  2.000000e-01  14169.000000
50%    2021.0    29.000000  6.490000e+00  2.000000e-01  14239.000000
```

```
75%     2021.0    36.000000  6.490000e+00  2.000000e-01  14308.500000
max     2021.0    43.000000  6.490000e+00  2.000000e-01  14378.000000

            Sales $  Gross Margin $  # Transactions that contained the product
count      3.000000        3.000000                                   3.000000
mean   92408.946667    34030.413333                               12609.666667
std      905.356938      333.405714                                 140.873466
min    91502.510000    33696.610000                               12447.000000
25%    91956.810000    33863.910000                               12569.000000
50%    92411.110000    34031.210000                               12691.000000
75%    92862.165000    34197.315000                               12691.000000
max    93313.220000    34363.420000                               12691.000000
```

[24]:
```python
#Take a look for Pantene's perfomance when discount rate is 30%
pantene_data[pantene_data['Discount'] == 0.3]
```

[24]:
```
    Year  week number  Product  Price On Flyer?  Discount  Units    Sales $  \
2   2021            3  Pantene   5.49       Yes       0.3  21568  118408.32
17  2021           18  Pantene   5.49       Yes       0.3  21995  120752.55
29  2021           30  Pantene   5.49       Yes       0.3  21363  117282.87
30  2021           31  Pantene   5.49        No       0.3  18339  100681.11
50  2021           51  Pantene   5.49       Yes       0.3  21576  118452.24
52  2022            1  Pantene   5.49       Yes       0.3  21157  116151.93
53  2022            2  Pantene   5.49        No       0.3  18338  100675.62

    Gross Margin $  # Transactions that contained the product Year-Week
2         29979.52                                      17117    2021-3
17        30573.05                                      17795   2021-18
29        29694.57                                      17117   2021-30
30        25491.21                                      14838   2021-31
50        29990.64                                      17456   2021-51
52        29408.23                                      17117    2022-1
53        25489.82                                      14694    2022-2
```

[25]:
```python
pantene_data[pantene_data['Discount'] == 0.3].describe()
```

[25]:
```
              Year  week number         Price  Discount         Units  \
count     7.000000     7.000000  7.000000e+00       7.0      7.000000
mean   2021.285714    19.428571  5.490000e+00       0.3  20619.428571
std       0.487950    18.963624  9.593423e-16       0.0   1578.721303
min    2021.000000     1.000000  5.490000e+00       0.3  18338.000000
25%    2021.000000     2.500000  5.490000e+00       0.3  19748.000000
50%    2021.000000    18.000000  5.490000e+00       0.3  21363.000000
75%    2021.500000    30.500000  5.490000e+00       0.3  21572.000000
max    2022.000000    51.000000  5.490000e+00       0.3  21995.000000

             Sales $  Gross Margin $  \
```

```
count       7.000000       7.000000
mean   113200.662857   28661.005714
std      8667.179953    2194.422611
min    100675.620000   25489.820000
25%    108416.520000   27449.720000
50%    117282.870000   29694.570000
75%    118430.280000   29985.080000
max    120752.550000   30573.050000

       # Transactions that contained the product
count                                     7.000000
mean                                  16590.571429
std                                    1271.448368
min                                   14694.000000
25%                                   15977.500000
50%                                   17117.000000
75%                                   17286.500000
max                                   17795.000000
```

[26]:

```python
from sklearn.linear_model import LinearRegression

#Group data by Discount and calculate average Units, Sales $ and Gross Margin $
discount_groups = pantene_data.groupby('Discount').agg({
    'Units': 'mean',
    'Sales $': 'mean',
    'Gross Margin $': 'mean'
}).reset_index()

discount_groups = discount_groups.round({
    'Units': 0,  # Rounding units to 0 decimal places for whole numbers
    'Sales $': 2,
    'Gross Margin $': 2
})

discount_groups
```

[26]:

	Discount	Units	Sales $	Gross Margin $
0	0.00	8636.0	69003.35	33594.87
1	0.05	9371.0	70188.79	31767.69
2	0.10	10183.0	74234.07	32483.77
3	0.15	12883.0	87472.66	34654.12
4	0.20	14239.0	92408.95	34030.41
5	0.30	20619.0	113200.66	28661.01
6	0.35	27942.0	147813.18	33250.98
7	0.40	32605.0	156176.03	22497.17
8	0.45	41056.0	184342.94	16011.97
9	0.50	56171.0	224121.79	-6178.80

[27]:
```
#Fit a linear regression model for each performance metric
X = discount_groups['Discount'].values.reshape(-1, 1) * 100  # Convert discount␣
↪rate into percentage terms for model
y_units = discount_groups['Units']
y_sales = discount_groups['Sales $']
y_margin = discount_groups['Gross Margin $']

model_units = LinearRegression().fit(np.vander(X.squeeze(), 3), y_units)  #␣
↪Polynomial degree 2
model_sales = LinearRegression().fit(np.vander(X.squeeze(), 3), y_sales)
model_margin = LinearRegression().fit(np.vander(X.squeeze(), 3), y_margin)
```

[28]:
```
pred_units_25 = model_units.predict(np.vander([25], 3))
pred_sales_25 = model_sales.predict(np.vander([25], 3))
pred_margin_25 = model_margin.predict(np.vander([25], 3))
```

[29]:
```
print(np.round(pred_units_25,decimals=0),np.round(pred_sales_25,2),np.
↪round(pred_margin_25,2))
```

```
[16907.] [104065.46] [34746.27]
```

Based on the linear regression results, if Pantene discount rate is 25%, then the units will be 16907, sales will be 104065.46 and gross margin will be 34746.27

Question 6: How would Pantene perform for units, sales and margin with a 60% discount?

[30]:
```
#Calculate new units, sales and margin with a 60% discount
pred_units_60 = model_units.predict(np.vander([60], 3))
pred_sales_60 = model_sales.predict(np.vander([60], 3))
pred_margin_60 = model_margin.predict(np.vander([60], 3))
```

[31]:
```
print(np.round(pred_units_60,0),np.round(pred_sales_60,2),np.
↪round(pred_margin_60,2))
```

```
[75491.] [286553.07] [-22962.57]
```

Based on the linear regression results, if Pantene discount rate is 60%, then the units will be 75491, sales will be 286553.07 and gross margin will be -22962.57

Question 7: What impact does being "On Flyer" have on performance?

[32]:
```
#Calculate average metrics for Aussie
aussie_grouped_flyer_data = aussie_data.groupby(['Product', 'On Flyer?',␣
↪'Discount']).agg(
    Average_Units_Sold=('Units', 'mean'),
    Average_Sales=('Sales $', 'mean'),
    Average_Gross_Margin=('Gross Margin $', 'mean')
).reset_index()
```

```
aussie_grouped_flyer_data = aussie_grouped_flyer_data.round({
    'Average_Units_Sold': 2,  # Rounding units to 0 decimal places for whole␣
 ↪numbers
    'Average_Sales': 2,
    'Average_Gross_Margin': 2
})

aussie_grouped_flyer_data
```

[32]:

```
   Product On Flyer?  Discount  Average_Units_Sold  Average_Sales  \
0   Aussie        No      0.00            10909.34       54437.63
1   Aussie        No      0.20            19408.00       77437.92
2   Aussie        No      0.30            32041.67      111825.42
3   Aussie        No      0.35            41457.50      136395.17
4   Aussie       Yes      0.05            11529.00       55223.91
5   Aussie       Yes      0.10            12630.00       56708.70
6   Aussie       Yes      0.15            15437.00       66224.73
7   Aussie       Yes      0.20            23394.33       93343.39
8   Aussie       Yes      0.30            37453.50      130712.72
9   Aussie       Yes      0.35            48499.80      159564.34
10  Aussie       Yes      0.40            57093.33      170709.07
11  Aussie       Yes      0.50            77200.00      192228.00

    Average_Gross_Margin
0               23891.47
1               23095.52
2               22108.75
3               20314.17
4               22942.71
5               21339.95
6               23264.14
7               27839.26
8               25842.92
9               23764.90
10              10847.73
11             -23932.00
```

[33]:

```
aussie_pivot_flyer_data = aussie_grouped_flyer_data.pivot_table(
    index=['Product', 'Discount'],
    columns='On Flyer?',
    values=['Average_Units_Sold', 'Average_Sales', 'Average_Gross_Margin']
)

aussie_pivot_flyer_data
```

[33]:

```
                  Average_Gross_Margin            Average_Sales             \
On Flyer?                           No        Yes            No        Yes
```

```
Product Discount
Aussie  0.00             23891.47       NaN     54437.63        NaN
        0.05                  NaN  22942.71          NaN   55223.91
        0.10                  NaN  21339.95          NaN   56708.70
        0.15                  NaN  23264.14          NaN   66224.73
        0.20             23095.52  27839.26     77437.92   93343.39
        0.30             22108.75  25842.92    111825.42  130712.72
        0.35             20314.17  23764.90    136395.17  159564.34
        0.40                  NaN  10847.73          NaN  170709.07
        0.50                  NaN -23932.00          NaN  192228.00

                 Average_Units_Sold
On Flyer?                        No       Yes
Product Discount
Aussie  0.00               10909.34       NaN
        0.05                    NaN  11529.00
        0.10                    NaN  12630.00
        0.15                    NaN  15437.00
        0.20               19408.00  23394.33
        0.30               32041.67  37453.50
        0.35               41457.50  48499.80
        0.40                    NaN  57093.33
        0.50                    NaN  77200.00
```

For 20% discount rate, if the product is on flyer, the average units sold will increase 3,986 units, average sales will increase 15,905.47 and average gross margin will increase 4,743.74. For 30% discount rate, if the product is on flyer, the average units sold will increase 5,412 units, average sales will increase 18,887.3 and average gross margin will increase 3,734.17. For 35% discount rate, if the product is on flyer, the average units sold will increase 7,042 units, average sales will increase 30,211.16 and average gross margin will increase 3,450.73.

[34]:
```python
#Calculate average metrics for Pantene
pantene_grouped_flyer_data = pantene_data.groupby(['Product', 'On Flyer?',␣
 ↪'Discount']).agg(
    Average_Units_Sold=('Units', 'mean'),
    Average_Sales=('Sales $', 'mean'),
    Average_Gross_Margin=('Gross Margin $', 'mean')
).reset_index()

pantene_grouped_flyer_data = pantene_grouped_flyer_data.round({
    'Average_Units_Sold': 2,  # Rounding units to 0 decimal places for whole␣
 ↪numbers
    'Average_Sales': 2,
    'Average_Gross_Margin': 2
})

pantene_grouped_flyer_data
```

[34]:

	Product	On Flyer?	Discount	Average_Units_Sold	Average_Sales	\
0	Pantene	No	0.00	8636.21	69003.35	
1	Pantene	No	0.15	11477.00	77928.83	
2	Pantene	No	0.30	18338.50	100678.36	
3	Pantene	No	0.45	37355.00	167723.95	
4	Pantene	Yes	0.05	9371.00	70188.79	
5	Pantene	Yes	0.10	10183.00	74234.07	
6	Pantene	Yes	0.15	13116.83	89063.30	
7	Pantene	Yes	0.20	14238.67	92408.95	
8	Pantene	Yes	0.30	21531.80	118209.58	
9	Pantene	Yes	0.35	27942.00	147813.18	
10	Pantene	Yes	0.40	32604.60	156176.03	
11	Pantene	Yes	0.45	42907.00	192652.43	
12	Pantene	Yes	0.50	56170.88	224121.79	

	Average_Gross_Margin
0	33594.87
1	30873.13
2	25490.52
3	14568.45
4	31767.69
5	32483.77
6	35284.28
7	34030.41
8	29929.20
9	33250.98
10	22497.17
11	16733.73
12	-6178.80

[35]:
```
pantene_pivot_flyer_data = pantene_grouped_flyer_data.pivot_table(
    index=['Product', 'Discount'],
    columns='On Flyer?',
    values=['Average_Units_Sold', 'Average_Sales', 'Average_Gross_Margin']
)

pantene_pivot_flyer_data
```

[35]:

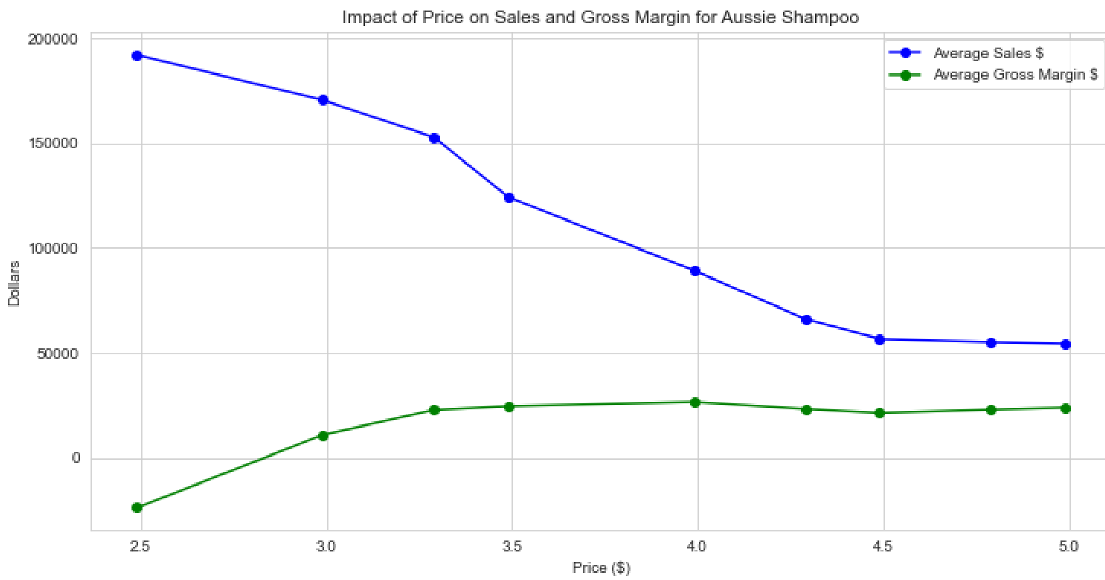
		Average_Gross_Margin		Average_Sales		\
On Flyer?		No	Yes	No	Yes	
Product	Discount					
Pantene	0.00	33594.87	NaN	69003.35	NaN	
	0.05	NaN	31767.69	NaN	70188.79	
	0.10	NaN	32483.77	NaN	74234.07	
	0.15	30873.13	35284.28	77928.83	89063.30	
	0.20	NaN	34030.41	NaN	92408.95	
	0.30	25490.52	29929.20	100678.36	118209.58	

```
         0.35                       NaN  33250.98          NaN  147813.18
         0.40                       NaN  22497.17          NaN  156176.03
         0.45                  14568.45  16733.73    167723.95  192652.43
         0.50                       NaN  -6178.80          NaN  224121.79

                  Average_Units_Sold
On Flyer?                         No       Yes
Product Discount
Pantene 0.00                 8636.21       NaN
        0.05                     NaN   9371.00
        0.10                     NaN  10183.00
        0.15                11477.00  13116.83
        0.20                     NaN  14238.67
        0.30                18338.50  21531.80
        0.35                     NaN  27942.00
        0.40                     NaN  32604.60
        0.45                37355.00  42907.00
        0.50                     NaN  56170.88
```

For 15% discount rate, if the product is on flyer, the average units sold will increase 1640 units, average sales will increase 11,134.47 and average gross margin will increase 4,411.15. For 30% discount rate, if the product is on flyer, the average units sold will increase 3193 units, average sales will increase 17,531.21 and average gross margin will increase 4,438.68. For 45% discount rate, if the product is on flyer, the average units sold will increase 5,552 units, average sales will increase 24,928.48 and average gross margin will increase 2165.28.

Question 8: Your director wants to change the price on an upcoming Aussie Shampoo flyer promotion. Her goal is to maximize sales, but she does not want to sacrifice too much margin. a. How would you present the data to help her make the decision? b. What price would you recommend?

[36]:
```python
aussie_plot_data = aussie_data.groupby('Price').agg({
    'Sales $': 'mean',
    'Gross Margin $': 'mean'
}).reset_index()

plt.figure(figsize=(12, 6))
plt.plot(aussie_plot_data['Price'], aussie_plot_data['Sales $'], label='Average Sales $', marker='o', color='blue')
plt.plot(aussie_plot_data['Price'], aussie_plot_data['Gross Margin $'], label='Average Gross Margin $', marker='o', color='green')
plt.title('Impact of Price on Sales and Gross Margin for Aussie Shampoo')
plt.xlabel('Price ($)')
plt.ylabel('Dollars')
plt.legend()
plt.grid(True)
plt.show()
```



The above graph shows the trend for sales vs price and gross margin vs price. For gross margin, it's clear that after the interval between price = 3.25 and price = 3.5 the gross margin become stable, however in the mean time, the sales drop rapidly after the interval between price = 3.25 and price = 3.5, therefor, the interval between 3.25 and 3.5 is the point of inflection, so I will recommand this interval.

Question 9: Aussie Shampoo sold at 2.49 is a "loss leader" promotion. We lose money selling it at this price, but hope that people who came to buy it will purchase other items. i. Is Aussie @ 2.49 an effective loss leader? Explain why or why not. ii. Your director proposes to change the promotion to 2 for 5 or pay 2.99 each, hoping that this will improve margin. Will this work? Explain why or why not.

If we sell Aussie at 2.49, we will lose money at this point, but we may attract high number of transaction and increase the store traffic. However, we cannot consider selling Aussie at 2.49 is an effective loss leader because it does not meet the goal which is to bring customer to the store and potentially boosting the sales for other products.

[37]:
```
aussie_data.groupby(['Price','# Transactions that contained the product']).
    ↪agg({'Gross Margin $': 'mean'}).reset_index().head(5)
```

[37]:

	Price	# Transactions that contained the product	Gross Margin $
0	2.49	22396	-23932.00
1	2.99	21955	10793.90
2	2.99	22173	10637.53
3	2.99	22390	10954.45
4	2.99	22608	10953.31

Given the cost for unit is $2.8, so the gross margin per unit is 2.5 - 2.8 = -0.3 if we sell 2 for 5, and the gross margin per unit is 2.99 - 2.8 = 0.19 if we sell 2.99 each. In order to find breakeven point that we will made positive margin, let's define x to be percentage of customer who purchuse 2 for 5.

[38]:
```python
from sympy import symbols, Eq, solve

#Define the variable that x be % of customer who purchase 1 for 2.99
x = symbols('x')

#Equation for break-even point
equation = Eq(-0.30*(1-x) + 0.19*x, 0)

#Solve the equation
break_even_x = solve(equation, x)
break_even_x
```

[38]:
```
[0.612244897959184]
```

The breakeven point shows if there are less than 38.76% of customer who purchase 2 for 5, which is 61.24% customer who choose to purchase one at 2.99, we will gain positive gross margin.