In [1]:
```
import pandas as pd
import numpy as np
```

Step 1: Select Control Stores

In [2]:
```
QVI_data = pd.read_csv('QVI_data.csv')
```

In [3]:
```
QVI_data.head()
```

Out[3]:

	LYLTY_CARD_NBR	DATE	STORE_NBR	TXN_ID	PROD_NBR	PROD_NAME	PROD_QTY
0	1000	2018-10-17	1	1	5	Natural Chip Compny SeaSalt175g	2
1	1002	2018-09-16	1	2	58	Red Rock Deli Chikn&Garlic Aioli 150g	1
2	1003	2019-03-07	1	3	52	Grain Waves Sour Cream&Chives 210G	1
3	1003	2019-03-08	1	4	106	Natural ChipCo Hony Soy Chckn175g	1
4	1004	2018-11-02	1	5	96	WW Original Stacked Chips 160g	1

In [4]:
```
QVI_data['DATE'] = pd.to_datetime(QVI_data['DATE'])
```

In [5]:
```
Pre_Trial = QVI_data[(QVI_data['DATE'] < '2019-02-01')]
```

In [6]:

```
Pre_Trial['MONTH/YEAR'] = Pre_Trial['DATE'].dt.to_period('M')
```

```
<ipython-input-6-818493148bcc>: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-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  Pre_Trial['MONTH/YEAR'] = Pre_Trial['DATE'].dt.to_period('M')
```

In [7]:

```
# Calculate the total sales and total transactions for each stores
Pre_Trial_sum = Pre_Trial.groupby(by = ['STORE_NBR','MONTH/YEAR']).sum().reset_index()
Pre_Trial_count = Pre_Trial.groupby(by = ['STORE_NBR','MONTH/YEAR']).count().reset_inde
x()
```

In [8]:

```
Pre_Trial_info = pd.merge(Pre_Trial_sum[['MONTH/YEAR','STORE_NBR','TOT_SALES','PROD_QT
Y']],Pre_Trial_count[['MONTH/YEAR','STORE_NBR','PREMIUM_CUSTOMER']], how = 'inner')
Pre_Trial_info.rename(columns= {'PREMIUM_CUSTOMER':'TOT_TRANSACTION'}, inplace= True)
```

In [9]:

```
Pre_Trial_info.head()
```

Out[9]:

	MONTH/YEAR	STORE_NBR	TOT_SALES	PROD_QTY	TOT_TRANSACTION
0	2018-07	1	206.9	62	52
1	2018-08	1	176.1	54	43
2	2018-09	1	278.8	75	62
3	2018-10	1	188.1	58	45
4	2018-11	1	192.6	57	47

In [10]:

```
#Calculate the total customers for each store, and merge the table with the info table
Pre_Trial_info = pd.merge(Pre_Trial.groupby(by = ['STORE_NBR','MONTH/YEAR']).nunique()[
'LYLTY_CARD_NBR'].reset_index(), Pre_Trial_info, how = 'inner')
```

In [11]:

```
Pre_Trial_info.rename(columns={'LYLTY_CARD_NBR':'TOT_CUSTOMER'}, inplace = True)
```

In [12]:

```
Pre_Trial_info['AVG_TRANS_per_CUSTOMER'] = Pre_Trial_info['TOT_TRANSACTION']/Pre_Trial_
info['TOT_CUSTOMER']
```

In [13]:

```
#drop the stores that doesn't operate during the entire pre-trial period
def is_full_pre_trial(s):
    return Pre_Trial_info[Pre_Trial_info['STORE_NBR'] == s]['MONTH/YEAR'].nunique() ==
Pre_Trial_info['MONTH/YEAR'].nunique()

Pre_Trial_info.drop(index = Pre_Trial_info[Pre_Trial_info['STORE_NBR'].apply(is_full_pr
e_trial)== False].index, inplace = True)
```

In [14]:

```
Pre_Trial_info.head()
```

Out[14]:

	STORE_NBR	MONTH/YEAR	TOT_CUSTOMER	TOT_SALES	PROD_QTY	TOT_TRANSACTI
0	1	2018-07	49	206.9	62	
1	1	2018-08	42	176.1	54	
2	1	2018-09	59	278.8	75	
3	1	2018-10	44	188.1	58	
4	1	2018-11	46	192.6	57	

In [15]:

```
#Create the data frame that shows how each stores is correlated to the trial stores
Pre_Trial_comparison = pd.DataFrame()
```

In [16]:

```
Pre_Trial_comparison['STORE_NBR'] = Pre_Trial_info['STORE_NBR'].unique()
```

In [17]:

```
#define a metric to calculate the correlation
def mean_dist(tri_str_num,control_str_num,FEATURE):
    mag_difference = 0
    for month in Pre_Trial_info['MONTH/YEAR'].unique():
        mag_difference += abs(Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == tri_str_nu
m) & (Pre_Trial_info['MONTH/YEAR'] == month)][FEATURE].item() -
                            Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == control_str_
num) & (Pre_Trial_info['MONTH/YEAR'] == month)][FEATURE].item())
    return (mag_difference/Pre_Trial_info['MONTH/YEAR'].nunique())
```

In [18]:

```
control_store_NBR = [77,86,88]
Features = ['TOT_CUSTOMER','TOT_SALES','AVG_TRANS_per_CUSTOMER']
```

In [19]:

```
for feature in Features:
    for num in control_store_NBR:
        Pre_Trial_comparison['mean_dif_'+str(num)+'_'+feature] = Pre_Trial_comparison[
'STORE_NBR'].apply(mean_dist,control_str_num = num, FEATURE = feature)
```

In [20]:

```
#standaardise the data for better comparison (1 = most related, 0 = not related)
comparison_col = Pre_Trial_comparison.columns
comparison_col = comparison_col.drop('STORE_NBR')

for col in comparison_col:
    Pre_Trial_comparison[col] = 1-(Pre_Trial_comparison[col]/Pre_Trial_comparison[col].
max())
```

In [21]:

```
#take an average of the scores for each store
# weight heavier for total sales and total customers
for num in control_store_NBR:
    Pre_Trial_comparison['avg_'+str(num)] = 0.4*Pre_Trial_comparison['mean_dif_'+str(nu
m)+'_'+'TOT_CUSTOMER']+ 0.4*Pre_Trial_comparison['mean_dif_'+str(num)+'_'+'TOT_SALES']+
0.2*Pre_Trial_comparison['mean_dif_'+str(num)+'_'+'AVG_TRANS_per_CUSTOMER']
```

In [22]:

```
#find the store with the cloest score to 77 to be control store
Pre_Trial_comparison.sort_values('avg_77',ascending= False,axis = 0)[['STORE_NBR','avg_
77']].head(3)
```

Out[22]:

	STORE_NBR	avg_77
72	77	1.000000
221	233	0.966890
42	46	0.951975

In [23]:

```
#find the store with the cloest score to 86 to be control store
Pre_Trial_comparison.sort_values('avg_86',ascending= False,axis = 0)[['STORE_NBR','avg_
86']].head(3)
```

Out[23]:

	STORE_NBR	avg_86
80	86	1.000000
147	155	0.926828
94	101	0.924705

In [24]:

```
#find the store with the cloest score to 88 to be control store
Pre_Trial_comparison.sort_values('avg_88',ascending= False,axis = 0)[['STORE_NBR','avg_
88']].head(3)
```

Out[24]:

	STORE_NBR	avg_88
82	88	1.000000
225	237	0.936315
194	203	0.915606

Control Stores for:

Store 77: Store 233
Store 86: Store 155
Store 88: Store 237

In [25]:

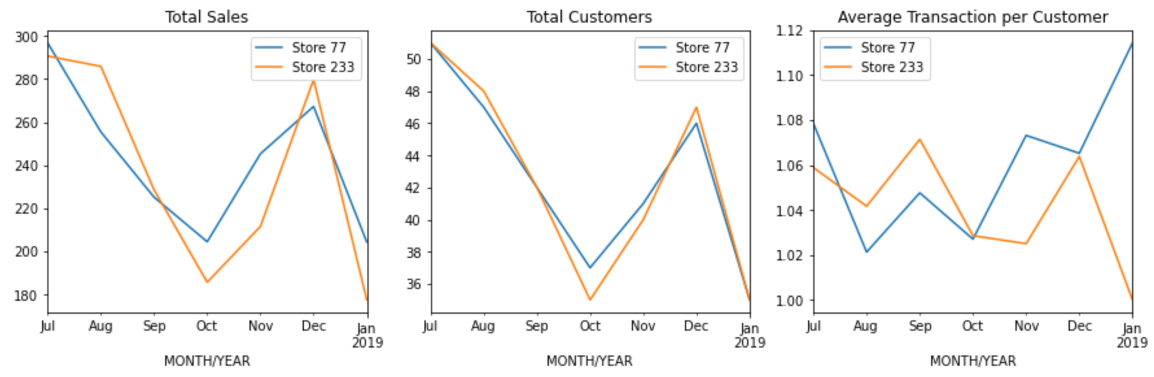
```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [26]:

```
#Compare the performance of Store 77 and Store 233
fig, axes= plt.subplots(ncols = 3, nrows = 1,figsize = (15,4))

#Total Sales
axes[0].set_title('Total Sales')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 77)].plot.line(x = 'MONTH/YEAR', y = 'TO
T_SALES', ax = axes[0], label = 'Store 77')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 233)].plot.line(x = 'MONTH/YEAR', y = 'T
OT_SALES', ax = axes[0], label = 'Store 233')

#Total Customers
axes[1].set_title('Total Customers')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 77)].plot.line(x = 'MONTH/YEAR', y = 'TO
T_CUSTOMER', ax = axes[1], label = 'Store 77')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 233)].plot.line(x = 'MONTH/YEAR', y = 'T
OT_CUSTOMER', ax = axes[1], label = 'Store 233')

#Average Transaction per Customer
axes[2].set_title('Average Transaction per Customer')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 77)].plot.line(x = 'MONTH/YEAR', y = 'AV
G_TRANS_per_CUSTOMER', ax = axes[2], label = 'Store 77')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 233)].plot.line(x = 'MONTH/YEAR', y = 'A
VG_TRANS_per_CUSTOMER', ax = axes[2], label = 'Store 233')
```

Out[26]:

```
<matplotlib.axes._subplots.AxesSubplot at 0xed85628>
```

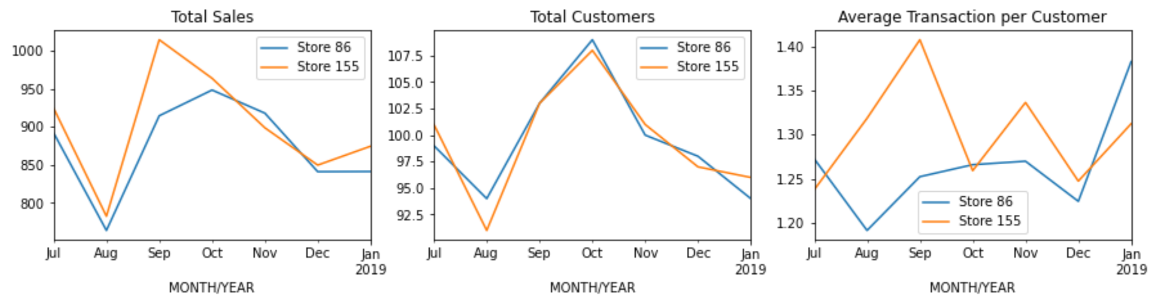


In [27]:

```
#Compare the performance of Store 86 and Store 155
fig, axes= plt.subplots(ncols = 3, nrows = 1,figsize = (15,3))

#Total Sales
axes[0].set_title('Total Sales')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 86)].plot.line(x = 'MONTH/YEAR', y = 'TO
T_SALES', ax = axes[0], label = 'Store 86')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 155)].plot.line(x = 'MONTH/YEAR', y = 'T
OT_SALES', ax = axes[0], label = 'Store 155')

#Total Customers
axes[1].set_title('Total Customers')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 86)].plot.line(x = 'MONTH/YEAR', y = 'TO
T_CUSTOMER', ax = axes[1], label = 'Store 86')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 155)].plot.line(x = 'MONTH/YEAR', y = 'T
OT_CUSTOMER', ax = axes[1], label = 'Store 155')

#Average Transaction per Customer
axes[2].set_title('Average Transaction per Customer')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 86)].plot.line(x = 'MONTH/YEAR', y = 'AV
G_TRANS_per_CUSTOMER', ax = axes[2], label = 'Store 86')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 155)].plot.line(x = 'MONTH/YEAR', y = 'A
VG_TRANS_per_CUSTOMER', ax = axes[2], label = 'Store 155')
```

Out[27]:

```
<matplotlib.axes._subplots.AxesSubplot at 0xf00b6d0>
```

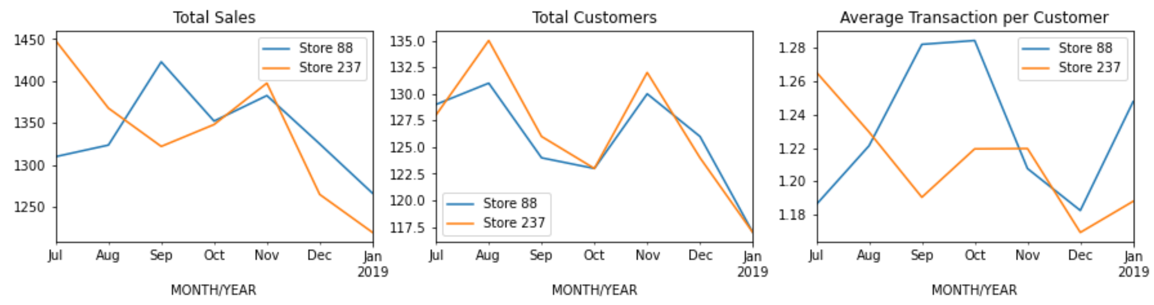


In [28]:

```
#Compare the performance of Store 88 and Store 237
fig, axes= plt.subplots(ncols = 3, nrows = 1,figsize = (15,3))

#Total Sales
axes[0].set_title('Total Sales')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 88)].plot.line(x = 'MONTH/YEAR', y = 'TO
T_SALES', ax = axes[0], label = 'Store 88')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 237)].plot.line(x = 'MONTH/YEAR', y = 'T
OT_SALES', ax = axes[0], label = 'Store 237')

#Total Customers
axes[1].set_title('Total Customers')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 88)].plot.line(x = 'MONTH/YEAR', y = 'TO
T_CUSTOMER', ax = axes[1], label = 'Store 88')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 237)].plot.line(x = 'MONTH/YEAR', y = 'T
OT_CUSTOMER', ax = axes[1], label = 'Store 237')

#Average Transaction per Customer
axes[2].set_title('Average Transaction per Customer')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 88)].plot.line(x = 'MONTH/YEAR', y = 'AV
G_TRANS_per_CUSTOMER', ax = axes[2], label = 'Store 88')
Pre_Trial_info[(Pre_Trial_info['STORE_NBR'] == 237)].plot.line(x = 'MONTH/YEAR', y = 'A
VG_TRANS_per_CUSTOMER', ax = axes[2], label = 'Store 237')
```

Out[28]:

```
<matplotlib.axes._subplots.AxesSubplot at 0xeef72e0>
```



Step 2: Trial Period Comparison

In [29]:

```
# Get the record over the trial period
Trial = QVI_data[(QVI_data['DATE']>= '2019-02-01') & (QVI_data['DATE']< '2019-05-01')]
```

In [30]:

```
# Drop the non-trial and non-control stores
Trial.drop(index = Trial[Trial['STORE_NBR'].apply(lambda s: s not in [77,86,88,155,233,
237])].index, inplace = True)
```

```
C:\Users\Jeff Lau\OneDrive\Anaconda\lib\site-packages\pandas\core\frame.p
y:3990: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  return super().drop(
```

In [31]:

```
#Record the trial stores and its control counterpart, for the control stores we assign
 itself for the calculation convenience
stores = {77: 233 , 86: 155, 88: 237, 233: 233, 155: 155, 237: 237}
```

In [32]:

```
control_store_NBR
```

Out[32]:

```
[77, 86, 88]
```

In [33]:

```
#Record the total sale of these stores before the trial period
Pre_Trial_overall= Pre_Trial_info[Pre_Trial_info['STORE_NBR'].apply(lambda s: s in [77,
86,88,155,233,237])].groupby(by = 'STORE_NBR').sum()
Pre_Trial_overall
```

Out[33]:

	TOT_CUSTOMER	TOT_SALES	PROD_QTY	TOT_TRANSACTION	AVG_TRANS_p
STORE_NBR					
77	299	1699.00	484	317	
86	697	6119.85	1754	882	
88	880	9383.60	2147	1082	
155	697	6308.70	1805	908	
233	298	1659.80	478	311	
237	885	9369.00	2121	1073	

In [34]:

```
# Calculate the scaling factor of total sales over the pre-trial period for the pairs,
 and apply it on the total sales in trial stores over the trial period
# First we define the method for the scaling factor

def scaled_quantity(tri_nbr,FEATURE,df):
    control_nbr = stores[tri_nbr]
    s = Pre_Trial_overall.loc[control_nbr][FEATURE]/Pre_Trial_overall.loc[tri_nbr][FEAT
URE]
    return (df[df['STORE_NBR'] == tri_nbr][FEATURE] * s ).item()
```

In [35]:

```
#Apply the scaling factor into the new columns and recorded

#total sales
Trial_sum = Trial.groupby(by = 'STORE_NBR').sum()['TOT_SALES'].reset_index()
Trial_sum['Scaled_TOT_SALES'] = Trial_sum['STORE_NBR'].apply(scaled_quantity,FEATURE =
'TOT_SALES',df = Trial_sum)
Trial_sum['Scaled_TOT_SALES']= Trial_sum['Scaled_TOT_SALES'].round(2)

#total customer
Trial_count = Trial.groupby(by = 'STORE_NBR').nunique()['LYLTY_CARD_NBR'].reset_index()
Trial_count.rename(columns={'LYLTY_CARD_NBR':'TOT_CUSTOMER'}, inplace = True)
Trial_count['Scaled_TOT_CUSTOMER'] = Trial_count['STORE_NBR'].apply(scaled_quantity,FEA
TURE = 'TOT_CUSTOMER', df = Trial_count)
Trial_count['Scaled_TOT_CUSTOMER'] = Trial_count['Scaled_TOT_CUSTOMER'].apply(lambda s
: int(s))
```

In [36]:

```
Trial_overall = pd.merge(Trial_sum, Trial_count).set_index("STORE_NBR")
Trial_overall
```

Out[36]:

	TOT_SALES	Scaled_TOT_SALES	TOT_CUSTOMER	Scaled_TOT_CUSTOMER
STORE_NBR				
77	777.0	759.07	124	123
86	2788.2	2874.24	215	215
88	4286.8	4280.13	261	262
155	2540.2	2540.20	190	190
233	601.7	601.70	112	112
237	3817.6	3817.60	262	262

In [37]:

```
#Display the percentage difference of total sales of each pair
percentd = {}

for num in control_store_NBR:
    percentd[(num, stores[num])] = (Trial_overall.loc[num]['Scaled_TOT_SALES'] - Trial_
overall.loc[stores[num]]['Scaled_TOT_SALES'])/(Trial_overall.loc[stores[num]]['Scaled_T
OT_SALES'])

percentd_data_0 = pd.DataFrame(percentd.items(), columns = ['Tri, Ctr','%_diff_TOT_SALE
S'])
```

In [38]:

```
#Display the percentage difference of total customers of each pair
for num in control_store_NBR:
    percentd[(num, stores[num])] = (Trial_overall.loc[num]['Scaled_TOT_CUSTOMER'] - Tri
al_overall.loc[stores[num]]['Scaled_TOT_CUSTOMER'])/(Trial_overall.loc[stores[num]]['Sc
aled_TOT_CUSTOMER'])

percentd_data_1 = pd.DataFrame(percentd.items(), columns = ['Tri, Ctr','%_diff_TOT_CUST
OMER'])


percentd_data = pd.merge(percentd_data_0,percentd_data_1)
```

In [39]:

```
percentd_data.set_index('Tri, Ctr',inplace = True)
percentd_data
```

Out[39]:

	%_diff_TOT_SALES	%_diff_TOT_CUSTOMER
Tri, Ctr		
(77, 233)	0.261542	0.098214
(86, 155)	0.131501	0.131579
(88, 237)	0.121157	0.000000

In [ ]:

In [ ]: