Report_Draft_Analysis Geography_v5

December 5, 2024

0.1 Geographic Impacts

The geographic distribution of sales across the US was examined. The results were very surprising and could either be due to very poor data collection or very unusual sales patterns.

The sales data was analysed in a variety of ways (box plot, scatter plot with regression line, top and bottom 5, a choropleth map) but all supported the following: - The spread of sales number and $ value is very small when the big differences in population across states are considered - For example the 4th highest sales are in the US Minor Outlying Islands which has a population of 300, and spending as much as Alabama which has a population of over 5 million - And, the largest state, California, with a population of nearly 39 million has the lowest sales total - The spread of customers across states is also very even, the interquartile range is approximately 80 to 95

This is in contrast to the number of physical store per state which do correlate well with population size. So it does seem likely that there is a problem with the quality of the sales data collected. Before making any business recommendations, the data collection pipeline and sources should be investigated; or worst case the operational information systems that provided the source data.

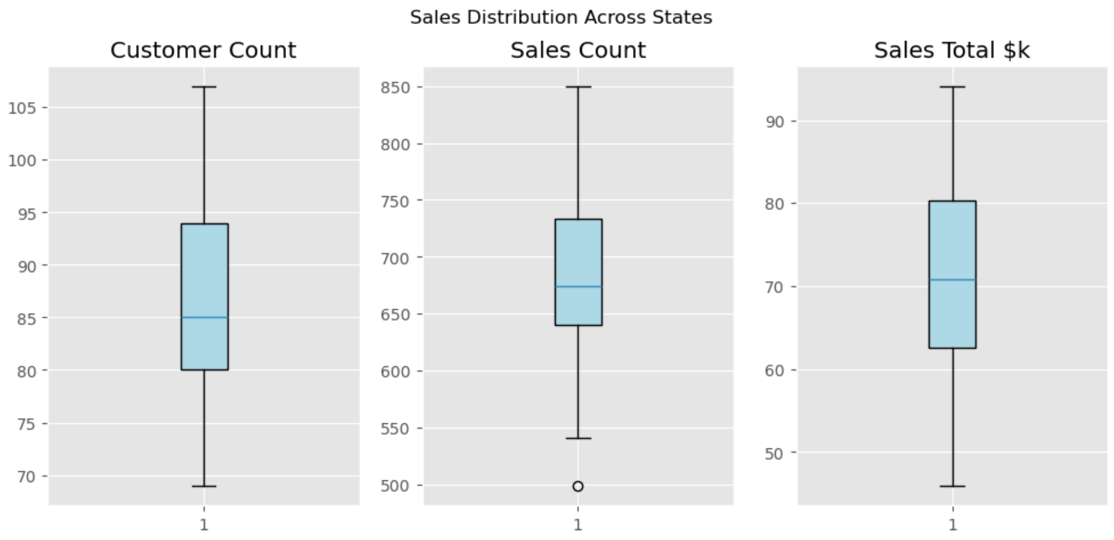
[1]:

```
# Retrieve the completed working dataframes for analysis
%store -r sales_df stock_df customer_reviews_df customers_df states_df
```

[2]:

```
# Examine key customer and sales data by state

import pandas as pd
import matplotlib.pyplot as plt
plt.style.use('ggplot')

# Aggregate customer sales counts and total value
cust_sales = pd.merge(customer_reviews_df, customers_df, on='customer_id')
cust_sales = pd.merge(cust_sales, sales_df, on='uniq_id')

cust_summary = cust_sales[['customer_id', 'state_ISO']].drop_duplicates()
groups = cust_sales.groupby('customer_id')
cust_summary['sales_count'] = groups['uniq_id'].transform('count')
cust_summary['sales_total$k'] = groups['sale_price'].transform('sum')
cust_summary['sales_total$k'] = (cust_summary['sales_total$k'] / 1000).round(2)

# Aggregate the customer counts and sales totals by state
states_working = states_df.copy()
```

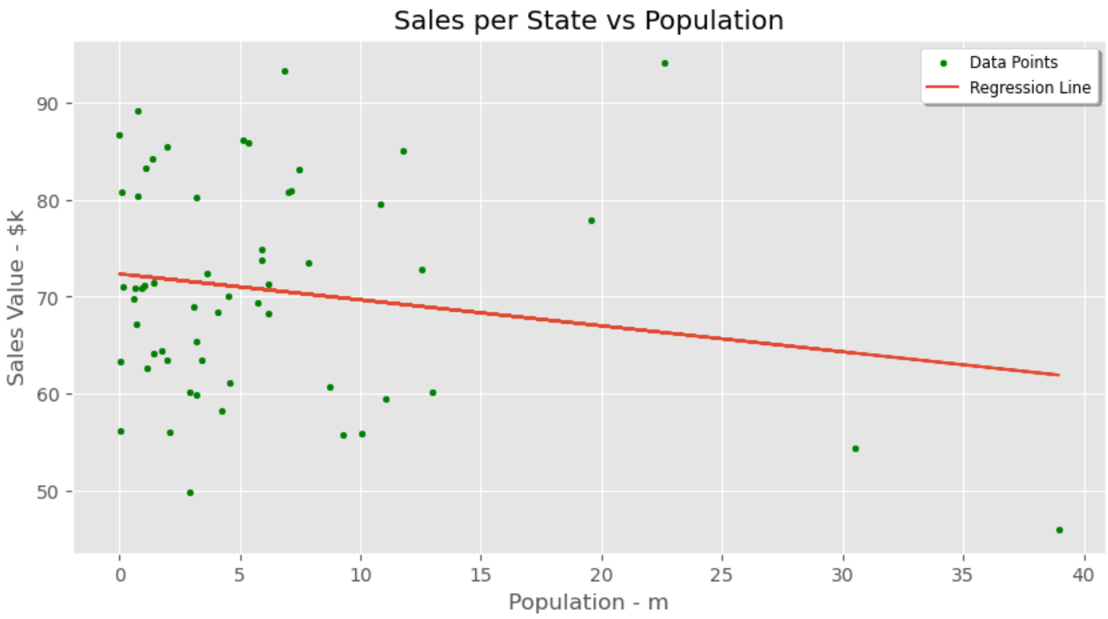
```
states_working['customer_count'] = customers_df.
 ↪groupby('state_ISO')['state_ISO'].transform('count')
states_working.reset_index()
states_working['sales_count'] = cust_summary.
 ↪groupby('state_ISO')['sales_count'].sum().reset_index()['sales_count']
states_working['sales_total$k'] = cust_summary.
 ↪groupby('state_ISO')['sales_total$k'].sum().reset_index()['sales_total$k']

# Some analysis of these figures geographical
# Too many states for a meaningful bar plot for each states ...

# Distribution of sales across states, using box plots
fig, (ax0, ax1, ax2) = plt.subplots(1, 3, figsize =(12, 5))
fig.suptitle('Sales Distribution Across States')

ax0.set_title('Customer Count')
ax1.set_title('Sales Count')
ax2.set_title('Sales Total $k')

box0 = ax0.boxplot(states_working['customer_count'], patch_artist=True)
for patch in box0['boxes']:
    patch.set(facecolor='lightblue')
box1 = ax1.boxplot(states_working['sales_count'], patch_artist=True)
for patch in box1['boxes']:
    patch.set(facecolor='lightblue')
box2 = ax2.boxplot(states_working['sales_total$k'], patch_artist=True)
for patch in box2['boxes']:
    patch.set(facecolor='lightblue')

plt.show()


# Examine top and bottom 5 states by sales value
top5 = states_working.nlargest(5, 'sales_total$k')
bottom5 = states_working.nsmallest(5, 'sales_total$k')

print('Top Five States by Sales Value')
display(top5[['state_name', 'population', 'customer_count', 'sales_count',␣
 ↪'sales_total$k']])
print('Bottom Five States by Sales Value')
display(bottom5[['state_name', 'population', 'customer_count', 'sales_count',␣
 ↪'sales_total$k']])

# some correlations with size, populations ...
```



```
Top Five States by Sales Value

                  state_name  population  customer_count  sales_count  \
9                    Florida    22610726              90          838
14                   Indiana     6862199              83          715
34              North Dakota      783926              79          802
53  US Minor Outlying Islands         300              79          716
0                    Alabama     5108468              96          774

    sales_total$k
9           94.10
14          93.25
34          89.19
53          86.74
0           86.14
Bottom Five States by Sales Value

    state_name  population  customer_count  sales_count  sales_total$k
4   California    38965193              79          546          45.95
16      Kansas     2940546              79          541          49.78
43       Texas    30503301              76          705          54.34
30  New Jersey     9290841             102          499          55.79
22    Michigan    10037261              69          630          55.90
```

[3]:
```
# Compare the sales value per state against the population
# Scatter plot and regression line

import scipy.stats

x = states_working['population'] / 1000000
```

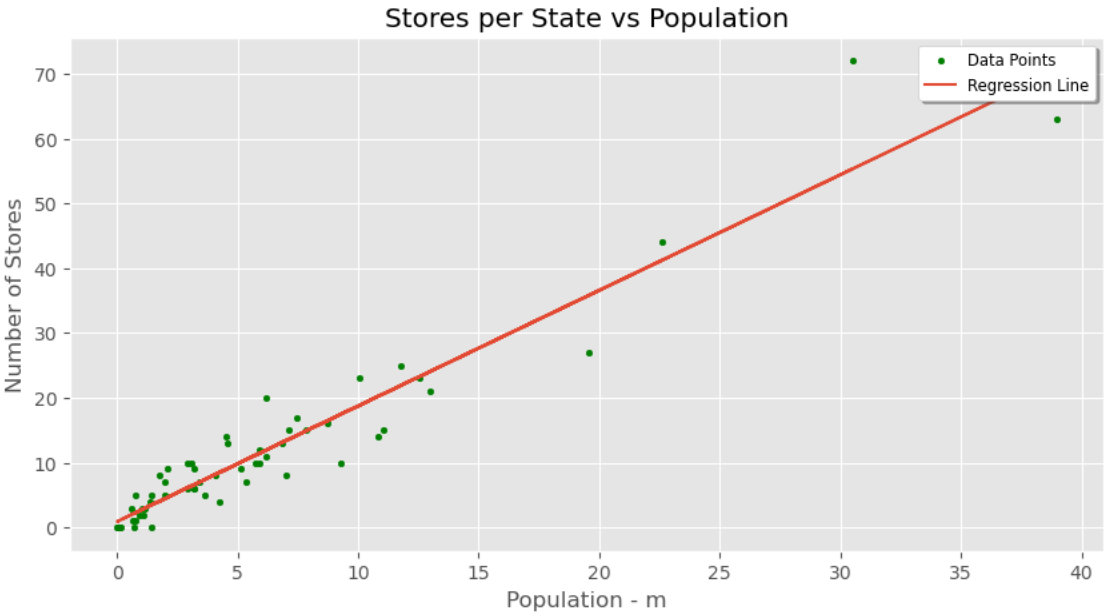
```
y = states_working['sales_total$k']

# Calculate the regression line
slope, intercept, r, p, stderr = scipy.stats.linregress(x, y)

# Scatter plot with fir line
fig, ax = plt.subplots(figsize =(10, 5))

ax.set_title('Sales per State vs Population')
ax.set_xlabel('Population - m')
ax.set_ylabel('Sales Value - $k')

ax.scatter(x, y, label= 'Data Points', color = 'g', s = 10)
ax.plot(x, intercept + slope * x, label='Regression Line')
ax.legend(fontsize='small', loc='upper right', shadow=True, facecolor='white')

plt.show()
```



[4]:

```
# Sanity check of physical stores per state against the population
# Scatter plot and regression line

import scipy.stats

x = states_working['population'] / 1000000
y = states_working['stores_total']
```

```
# Calculate the regression line
slope, intercept, r, p, stderr = scipy.stats.linregress(x, y)

# Scatter plot with fir line
fig, ax = plt.subplots(figsize =(10, 5))

ax.set_title('Stores per State vs Population')
ax.set_xlabel('Population - m')
ax.set_ylabel('Number of Stores')

ax.scatter(x, y, label= 'Data Points', color = 'g', s = 10)
ax.plot(x, intercept + slope * x, label='Regression Line')
ax.legend(fontsize='small', loc='upper right', shadow=True, facecolor='white')

plt.show()
```



[5]:
```
# Map plot of sales totals per state
import plotly.express as px

fig = px.choropleth(states_working, locations='state_ISO',␣
 ↪locationmode='USA-states', color='sales_total$k',          # Column to color␣
 ↪by
        color_continuous_scale='Blues', scope='usa', title='Sales Value $k by␣
 ↪State')

fig.show()
```