In [1]:

```
import scipy as sp
import scipy.stats as stats
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import copy
# Set color map to have light blue background
sns.set()
import statsmodels.formula.api as smf
import statsmodels.api as sm
%matplotlib inline

```

About the Data

The data that I used for this analysis and project is from the Federal Reserve Economic Data (FRED) site of the St. Louis Federal Reserve (St. Louis Fed). I will be evaluating the average monthly price on groceries in urban areas. There will be comparisons between each of the grocery items being compared to each other as well as to the monthly US Urban Consumer Price Index (CPI).

All data came in the form of Comma Separate Value (CSV) files.

The grocery items being compared and run through for exploratory data analysis are: white bread, ground beef, eggs, whole milk, and bananas. Another column, urban_cpi, is the average urban Consumer Price Index (CPI) for spending on groceries in urban US areas.

There were some empty data points with each of the CSV files that I was working with, but they have been edited to make sure that any empty values were filled or removed accordingly. There were six CSV files combined into one CSV file containing all of the columns of average grocery items' prices. The dates were also reformatted in the CSV files using Microsoft Excel where the dates, initially listed in its respective column in the form **M/D/YYYY** are now listed in the form **YYYY/MM/DD**.

All economic data from the Federal Reserve can be found at https://fred.stlouisfed.org (https://fred.stlouisfed.org)

In [2]:

```
"""
Get the FRED dataset, a collection of average prices of groceries data in
from February 1999 to February 2024

Read the .csv file, then get the dataframe's strctural info
Includes columns' names, index ranges for each column, and their data type
"""
groceries_df = pd.read_csv("fred_groceries_021999_022024.csv", encoding='u
groceries_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 301 entries, 0 to 300
Data columns (total 7 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   DATE         301 non-null    object 
 1   white_bread  301 non-null    float64
 2   ground_beef  301 non-null    float64
 3   egg          301 non-null    float64
 4   whole_milk   301 non-null    float64
 5   banana       301 non-null    float64
 6   urban_cpi    301 non-null    float64
dtypes: float64(6), object(1)
memory usage: 16.6+ KB
```

Information about the Columns/Grocery Items

There is one object column: DATE

Urban CPI: Consumer Price Index for All Urban Consumers: Food in U.S. City Average

Grocery items - average monthly cost in US City/urban areas:

White bread: cost per pound
Bananas: cost per pound
Eggs: Grade A, Large, cost per dozen
Whole Milk: cost per gallon
Ground Beef: 100% beef, cost per pound

In [3]:

```
# Get a sample of what the data looks like by calling the dataframe
# Call the dataframe's first 5 rows using head()
groceries_df.head()
```

Out[3]:

	DATE	white_bread	ground_beef	egg	whole_milk	banana	urban_cpi
0	1999-02-01	0.880	1.431	1.078	3.004	0.509	163.3
1	1999-03-01	0.883	1.404	1.005	3.003	0.506	163.3
2	1999-04-01	0.897	1.429	0.942	2.707	0.482	163.4
3	1999-05-01	0.886	1.444	0.900	2.716	0.492	163.7
4	1999-06-01	0.885	1.448	0.949	2.704	0.502	163.6

In [4]:

```python
# Gets the names of each of the colums in this pandas dataframe
groceries_df.columns
```

Out[4]:

```
Index(['DATE', 'white_bread', 'ground_beef', 'egg', 'whole_milk', 'banana',
       'urban_cpi'],
      dtype='object')
```

In [5]:

```python
# Gets the shape of the dataframe
groceries_df.shape
```

Out[5]:

```
(301, 7)
```

In [6]:

```python
# Gets the descriptive statistics from the dataframe
groceries_df.describe()
```

Out[6]:

	white_bread	ground_beef	egg	whole_milk	banana	urban_cpi
count	301.000000	301.000000	301.000000	301.000000	301.000000	301.000000
mean	1.297900	2.999774	1.651575	3.289449	0.561970	227.267920
std	0.258624	1.078457	0.579640	0.392196	0.049593	42.223027
min	0.878000	0.000000	0.838000	2.656000	0.469000	163.300000
25%	1.046000	2.196000	1.257000	2.964000	0.509000	190.400000
50%	1.358000	2.818000	1.599000	3.241000	0.574000	229.554000
75%	1.419000	3.841000	1.920000	3.557000	0.601000	251.238000
max	2.033000	5.353000	4.823000	4.218000	0.643000	327.731000

Get the correlation of all the attributes from `groceries_df` .

Create a new dataframe, `no_date_groceries` , to be set to groceries_df. Then, drop the DATE column and create a correlation table.

Afterwards, create a heatmap using `sns.heatmap` from the `seaborn` library to visualize all possible correlations.

In [7]:

```python
no_date_groceries = groceries_df.drop(['DATE'], axis=1)
```

In [8]:

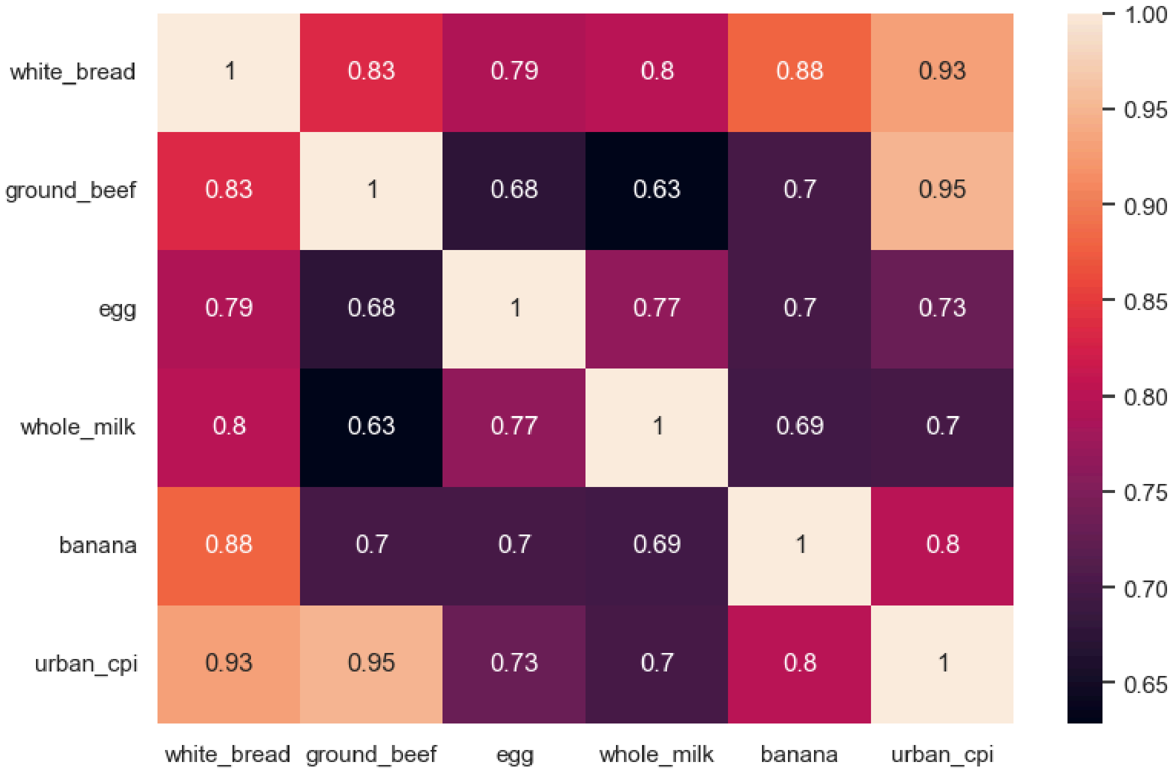
```python
# Create a correlation table with the numbers and with using heatmap from
no_date_groceries.corr()
```

Out[8]:

	white_bread	ground_beef	egg	whole_milk	banana	urban_cpi
white_bread	1.000000	0.833918	0.792305	0.798335	0.879341	0.931455
ground_beef	0.833918	1.000000	0.675822	0.628957	0.699347	0.949594
egg	0.792305	0.675822	1.000000	0.765661	0.700878	0.732184
whole_milk	0.798335	0.628957	0.765661	1.000000	0.694529	0.698135
banana	0.879341	0.699347	0.700878	0.694529	1.000000	0.799794
urban_cpi	0.931455	0.949594	0.732184	0.698135	0.799794	1.000000

In [9]:

```
# Visualize the correlation table via heatmap from seaborn library.
# Numeric labels also included.

plt.figure(figsize=(9,6))
sns.heatmap(no_date_groceries.corr(), annot=True)
plt.show()
```



Based on the heatmap, `urban_cpi` have fairly high correlations with the five grocery items that it is being compared to, but the items closer to 1 were `white_bread` and `ground_beef` , with correlation rank values of 0.93 and 0.95, respectively.

In [10]:

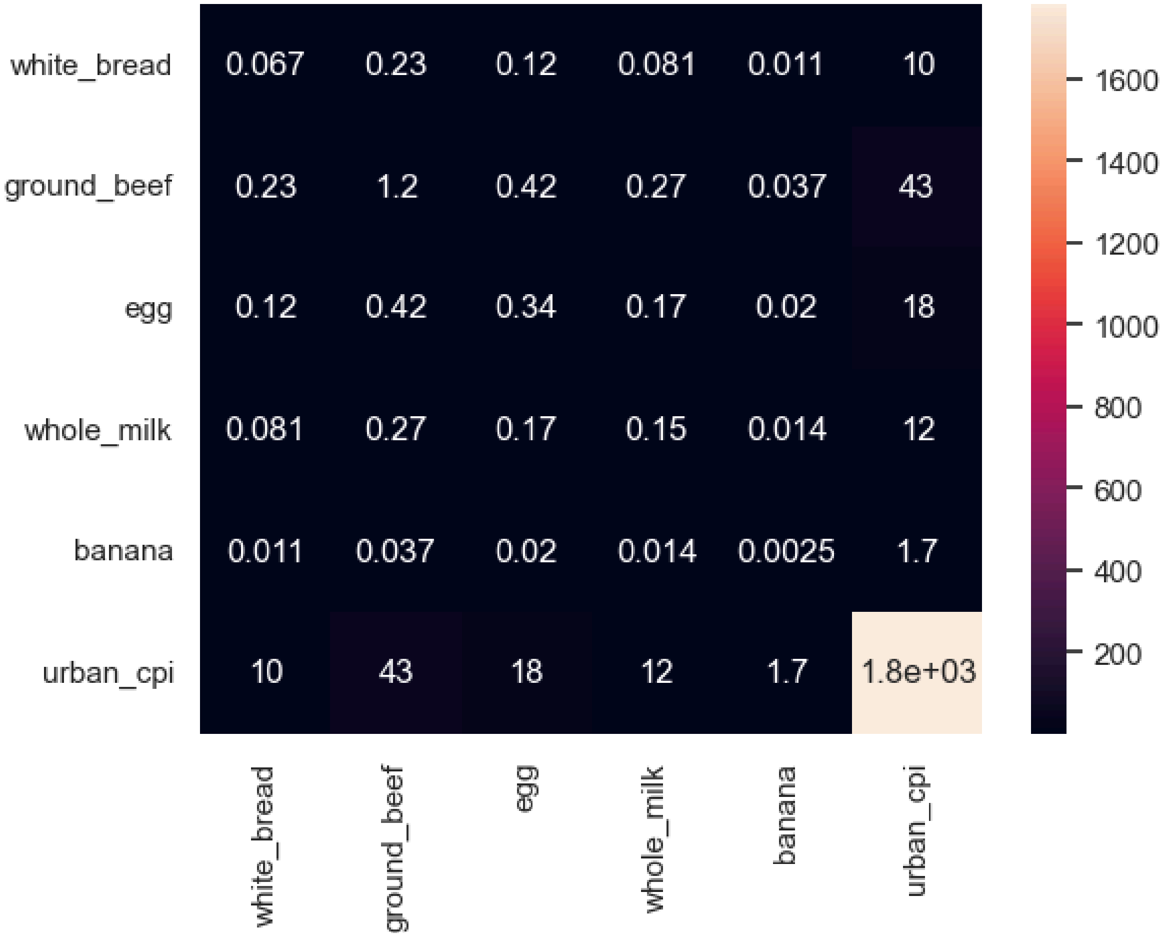
```
# Get the covariance of the grocery items
no_date_groceries.cov()
```

Out[10]:

	white_bread	ground_beef	egg	whole_milk	banana	urban_cpi
white_bread	0.066886	0.232592	0.118774	0.080976	0.011278	10.171383
ground_beef	0.232592	1.163069	0.422468	0.266027	0.037404	43.240440
egg	0.118774	0.422468	0.335983	0.174060	0.020147	17.919599
whole_milk	0.080976	0.266027	0.174060	0.153818	0.013509	11.560904
banana	0.011278	0.037404	0.020147	0.013509	0.002459	1.674729
urban_cpi	10.171383	43.240440	17.919599	11.560904	1.674729	1782.784039

In [35]:

```
sns.heatmap(no_date_groceries.cov(), annot=True)
plt.show()
```



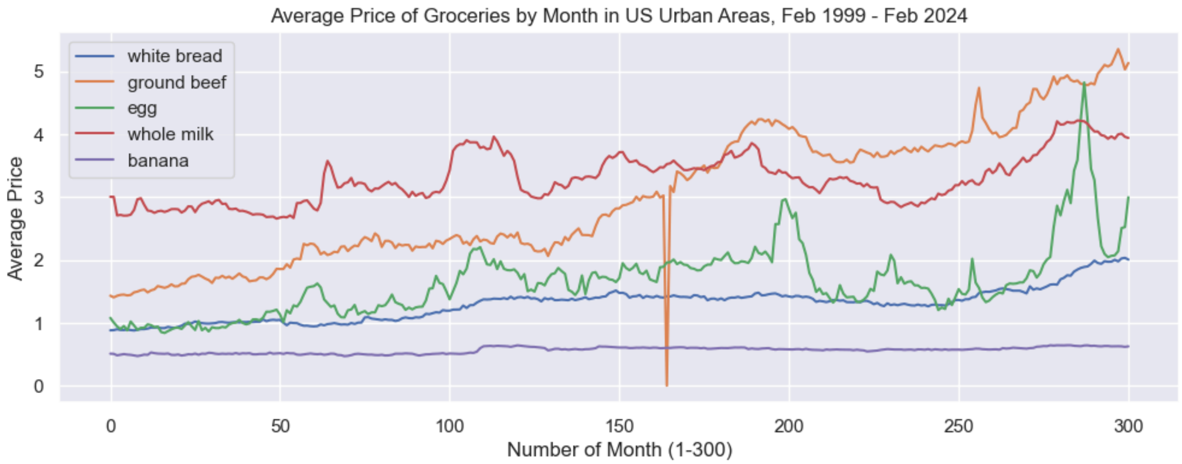
NOTE: No dates are shown in x-axis of table; there are 25 years of data, or 300 months. The dates range from February 1999 (month 1) to February 2024 (month 300).

Create a legend for each of the items picked and plot their average price per month.

NOTE: The price of ground beef for one of the months is listed as 0 because initially there was no listed average value for that month.

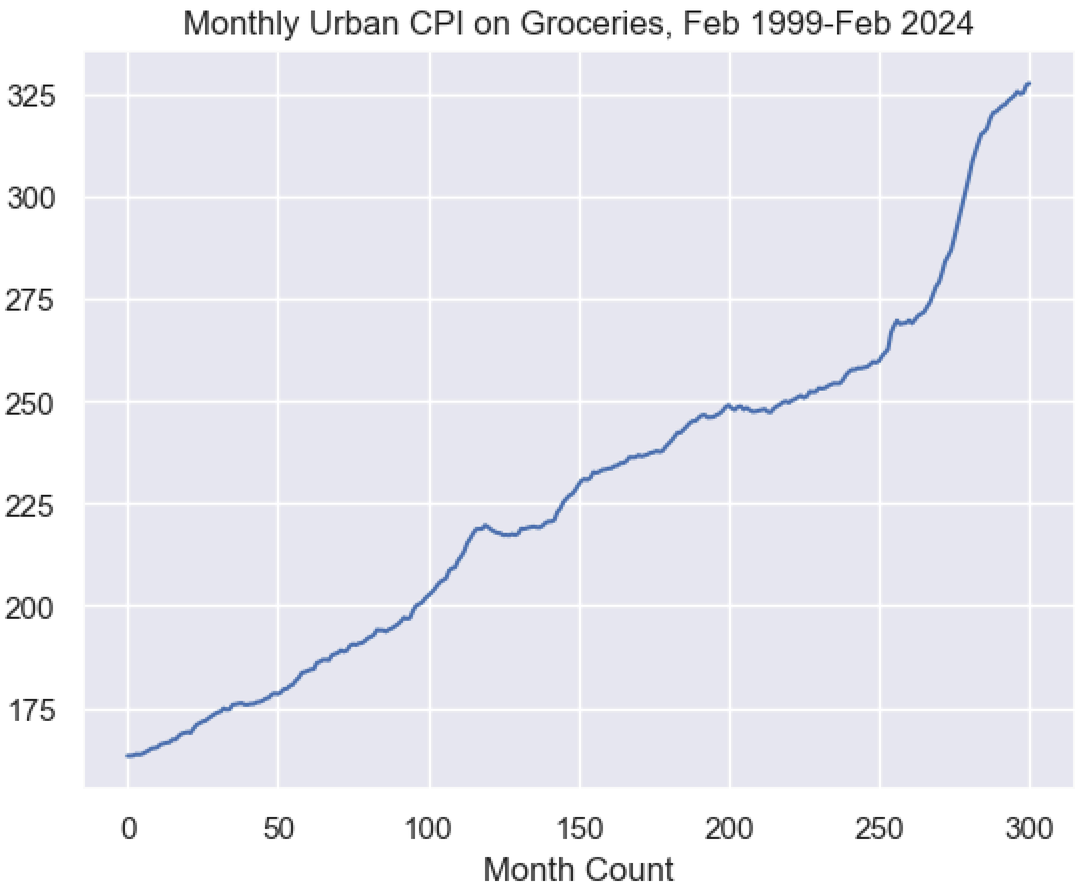
In [32]:

```
plt.figure(figsize=(12,4))
plt.plot(groceries_df['white_bread'])
plt.plot(groceries_df['ground_beef'])
plt.plot(groceries_df['egg'])
plt.plot(groceries_df['whole_milk'])
plt.plot(groceries_df['banana'])
plt.legend(['white bread', 'ground beef', 'egg', 'whole milk', 'banana'])
plt.xlabel("Number of Month (1-300)")
plt.ylabel("Average Price")
plt.title("Average Price of Groceries by Month in US Urban Areas, Feb 1999
plt.show()
```



In [33]:

```
# Line graph of Urban CPI from Feb 1999 to Feb 2024

plt.plot(groceries_df['urban_cpi'])
plt.title("Monthly Urban CPI on Groceries, Feb 1999-Feb 2024")
plt.xlabel("Month Count")
plt.show()
```



In [13]:

```
# Use groupby to get the average price of each item by date

groceries_df.groupby(['DATE']).mean()
```

Out[13]:

```
            white_bread  ground_beef    egg  whole_milk  banana  urban_cpi
DATE
1999-02-01        0.880        1.431  1.078       3.004   0.509    163.300
1999-03-01        0.883        1.404  1.005       3.003   0.506    163.300
1999-04-01        0.897        1.429  0.942       2.707   0.482    163.400
1999-05-01        0.886        1.444  0.900       2.716   0.492    163.700
1999-06-01        0.885        1.448  0.949       2.704   0.502    163.600
       ...          ...          ...    ...         ...     ...        ...
2023-10-01        2.002        5.226  2.072       3.927   0.626    325.731
2023-11-01        1.976        5.353  2.138       3.997   0.627    325.172
2023-12-01        2.024        5.210  2.507       4.008   0.625    325.409
2024-01-01        2.033        5.030  2.522       3.958   0.617    327.327
2024-02-01        2.006        5.132  2.996       3.940   0.625    327.731

301 rows × 6 columns
```

In [14]:

```
# Use groupby and arrange average price of each item by date and urban CPI

groceries_df.groupby(['DATE', 'urban_cpi']).mean()
```

Out[14]:

```
                      white_bread  ground_beef    egg  whole_milk  banana
      DATE  urban_cpi
1999-02-01    163.300       0.880        1.431  1.078       3.004   0.509
1999-03-01    163.300       0.883        1.404  1.005       3.003   0.506
1999-04-01    163.400       0.897        1.429  0.942       2.707   0.482
1999-05-01    163.700       0.886        1.444  0.900       2.716   0.492
1999-06-01    163.600       0.885        1.448  0.949       2.704   0.502
       ...        ...         ...          ...    ...         ...     ...
2023-10-01    325.731       2.002        5.226  2.072       3.927   0.626
2023-11-01    325.172       1.976        5.353  2.138       3.997   0.627
2023-12-01    325.409       2.024        5.210  2.507       4.008   0.625
2024-01-01    327.327       2.033        5.030  2.522       3.958   0.617
2024-02-01    327.731       2.006        5.132  2.996       3.940   0.625

301 rows × 5 columns
```

In [15]:

```
# Use groupby and arrange average price of each item by date and urban CPI

groceries_df.groupby(['DATE', 'urban_cpi']).mean()
```

Out[15]:

		white_bread	ground_beef	egg	whole_milk	banana
DATE	**urban_cpi**					
1999-02-01	**163.300**	0.880	1.431	1.078	3.004	0.509
1999-03-01	**163.300**	0.883	1.404	1.005	3.003	0.506
1999-04-01	**163.400**	0.897	1.429	0.942	2.707	0.482
1999-05-01	**163.700**	0.886	1.444	0.900	2.716	0.492
1999-06-01	**163.600**	0.885	1.448	0.949	2.704	0.502
...	**...**	...	...	...	...	...
2023-10-01	**325.731**	2.002	5.226	2.072	3.927	0.626
2023-11-01	**325.172**	1.976	5.353	2.138	3.997	0.627
2023-12-01	**325.409**	2.024	5.210	2.507	4.008	0.625
2024-01-01	**327.327**	2.033	5.030	2.522	3.958	0.617
2024-02-01	**327.731**	2.006	5.132	2.996	3.940	0.625

301 rows × 5 columns

NOTE: One of the challenges of working with the columns is that the only non-numerical attribute in the dataframe is `DATE` .

This was somewhat of a problem when I tried extracting the month and year from `DATE` to possibly find any connections between changes in monthly prices and the months of the year, the years themselves, or possible seasons with respect to the calendar months the prices were being listed under for each row.

In [16]:

```
"""Add two new columns:
- month
- year

Get these from the DATE object column, listed as strings
"""

groceries_df['month'] = groceries_df.DATE.apply(lambda x: int(x[5:7]))
groceries_df['year'] = groceries_df.DATE.apply(lambda x: int(x[0:4]))
```

In [17]:

```
groceries_df['month'].unique()
```

Out[17]:

```
array([ 2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12,  1], dtype=int64)
```

In [18]:

```
groceries_df['year'].unique()
```

Out[18]:

```
array([1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009,
       2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020,
       2021, 2022, 2023, 2024], dtype=int64)
```

In [19]:

```python
# Use groupby to get the average price of each item by date and month

groceries_df.groupby(['DATE', 'month']).mean()
```

Out[19]:

		white_bread	ground_beef	egg	whole_milk	banana	urban_cpi	year
DATE	**month**							
1999-02-01	**2**	0.880	1.431	1.078	3.004	0.509	163.300	1999.0
1999-03-01	**3**	0.883	1.404	1.005	3.003	0.506	163.300	1999.0
1999-04-01	**4**	0.897	1.429	0.942	2.707	0.482	163.400	1999.0
1999-05-01	**5**	0.886	1.444	0.900	2.716	0.492	163.700	1999.0
1999-06-01	**6**	0.885	1.448	0.949	2.704	0.502	163.600	1999.0
...	**...**	...	...	...	...	...	...	...
2023-10-01	**10**	2.002	5.226	2.072	3.927	0.626	325.731	2023.0
2023-11-01	**11**	1.976	5.353	2.138	3.997	0.627	325.172	2023.0
2023-12-01	**12**	2.024	5.210	2.507	4.008	0.625	325.409	2023.0
2024-01-01	**1**	2.033	5.030	2.522	3.958	0.617	327.327	2024.0
2024-02-01	**2**	2.006	5.132	2.996	3.940	0.625	327.731	2024.0

301 rows × 7 columns

In [20]:

```python
# Group by date and month number for median price of items

groceries_df.groupby(['DATE', 'month']).median()
```

Out[20]:

		white_bread	ground_beef	egg	whole_milk	banana	urban_cpi	year
DATE	**month**							
1999-02-01	**2**	0.880	1.431	1.078	3.004	0.509	163.300	1999.0
1999-03-01	**3**	0.883	1.404	1.005	3.003	0.506	163.300	1999.0
1999-04-01	**4**	0.897	1.429	0.942	2.707	0.482	163.400	1999.0
1999-05-01	**5**	0.886	1.444	0.900	2.716	0.492	163.700	1999.0
1999-06-01	**6**	0.885	1.448	0.949	2.704	0.502	163.600	1999.0
...	**...**	...	...	...	...	...	...	...
2023-10-01	**10**	2.002	5.226	2.072	3.927	0.626	325.731	2023.0
2023-11-01	**11**	1.976	5.353	2.138	3.997	0.627	325.172	2023.0
2023-12-01	**12**	2.024	5.210	2.507	4.008	0.625	325.409	2023.0
2024-01-01	**1**	2.033	5.030	2.522	3.958	0.617	327.327	2024.0
2024-02-01	**2**	2.006	5.132	2.996	3.940	0.625	327.731	2024.0

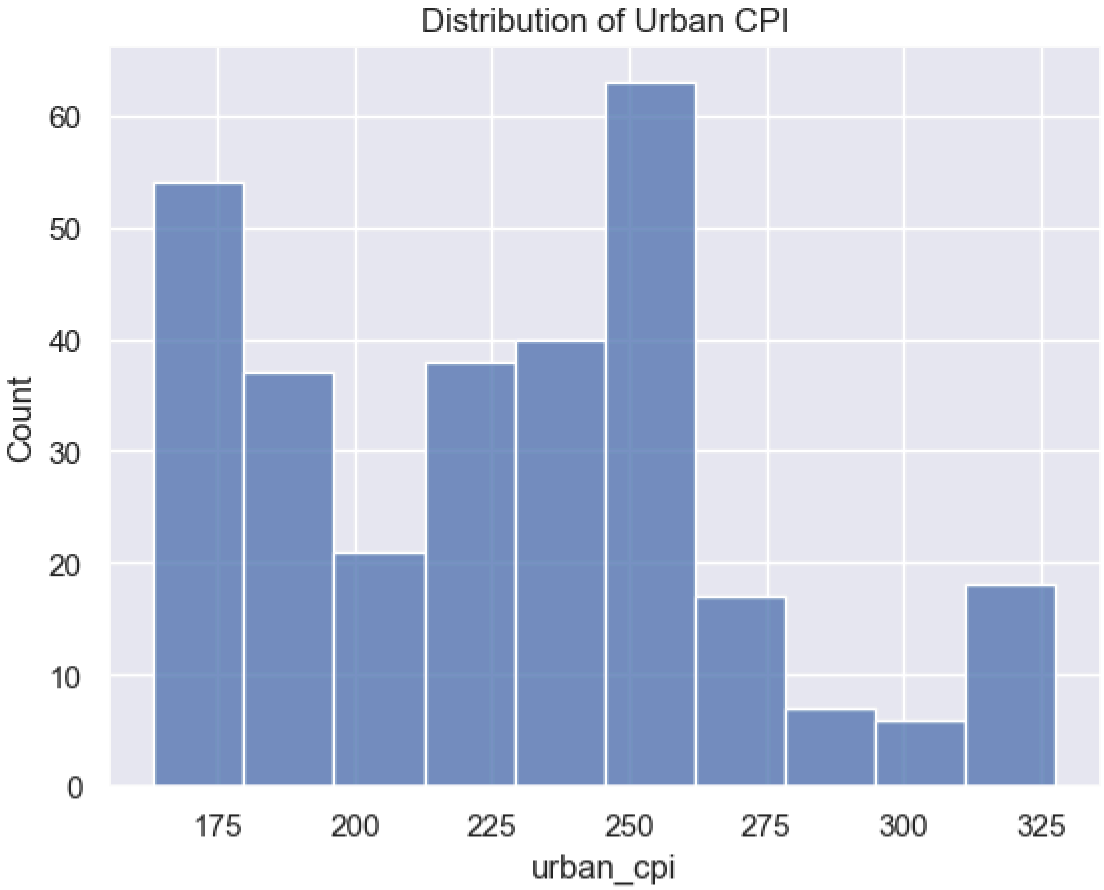
301 rows × 7 columns

In [ ]:

```

```

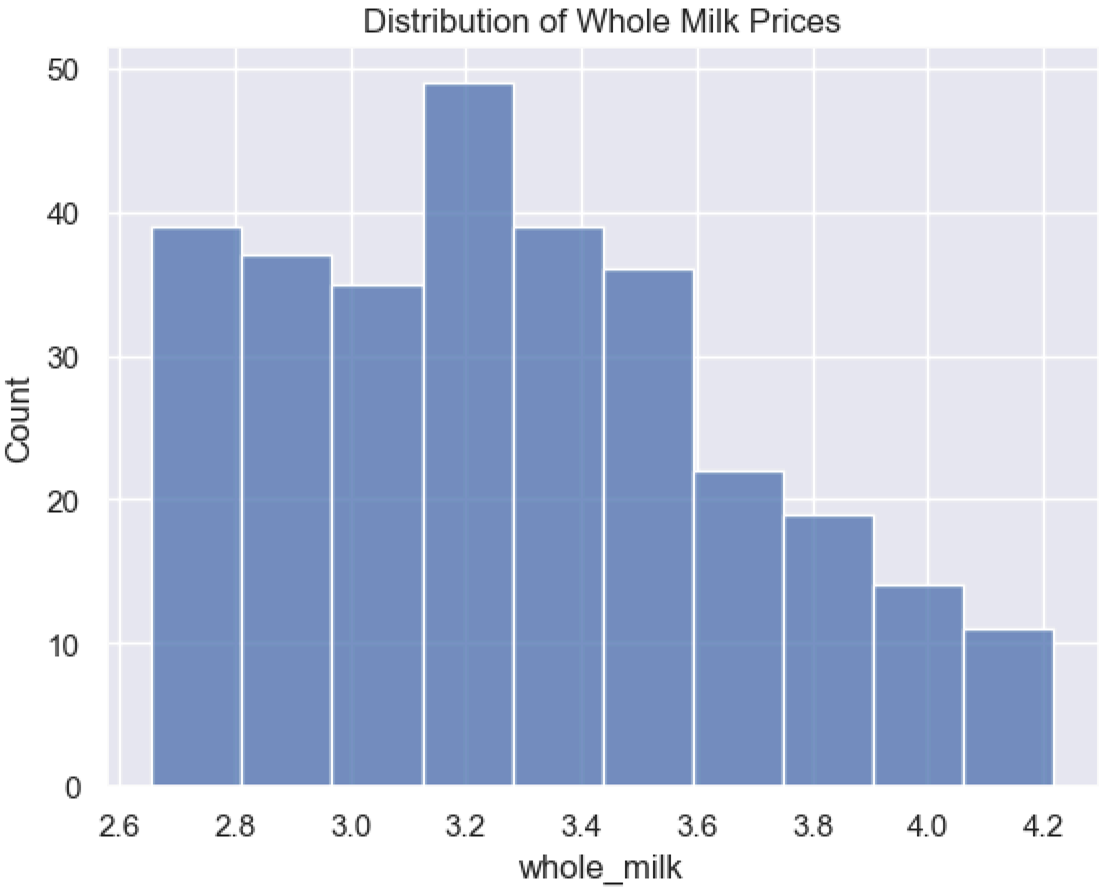
In [21]:

```
# Return histograms of each of the six numerical columns
# Get histogram of the distribution of average US Urban Consumer Price Ind

sns.histplot(groceries_df['urban_cpi'])
plt.title('Distribution of Urban CPI')
plt.show()
```



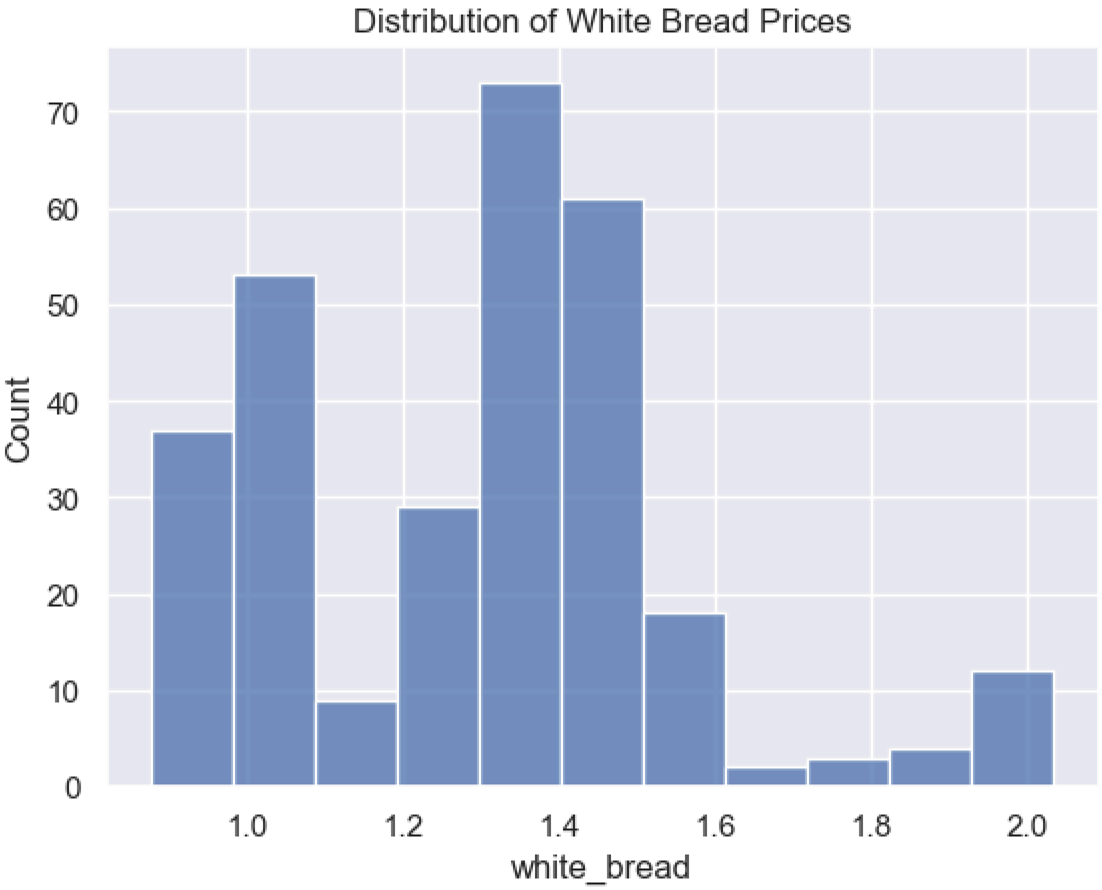
In [22]:

```
# Get histogram of the distribution of average whole milk prices

sns.histplot(groceries_df['whole_milk'])
plt.title('Distribution of Whole Milk Prices')
plt.show()
```



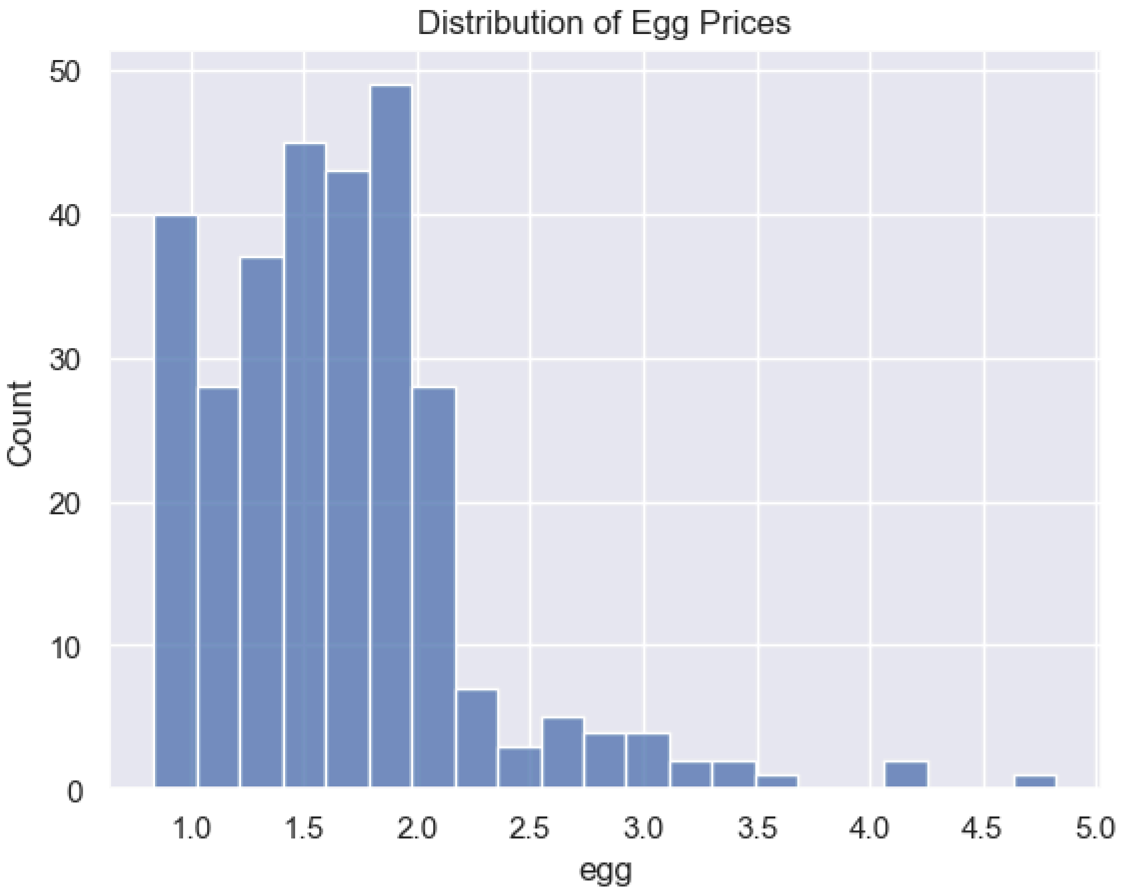
In [23]:

```
# Get histogram of the distribution of average white bread prices

sns.histplot(groceries_df['white_bread'])
plt.title('Distribution of White Bread Prices')
plt.show()
```



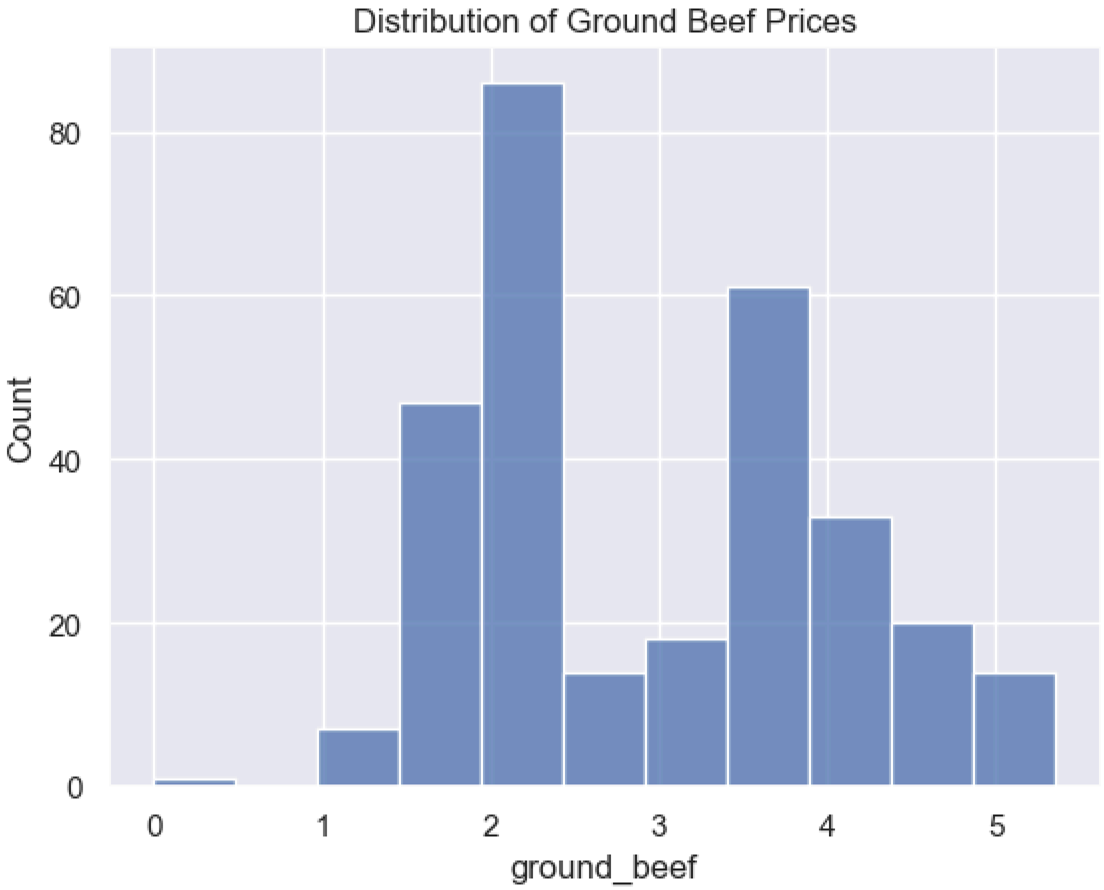
In [24]:

```
# Get histogram of the distribution of average egg prices

sns.histplot(groceries_df['egg'])
plt.title('Distribution of Egg Prices')
plt.show()
```



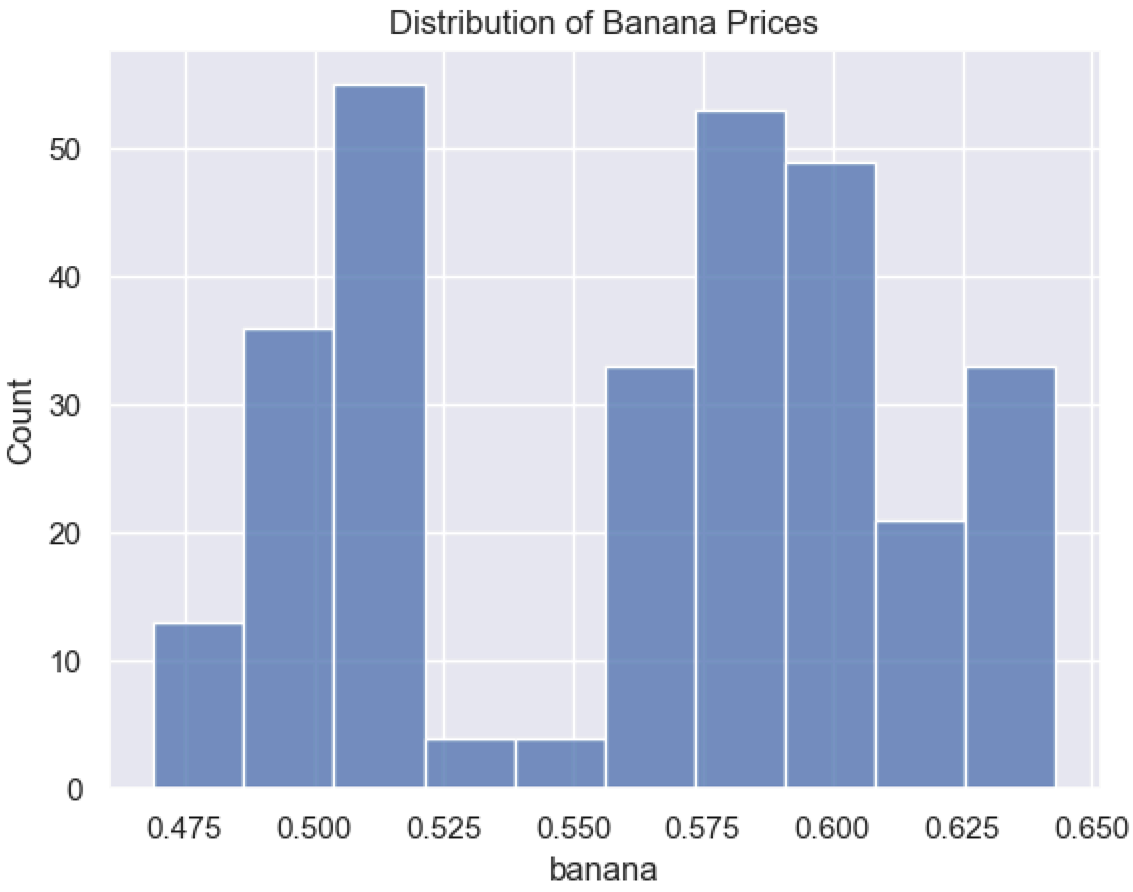
In [25]:

```
# Get histogram of the distribution of average ground beef prices

sns.histplot(groceries_df['ground_beef'])
plt.title('Distribution of Ground Beef Prices')
plt.show()
```



In [27]:

```
# Get histogram of the distribution of average banana prices

sns.histplot(groceries_df['banana'])
plt.title('Distribution of Banana Prices')
plt.show()
```



In [ ]:

```

```

In [ ]:

```

```