data-exploration-and-cleaning

February 18, 2022

1 Data Cleaning and Exploration Notebook

In this notebook, I'm going to import data collected from various sources, clean it, make it uniform and merge it together before exporting it to excel as a dataset containing everything I'll use for my analysis.

1.1 Contents

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1.2 Setup

[1]:

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import datetime as dt
import calendar
import math
import re
```

[2]:

```
# Create a map of 3-letter month to 2-digit month
month_map = {'JAN':'01', 'FEB':'02', 'MAR':'03', 'APR':'04', 'MAY':'05', 'JUN':
 ↪'06', 'JUL':'07', 'AUG':'08', 'SEP':'09', 'OCT':'10', 'NOV':'11', 'DEC':'12'}
```

[3]:

```
# Pathnames for various datasets
avg_price_data = '../data/avg-price-us-cities.xlsx'
tariff_active_data = '../data/ukfrspger_25.xlsx'
ukfrspde_imports_data = '../data/usitc-ukfrspde-imports.xlsx'
world_imports_data = '../data/usitc-world-wine-imports.xlsx'
```

```
us_production_data = '../data/wine-prod-ttb.xlsx'
us_exports_data = '../data/exports-monetary-value-and-liters.xlsx'
ppi_data = '../data/PCU3121303121300.xls'
population_data = '../data/POPTHM.xls'
```

[4]:
```
# Making plots a bit more accessible
sns.set_palette('colorblind')
```

1.3 Import Datasets

[5]:
```
production_df = pd.read_excel(io=us_production_data, header=3)
exports_dict = pd.read_excel(io=us_exports_data, sheet_name=['FAS Value','First␣
 ↪Unit of Quantity'])
wine_prices_df = pd.read_excel(io=avg_price_data)
imports_world_dict = pd.read_excel(world_imports_data, sheet_name=None)
imports_ukfrspde_dict = pd.read_excel(ukfrspde_imports_data, sheet_name=None)
tariff_df = pd.read_excel(tariff_active_data)
ppi_df = pd.read_excel(io=ppi_data, header=10)
population_df = pd.read_excel(io=population_data, header=10)
```

1.3.1 Convert Data Presentation to Long

The exports and imports datasets are in a wide format where each row corresponds to a year and each column a month of that year. The sheets of these datasets are different datapoints being reported.

I'll want to convert the rows to correspond to months in the format YYYY-MM and the columns to the specific datapoints being reported.

Let's define a function to help convert the datasets.

[6]:
```
def wide_to_long(df, col_name):
    df = pd.melt(df, id_vars=['Year'], var_name='month', value_name=col_name)

    df['month'] = df['month'].map(month_map)
    df['month'] = df['Year'].astype(str) + '-' + df['month']

    df.drop(columns='Year', inplace=True)
    return df
```

Let's add another function to get the last day of the month.

[7]:
```
def last_day_of_month(month):
    if pd.isnull(month):
        return

    d = month.split('-')
    date = dt.date(pd.to_numeric(d[0]), pd.to_numeric(d[1]), 1)
    return date.replace(day = calendar.monthrange(date.year, date.month)[1])
```

We'll also need a time series for joining the data together.

[8]:

```
months = pd.date_range('2000-01-01', '2022-01-01', freq='M')
```

Now we can get the imports data as a long dataset.

We'll first grab the imports data for the entire world and then we'll go and get the data for just the U.K., France, Spain, and Germany.

[9]:

```
imports_world_df = pd.DataFrame()
imports_world_df['month'] = months

for name, sheet in imports_world_dict.items():
    if name != 'Query Parameters' and name != 'Query Results':
        sheet_df = pd.DataFrame(sheet)
        sheet_df.columns = sheet_df.iloc[0]
        sheet_df = sheet_df.iloc[1: , :]
        sheet_df = sheet_df[['Year','JAN', 'FEB', 'MAR', 'APR', 'MAY', 'JUN',␣
 ↪'JUL', 'AUG', 'SEP', 'OCT', 'NOV', 'DEC']]

        temp_df = wide_to_long(sheet_df, col_name=name)
        temp_df['month'] = temp_df['month'].map(lambda x: last_day_of_month(x))
        temp_df['month'] = temp_df['month'].astype('datetime64[ns]')
        imports_world_df = imports_world_df.merge(temp_df, on='month')

imports_world_df.sort_values('month', ascending=True, inplace=True)
imports_world_df.head()
```

[9]:

```
       month Dutiable Value Landed Duty-Paid Value Customs Value  \
0 2000-01-31      133791586              144253063     134876329
1 2000-02-29      140504325              149395178     141089327
2 2000-03-31      168440973              181115109     170803664
3 2000-04-30      174444956              186771728     175506155
4 2000-05-31      177795372              190281882     178396150

  First Unit of Quantity Charges, Insurance, and Freight Calculated Duties
0               30869692                         7058649           2318085
1               27334547                         6156122           2149729
2               33950034                         7719881           2591564
3               37381318                         8447127           2818446
4               38726698                         9091316           2794416
```

Alright, let's pull the data for the countries that the U.S. levvied the higher tariffs on.

[10]:

```
imports_ukfrspde_dict = pd.read_excel(ukfrspde_imports_data, sheet_name=None)

imports_ukfrspde_df = pd.DataFrame()
imports_ukfrspde_df['month'] = months
imports_uk_df = imports_ukfrspde_df.copy()
```

```
imports_fr_df = imports_ukfrspde_df.copy()
imports_de_df = imports_ukfrspde_df.copy()
imports_sp_df = imports_ukfrspde_df.copy()

for name, sheet in imports_ukfrspde_dict.items():
    if name != 'Query Parameters' and name != 'Query Results':
        sheet_df = pd.DataFrame(sheet)
        sheet_df.columns = sheet_df.iloc[0]
        sheet_df = sheet_df.iloc[1: , :]
        sheet_df = sheet_df[['Country','Year','JAN', 'FEB', 'MAR', 'APR',␣
 ↪'MAY', 'JUN', 'JUL', 'AUG', 'SEP', 'OCT', 'NOV', 'DEC']]

        temp_fr_df = sheet_df.loc[(sheet_df['Country'] == 'France')]
        temp_de_df = sheet_df.loc[(sheet_df['Country'] == 'Germany')]
        temp_sp_df = sheet_df.loc[(sheet_df['Country'] == 'Spain')]
        temp_uk_df = sheet_df.loc[(sheet_df['Country'] == 'United Kingdom')]
        temp_all_df = sheet_df.loc[(sheet_df['Country'].str.contains('Total'))]

        temp_fr_df2 = wide_to_long(temp_fr_df, col_name=name)
        temp_de_df2 = wide_to_long(temp_de_df, col_name=name)
        temp_sp_df2 = wide_to_long(temp_sp_df, col_name=name)
        temp_uk_df2 = wide_to_long(temp_uk_df, col_name=name)
        temp_all_df2 = wide_to_long(temp_all_df, col_name=name)

        temp_fr_df2['month'] = temp_fr_df2['month'].map(lambda x:␣
 ↪last_day_of_month(x))
        temp_fr_df2['month'] = temp_fr_df2['month'].astype('datetime64[ns]')
        imports_fr_df = imports_fr_df.merge(temp_fr_df2, on='month')

        temp_de_df2['month'] = temp_de_df2['month'].map(lambda x:␣
 ↪last_day_of_month(x))
        temp_de_df2['month'] = temp_de_df2['month'].astype('datetime64[ns]')
        imports_de_df = imports_de_df.merge(temp_de_df2, on='month')

        temp_sp_df2['month'] = temp_sp_df2['month'].map(lambda x:␣
 ↪last_day_of_month(x))
        temp_sp_df2['month'] = temp_sp_df2['month'].astype('datetime64[ns]')
        imports_sp_df = imports_sp_df.merge(temp_sp_df2, on='month')

        temp_uk_df2['month'] = temp_uk_df2['month'].map(lambda x:␣
 ↪last_day_of_month(x))
        temp_uk_df2['month'] = temp_uk_df2['month'].astype('datetime64[ns]')
        imports_uk_df = imports_uk_df.merge(temp_uk_df2, on='month')

        temp_all_df2['month'] = temp_all_df2['month'].map(lambda x:␣
 ↪last_day_of_month(x))
```

```
        temp_all_df2['month'] = temp_all_df2['month'].astype('datetime64[ns]')
        imports_ukfrspde_df = imports_ukfrspde_df.merge(temp_all_df2,␣
 ↪on='month')

imports_ukfrspde_df.sort_values('month', ascending=True, inplace=True)
imports_ukfrspde_df.head()
```

[10]:

```
       month Charges, Insurance, and Freight Calculated Duties Dutiable Value  \
0 2000-01-31                         2406931            699303       56667673
1 2000-02-29                         2356486            857890       73857433
2 2000-03-31                         2804317            914008       83440008
3 2000-04-30                         2989501            974797       83020862
4 2000-05-31                         3037785            897331       75535353

  Landed Duty-Paid Value First Unit of Quantity Customs Value
0               59812261                8768676      56706027
1               77087577                8961916      73873201
2               87219165               10474993      83500840
3               87040067               11128077      83075769
4               79534639               10874051      75599523
```

Now let's make the exports data long.

[11]:

```
for name, sheet in exports_dict.items():
    if name == 'FAS Value':
        exports_value_df = pd.DataFrame(sheet)
        exports_value_df.columns = exports_value_df.iloc[0]
        exports_value_df = exports_value_df.iloc[1: , :]
        exports_value_df = wide_to_long(exports_value_df, col_name=name)
    if name == 'First Unit of Quantity':
        exports_quantity_df = pd.DataFrame(sheet)
        exports_quantity_df.columns = exports_quantity_df.iloc[0]
        exports_quantity_df = exports_quantity_df.iloc[1: , :]
        exports_quantity_df = wide_to_long(exports_quantity_df, col_name=name)

exports_df = exports_value_df.merge(exports_quantity_df, on='month')

# There are 108 empty rows at the bottom of the dataframe due to extra cells in␣
 ↪the
# excel spreadsheet. After checking, these are the only empty rows and dropping␣
 ↪them
# leaves 264 entries, as there should be.
exports_df.dropna(inplace=True)

exports_df['month'] = exports_df['month'].map(lambda x: last_day_of_month(x))
exports_df.sort_values('month', ascending=True, inplace=True)
exports_df.head()
```

[11]:

```
           month FAS Value First Unit of Quantity
0     2000-01-31  45525687               22385348
31    2000-02-29  41336082               20954045
62    2000-03-31  41446856               20240059
93    2000-04-30  41411758               21745478
124   2000-05-31  42672115               22059299
```

1.3.2 Inspect Data

Here I'll provide summary statistics for each of the datasets before we go on to do any transformations on the data.

Producer Price Index I'm going to adjust for inflation using the industry-specific series for the producer price index as provided by the Federal Reserve (FRED). I'm doing this because most of the data used is production-side and this provides a more-specific inflation adjustment for this industry than the regular CPI.

The series is PCU3121303121300.

FRED summarizes the dataset as follows: Producer Price Index by Industry: Wineries: Wines, Brandy, and Brandy Spirits, Index Dec 1998=100, Monthly, Not Seasonally Adjusted

[12]:

```
# Get the last day of the month
ppi_df['month'] = ppi_df['observation_date'].map(lambda x: str(x.year) + '-' +␣
 ↪'{:02d}'.format(x.month))
ppi_df['month'] = ppi_df['month'].map(lambda x: last_day_of_month(x))
ppi_df['month'] = ppi_df['month'].astype('datetime64[ns]')
```

[13]:

```
display(ppi_df.head())
display(ppi_df.info())
display(ppi_df.describe())
```

```
  observation_date  PCU3121303121300      month
0       2000-01-01             103.0 2000-01-31
1       2000-02-01             101.1 2000-02-29
2       2000-03-01             103.0 2000-03-31
3       2000-04-01             101.0 2000-04-30
4       2000-05-01             101.9 2000-05-31
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 265 entries, 0 to 264
Data columns (total 3 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   observation_date  265 non-null    datetime64[ns]
 1   PCU3121303121300  265 non-null    float64
 2   month             265 non-null    datetime64[ns]
```

```
dtypes: datetime64[ns](2), float64(1)
memory usage: 6.3 KB
```

```
None
```

```
       PCU3121303121300
count        265.000000
mean         116.637834
std            9.501049
min          100.900000
25%          106.000000
50%          118.800000
75%          123.400000
max          134.442000
```

U.S. Population Population Data provided by the Federal Reserve (FRED). I'll be using this to adjust for per-capita wine quantities. This data is presently in thousands.

POPTHM: Population, Thousands, Monthly, Not Seasonally Adjusted

[14]:
```
population_df['month'] = population_df['observation_date'].map(lambda x: str(x.
 ↪year) + '-' + '{:02d}'.format(x.month))
population_df['month'] = population_df['month'].map(lambda x:␣
 ↪last_day_of_month(x))
population_df['month'] = population_df['month'].astype('datetime64[ns]')
population_df['population'] = population_df['POPTHM'] * 1000
```

[15]:
```
display(population_df.info())
display(population_df.describe())
display(population_df.head())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 264 entries, 0 to 263
Data columns (total 4 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   observation_date  264 non-null    datetime64[ns]
 1   POPTHM            264 non-null    int64
 2   month             264 non-null    datetime64[ns]
 3   population        264 non-null    int64
dtypes: datetime64[ns](2), int64(2)
memory usage: 8.4 KB
```

```
None
```

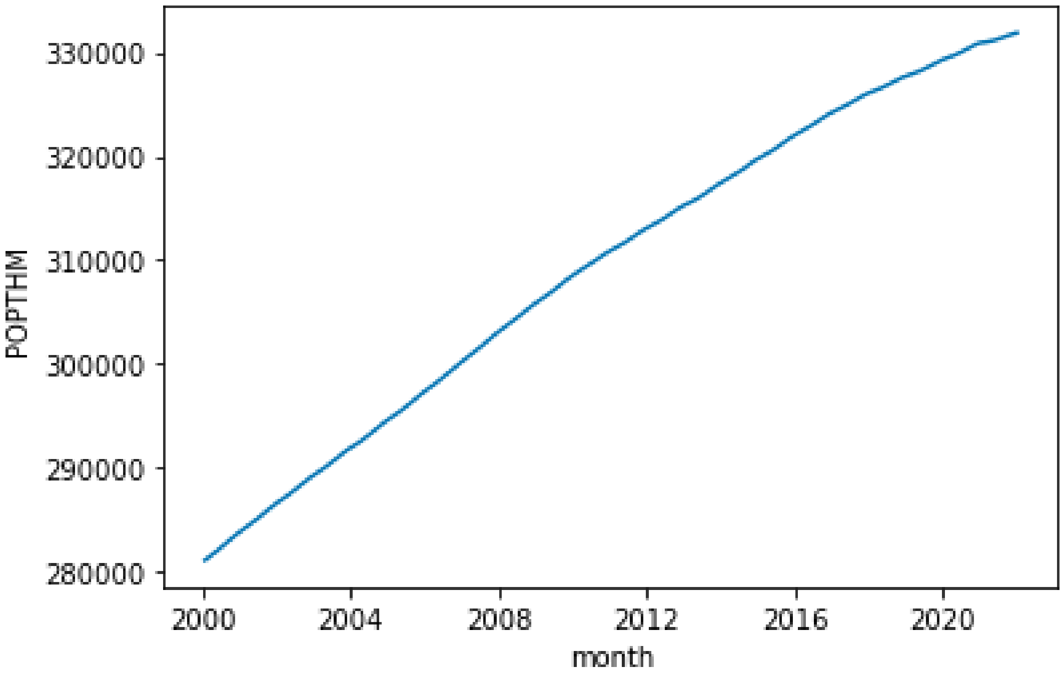
```
              POPTHM    population
count     264.000000  2.640000e+02
mean   309321.689394  3.093217e+08
std     15255.933065  1.525593e+07
min    281083.000000  2.810830e+08
```

```
25%    296013.750000  2.960138e+08
50%    310940.500000  3.109405e+08
75%    323112.000000  3.231120e+08
max    331895.000000  3.318950e+08
```

```
  observation_date  POPTHM      month  population
0       2000-01-01  281083 2000-01-31   281083000
1       2000-02-01  281299 2000-02-29   281299000
2       2000-03-01  281531 2000-03-31   281531000
3       2000-04-01  281763 2000-04-30   281763000
4       2000-05-01  281996 2000-05-31   281996000
```

[16]:
```
sns.lineplot(data=population_df, x='month', y='POPTHM')
```

[16]:
```
<AxesSubplot:xlabel='month', ylabel='POPTHM'>
```



World Imports

[17]:
```
display(imports_world_df.head())
display(imports_world_df.describe())
display(imports_world_df.info())
```

```
       month Dutiable Value Landed Duty-Paid Value Customs Value  \
0 2000-01-31      133791586              144253063     134876329
1 2000-02-29      140504325              149395178     141089327
2 2000-03-31      168440973              181115109     170803664
3 2000-04-30      174444956              186771728     175506155
```

```
4 2000-05-31      177795372             190281882     178396150

  First Unit of Quantity Charges, Insurance, and Freight Calculated Duties
0               30869692                         7058649          2318085
1               27334547                         6156122          2149729
2               33950034                         7719881          2591564
3               37381318                         8447127          2818446
4               38726698                         9091316          2794416
```

```
<ipython-input-17-09d884bef029>:2: FutureWarning: Treating datetime data as
categorical rather than numeric in `.describe` is deprecated and will be removed
in a future version of pandas. Specify `datetime_is_numeric=True` to silence
this warning and adopt the future behavior now.
  display(imports_world_df.describe())
```

```
                      month  Dutiable Value  Landed Duty-Paid Value  \
count                   264           264.0                   264.0
unique                  264           264.0                   264.0
top     2009-05-31 00:00:00     387436035.0             389987329.0
freq                      1             1.0                     1.0
first   2000-01-31 00:00:00             NaN                     NaN
last    2021-12-31 00:00:00             NaN                     NaN

        Customs Value  First Unit of Quantity  \
count           264.0                   264.0
unique          264.0                   264.0
top       305807449.0              67360257.0
freq              1.0                     1.0
first             NaN                     NaN
last              NaN                     NaN

        Charges, Insurance, and Freight  Calculated Duties
count                             264.0              264.0
unique                            264.0              264.0
top                          12248065.0          5050881.0
freq                                1.0                1.0
first                               NaN                NaN
last                                NaN                NaN
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 264 entries, 0 to 263
Data columns (total 7 columns):
 #   Column                           Non-Null Count  Dtype
---  ------                           --------------  -----
 0   month                            264 non-null    datetime64[ns]
 1   Dutiable Value                   264 non-null    object
 2   Landed Duty-Paid Value           264 non-null    object
 3   Customs Value                    264 non-null    object
 4   First Unit of Quantity           264 non-null    object
 5   Charges, Insurance, and Freight  264 non-null    object
 6   Calculated Duties                264 non-null    object
dtypes: datetime64[ns](1), object(6)
memory usage: 16.5+ KB
```

```
None
```

I'll clean up some of these variable names to make them cleaner.

[18]:

```
def reformat_column_names(col_name):
    return str.lower(re.subn(' |, |-', '_', col_name)[0])
```

Before looking into the values' distributions, I'm going to adjust for inflation and population.

[19]:

```
imports_world_df = imports_world_df.merge(ppi_df, on='month')
imports_world_df = imports_world_df.merge(population_df[['month',␣
 ↪'population']], on='month')

for c in imports_world_df.columns:
    col_name = reformat_column_names(c) + '_adj'
    if c == 'population':
        imports_world_df['wine_quantity_per_capita'] = imports_world_df['First␣
 ↪Unit of Quantity'] / imports_world_df[c].astype('f4')
    elif c != 'First Unit of Quantity' and c != 'month' and c !=␣
 ↪'PCU3121303121300' and c != 'observation_date':
        imports_world_df[col_name] = imports_world_df[c] /␣
 ↪imports_world_df['PCU3121303121300'] * 100

imports_world_df.head()
```

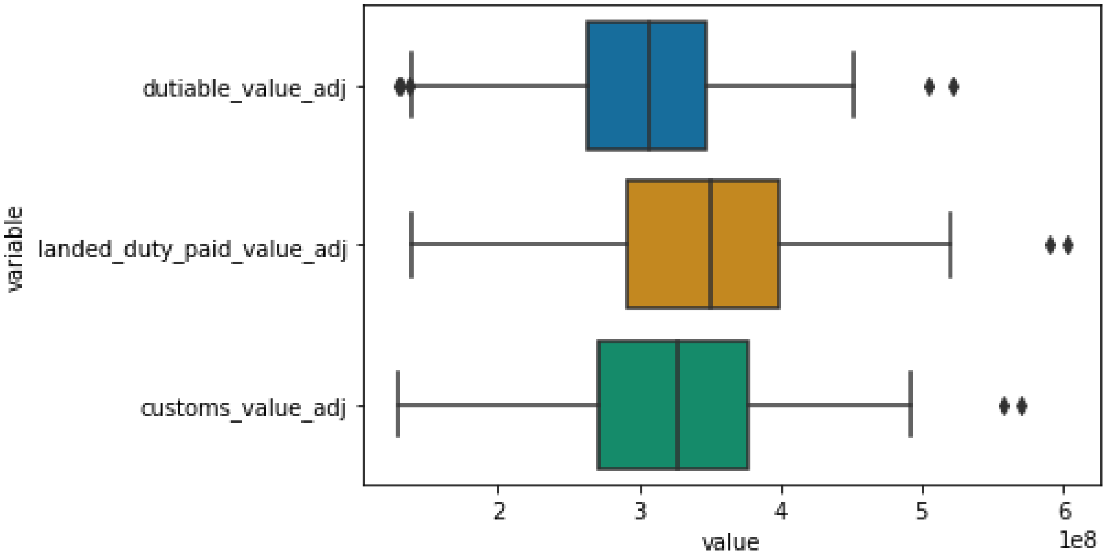
[19]:

```
       month Dutiable Value Landed Duty-Paid Value Customs Value  \
0 2000-01-31      133791586              144253063     134876329
1 2000-02-29      140504325              149395178     141089327
2 2000-03-31      168440973              181115109     170803664
3 2000-04-30      174444956              186771728     175506155
4 2000-05-31      177795372              190281882     178396150

  First Unit of Quantity Charges, Insurance, and Freight Calculated Duties  \
0               30869692                         7058649           2318085
1               27334547                         6156122           2149729
2               33950034                         7719881           2591564
3               37381318                         8447127           2818446
4               38726698                         9091316           2794416

  observation_date  PCU3121303121300  population dutiable_value_adj  \
0       2000-01-01             103.0   281083000     129894743.68932
1       2000-02-01             101.1   281299000     138975593.47181
2       2000-03-01             103.0   281531000    163534925.242718
3       2000-04-01             101.0   281763000    172717778.217822
```

```
4       2000-05-01             101.9   281996000   174480247.301276

  landed_duty_paid_value_adj customs_value_adj  \
0           140051517.475728   130947892.23301
1           147769711.177052  139554230.464886
2           175839911.650485       165828800.0
3           184922502.970297   173768470.29703
4           186733937.193327  175069823.356232

  charges_insurance_and_freight_adj calculated_duties_adj  \
0                    6853057.281553        2250567.961165
1                    6089141.444115        2126339.268051
2                    7495030.097087        2516081.553398
3                    8363492.079208        2790540.594059
4                    8921801.766438        2742312.070658

  wine_quantity_per_capita
0                 0.109824
1                 0.097173
2                 0.120591
3                 0.132669
4                 0.137331
```

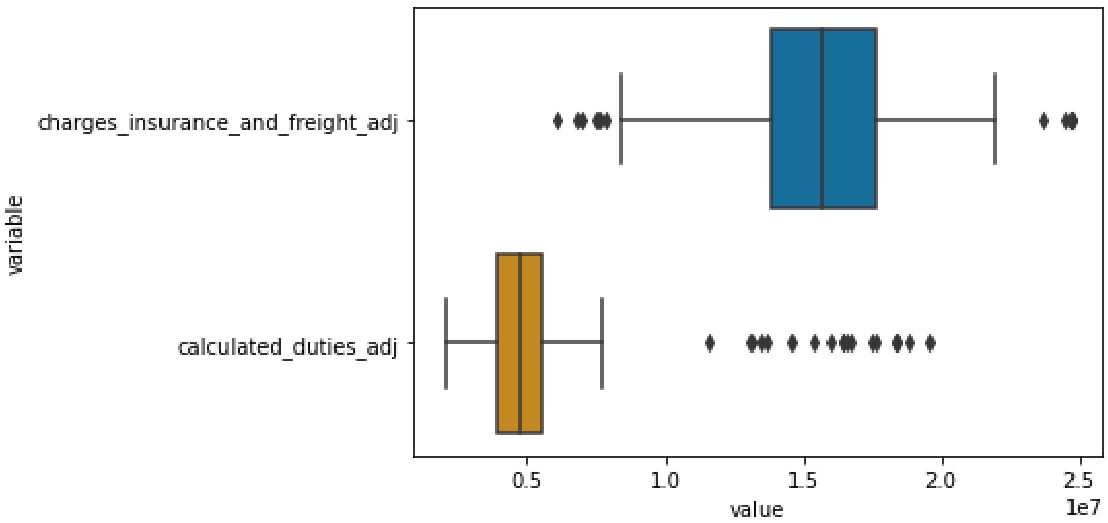
[20]:
```
imports_value_boxplot_data = pd.melt(imports_world_df[['dutiable_value_adj',␣
↪'landed_duty_paid_value_adj', 'customs_value_adj']])
sns.boxplot(data=imports_value_boxplot_data, y='variable', x='value')
```

[20]:
```
<AxesSubplot:xlabel='value', ylabel='variable'>
```



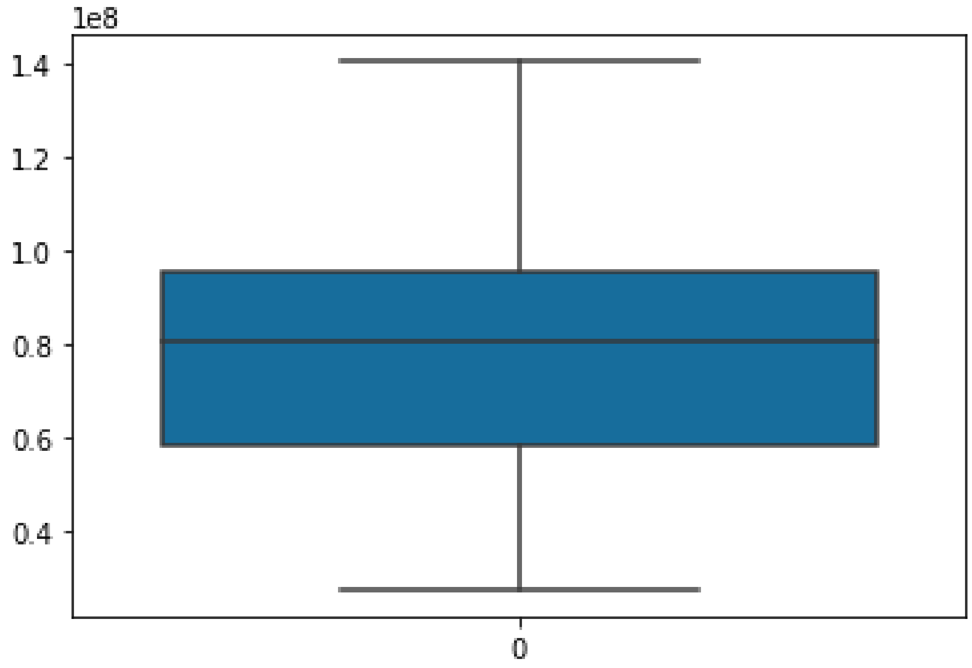
```
[21]: imports_boxplot_data = pd.
       ↪melt(imports_world_df[['charges_insurance_and_freight_adj',␣
       ↪'calculated_duties_adj']])
      sns.boxplot(data=imports_boxplot_data, y='variable', x='value')
```

```
[21]: <AxesSubplot:xlabel='value', ylabel='variable'>
```



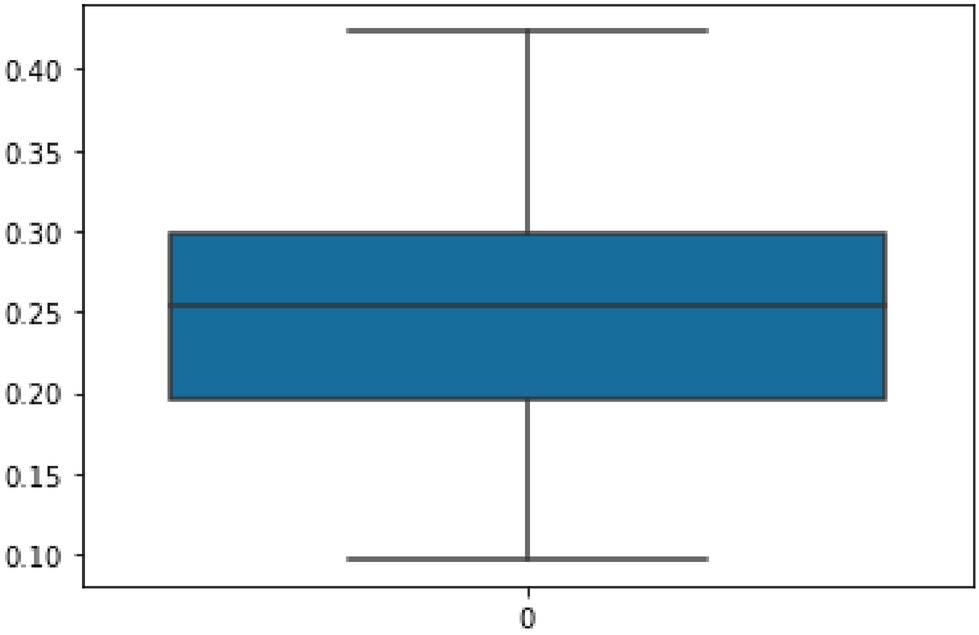
```
[22]: sns.boxplot(data=imports_world_df['First Unit of Quantity'])
```

```
[22]: <AxesSubplot:>
```



```
[23]: sns.boxplot(data=imports_world_df['wine_quantity_per_capita'])
```

```
[23]: <AxesSubplot:>
```



U.K., France, Germany, Spain Imports

[24]:
```
imports_ukfrspde_df = imports_ukfrspde_df.merge(ppi_df, on='month')
imports_ukfrspde_df = imports_ukfrspde_df.merge(population_df[['month',␣
 ↪'population']], on='month')

for c in imports_ukfrspde_df.columns:
    if c == 'population':
        imports_ukfrspde_df['wine_quantity_per_capita'] =␣
 ↪imports_ukfrspde_df['First Unit of Quantity'] /␣
 ↪imports_ukfrspde_df['population']
    elif c != 'First Unit of Quantity' and c != 'month' and c !=␣
 ↪'PCU3121303121300' and c != 'observation_date':
        col_name = reformat_column_names(c) + '_adj'
        imports_ukfrspde_df[col_name] = imports_ukfrspde_df[c] /␣
 ↪imports_ukfrspde_df['PCU3121303121300'] * 100

imports_ukfrspde_df.head()
```

[24]:
```
        month Charges, Insurance, and Freight Calculated Duties Dutiable Value  \
0 2000-01-31                          2406931            699303       56667673
1 2000-02-29                          2356486            857890       73857433
2 2000-03-31                          2804317            914008       83440008
3 2000-04-30                          2989501            974797       83020862
4 2000-05-31                          3037785            897331       75535353

  Landed Duty-Paid Value First Unit of Quantity Customs Value  \
0               59812261                8768676      56706027
1               77087577                8961916      73873201
2               87219165               10474993      83500840
3               87040067               11128077      83075769
4               79534639               10874051      75599523

  observation_date  PCU3121303121300  population  \
0       2000-01-01             103.0   281083000
1       2000-02-01             101.1   281299000
2       2000-03-01             103.0   281531000
3       2000-04-01             101.0   281763000
4       2000-05-01             101.9   281996000

  charges_insurance_and_freight_adj calculated_duties_adj dutiable_value_adj  \
0                    2336826.213592         678934.951456   55017158.252427
1                    2330846.686449         848555.885262   73053840.751731
2                    2722637.864078         887386.407767   81009716.504854
3                    2959901.980198         965145.544554   82198873.267327
4                    2981143.277723         880599.607458   74126941.118744

  landed_duty_paid_value_adj customs_value_adj wine_quantity_per_capita
```

```
 0            58070156.31068   55054395.145631                 0.031196
 1           76248839.762611     73069437.1909                 0.031859
 2           84678800.970874   81068776.699029                 0.037207
 3           86178284.158416   82253236.633663                 0.039494
 4            78051657.50736   74189914.622179                 0.038561
```

[25]:
```
display(imports_ukfrspde_df.head())
display(imports_ukfrspde_df.describe())
display(imports_ukfrspde_df.info())
```

```
       month Charges, Insurance, and Freight Calculated Duties Dutiable Value  \
0 2000-01-31                         2406931            699303       56667673
1 2000-02-29                         2356486            857890       73857433
2 2000-03-31                         2804317            914008       83440008
3 2000-04-30                         2989501            974797       83020862
4 2000-05-31                         3037785            897331       75535353

  Landed Duty-Paid Value First Unit of Quantity Customs Value  \
0               59812261                8768676      56706027
1               77087577                8961916      73873201
2               87219165               10474993      83500840
3               87040067               11128077      83075769
4               79534639               10874051      75599523

  observation_date  PCU3121303121300  population  \
0       2000-01-01             103.0   281083000
1       2000-02-01             101.1   281299000
2       2000-03-01             103.0   281531000
3       2000-04-01             101.0   281763000
4       2000-05-01             101.9   281996000

  charges_insurance_and_freight_adj calculated_duties_adj dutiable_value_adj  \
0                    2336826.213592         678934.951456    55017158.252427
1                    2330846.686449         848555.885262    73053840.751731
2                    2722637.864078         887386.407767    81009716.504854
3                    2959901.980198         965145.544554    82198873.267327
4                    2981143.277723         880599.607458    74126941.118744

  landed_duty_paid_value_adj customs_value_adj wine_quantity_per_capita
0             58070156.31068   55054395.145631                 0.031196
1            76248839.762611     73069437.1909                 0.031859
2            84678800.970874   81068776.699029                 0.037207
3            86178284.158416   82253236.633663                 0.039494
4             78051657.50736   74189914.622179                 0.038561

       PCU3121303121300    population
count        264.000000  2.640000e+02
mean         116.571076  3.093217e+08
```

```
std           9.456620  1.525593e+07
min         100.900000  2.810830e+08
25%         105.925000  2.960138e+08
50%         118.800000  3.109405e+08
75%         123.175000  3.231120e+08
max         134.442000  3.318950e+08
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 264 entries, 0 to 263
Data columns (total 16 columns):
 #   Column                             Non-Null Count  Dtype
---  ------                             --------------  -----
 0   month                              264 non-null    datetime64[ns]
 1   Charges, Insurance, and Freight    264 non-null    object
 2   Calculated Duties                  264 non-null    object
 3   Dutiable Value                     264 non-null    object
 4   Landed Duty-Paid Value             264 non-null    object
 5   First Unit of Quantity             264 non-null    object
 6   Customs Value                      264 non-null    object
 7   observation_date                   264 non-null    datetime64[ns]
 8   PCU3121303121300                   264 non-null    float64
 9   population                         264 non-null    int64
 10  charges_insurance_and_freight_adj  264 non-null    object
 11  calculated_duties_adj              264 non-null    object
 12  dutiable_value_adj                 264 non-null    object
 13  landed_duty_paid_value_adj         264 non-null    object
 14  customs_value_adj                  264 non-null    object
 15  wine_quantity_per_capita           264 non-null    object
dtypes: datetime64[ns](2), float64(1), int64(1), object(12)
memory usage: 35.1+ KB
```

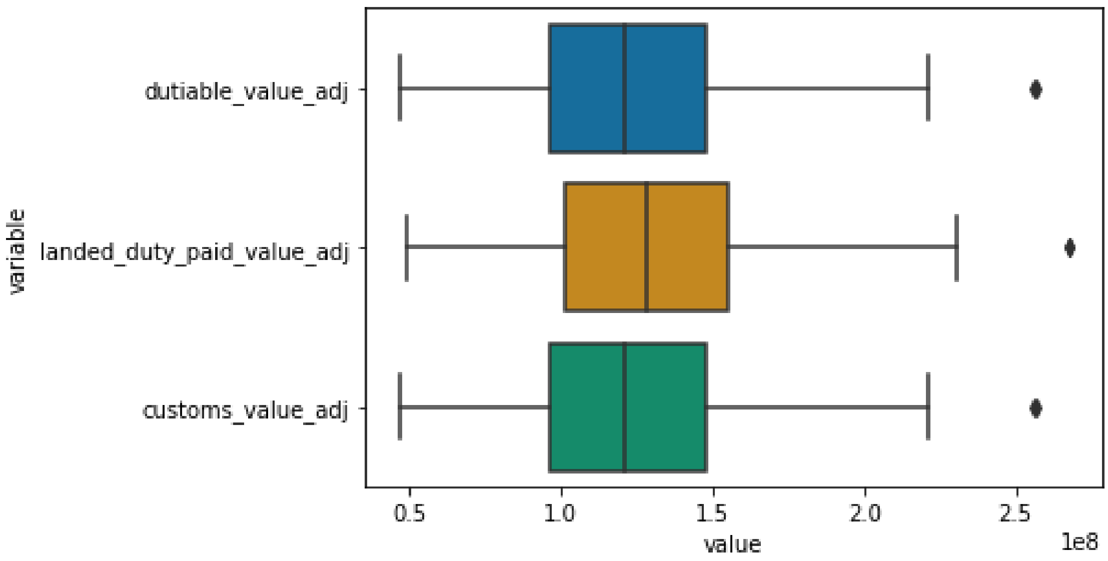
```
None
```

[26]:

```
imports_value_boxplot_ukfrspde_df = pd.
 ↪melt(imports_ukfrspde_df[['dutiable_value_adj',␣
 ↪'landed_duty_paid_value_adj', 'customs_value_adj']])
sns.boxplot(data=imports_value_boxplot_ukfrspde_df, y='variable', x='value')
```

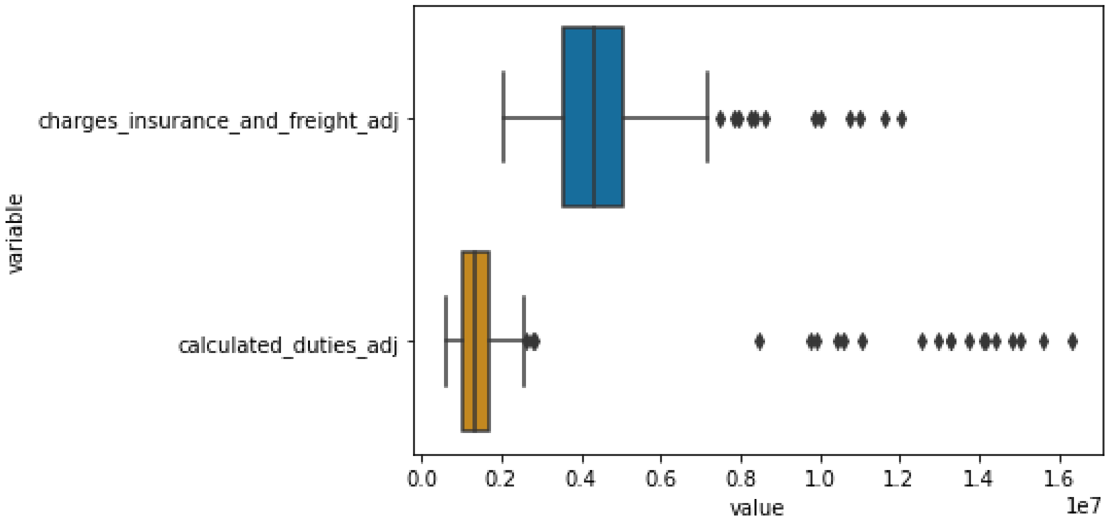
[26]:

```
<AxesSubplot:xlabel='value', ylabel='variable'>
```



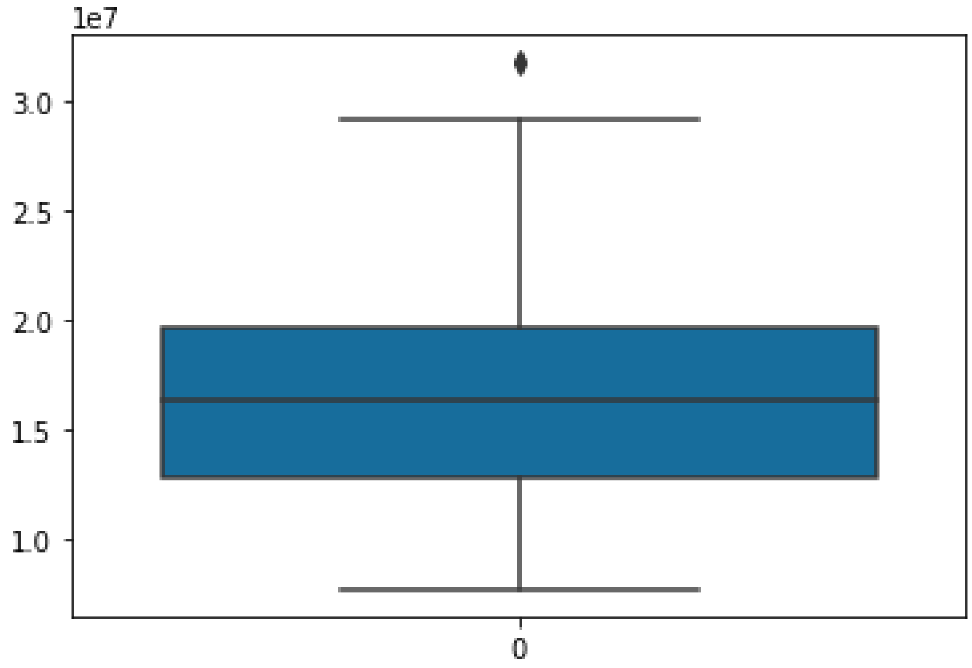
```
[27]: imports_boxplot_ukfrspde_df = pd.
       ↪melt(imports_ukfrspde_df[['charges_insurance_and_freight_adj',␣
       ↪'calculated_duties_adj']])
      sns.boxplot(data=imports_boxplot_ukfrspde_df, y='variable', x='value')
```

```
[27]: <AxesSubplot:xlabel='value', ylabel='variable'>
```



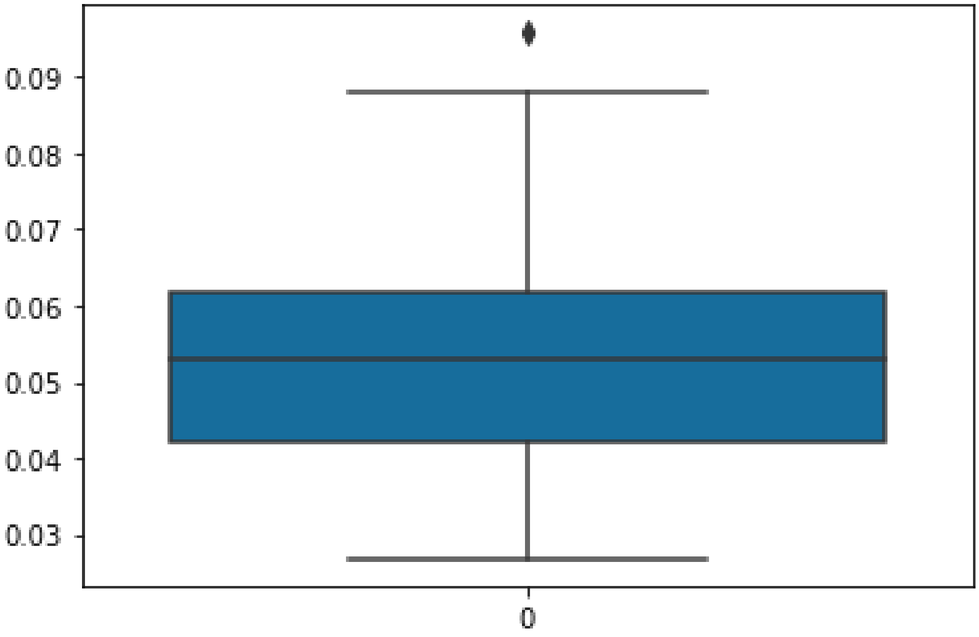
```
[28]: sns.boxplot(data=imports_ukfrspde_df['First Unit of Quantity'])
```

```
[28]: <AxesSubplot:>
```



[29]:
```
sns.boxplot(data=imports_ukfrspde_df['wine_quantity_per_capita'])
```

[29]:
```
<AxesSubplot:>
```



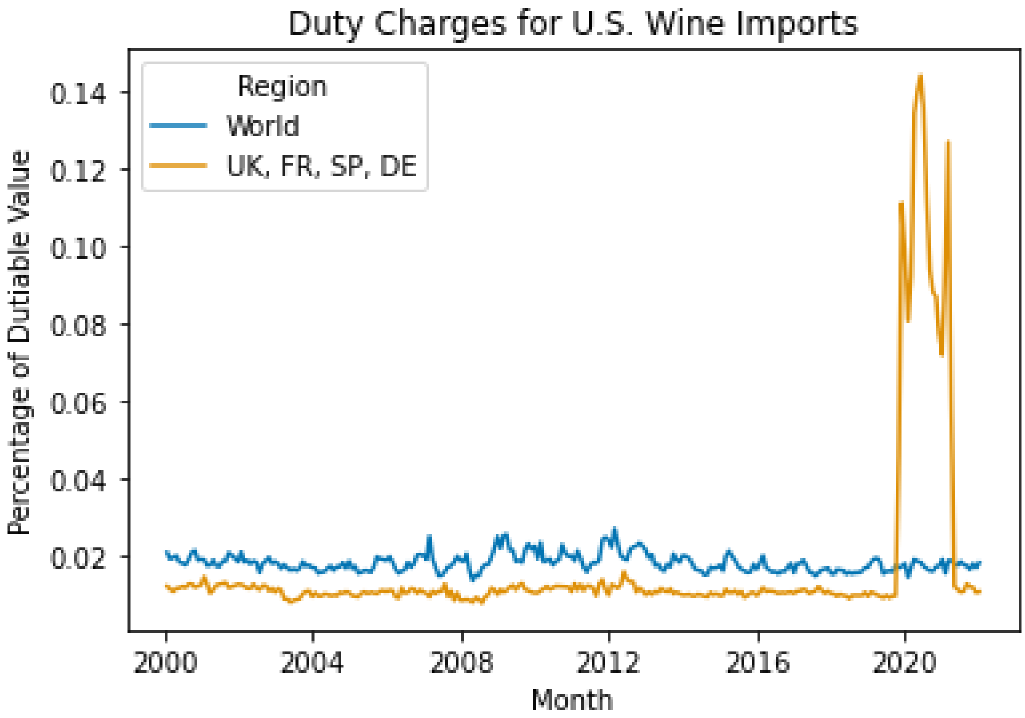
Let’s look at some differences in the duties between the set of countries this additional tariff was put on and the rest of the world.

[30]:

```
various_duties_df = imports_world_df[['month']]

various_duties_df['world_average_duties'] =␣
 ↪(imports_world_df['calculated_duties_adj'] -␣
 ↪imports_ukfrspde_df['calculated_duties_adj']) /␣
 ↪(imports_world_df['dutiable_value_adj'] -␣
 ↪imports_ukfrspde_df['dutiable_value_adj'])
various_duties_df['world_average_duties'] =␣
 ↪various_duties_df['world_average_duties'].astype('f4')

various_duties_df['ukfrspde_average_duties'] =␣
 ↪imports_ukfrspde_df['calculated_duties_adj'] /␣
 ↪imports_ukfrspde_df['dutiable_value_adj']
various_duties_df['ukfrspde_average_duties'] =␣
 ↪various_duties_df['ukfrspde_average_duties'].astype('f4')

duties_plot = sns.lineplot(data=pd.melt(various_duties_df, ['month']),␣
 ↪x='month', y='value', hue='variable',)
duties_plot.set(title='Duty Charges for U.S. Wine Imports', xlabel='Month',␣
 ↪ylabel='Percentage of Dutiable Value')

plt.legend(title='Region', loc='upper left', labels=['World', 'UK, FR, SP, DE'])
plt.show(duties_plot)
```

```
<ipython-input-30-dbdba5509ea0>:3: 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
  various_duties_df['world_average_duties'] =
(imports_world_df['calculated_duties_adj'] -
imports_ukfrspde_df['calculated_duties_adj']) /
(imports_world_df['dutiable_value_adj'] -
imports_ukfrspde_df['dutiable_value_adj'])
<ipython-input-30-dbdba5509ea0>:4: 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
  various_duties_df['world_average_duties'] =
various_duties_df['world_average_duties'].astype('f4')
<ipython-input-30-dbdba5509ea0>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
```

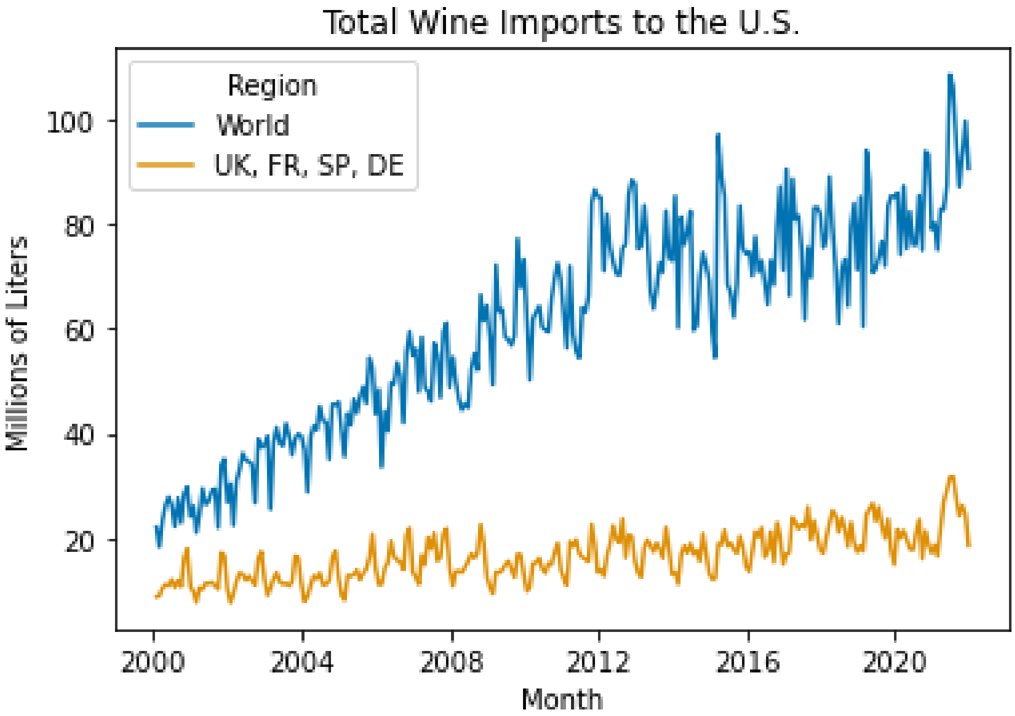
```
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  various_duties_df['ukfrspde_average_duties'] =
imports_ukfrspde_df['calculated_duties_adj'] /
imports_ukfrspde_df['dutiable_value_adj']
<ipython-input-30-dbdba5509ea0>:7: 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
  various_duties_df['ukfrspde_average_duties'] =
various_duties_df['ukfrspde_average_duties'].astype('f4')
```



```
[31]: various_duties_df['ukfrspde_quantity'] = imports_ukfrspde_df['First Unit of␣
       ↪Quantity'] / 1000000
      various_duties_df['ukfrspde_quantity'] = various_duties_df['ukfrspde_quantity'].
       ↪astype('f4')
      various_duties_df['world_quantity'] = (imports_world_df['First Unit of␣
       ↪Quantity'] - imports_ukfrspde_df['First Unit of Quantity']) / 1000000
```

```
various_duties_df['world_quantity'] = various_duties_df['world_quantity'].
 ↪astype('f4')

imports_quantity_plot = sns.lineplot(data=pd.melt(various_duties_df[['month',␣
 ↪'world_quantity', 'ukfrspde_quantity']], ['month']), x='month', y='value',␣
 ↪hue='variable',)
imports_quantity_plot.set(title='Total Wine Imports to the U.S.',␣
 ↪xlabel='Month', ylabel='Millions of Liters')

plt.legend(title='Region', loc='upper left', labels=['World', 'UK, FR, SP, DE'])
plt.show()
```

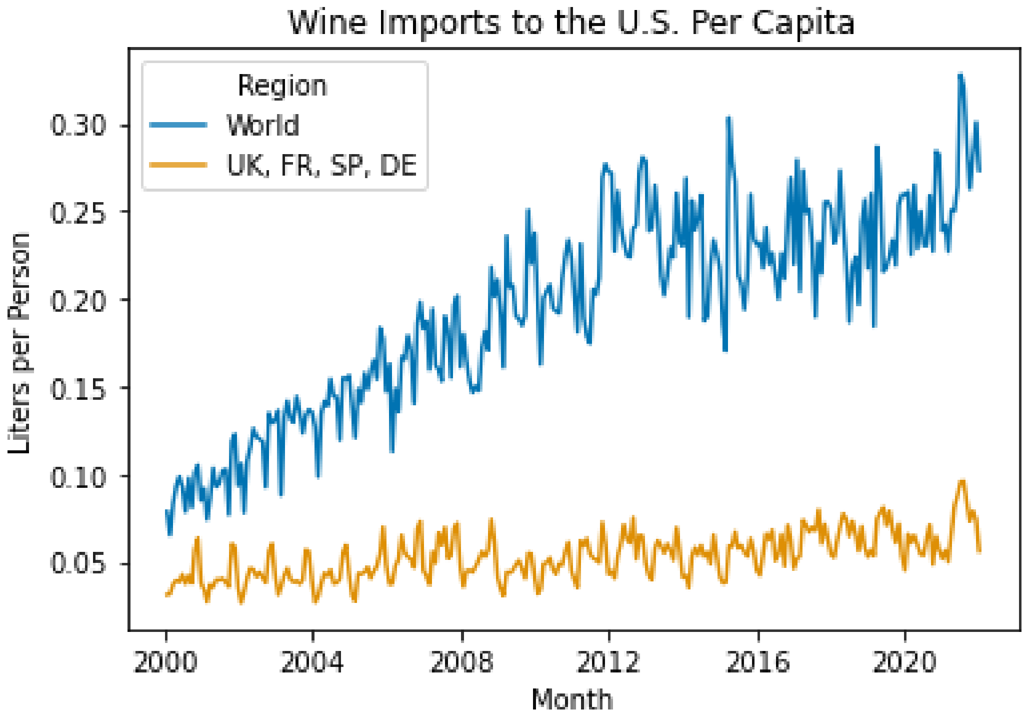
```
<ipython-input-31-54b5555526f5>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  various_duties_df['ukfrspde_quantity'] = imports_ukfrspde_df['First Unit of
Quantity'] / 1000000
<ipython-input-31-54b5555526f5>: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
  various_duties_df['ukfrspde_quantity'] =
various_duties_df['ukfrspde_quantity'].astype('f4')
<ipython-input-31-54b5555526f5>:3: 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
  various_duties_df['world_quantity'] = (imports_world_df['First Unit of
Quantity'] - imports_ukfrspde_df['First Unit of Quantity']) / 1000000
<ipython-input-31-54b5555526f5>:4: 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
  various_duties_df['world_quantity'] =
various_duties_df['world_quantity'].astype('f4')
```



```
[32]: various_duties_df['ukfrspde_quantity'] = imports_ukfrspde_df['First Unit of␣
       ↪Quantity']
      various_duties_df['ukfrspde_quantity'] = various_duties_df['ukfrspde_quantity'].
       ↪astype('f4')
      various_duties_df['ukfrspde_quantity_per_capita'] =␣
       ↪various_duties_df['ukfrspde_quantity'] / imports_ukfrspde_df['population']
      various_duties_df['world_quantity'] = (imports_world_df['First Unit of␣
       ↪Quantity'] - imports_ukfrspde_df['First Unit of Quantity'])
      various_duties_df['world_quantity'] = various_duties_df['world_quantity'].
       ↪astype('f4')
      various_duties_df['world_quantity_per_capita'] =␣
       ↪various_duties_df['world_quantity'] / imports_world_df['population']

      imports_quantity_plot = sns.lineplot(data=pd.melt(various_duties_df[['month',␣
       ↪'world_quantity_per_capita', 'ukfrspde_quantity_per_capita']], ['month']),␣
       ↪x='month', y='value', hue='variable',)
      imports_quantity_plot.set(title='Wine Imports to the U.S. Per Capita',␣
       ↪xlabel='Month', ylabel='Liters per Person')

      plt.legend(title='Region', loc='upper left', labels=['World', 'UK, FR, SP, DE'])
      plt.show()
```

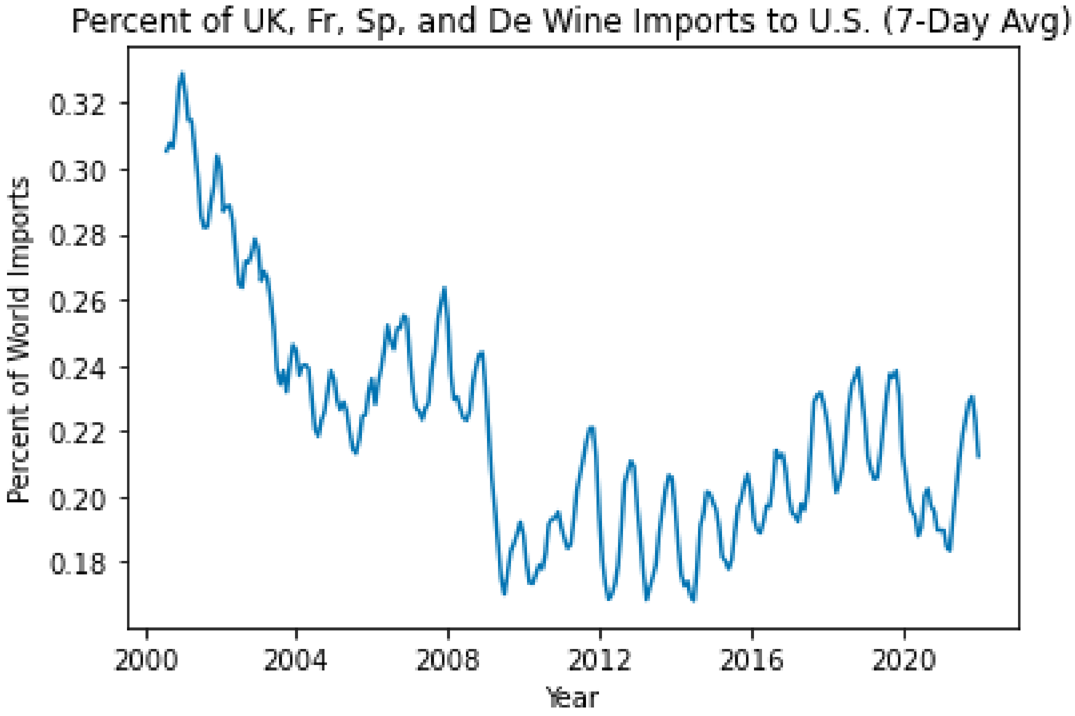
```
<ipython-input-32-1b6560be979d>:1: SettingWithCopyWarning:
```

```
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
  various_duties_df['ukfrspde_quantity'] = imports_ukfrspde_df['First Unit of
Quantity']
<ipython-input-32-1b6560be979d>: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
  various_duties_df['ukfrspde_quantity'] =
various_duties_df['ukfrspde_quantity'].astype('f4')
<ipython-input-32-1b6560be979d>:3: 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
  various_duties_df['ukfrspde_quantity_per_capita'] =
various_duties_df['ukfrspde_quantity'] / imports_ukfrspde_df['population']
<ipython-input-32-1b6560be979d>:4: 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
  various_duties_df['world_quantity'] = (imports_world_df['First Unit of
Quantity'] - imports_ukfrspde_df['First Unit of Quantity'])
<ipython-input-32-1b6560be979d>:5: 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
  various_duties_df['world_quantity'] =
various_duties_df['world_quantity'].astype('f4')
<ipython-input-32-1b6560be979d>:6: 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
  various_duties_df['world_quantity_per_capita'] =
various_duties_df['world_quantity'] / imports_world_df['population']
```



```
[33]: various_duties_df['ukfrspde_percentage'] =␣
       ↪various_duties_df['ukfrspde_quantity'] /␣
       ↪(various_duties_df['world_quantity'] +␣
       ↪various_duties_df['ukfrspde_quantity'])
      various_duties_df['ukfrspde_percentage'] =␣
       ↪various_duties_df['ukfrspde_percentage'].astype('f4')
      various_duties_df['percentage_rolling_avg_7'] = various_duties_df.
       ↪ukfrspde_percentage.rolling(7).mean()

      percentage_rolling_avg_plot = sns.lineplot(x='month',␣
       ↪y='percentage_rolling_avg_7', data=various_duties_df)
      percentage_rolling_avg_plot.set(title='Percent of UK, Fr, Sp, and De Wine␣
       ↪Imports to U.S. (7-Day Avg)', xlabel='Year', ylabel='Percent of World␣
       ↪Imports')
      plt.show()
```

```
<ipython-input-33-c614e1da5919>: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
  various_duties_df['ukfrspde_percentage'] =
various_duties_df['ukfrspde_quantity'] / (various_duties_df['world_quantity'] +
various_duties_df['ukfrspde_quantity'])
<ipython-input-33-c614e1da5919>: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
  various_duties_df['ukfrspde_percentage'] =
various_duties_df['ukfrspde_percentage'].astype('f4')
<ipython-input-33-c614e1da5919>:3: 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
  various_duties_df['percentage_rolling_avg_7'] =
various_duties_df.ukfrspde_percentage.rolling(7).mean()
```



U.S. Exports First let's adjust for inflation and population.

[34]:

```
exports_df['month'] = exports_df['month'].astype('datetime64[ns]')
exports_df = exports_df.merge(ppi_df, on='month')
exports_df = exports_df.merge(population_df[['month', 'population']],␣
 ↪on='month')

exports_df['fas_value_adj'] = exports_df['FAS Value'] /␣
 ↪exports_df['PCU3121303121300'] * 100
exports_df['quantity_per_capita'] = exports_df['First Unit of Quantity'] /␣
 ↪exports_df['population']

exports_df.head()
```

```
[34]:         month  FAS Value  First Unit of Quantity observation_date  \
      0 2000-01-31   45525687                22385348       2000-01-01
      1 2000-02-29   41336082                20954045       2000-02-01
      2 2000-03-31   41446856                20240059       2000-03-01
      3 2000-04-30   41411758                21745478       2000-04-01
      4 2000-05-31   42672115                22059299       2000-05-01

         PCU3121303121300  population   fas_value_adj  quantity_per_capita
      0             103.0   281083000  44199696.116505             0.07964
      1             101.1   281299000  40886332.344214             0.07449
      2             103.0   281531000  40239666.019417            0.071893
      3             101.0   281763000  41001740.594059            0.077176
      4             101.9   281996000  41876462.217861            0.078226
```

```
[35]: display(exports_df.head())
      display(exports_df.describe())
      display(exports_df.info())
```

```
        month  FAS Value  First Unit of Quantity observation_date  \
0 2000-01-31   45525687                22385348       2000-01-01
1 2000-02-29   41336082                20954045       2000-02-01
2 2000-03-31   41446856                20240059       2000-03-01
3 2000-04-30   41411758                21745478       2000-04-01
4 2000-05-31   42672115                22059299       2000-05-01

   PCU3121303121300  population   fas_value_adj  quantity_per_capita
0             103.0   281083000  44199696.116505             0.07964
1             101.1   281299000  40886332.344214             0.07449
2             103.0   281531000  40239666.019417            0.071893
3             101.0   281763000  41001740.594059            0.077176
4             101.9   281996000  41876462.217861            0.078226

       PCU3121303121300    population
count        264.000000  2.640000e+02
mean         116.571076  3.093217e+08
std            9.456620  1.525593e+07
min          100.900000  2.810830e+08
25%          105.925000  2.960138e+08
```

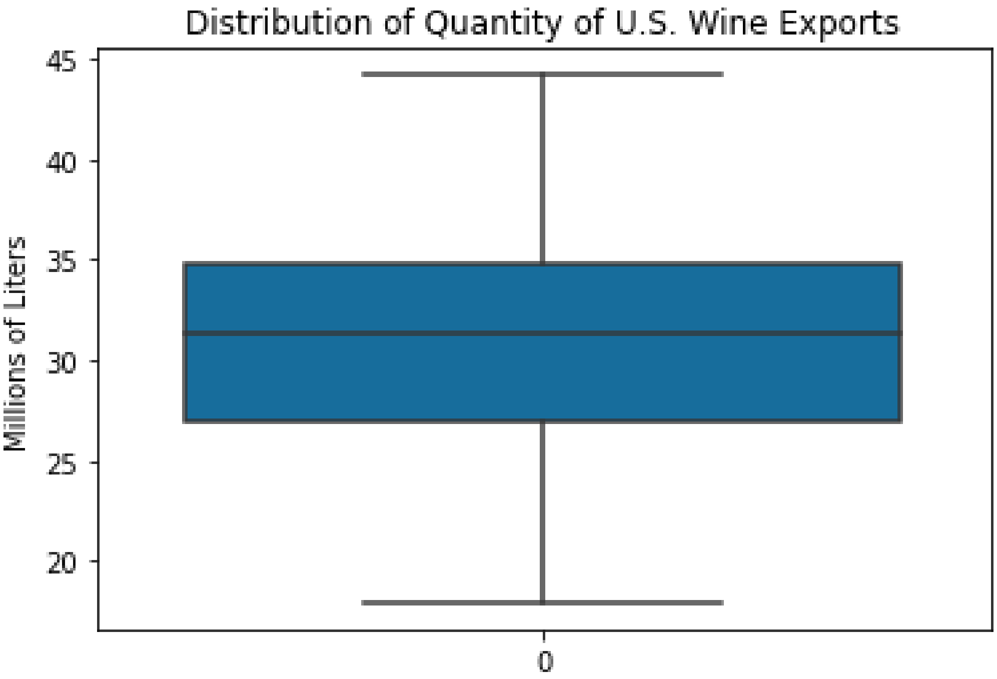
```
50%          118.800000  3.109405e+08
75%          123.175000  3.231120e+08
max          134.442000  3.318950e+08
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 264 entries, 0 to 263
Data columns (total 8 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   month                   264 non-null    datetime64[ns]
 1   FAS Value               264 non-null    object
 2   First Unit of Quantity  264 non-null    object
 3   observation_date        264 non-null    datetime64[ns]
 4   PCU3121303121300        264 non-null    float64
 5   population              264 non-null    int64
 6   fas_value_adj           264 non-null    object
 7   quantity_per_capita     264 non-null    object
dtypes: datetime64[ns](2), float64(1), int64(1), object(4)
memory usage: 18.6+ KB
```

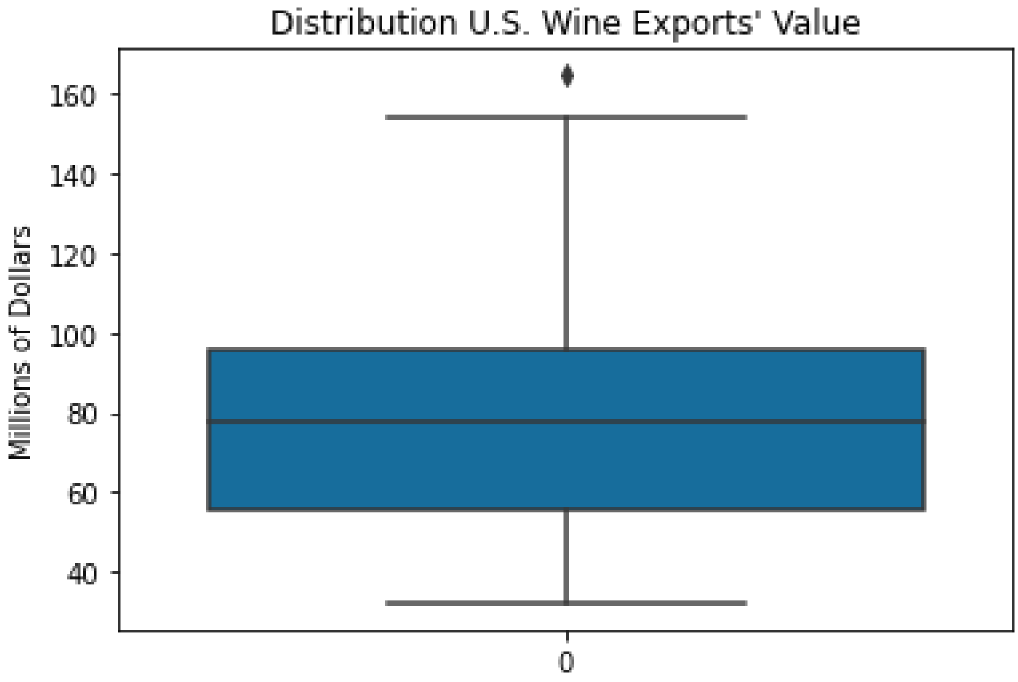
```
None
```

[36]:

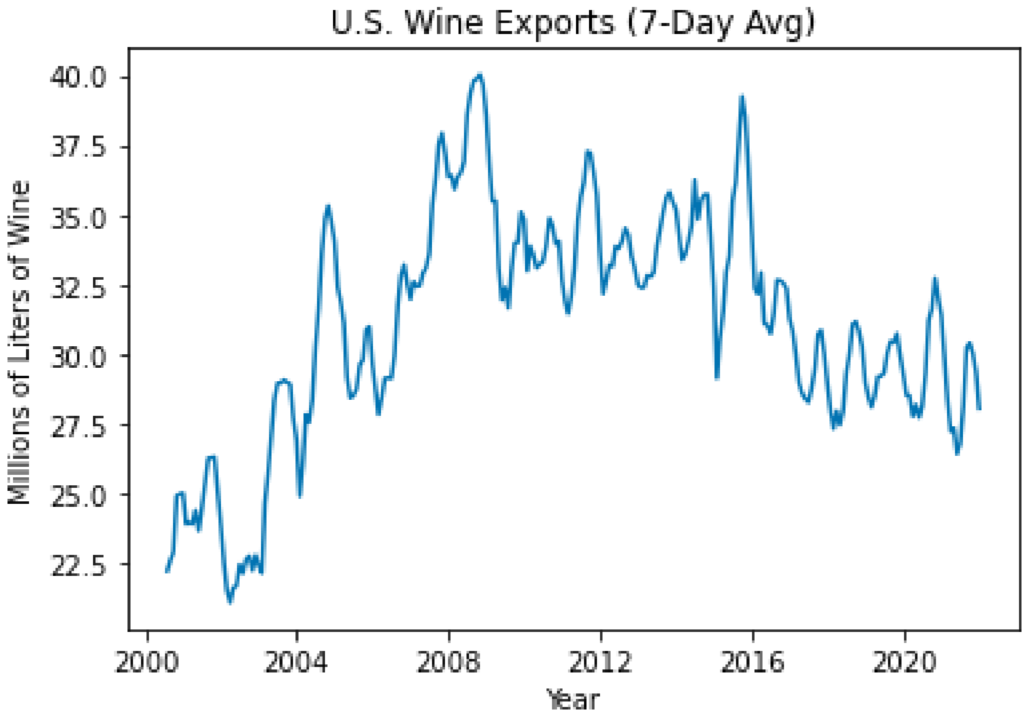
```
exports_quantity_boxplot = sns.boxplot(data=exports_df['First Unit of␣
 ↪Quantity'] / 1000000)
exports_quantity_boxplot.set(title='Distribution of Quantity of U.S. Wine␣
 ↪Exports', ylabel='Millions of Liters')
plt.show()
```



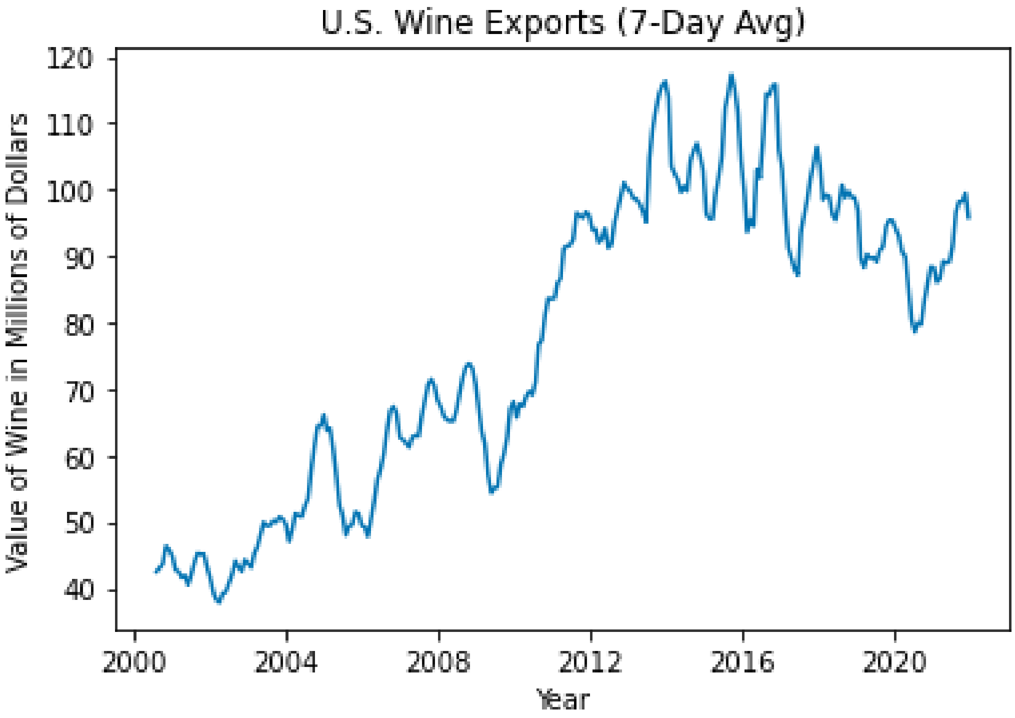
```
[37]: exports_value_boxplot = sns.boxplot(data=exports_df['fas_value_adj'] / 1000000)
      exports_value_boxplot.set(title='Distribution U.S. Wine Exports\' Value',␣
       ↪ylabel='Millions of Dollars')
      plt.show()
```



```
[38]: exports_df['first_unit_of_quantity_millions'] = exports_df['First Unit of␣
       ↪Quantity'].astype('f4') / 1000000
      exports_df['quantity_in_mil_rolling_avg_7'] = exports_df.
       ↪first_unit_of_quantity_millions.rolling(7).mean()

      exports_quantity_plot = sns.lineplot(data=exports_df, x='month',␣
       ↪y='quantity_in_mil_rolling_avg_7')
      exports_quantity_plot.set(title='U.S. Wine Exports (7-Day Avg)',␣
       ↪ylabel='Millions of Liters of Wine', xlabel='Year')
      plt.show()
```



[39]:
```
exports_df['fas_value_millions'] = exports_df['fas_value_adj'].astype('f4') /␣
 ↪1000000
exports_df['fas_value_millions_rolling_avg_7'] = exports_df.fas_value_millions.
 ↪rolling(7).mean()

exports_quantity_plot = sns.lineplot(data=exports_df, x='month',␣
 ↪y='fas_value_millions_rolling_avg_7')
exports_quantity_plot.set(title='U.S. Wine Exports (7-Day Avg)', ylabel='Value␣
 ↪of Wine in Millions of Dollars', xlabel='Year')
plt.show()
```



Domestic Production This data is provided by the Alcohol and Tobacco Tax and Trade Bureau (TTB). The data is in gallons instead of liters. Before looking into it, I'm going to quickly convert the timestamp to be the last day of the month and the values to be in liters instead of gallons.

[40]:

```
def galons_to_liters(g):
    if math.isnan(g):
        return
    return g * 3.785411784
```

[41]:

```
production_df['month'] = production_df['month'].astype(str).map(lambda x:␣
 ↪last_day_of_month(x))
production_df['month'] = production_df['month'].astype('datetime64[ns]')

for c in ['bulk', 'bottled', 'cider', 'effervescent', 'wine_gross']:
    production_df[c] = production_df[c].map(lambda x: galons_to_liters(x))
```

Now let's adjust for per-capita rates.

[42]:

```
production_df = production_df.merge(population_df[['month', 'population']],␣
 ↪on='month')
for c in production_df.columns:
    if c != 'month' and c != 'population':
        col_name = c + '_adj'
        production_df[col_name] = production_df[c] / production_df['population']
```

[43]:

```
display(production_df.head())
display(production_df.describe())
display(production_df.info())
```

```
       month          bulk       bottled         cider  effervescent  \
0 2000-01-31  1.131505e+08  1.244070e+08           NaN  6.909175e+06
1 2000-02-29  7.179357e+07  1.375283e+08           NaN  4.377026e+06
2 2000-03-31  4.635628e+07  1.603837e+08           NaN  9.321474e+06
3 2000-04-30  3.296724e+07  1.423004e+08  2.045088e+06  7.881046e+06
4 2000-05-31  3.178035e+07  1.612658e+08  6.959646e+06  6.334834e+06

     wine_gross  population  bulk_adj  bottled_adj  cider_adj  \
0  2.444667e+08   281083000  0.402552     0.442599        NaN
1  2.136989e+08   281299000  0.255222     0.488904        NaN
2  2.160614e+08   281531000  0.164658     0.569684        NaN
3  1.811036e+08   281763000  0.117003     0.505036   0.007258
4  1.924214e+08   281996000  0.112698     0.571873   0.024680

   effervescent_adj  wine_gross_adj  population_adj
0          0.024581        0.869731             1.0
1          0.015560        0.759686             1.0
2          0.033110        0.767452             1.0
3          0.027970        0.642752             1.0
4          0.022464        0.682355             1.0
```

```
               bulk       bottled         cider  effervescent    wine_gross  \
count  2.620000e+02  2.620000e+02  2.590000e+02  2.620000e+02  2.640000e+02
mean   2.366476e+08  1.929920e+08  7.290981e+06  8.266621e+06  4.274359e+08
std    2.329463e+08  3.586958e+07  6.452561e+06  2.698712e+06  2.328960e+08
min    2.661546e+07  1.244070e+08  5.490210e+05  2.678186e+06  0.000000e+00
25%    4.742184e+07  1.640341e+08  1.826624e+06  6.121333e+06  2.391613e+08
50%    1.180365e+08  1.899242e+08  2.811740e+06  8.068083e+06  3.199454e+08
75%    4.498815e+08  2.169504e+08  1.328316e+07  1.011393e+07  6.190754e+08
max    8.200452e+08  3.474637e+08  2.140858e+07  1.481254e+07  1.019108e+09

         population    bulk_adj  bottled_adj   cider_adj  effervescent_adj  \
count  2.640000e+02  262.000000   262.000000  259.000000        262.000000
mean   3.093217e+08    0.762839     0.621356    0.022790          0.026546
std    1.525593e+07    0.749701     0.093725    0.019675          0.007954
min    2.810830e+08    0.090648     0.442599    0.001865          0.009267
25%    2.960138e+08    0.156859     0.550870    0.006125          0.020363
50%    3.109405e+08    0.377495     0.611718    0.009091          0.026252
75%    3.231120e+08    1.410859     0.678556    0.040792          0.032392
max    3.318950e+08    2.622399     1.112624    0.066741          0.046178

       wine_gross_adj  population_adj
count      264.000000           264.0
mean         1.377695             1.0
```

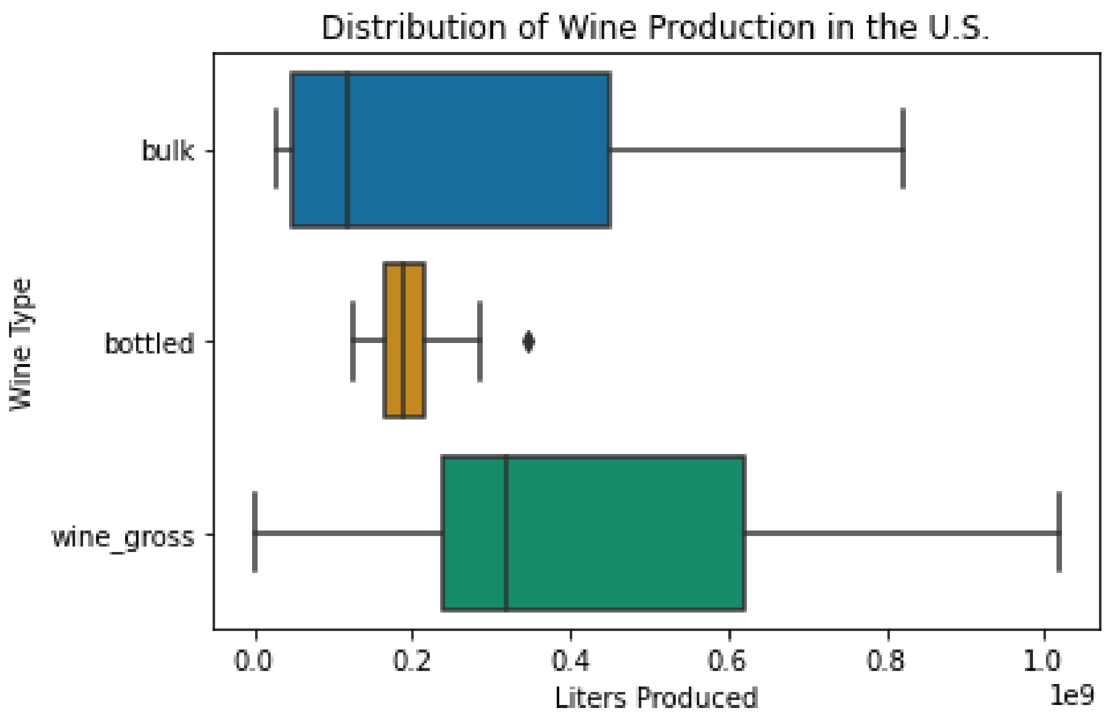
```
std          0.741864            0.0
min          0.000000            1.0
25%          0.782410            1.0
50%          1.034645            1.0
75%          1.999028            1.0
max          3.258976            1.0
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 264 entries, 0 to 263
Data columns (total 13 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   month             264 non-null    datetime64[ns]
 1   bulk              262 non-null    float64
 2   bottled           262 non-null    float64
 3   cider             259 non-null    float64
 4   effervescent      262 non-null    float64
 5   wine_gross        264 non-null    float64
 6   population        264 non-null    int64
 7   bulk_adj          262 non-null    float64
 8   bottled_adj       262 non-null    float64
 9   cider_adj         259 non-null    float64
 10  effervescent_adj  262 non-null    float64
 11  wine_gross_adj    264 non-null    float64
 12  population_adj    264 non-null    float64
dtypes: datetime64[ns](1), float64(11), int64(1)
memory usage: 28.9 KB
```

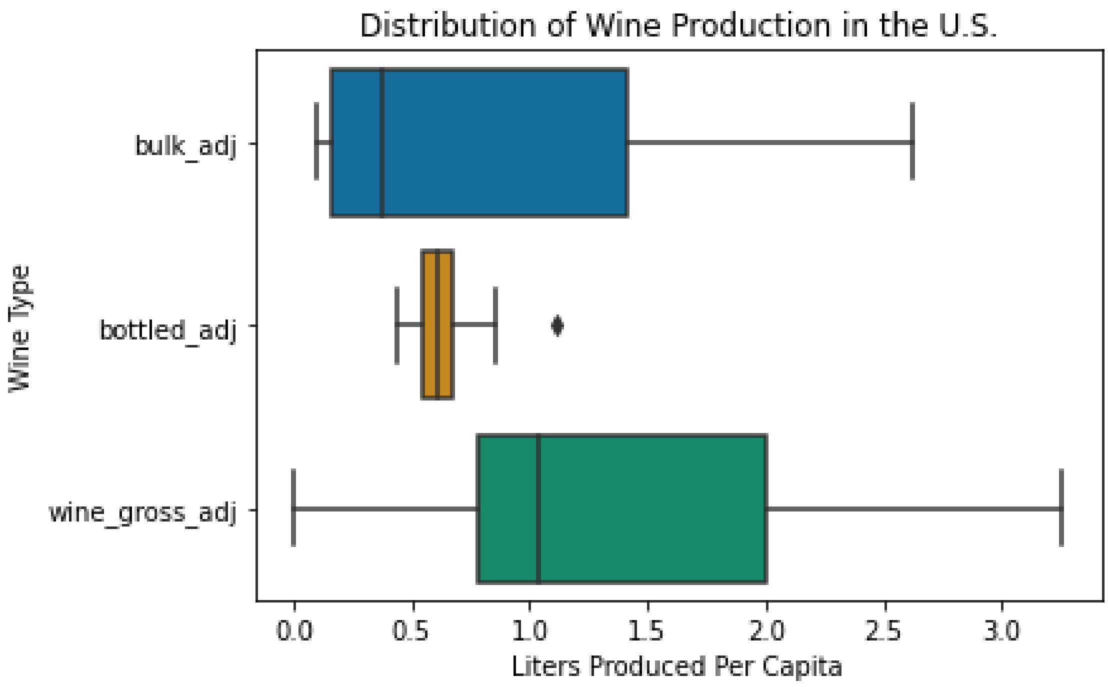
```
None
```

[44]:

```
wine_prod_boxplot_df = pd.melt(production_df[['bulk', 'bottled', 'wine_gross']])
wine_prod_boxplot = sns.boxplot(data=wine_prod_boxplot_df, y='variable',␣
 ↪x='value')
wine_prod_boxplot.set(title='Distribution of Wine Production in the U.S.',␣
 ↪xlabel='Liters Produced', ylabel='Wine Type')
plt.show()
```

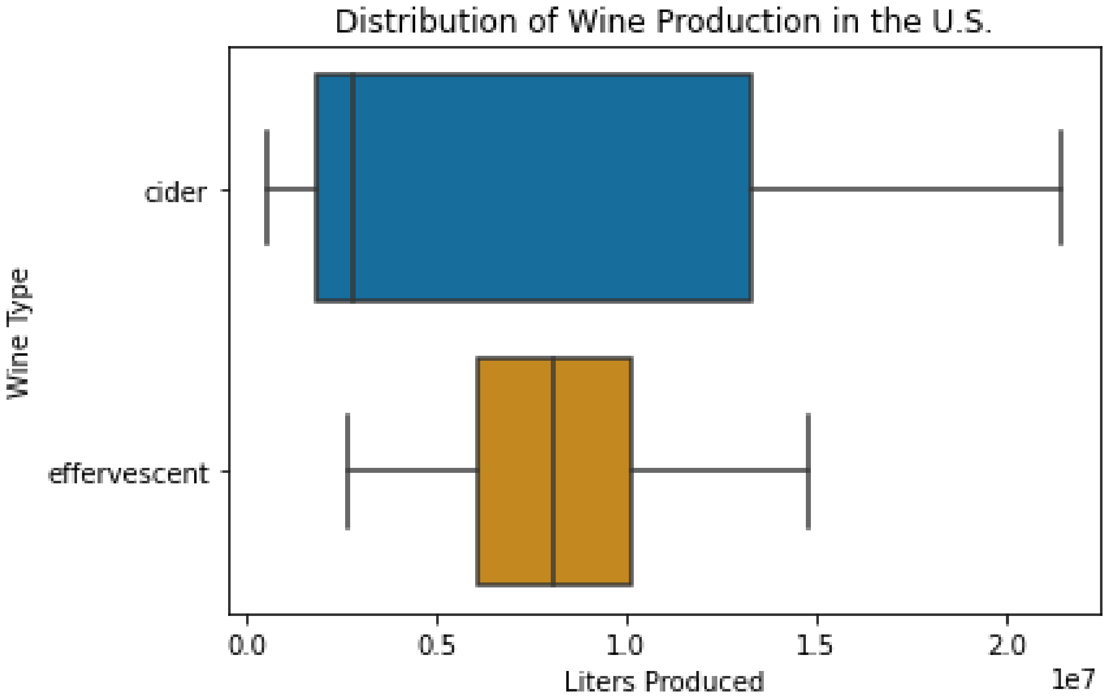


```
[45]: wine_prod_boxplot_adj_df = pd.melt(production_df[['bulk_adj', 'bottled_adj',␣
       ↪'wine_gross_adj']])
      wine_prod_boxplot_adj = sns.boxplot(data=wine_prod_boxplot_adj_df,␣
       ↪y='variable', x='value')
      wine_prod_boxplot_adj.set(title='Distribution of Wine Production in the U.S.',␣
       ↪xlabel='Liters Produced Per Capita', ylabel='Wine Type')
      plt.show()
```

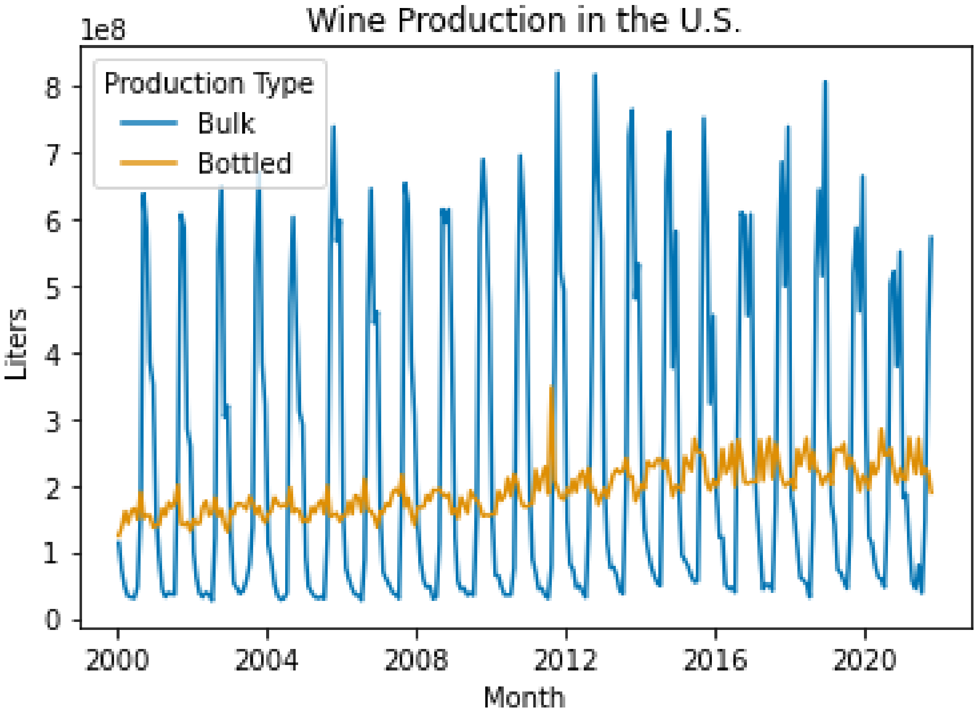


[46]:

```
wine_prod_alt_boxplot_df = pd.melt(production_df[['cider', 'effervescent']])
wine_prod_alt_boxplot = sns.boxplot(data=wine_prod_alt_boxplot_df,␣
 ↪y='variable', x='value')
wine_prod_alt_boxplot.set(title='Distribution of Wine Production in the U.S.',␣
 ↪xlabel='Liters Produced', ylabel='Wine Type')
plt.show()
```

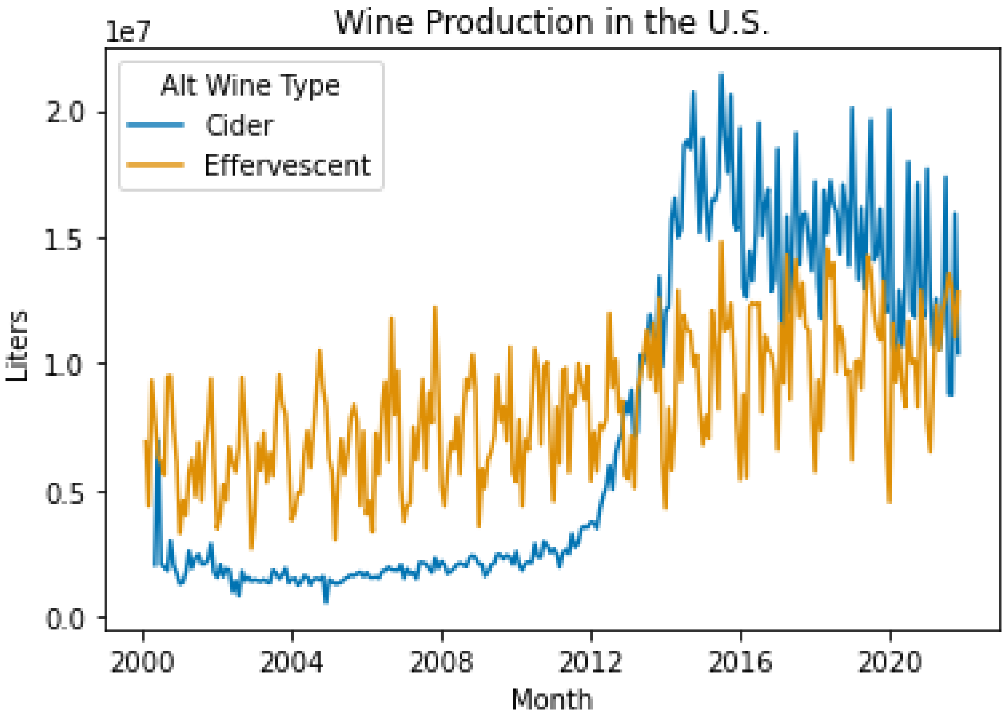


```
[47]: production_quantity_plot = sns.lineplot(data=pd.melt(production_df[['month',␣
       ↪'bulk', 'bottled']], ['month']), x='month', y='value', hue='variable',)
      production_quantity_plot.set(title='Wine Production in the U.S.',␣
       ↪xlabel='Month', ylabel='Liters')

      plt.legend(title='Production Type', loc='upper left', labels=['Bulk',␣
       ↪'Bottled'])
      plt.show()
```



[48]:

```
production_quantity_plot = sns.lineplot(data=pd.melt(production_df[['month',␣
 ↪'cider', 'effervescent']], ['month']), x='month', y='value', hue='variable',)
production_quantity_plot.set(title='Wine Production in the U.S.',␣
 ↪xlabel='Month', ylabel='Liters')

plt.legend(title='Alt Wine Type', loc='upper left', labels=['Cider',␣
 ↪'Effervescent'])
plt.show()
```



Average Wine Prices in U.S. Cities This data is retrieved from the federal reserve (FRED).

```
[49]: # Standardize dates
wine_prices_df['month'] = wine_prices_df['month'].map(lambda x:␣
 ↪last_day_of_month(x))
wine_prices_df['month'] = wine_prices_df['month'].astype('datetime64[ns]')

# Adjust for inflation
wine_prices_df = wine_prices_df.merge(ppi_df, on='month')
wine_prices_df['price_adj'] = wine_prices_df['price'] /␣
 ↪exports_df['PCU3121303121300'] * 100
```

```
[50]: display(wine_prices_df.head())
display(wine_prices_df.describe())
display(wine_prices_df.info())
```

```
       month  price observation_date  PCU3121303121300  price_adj
0 2000-01-31  5.458       2000-01-01             103.0   5.299029
1 2000-02-29  5.256       2000-02-01             101.1   5.198813
2 2000-03-31  5.471       2000-03-01             103.0   5.311650
3 2000-04-30  5.156       2000-04-01             101.0   5.104950
4 2000-05-31  5.530       2000-05-01             101.9   5.426889

            price  PCU3121303121300   price_adj
```

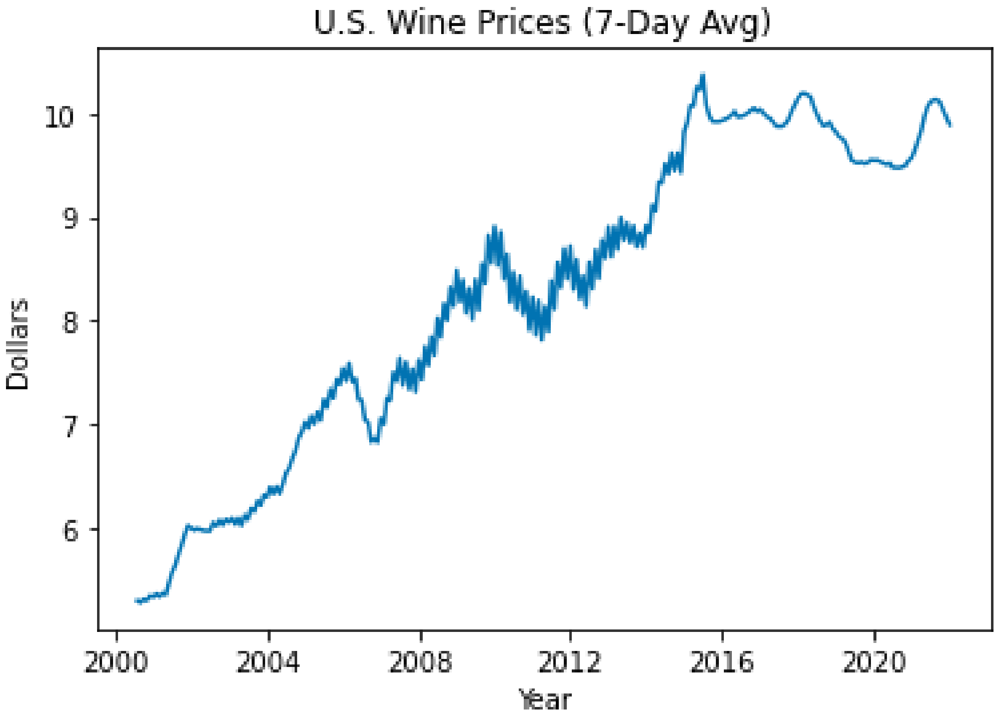
```
count  264.000000        265.000000  264.000000
mean     9.740682        116.637834    8.241252
std      2.578523          9.501049    1.652331
min      5.156000        100.900000    5.104950
25%      7.386500        106.000000    6.774410
50%     10.025000        118.800000    8.631385
75%     12.197750        123.400000    9.803208
max     14.420000        134.442000   11.848809
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 265 entries, 0 to 264
Data columns (total 5 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   month             265 non-null    datetime64[ns]
 1   price             264 non-null    float64
 2   observation_date  265 non-null    datetime64[ns]
 3   PCU3121303121300  265 non-null    float64
 4   price_adj         264 non-null    float64
dtypes: datetime64[ns](2), float64(3)
memory usage: 20.5 KB
```

```
None
```

```
[51]: wine_prices_df['prices_rolling_avg_7'] = wine_prices_df.price_adj.rolling(7).
       ↪mean()

      wine_prices_plot = sns.lineplot(data=wine_prices_df, x='month',␣
       ↪y='prices_rolling_avg_7')
      wine_prices_plot.set(title='U.S. Wine Prices (7-Day Avg)', ylabel='Dollars',␣
       ↪xlabel='Year')
```

```
[51]: [Text(0.5, 1.0, 'U.S. Wine Prices (7-Day Avg)'),
       Text(0, 0.5, 'Dollars'),
       Text(0.5, 0, 'Year')]
```



1.4 Combine Datasets

Construct a master dataset.

[63]:
```
tariff_df.head()
```

[63]:
```
     month  frspger_25
0  2000-01           0
1  2000-02           0
2  2000-03           0
3  2000-04           0
4  2000-05           0
```

[66]:
```
master_df = pd.DataFrame()
master_df['month'] = months

# Population
master_df = master_df.merge(population_df[['month', 'population']], on='month')

# Prices
master_df = master_df.merge(wine_prices_df[['month', 'price', 'price_adj']],␣
 ↪on='month')

# Domestic Production
```

```
master_df = master_df.merge(production_df[['month', 'bulk', 'bottled', 'cider',␣
 ↪'effervescent', 'wine_gross', 'bulk_adj', 'bottled_adj', 'cider_adj',␣
 ↪'effervescent_adj', 'wine_gross_adj']], on='month')

# Exports
## renaming columns
exports_df.rename(columns={
    'First Unit of Quantity':'quantity_exports',
    'fas_value_adj': 'fas_value_adj_exports'
    }, inplace=True)
## merging
master_df = master_df.merge(exports_df[['month', 'quantity_exports',␣
 ↪'fas_value_adj_exports']], on='month')

# Imports
## renaming world imports columns
imports_world_df.rename(columns={
    'Dutiable Value':'dutiable_value_world_imports',
    'dutiable_value_adj':'dutiable_value_adj_world_imports',
    'Landed Duty-Paid Value': 'landed_duty_paid_value_world_imports',
    'landed_duty_paid_value_adj': 'landed_duty_paid_value_adj_world_imports',
    'Customs Value': 'customs_value_world_imports',
    'customs_value_adj': 'customs_value_adj_world_imports',
    'First Unit of Quantity': 'quantity_world_imports',
    'Charges, Insurance, and Freight':␣
 ↪'charges_insurance_freight_world_imports',
    'charges_insurance_and_freight_adj':␣
 ↪'charges_insurance_freight_adj_world_imports',
    'Calculated Duties': 'calculated_duties_world_imports',
    'calculated_duties_adj': 'calculated_duties_adj_world_imports'
    }, inplace=True)
## renaming ukspfrde imports columns
imports_ukfrspde_df.rename(columns={
    'Dutiable Value':'dutiable_value_ukfrspde_imports',
    'dutiable_value_adj':'dutiable_value_adj_ukfrspde_imports',
    'Landed Duty-Paid Value': 'landed_duty_paid_value_ukfrspde_imports',
    'landed_duty_paid_value_adj': 'landed_duty_paid_value_adj_ukfrspde_imports',
    'Customs Value': 'customs_value_ukfrspde_imports',
    'customs_value_adj': 'customs_value_adj_ukfrspde_imports',
    'First Unit of Quantity': 'quantity_ukfrspde_imports',
    'Charges, Insurance, and Freight':
 ↪'charges_insurance_freight_ukfrspde_imports',
    'charges_insurance_and_freight_adj':
 ↪'charges_insurance_freight_adj_ukfrspde_imports',
    'Calculated Duties': 'calculated_duties_ukfrspde_imports',
    'calculated_duties_adj': 'calculated_duties_adj_ukfrspde_imports'
    }, inplace=True)
## merging
master_df = master_df.merge(imports_world_df[['month',␣
 ↪'dutiable_value_world_imports',
    'dutiable_value_adj_world_imports', 'landed_duty_paid_value_world_imports',
    'landed_duty_paid_value_adj_world_imports', 'customs_value_world_imports',
    'customs_value_adj_world_imports', 'quantity_world_imports',
    'charges_insurance_freight_world_imports',␣
 ↪'charges_insurance_freight_adj_world_imports',
    'calculated_duties_world_imports', 'calculated_duties_adj_world_imports']],␣
 ↪on='month')
master_df = master_df.merge(imports_ukfrspde_df[['month',␣
 ↪'dutiable_value_ukfrspde_imports',
    'dutiable_value_adj_ukfrspde_imports',␣
 ↪'landed_duty_paid_value_ukfrspde_imports',
    'landed_duty_paid_value_adj_ukfrspde_imports',␣
 ↪'customs_value_ukfrspde_imports',
    'customs_value_adj_ukfrspde_imports', 'quantity_ukfrspde_imports',
    'charges_insurance_freight_ukfrspde_imports',␣
 ↪'charges_insurance_freight_adj_ukfrspde_imports',
    'calculated_duties_ukfrspde_imports',␣
 ↪'calculated_duties_adj_ukfrspde_imports']], on='month')

# Tariff Enacted Boolean
tariff_df['month'] = tariff_df['month'].map(lambda x: last_day_of_month(str(x)))
tariff_df['month'] = tariff_df['month'].astype('datetime64[ns]')
master_df = master_df.merge(tariff_df, on='month')
```

```
[66]: Index(['month', 'population', 'price', 'price_adj', 'bulk', 'bottled', 'cider',
             'effervescent', 'wine_gross', 'bulk_adj', 'bottled_adj', 'cider_adj',
             'effervescent_adj', 'wine_gross_adj', 'quantity_exports',
             'fas_value_adj_exports', 'dutiable_value_world_imports',
             'dutiable_value_adj_world_imports',
             'landed_duty_paid_value_world_imports',
             'landed_duty_paid_value_adj_world_imports',
             'customs_value_world_imports', 'customs_value_adj_world_imports',
             'quantity_world_imports', 'charges_insurance_freight_world_imports',
             'charges_insurance_freight_adj_world_imports',
             'calculated_duties_world_imports',
             'calculated_duties_adj_world_imports',
             'dutiable_value_ukfrspde_imports',
             'dutiable_value_adj_ukfrspde_imports',
             'landed_duty_paid_value_ukfrspde_imports',
             'landed_duty_paid_value_adj_ukfrspde_imports',
             'customs_value_ukfrspde_imports', 'customs_value_adj_ukfrspde_imports',
             'quantity_ukfrspde_imports',
             'charges_insurance_freight_ukfrspde_imports',
             'charges_insurance_freight_adj_ukfrspde_imports',
             'calculated_duties_ukfrspde_imports',
             'calculated_duties_adj_ukfrspde_imports', 'frspger_25'],
            dtype='object')
```

The dataset looks pretty good. I'll export this as an excel file just to hold on to it as is.

```
[67]: display(master_df.head())
      display(master_df.describe())
      display(master_df.info())
```

```
       month  population  price  price_adj          bulk       bottled  \
0 2000-01-31   281083000  5.458   5.299029  1.131505e+08  1.244070e+08
1 2000-02-29   281299000  5.256   5.198813  7.179357e+07  1.375283e+08
2 2000-03-31   281531000  5.471   5.311650  4.635628e+07  1.603837e+08
3 2000-04-30   281763000  5.156   5.104950  3.296724e+07  1.423004e+08
4 2000-05-31   281996000  5.530   5.426889  3.178035e+07  1.612658e+08

          cider  effervescent    wine_gross  bulk_adj  …  \
0           NaN  6.909175e+06  2.444667e+08  0.402552  …
1           NaN  4.377026e+06  2.136989e+08  0.255222  …
2           NaN  9.321474e+06  2.160614e+08  0.164658  …
3  2.045088e+06  7.881046e+06  1.811036e+08  0.117003  …
4  6.959646e+06  6.334834e+06  1.924214e+08  0.112698  …

   landed_duty_paid_value_ukfrspde_imports  \
0                                 59812261
1                                 77087577
2                                 87219165
3                                 87040067
4                                 79534639

   landed_duty_paid_value_adj_ukfrspde_imports  \
0                                   58070156.31068
1                                  76248839.762611
2                                  84678800.970874
3                                  86178284.158416
4                                   78051657.50736

   customs_value_ukfrspde_imports  customs_value_adj_ukfrspde_imports  \
0                        56706027                     55054395.145631
1                        73873201                       73069437.1909
2                        83500840                     81068776.699029
3                        83075769                     82253236.633663
4                        75599523                     74189914.622179

  quantity_ukfrspde_imports charges_insurance_freight_ukfrspde_imports  \
0                   8768676                                    2406931
1                   8961916                                    2356486
2                  10474993                                    2804317
3                  11128077                                    2989501
4                  10874051                                    3037785

  charges_insurance_freight_adj_ukfrspde_imports  \
0                                 2336826.213592
1                                 2330846.686449
2                                 2722637.864078
3                                 2959901.980198
4                                 2981143.277723

  calculated_duties_ukfrspde_imports calculated_duties_adj_ukfrspde_imports  \
0                             699303                          678934.951456
1                             857890                          848555.885262
2                             914008                          887386.407767
3                             974797                          965145.544554
4                             897331                          880599.607458

  frspger_25
0          0
1          0
2          0
3          0
4          0

[5 rows x 39 columns]
         population       price   price_adj          bulk       bottled  \
count  2.640000e+02  264.000000  264.000000  2.620000e+02  2.620000e+02
mean   3.093217e+08    9.740682    8.241252  2.366476e+08  1.929920e+08
std    1.525593e+07    2.578523    1.652331  2.329463e+08  3.586958e+07
min    2.810830e+08    5.156000    5.104950  2.661546e+07  1.244070e+08
25%    2.960138e+08    7.386500    6.774410  4.742184e+07  1.640341e+08
50%    3.109405e+08   10.025000    8.631385  1.180365e+08  1.899242e+08
75%    3.231120e+08   12.197750    9.803208  4.498815e+08  2.169504e+08
max    3.318950e+08   14.420000   11.848809  8.200452e+08  3.474637e+08

              cider  effervescent    wine_gross    bulk_adj  bottled_adj  \
count  2.590000e+02  2.620000e+02  2.640000e+02  262.000000   262.000000
mean   7.290981e+06  8.266621e+06  4.274359e+08    0.762839     0.621356
std    6.452561e+06  2.698712e+06  2.328960e+08    0.749701     0.093725
min    5.490210e+05  2.678186e+06  0.000000e+00    0.090648     0.442599
25%    1.826624e+06  6.121333e+06  2.391613e+08    0.156859     0.550870
50%    2.811740e+06  8.068083e+06  3.199454e+08    0.377495     0.611718
75%    1.328316e+07  1.011393e+07  6.190754e+08    1.410859     0.678556
max    2.140858e+07  1.481254e+07  1.019108e+09    2.622399     1.112624
```

```
       cider_adj  effervescent_adj  wine_gross_adj  frspger_25
count  259.000000        262.000000      264.000000  264.000000
mean     0.022790          0.026546        1.377695    0.079545
std      0.019675          0.007954        0.741864    0.271102
min      0.001865          0.009267        0.000000    0.000000
25%      0.006125          0.020363        0.782410    0.000000
50%      0.009091          0.026252        1.034645    0.000000
75%      0.040792          0.032392        1.999028    0.000000
max      0.066741          0.046178        3.258976    1.000000
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 264 entries, 0 to 263
Data columns (total 39 columns):
 #   Column                                          Non-Null Count  Dtype
---  ------                                          --------------  -----
 0   month                                           264 non-null
datetime64[ns]
 1   population                                      264 non-null    int64
 2   price                                           264 non-null    float64
 3   price_adj                                       264 non-null    float64
 4   bulk                                            262 non-null    float64
 5   bottled                                         262 non-null    float64
 6   cider                                           259 non-null    float64
 7   effervescent                                    262 non-null    float64
 8   wine_gross                                      264 non-null    float64
 9   bulk_adj                                        262 non-null    float64
 10  bottled_adj                                     262 non-null    float64
 11  cider_adj                                       259 non-null    float64
 12  effervescent_adj                                262 non-null    float64
 13  wine_gross_adj                                  264 non-null    float64
 14  quantity_exports                                264 non-null    object
 15  fas_value_adj_exports                           264 non-null    object
 16  dutiable_value_world_imports                    264 non-null    object
 17  dutiable_value_adj_world_imports                264 non-null    object
 18  landed_duty_paid_value_world_imports            264 non-null    object
 19  landed_duty_paid_value_adj_world_imports        264 non-null    object
 20  customs_value_world_imports                     264 non-null    object
 21  customs_value_adj_world_imports                 264 non-null    object
 22  quantity_world_imports                          264 non-null    object
 23  charges_insurance_freight_world_imports         264 non-null    object
 24  charges_insurance_freight_adj_world_imports     264 non-null    object
 25  calculated_duties_world_imports                 264 non-null    object
 26  calculated_duties_adj_world_imports             264 non-null    object
 27  dutiable_value_ukfrspde_imports                 264 non-null    object
 28  dutiable_value_adj_ukfrspde_imports             264 non-null    object
 29  landed_duty_paid_value_ukfrspde_imports         264 non-null    object
 30  landed_duty_paid_value_adj_ukfrspde_imports     264 non-null    object
 31  customs_value_ukfrspde_imports                  264 non-null    object
 32  customs_value_adj_ukfrspde_imports              264 non-null    object
 33  quantity_ukfrspde_imports                       264 non-null    object
 34  charges_insurance_freight_ukfrspde_imports      264 non-null    object
 35  charges_insurance_freight_adj_ukfrspde_imports  264 non-null    object
 36  calculated_duties_ukfrspde_imports              264 non-null    object
 37  calculated_duties_adj_ukfrspde_imports          264 non-null    object
 38  frspger_25                                      264 non-null    int64
dtypes: datetime64[ns](1), float64(12), int64(2), object(24)
memory usage: 82.5+ KB
```

```
None
```

[68]:

```
master_df.to_excel('../data/master-data.xlsx')
```