team-friday-assigment

April 3, 2024

[ ]:
```
import pandas as pd
from numpy.linalg import solve
import numpy as np

df = pd.read_csv('/content/current.csv')
```

[ ]:
```
##cleaning the dataset
df_cleaned = df.drop(index=0)
df_cleaned.reset_index(drop=True, inplace=True)
df_cleaned['sasdate'] = pd.to_datetime(df_cleaned['sasdate'], format='%m/%d/%Y')
df_cleaned
```

[ ]:

	sasdate	RPI	W875RX1	DPCERA3M086SBEA	CMRMTSPLx	\
0	1959-01-01	2583.560	2426.0	15.188	2.766768e+05	
1	1959-02-01	2593.596	2434.8	15.346	2.787140e+05	
2	1959-03-01	2610.396	2452.7	15.491	2.777753e+05	
3	1959-04-01	2627.446	2470.0	15.435	2.833627e+05	
4	1959-05-01	2642.720	2486.4	15.622	2.853072e+05	
..	…	…	…	…	…	
776	2023-09-01	19111.748	15741.9	116.594	1.507530e+06	
777	2023-10-01	19145.402	15784.6	116.663	1.505477e+06	
778	2023-11-01	19213.108	15859.9	117.127	1.514733e+06	
779	2023-12-01	19251.946	15899.0	117.773	1.530296e+06	
780	2024-01-01	19377.558	15948.8	117.639	NaN	

	RETAILx	INDPRO	IPFPNSS	IPFINAL	IPCONGD	…	\
0	18235.77392	21.9665	23.3891	22.2688	31.7011	…	
1	18369.56308	22.3966	23.7048	22.4617	31.9337	…	
2	18523.05762	22.7193	23.8483	22.5719	31.9337	…	
3	18534.46600	23.2032	24.1927	22.9026	32.4374	…	
4	18679.66354	23.5528	24.3936	23.1231	32.5925	…	
..	…	…	…	…	…	…	
776	705304.00000	103.2096	101.0935	101.3665	102.1034	…	
777	703528.00000	102.3722	100.5292	100.5527	101.1664	…	
778	703336.00000	102.6710	100.9362	101.2159	101.8557	…	
779	706180.00000	102.6715	100.8332	101.2843	101.9884	…	
780	700291.00000	102.5739	100.9984	101.7258	102.6235	…	

```
     DNDGRG3M086SBEA  DSERRG3M086SBEA  CES0600000008  CES2000000008  \
0             18.294           10.152           2.13           2.45
1             18.302           10.167           2.14           2.46
2             18.289           10.185           2.15           2.45
3             18.300           10.221           2.16           2.47
4             18.280           10.238           2.17           2.48
..               …                …              …              …
776          120.395          123.976          29.90          34.55
777          120.040          124.228          29.97          34.67
778          119.325          124.551          30.26          34.96
779          119.193          124.917          30.45          35.01
780          118.745          125.662          30.56          35.21

     CES3000000008  UMCSENTx  DTCOLNVHFNM   DTCTHFNM     INVEST  VIXCLSx
0             2.04       NaN      6476.00   12298.00    84.2043      NaN
1             2.05       NaN      6476.00   12298.00    83.5280      NaN
2             2.07       NaN      6508.00   12349.00    81.6405      NaN
3             2.08       NaN      6620.00   12484.00    81.8099      NaN
4             2.08      95.3      6753.00   12646.00    80.7315      NaN
..             …         …            …          …         …       …
776          26.62      67.9    508808.61  913938.95  5074.6108  15.0424
777          26.65      63.8    513229.64  918210.64  5015.5456  19.0462
778          26.89      61.3    517434.30  922552.40  4999.7208  13.8563
779          27.14      69.7    522366.13  928336.14  5077.4222  12.6960
780          27.22       NaN          NaN        NaN  5105.3504  13.3453

[781 rows x 128 columns]
```

[ ]:
```python
##extract transformation code
transformation_codes = df.iloc[0, 1:].to_frame().reset_index()
transformation_codes.columns = ['Series', 'Transformation_Code']

# Function to apply transformations based on the transformation code
def apply_transformation(series, code):
    if code == 1:
        # No transformation
        return series
    elif code == 2:
        # First difference
        return series.diff()
    elif code == 3:
        # Second difference
        return series.diff().diff()
    elif code == 4:
        # Log
        return np.log(series)
```

```
    elif code == 5:
        # First difference of log
        return np.log(series).diff()
    elif code == 6:
        # Second difference of log
        return np.log(series).diff().diff()
    elif code == 7:
        # Delta (x_t/x_{t-1} - 1)
        return series.pct_change()
    else:
        raise ValueError("Invalid transformation code")



for series_name, code in transformation_codes.values:
    df_cleaned[series_name] = apply_transformation(df_cleaned[series_name].
 ↪astype(float), float(code))

df_cleaned = df_cleaned[2:]
df_cleaned.reset_index(drop=True, inplace=True)
df_cleaned.head()
```

[ ]:

	sasdate	RPI	W875RX1	DPCERA3M086SBEA	CMRMTSPLx	RETAILx	\
0	1959-03-01	0.006457	0.007325	0.009404	-0.003374	0.008321	
1	1959-04-01	0.006510	0.007029	-0.003622	0.019915	0.000616	
2	1959-05-01	0.005796	0.006618	0.012043	0.006839	0.007803	
3	1959-06-01	0.003068	0.003012	0.003642	-0.000097	0.009064	
4	1959-07-01	-0.000580	-0.000762	-0.003386	0.012155	-0.000330	

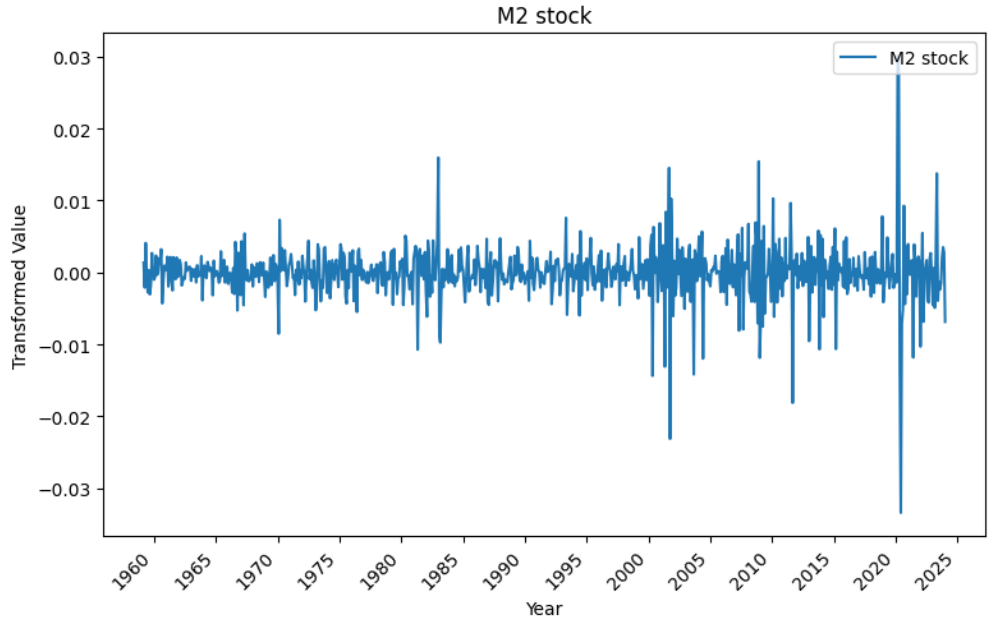
	INDPRO	IPFPNSS	IPFINAL	IPCONGD	…	DNDGRG3M086SBEA	\
0	0.014306	0.006035	0.004894	0.000000	…	-0.001148	
1	0.021075	0.014338	0.014545	0.015650	…	0.001312	
2	0.014955	0.008270	0.009582	0.004770	…	-0.001695	
3	0.001141	0.007034	0.007128	-0.004767	…	0.003334	
4	-0.024240	0.001168	0.008249	0.013054	…	-0.001204	

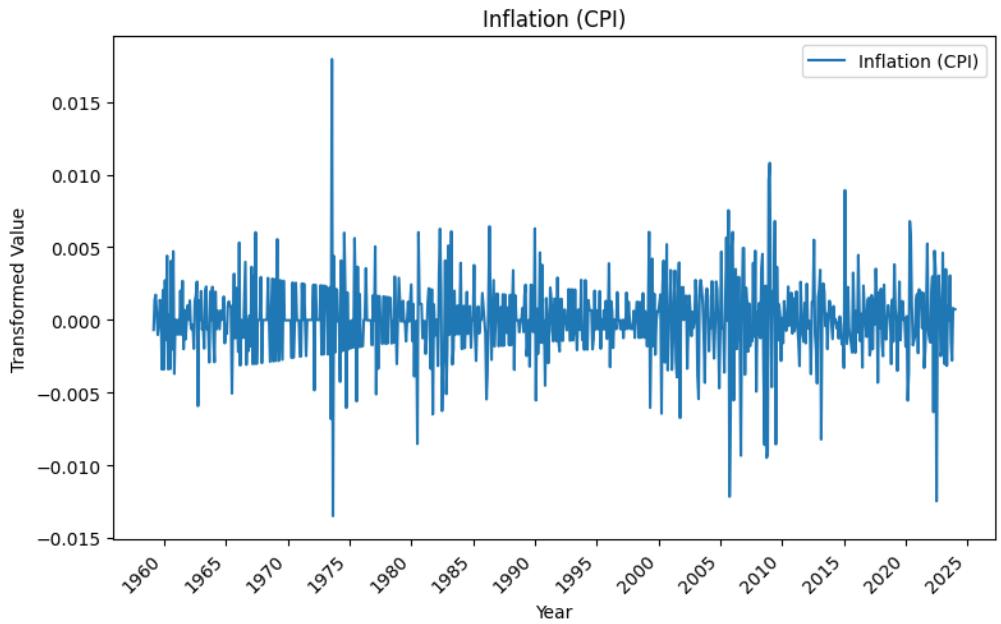
	DSERRG3M086SBEA	CES0600000008	CES2000000008	CES3000000008	UMCSENTx	\
0	0.000292	-0.000022	-0.008147	0.004819	NaN	
1	0.001760	-0.000022	0.012203	-0.004890	NaN	
2	-0.001867	-0.000021	-0.004090	-0.004819	NaN	
3	0.001946	-0.004619	0.003992	0.004796	NaN	
4	-0.000013	0.000000	-0.004040	-0.004796	NaN	

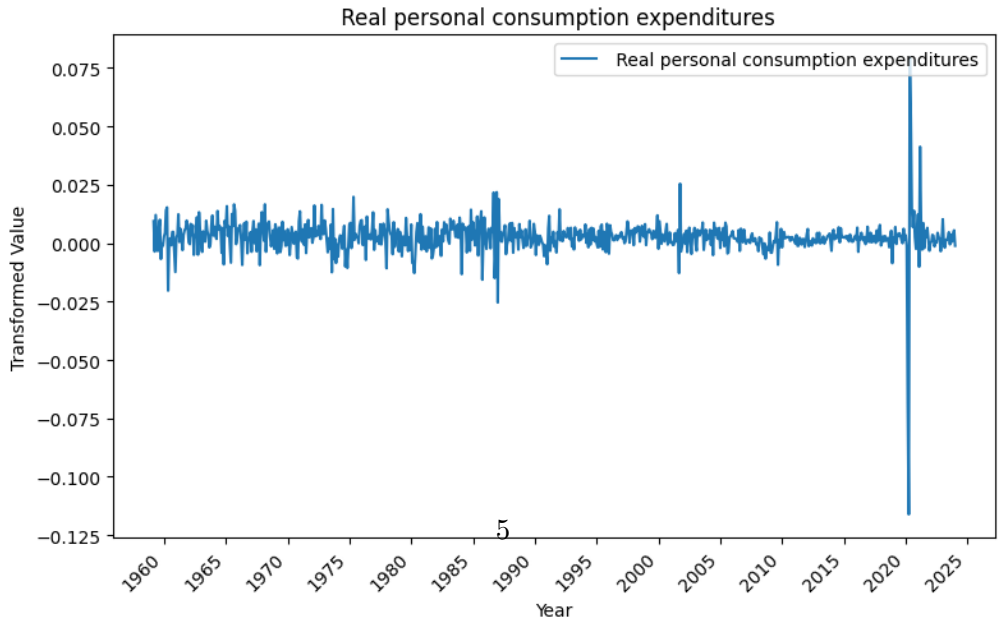
	DTCOLNVHFNM	DTCTHFNM	INVEST	VIXCLSx
0	0.004929	0.004138	-0.014792	NaN
1	0.012134	0.006734	0.024929	NaN
2	0.002828	0.002020	-0.015342	NaN

```
3     0.009726  0.009007 -0.012252      NaN
4    -0.004631 -0.001000  0.029341      NaN

[5 rows x 128 columns]
```

[ ]:
```python
#plot
import matplotlib.pyplot as plt
import matplotlib.dates as mdates
series_to_plot = ['M2SL', 'CPIAUCSL', 'DPCERA3M086SBEA']
series_names = ['M2 stock',
                'Inflation (CPI)',
                ' Real personal consumption expenditures']
fig, axs = plt.subplots(len(series_to_plot), 1, figsize=(8, 15))
for ax, series_name, plot_title in zip(axs, series_to_plot, series_names):
    if series_name in df_cleaned.columns:
        dates = pd.to_datetime(df_cleaned['sasdate'], format='%m/%d/%Y')
        ax.plot(dates, df_cleaned[series_name], label=plot_title)
        ax.xaxis.set_major_locator(mdates.YearLocator(base=5))
        ax.xaxis.set_major_formatter(mdates.DateFormatter('%Y'))
        ax.set_title(plot_title)
        ax.set_xlabel('Year')
        ax.set_ylabel('Transformed Value')
        ax.legend(loc='upper right')
        plt.setp(ax.xaxis.get_majorticklabels(), rotation=45, ha='right')
    else:
        ax.set_visible(False)  # Hide plots for which the data is not available

plt.tight_layout()
plt.show()
```


M2 stock
M2 stock
Transformed Value
Year


Inflation (CPI)
Inflation (CPI)
Transformed Value
Year


Real personal consumption expenditures
Real personal consumption expenditures
Transformed Value
Year

[ ]:
```
#matrix X and vector Y
Yraw = df_cleaned['CPIAUCSL']
Xraw = df_cleaned[['M2SL', 'DNDGRG3M086SBEA']]
num_lags = 8
num_leads = 4
X = pd.DataFrame()
col = 'CPIAUCSL'
for lag in range (0, num_lags+1):
        X[f'{col}_lag{lag}'] = Yraw.shift(lag)
for col in Xraw.columns:
    for lag in range (0, num_lags+1):
        X[f'{col}_lag{lag}'] = Xraw[col].shift(lag)
X.insert(0, 'Ones', np.ones(len(X)))
X
```

[ ]:

	Ones	CPIAUCSL_lag0	CPIAUCSL_lag1	CPIAUCSL_lag2	CPIAUCSL_lag3	\
0	1.0	-0.000690	NaN	NaN	NaN	
1	1.0	0.001380	-0.000690	NaN	NaN	
2	1.0	0.001723	0.001380	-0.000690	NaN	
3	1.0	0.000339	0.001723	0.001380	-0.000690	
4	1.0	-0.001034	0.000339	0.001723	0.001380	
..	…	…	…	…	…	
774	1.0	-0.001515	0.003051	-0.000047	0.001003	
775	1.0	-0.002799	-0.001515	0.003051	-0.000047	
776	1.0	0.000811	-0.002799	-0.001515	0.003051	
777	1.0	0.000726	0.000811	-0.002799	-0.001515	
778	1.0	0.000721	0.000726	0.000811	-0.002799	

	CPIAUCSL_lag4	CPIAUCSL_lag5	CPIAUCSL_lag6	CPIAUCSL_lag7	\
0	NaN	NaN	NaN	NaN	
1	NaN	NaN	NaN	NaN	
2	NaN	NaN	NaN	NaN	
3	NaN	NaN	NaN	NaN	
4	-0.000690	NaN	NaN	NaN	
..	…	…	…	…	
774	-0.003161	0.003480	-0.003052	-0.001322	
775	0.001003	-0.003161	0.003480	-0.003052	
776	-0.000047	0.001003	-0.003161	0.003480	
777	0.003051	-0.000047	0.001003	-0.003161	
778	-0.001515	0.003051	-0.000047	0.001003	

	CPIAUCSL_lag8	…	M2SL_lag8	DNDGRG3M086SBEA_lag0	\
0	NaN	…	NaN	-0.001148	
1	NaN	…	NaN	0.001312	
2	NaN	…	NaN	-0.001695	

```
3              NaN  …         NaN              0.003334
4              NaN  …         NaN             -0.001204
..             …  …          …                 …
774       0.004605  …  -0.004497             -0.010725
775      -0.001322  …   0.000641             -0.006139
776      -0.003052  …  -0.004907             -0.003021
777       0.003480  …   0.002439              0.004867
778      -0.003161  …   0.013769             -0.002659

     DNDGRG3M086SBEA_lag1  DNDGRG3M086SBEA_lag2  DNDGRG3M086SBEA_lag3  \
0                     NaN                   NaN                   NaN
1               -0.001148                   NaN                   NaN
2                0.001312             -0.001148                   NaN
3               -0.001695              0.001312             -0.001148
4                0.003334             -0.001695              0.001312
..                    …                     …                     …
774              0.014038             -0.000887              0.004187
775             -0.010725              0.014038             -0.000887
776             -0.006139             -0.010725              0.014038
777             -0.003021             -0.006139             -0.010725
778              0.004867             -0.003021             -0.006139

     DNDGRG3M086SBEA_lag4  DNDGRG3M086SBEA_lag5  DNDGRG3M086SBEA_lag6  \
0                     NaN                   NaN                   NaN
1                     NaN                   NaN                   NaN
2                     NaN                   NaN                   NaN
3                     NaN                   NaN                   NaN
4               -0.001148                   NaN                   NaN
..                    …                     …                     …
774             -0.007022              0.006627             -0.006705
775              0.004187             -0.007022              0.006627
776             -0.000887              0.004187             -0.007022
777              0.014038             -0.000887              0.004187
778             -0.010725              0.014038             -0.000887

     DNDGRG3M086SBEA_lag7  DNDGRG3M086SBEA_lag8
0                     NaN                   NaN
1                     NaN                   NaN
2                     NaN                   NaN
3                     NaN                   NaN
4                     NaN                   NaN
..                    …                     …
774             -0.003289              0.013510
775             -0.006705             -0.003289
776              0.006627             -0.006705
777             -0.007022              0.006627
778              0.004187             -0.007022
```

```
[779 rows x 28 columns]
```

[ ]:
```
y = Yraw.shift(-num_leads)
y
```

[ ]:
```
0     -0.001034
1     -0.000345
2      0.001367
3      0.001017
4     -0.003413
          …
774    0.000721
775         NaN
776         NaN
777         NaN
778         NaN
Name: CPIAUCSL, Length: 779, dtype: float64
```

[ ]:
```
X_T = X.iloc[-1:].values
X_T
```

[ ]:
```
array([[ 1.00000000e+00,  7.21400503e-04,  7.26467817e-04,
         8.11330254e-04, -2.79891559e-03, -1.51527417e-03,
         3.05087605e-03, -4.70784880e-05,  1.00257828e-03,
        -3.16114422e-03, -6.86011934e-03,  2.77062956e-03,
         3.51058387e-03,  1.99477265e-03, -1.51356295e-03,
        -2.37724874e-03, -1.26831670e-03, -3.92912202e-03,
         1.37692721e-02, -2.65885649e-03,  4.86732286e-03,
        -3.02117448e-03, -6.13924919e-03, -1.07253383e-02,
         1.40383347e-02, -8.87353808e-04,  4.18730761e-03,
        -7.02247442e-03]])
```

[ ]:
```
y = y.iloc[num_lags:-num_leads]
X = X.iloc[num_lags:-num_leads]
y
```

[ ]:
```
8     -0.001361
9      0.004411
10    -0.003395
11     0.000337
12    -0.003380
          …
770   -0.001515
771   -0.002799
772    0.000811
773    0.000726
```

```
774    0.000721
Name: CPIAUCSL, Length: 767, dtype: float64
```

[ ]:
```
from numpy.linalg import solve
beta_ols = solve(X.T @ X, X.T @ y)
forecast = X_T@beta_ols*100
forecast
```

[ ]:
```
array([0.01295211])
```

[ ]:
```
#real test
def calculate_forecast(df_cleaned,
                       p = 4,
                       H = [1,4,8],
                       end_date = '12/01/1999',
                       target = 'CPIAUCSL',
                       xvars = ['M2SL', 'DNDGRG3M086SBEA']):
 rt_df = df_cleaned[df_cleaned['sasdate'] <= pd.Timestamp(end_date)]
 Y_actual = []
 for h in H:
     os = pd.Timestamp(end_date) + pd.DateOffset(months=h)
     Y_actual.append(df_cleaned[df_cleaned['sasdate'] == os][target]*100)
 Yraw = rt_df[target]
 Xraw = rt_df[xvars]
 X = pd.DataFrame()
 for lag in range(0,p):
     X[f'{target}_lag{lag}'] = Yraw.shift(lag)
 for col in Xraw.columns:
     for lag in range(0,p):
         X[f'{col}_lag{lag}'] = Xraw[col].shift(lag)
 X.insert(0, 'Ones', np.ones(len(X)))
 X_T = X.iloc[-1:].values
 Yhat = []
 for h in H:
     y_h = Yraw.shift(-h)
     y = y_h.iloc[p:-h].values
     X_ = X.iloc[p:-h].values
     beta_ols = solve(X_.T @ X_, X_.T @ y)
     Yhat.append(X_T@beta_ols*100)
 return np.array(Y_actual) - np.array(Yhat)
```

[ ]:
```
t0 = pd.Timestamp('12/1/1999')
e = []
T = []
for j in range(0, 10):
    t0 = t0 + pd.DateOffset(months=1)
    print(f'Using data up to {t0}')
```

```
    ehat = calculate_forecast(df_cleaned, p = 4, H = [1,4,8], end_date = t0)
    e.append(ehat.flatten())
    T.append(t0)
```

```
Using data up to 2000-01-01 00:00:00
Using data up to 2000-02-01 00:00:00
Using data up to 2000-03-01 00:00:00
Using data up to 2000-04-01 00:00:00
Using data up to 2000-05-01 00:00:00
Using data up to 2000-06-01 00:00:00
Using data up to 2000-07-01 00:00:00
Using data up to 2000-08-01 00:00:00
Using data up to 2000-09-01 00:00:00
Using data up to 2000-10-01 00:00:00
```

[ ]:
```
edf = pd.DataFrame(e)
np.sqrt(edf.apply(np.square).mean())
```

[ ]:
```
0    0.282944
1    0.318535
2    0.301497
dtype: float64
```