In [2]:
```
import pandas as pd
import numpy as np
```

In [3]:
```
filepath = '../final_dataset.csv'
df = pd.read_csv(filepath)
df.rename(columns={'Unnamed: 0': 'Date'}, inplace=True)
df.head()
```

Out[3]:

	Date	S&P500_Adj_Close	S&P500_Close	S&P500_High	S&P500_Low	S&P500_Open	S&P500_Volume	VIX_Daily_Returns	VIX_Adj_Close	VIX_Close	...
0	2000-07-03	1469.540039	1469.540039	1469.579956	1450.849976	1454.599976	4.519000e+08	0.010271	19.830000	19.830000	...
1	2000-07-05	1446.229980	1446.229980	1469.540039	1442.449951	1469.540039	1.019300e+09	-0.015862	21.160000	21.160000	...
2	2000-07-06	1456.670044	1456.670044	1461.650024	1439.560059	1446.229980	9.473000e+08	0.007219	20.940001	20.940001	...
3	2000-07-07	1478.900024	1478.900024	1484.119995	1456.670044	1456.670044	9.317000e+08	0.015261	19.219999	19.219999	...
4	2000-07-10	1475.619995	1475.619995	1486.560059	1474.760010	1478.900024	8.387000e+08	-0.002218	20.330000	20.330000	...

5 rows × 22 columns

In [4]:
```
df['Date'] = pd.to_datetime(df['Date'])
df.set_index('Date', inplace=True)
```

In [5]:
```
aggregation_rules = {
    'S&P500_Adj_Close': 'mean',
    'S&P500_Close': 'mean',
    'S&P500_High': 'mean',
    'S&P500_Low': 'mean',
    'S&P500_Open': 'mean',
    'S&P500_Volume': 'sum',
    'VIX_Daily_Returns': 'mean',
    'VIX_Adj_Close': 'mean',
    'VIX_Close': 'mean',
    'VIX_High': 'mean',
```

```
    'VIX_Low': 'mean',
    'VIX_Open': 'mean',
    'VIX_Volume': 'sum',
    'VIX_Daily_Returns.1': 'mean',
    'USD_EUR_Exchange_Rate': 'mean',
    'Effective_Federal_Funds_Rate': 'mean',
    'US_Dollar_Index': 'mean',
    'CPI_All_Items': 'mean',
    'Consumer_Sentiment_Index': 'mean',
    'Unemployment_Rate': 'mean',
    'GDP': 'mean',  # GDP should already be quarterly, so this will ensure no data is lost
}
```

In [6]:

```
non_numeric_columns = df.select_dtypes(include=['object']).columns

# Attempt to convert non-numeric columns to numeric, coercing errors to NaN
for column in non_numeric_columns:
    if column == 'Date':
        continue
    print(f'Converting {column} to numeric')
    df[column] = pd.to_numeric(df[column], errors='coerce')

# forward fill the NaN values
df.fillna(method='ffill', inplace=True)
```

```
Converting USD_EUR_Exchange_Rate to numeric
Converting Effective_Federal_Funds_Rate to numeric
```

```
C:\Users\Alli Ajagbe\AppData\Local\Temp\ipykernel_22448\3836609432.py:11: FutureWarning: DataFrame.fillna with 'method' is depre
cated and will raise in a future version. Use obj.ffill() or obj.bfill() instead.
  df.fillna(method='ffill', inplace=True)
```

In [7]:

```
quarterly_data = df.resample('QE').agg(aggregation_rules)
```

In [8]:

```
len(quarterly_data)
```

Out[8]: 94

In [9]:

```
quarterly_data
```

Out[9]:

Date	S&P500_Adj_Close	S&P500_Close	S&P500_High	S&P500_Low	S&P500_Open	S&P500_Volume	VIX_Daily_Returns	VIX_Adj_Close	VIX_Close	VIX_
2000-09-30	1475.978888	1475.978888	1485.611268	1467.169687	1476.266030	6.029110e+10	-0.000161	19.169048	19.169048	19.62
2000-12-31	1366.310312	1366.310312	1381.009047	1353.282070	1368.190949	7.009450e+10	-0.001227	26.016667	26.016667	26.79
2001-03-31	1273.329039	1273.329039	1285.768391	1260.875803	1275.914846	7.728081e+10	-0.001965	25.726452	25.726452	26.67
2001-06-30	1234.250314	1234.250314	1243.688573	1222.726347	1233.284598	7.468392e+10	0.000943	23.923810	23.923810	24.66
2001-09-30	1153.706613	1153.706613	1164.702715	1144.440006	1156.816783	7.217820e+10	-0.002646	25.380339	25.380339	26.29
...	...	...	...	...	...	...	...	...	...	
2022-12-31	3851.973501	3851.973501	3883.685074	3817.123322	3849.681745	2.737450e+11	0.001208	25.075397	25.075397	26.23
2023-03-31	4000.064528	4000.064528	4025.099361	3968.538700	3994.812437	2.742509e+11	0.001151	20.694516	20.694516	22.07
2023-06-30	4206.072900	4206.072900	4221.982914	4183.719699	4201.399828	2.477736e+11	0.001314	16.461129	16.461129	17.34
2023-09-30	4458.137447	4458.137447	4479.519686	4441.185361	4461.957744	2.353870e+11	-0.000567	15.053016	15.053016	15.79
2023-12-31	4464.907622	4464.907622	4482.201924	4441.094920	4459.284939	2.460207e+11	0.001720	15.325714	15.325714	16.16

94 rows × 21 columns

In [10]:

```
# save the data
quarterly_data.to_csv('../final_dataset_quarterly.csv')
print('Data saved to final_dataset_quarterly.csv')
```

```
Data saved to final_dataset_quarterly.csv
```

In [11]:

```
quarterly_data.columns
```

Out[11]:
```
Index(['S&P500_Adj_Close', 'S&P500_Close', 'S&P500_High', 'S&P500_Low',
       'S&P500_Open', 'S&P500_Volume', 'VIX_Daily_Returns', 'VIX_Adj_Close',
       'VIX_Close', 'VIX_High', 'VIX_Low', 'VIX_Open', 'VIX_Volume',
       'VIX_Daily_Returns.1', 'USD_EUR_Exchange_Rate',
       'Effective_Federal_Funds_Rate', 'US_Dollar_Index', 'CPI_All_Items',
       'Consumer_Sentiment_Index', 'Unemployment_Rate', 'GDP'],
      dtype='object')
```

In [12]:
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from statsmodels.tsa.stattools import adfuller, grangercausalitytests, coint
from statsmodels.tsa.api import VAR
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
from arch import arch_model
import warnings

warnings.filterwarnings("ignore")
```

In [13]:
```python
df = pd.read_csv("../final_dataset_quarterly.csv", parse_dates=["Date"], index_col="Date")

# 1. EDA
print("Data Summary:")
df.describe()
```

```
Data Summary:
```

Out[13]:

	S&P500_Adj_Close	S&P500_Close	S&P500_High	S&P500_Low	S&P500_Open	S&P500_Volume	VIX_Daily_Returns	VIX_Adj_Close	VIX_Close	VIX_
count	94.000000	94.000000	94.000000	94.000000	94.000000	9.400000e+01	94.000000	94.000000	94.000000	94.0(
mean	1984.823453	1984.823453	1996.148144	1972.072357	1984.533872	2.122213e+11	0.000273	19.966314	19.966314	21.0(
std	1072.314500	1072.314500	1077.762969	1066.131093	1072.041772	8.327838e+10	0.001304	7.670151	7.670151	8.1:
min	807.665901	807.665901	820.841145	794.834589	808.660491	6.029110e+10	-0.003101	10.307937	10.307937	10.8!
25%	1195.107306	1195.107306	1200.428518	1189.717909	1195.080870	1.475001e+11	-0.000324	14.341948	14.341948	14.9!
50%	1482.721191	1482.721191	1492.646348	1472.560874	1482.654839	2.245728e+11	0.000448	18.102016	18.102016	19.2:
75%	2675.014450	2675.014450	2688.870691	2656.405753	2678.455275	2.609809e+11	0.001142	24.619336	24.619336	25.8!
max	4602.108894	4602.108894	4623.372498	4576.220802	4597.917496	3.984265e+11	0.003090	58.595937	58.595937	62.6:

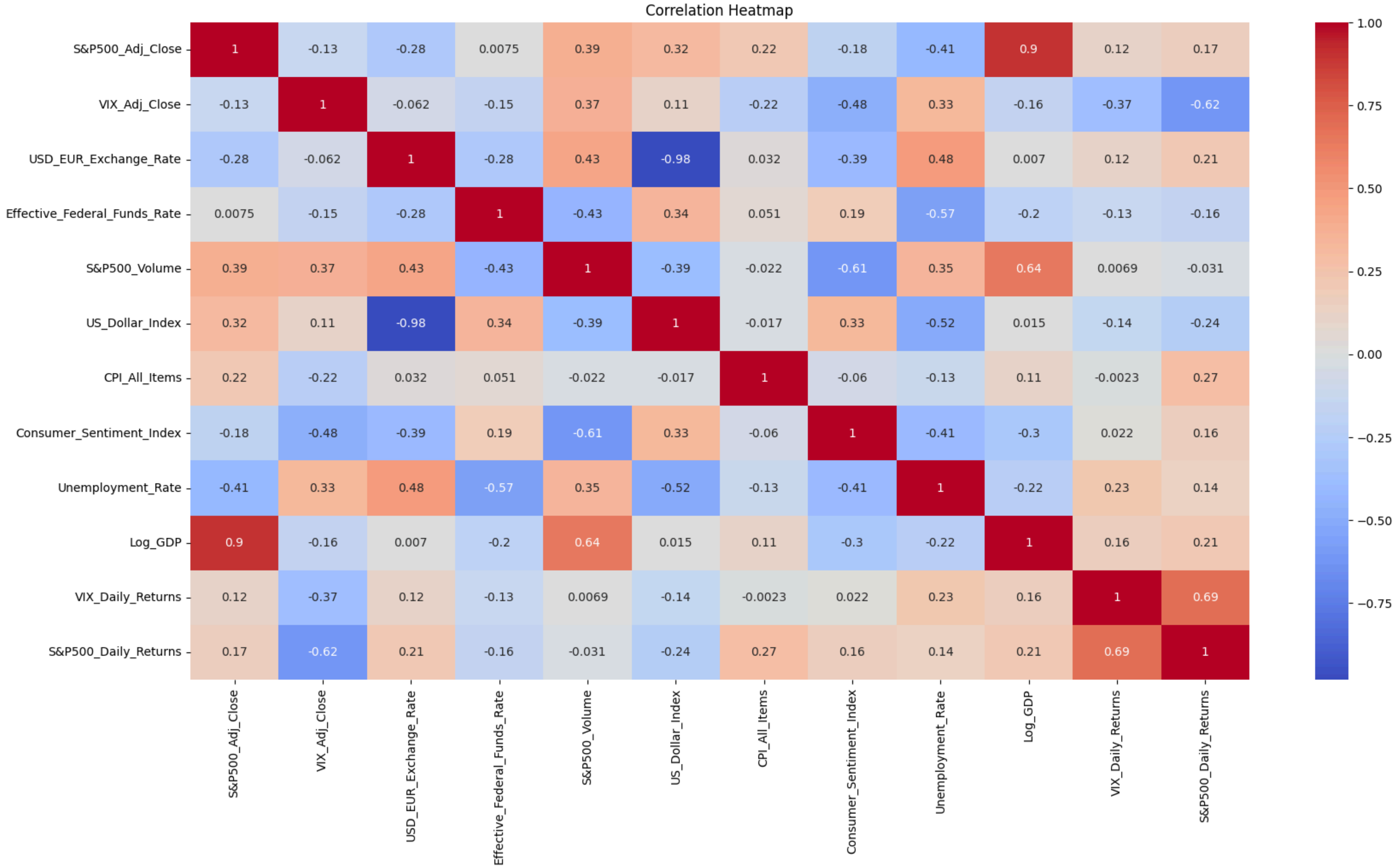
8 rows × 21 columns

In [14]:

```
df['Log_GDP'] = np.log(df['GDP'])
df['S&P500_Daily_Returns'] = df['S&P500_Adj_Close'].pct_change()
```

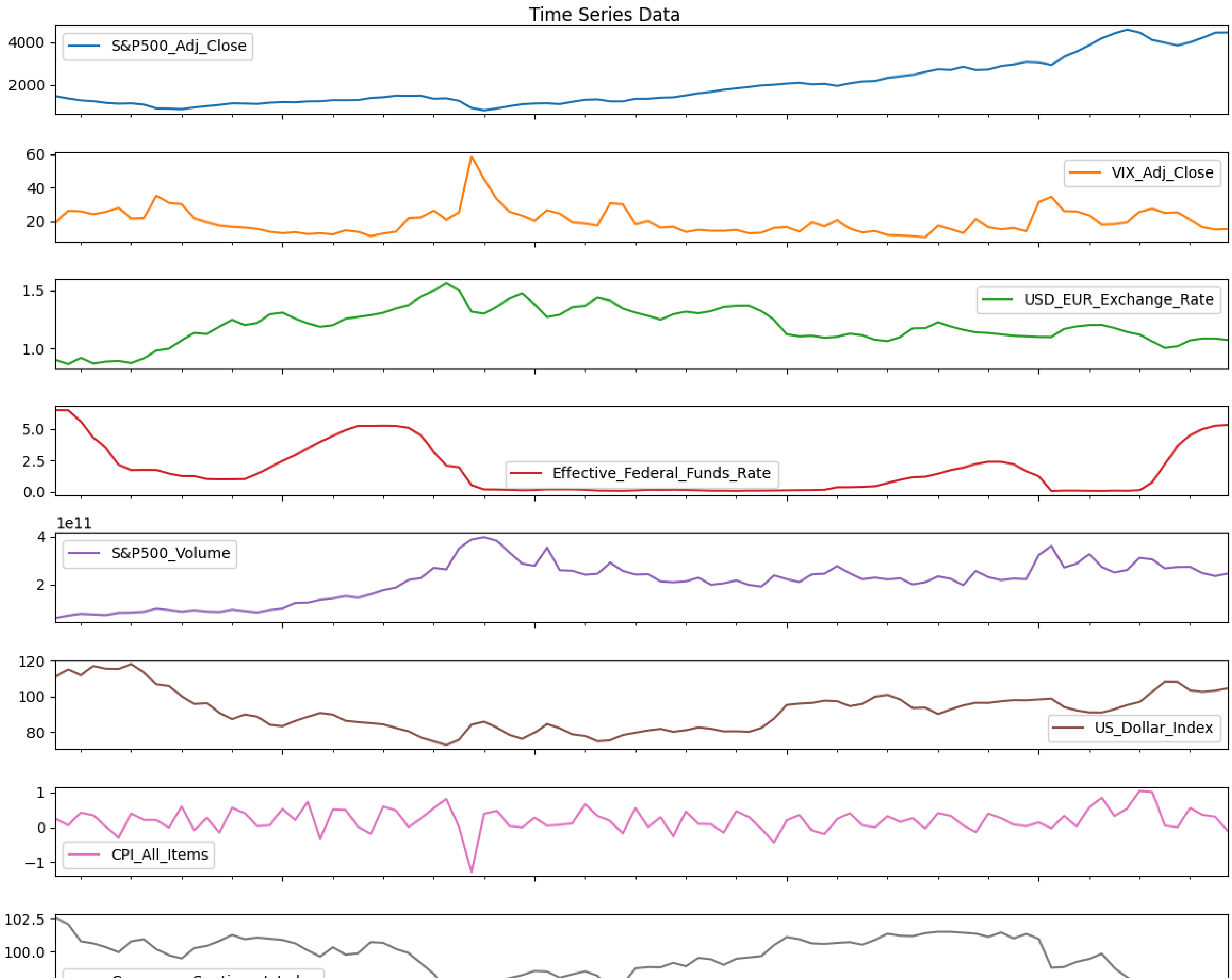
In [15]:

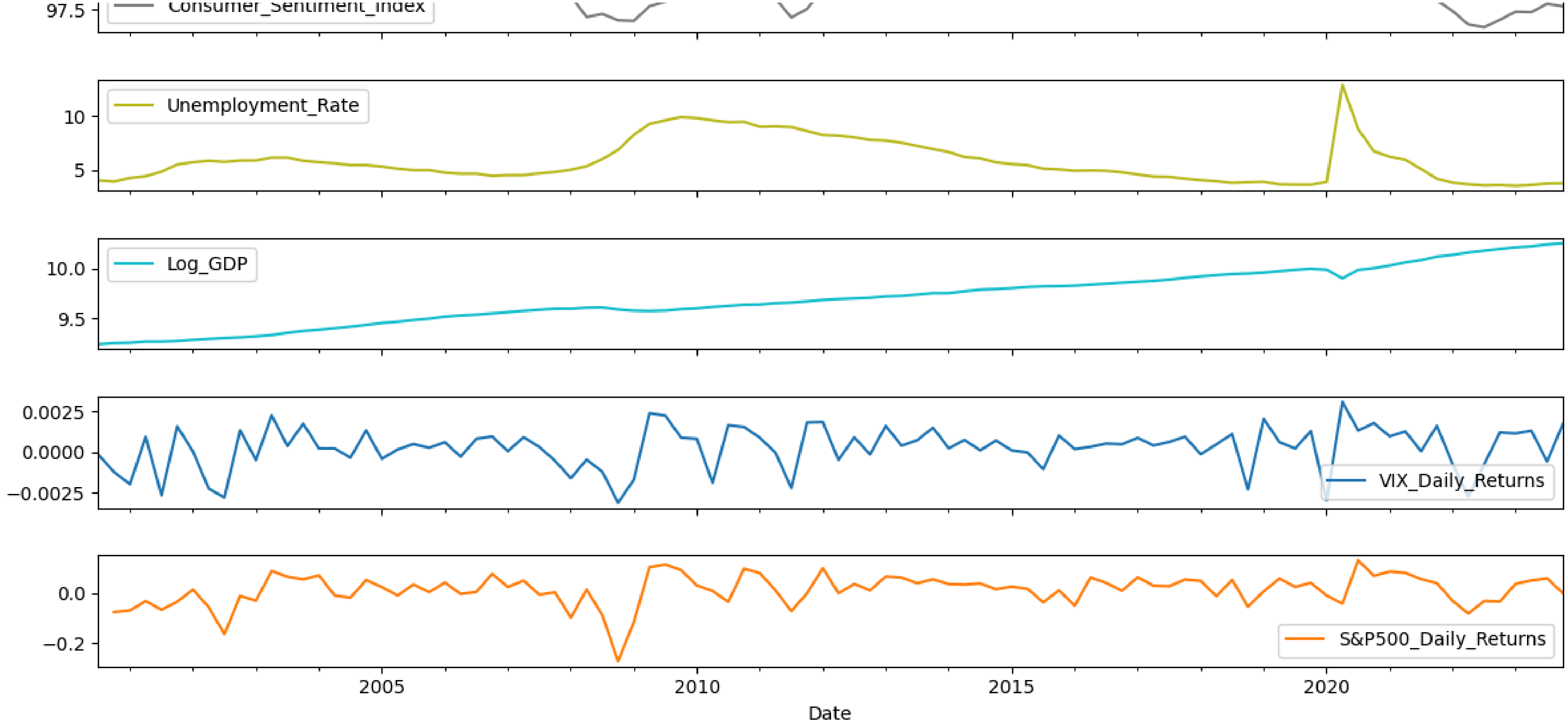
```
# Correlation heatmap
columns_to_select = ['S&P500_Adj_Close', 'VIX_Adj_Close', 'USD_EUR_Exchange_Rate',
                     'Effective_Federal_Funds_Rate', 'S&P500_Volume', 'US_Dollar_Index',
                     'CPI_All_Items', 'Consumer_Sentiment_Index', 'Unemployment_Rate',
                     'Log_GDP', 'VIX_Daily_Returns', 'S&P500_Daily_Returns']
plt.figure(figsize=(20, 10))
sns.heatmap(df[columns_to_select].corr(), annot=True, cmap="coolwarm")
plt.title("Correlation Heatmap")
plt.show()
```



In [16]:

```
# Time series plots
df[columns_to_select].plot(subplots=True, figsize=(12, 15), title="Time Series Data")
plt.tight_layout()
plt.show()
```


Time Series Data
4000
2000
S&P500_Adj_Close
60
40
20
VIX_Adj_Close
1.5
1.0
USD_EUR_Exchange_Rate
5.0
2.5
0.0
Effective_Federal_Funds_Rate
1e11
4
2
S&P500_Volume
120
100
80
US_Dollar_Index
1
0
−1
CPI_All_Items
102.5
100.0



In [17]:
```
# 2. Stationarity check
def test_stationarity(series, name):
    result = adfuller(series.dropna())
    print(f"ADF Test for {name}:")
    print(f"Test Statistic: {result[0]}")
    print(f"p-value: {result[1]}")
    if result[1] <= 0.05:
        print(f"{name} is stationary.\n")
    else:
        print(f"{name} is not stationary. Differencing recommended.\n")
```

In [18]:
```
# Test stationarity for all columns
for column in columns_to_select:
    test_stationarity(df[column], column)
```

```
ADF Test for S&P500_Adj_Close:
Test Statistic: 1.2978861290135857
p-value: 0.9965970739742259
S&P500_Adj_Close is not stationary. Differencing recommended.

ADF Test for VIX_Adj_Close:
Test Statistic: -3.950908610457542
p-value: 0.0016905460474772014
VIX_Adj_Close is stationary.

ADF Test for USD_EUR_Exchange_Rate:
Test Statistic: -2.214902149550946
p-value: 0.20088136207577145
USD_EUR_Exchange_Rate is not stationary. Differencing recommended.

ADF Test for Effective_Federal_Funds_Rate:
Test Statistic: -3.2847579736738868
p-value: 0.015573693732314936
Effective_Federal_Funds_Rate is stationary.

ADF Test for S&P500_Volume:
Test Statistic: -2.231991176520609
p-value: 0.19484001734000256
S&P500_Volume is not stationary. Differencing recommended.

ADF Test for US_Dollar_Index:
Test Statistic: -1.8282815599742883
p-value: 0.36651380822972995
US_Dollar_Index is not stationary. Differencing recommended.

ADF Test for CPI_All_Items:
Test Statistic: -1.748405089134134
p-value: 0.4063609283717741
CPI_All_Items is not stationary. Differencing recommended.

ADF Test for Consumer_Sentiment_Index:
Test Statistic: -1.3772381871627726
p-value: 0.5931384729241126
Consumer_Sentiment_Index is not stationary. Differencing recommended.

ADF Test for Unemployment_Rate:
Test Statistic: -2.79129442843096
p-value: 0.05952809740868981
Unemployment_Rate is not stationary. Differencing recommended.
```

```
ADF Test for Log_GDP:
Test Statistic: 0.8137685999496348
p-value: 0.9918551993646437
Log_GDP is not stationary. Differencing recommended.

ADF Test for VIX_Daily_Returns:
Test Statistic: -9.42609660423954
p-value: 5.341762841579538e-16
VIX_Daily_Returns is stationary.

ADF Test for S&P500_Daily_Returns:
Test Statistic: -5.86837981759373
p-value: 3.284250259396917e-07
S&P500_Daily_Returns is stationary.
```

In [19]:

```
# Differencing for stationarity
df_diff = df.diff().dropna()
for column in columns_to_select:
    test_stationarity(df_diff[column], column)
```

```
ADF Test for S&P500_Adj_Close:
Test Statistic: -5.418735077056917
p-value: 3.0934392584698528e-06
S&P500_Adj_Close is stationary.

ADF Test for VIX_Adj_Close:
Test Statistic: -6.677158792334924
p-value: 4.4353584613713245e-09
VIX_Adj_Close is stationary.

ADF Test for USD_EUR_Exchange_Rate:
Test Statistic: -3.7726427972129883
p-value: 0.0031999498600247026
USD_EUR_Exchange_Rate is stationary.

ADF Test for Effective_Federal_Funds_Rate:
Test Statistic: -3.968547840446588
p-value: 0.0015844606251661337
Effective_Federal_Funds_Rate is stationary.

ADF Test for S&P500_Volume:
Test Statistic: -8.688918295230598
p-value: 4.09089711601194e-14
S&P500_Volume is stationary.

ADF Test for US_Dollar_Index:
Test Statistic: -6.762220596318513
p-value: 2.7736657474460574e-09
US_Dollar_Index is stationary.

ADF Test for CPI_All_Items:
Test Statistic: -5.327624282826183
p-value: 4.79847259438438e-06
CPI_All_Items is stationary.

ADF Test for Consumer_Sentiment_Index:
Test Statistic: -5.703221115685165
p-value: 7.591313384720368e-07
Consumer_Sentiment_Index is stationary.

ADF Test for Unemployment_Rate:
Test Statistic: -11.106423270858159
p-value: 3.752921161796095e-20
Unemployment_Rate is stationary.
```

```
ADF Test for Log_GDP:
Test Statistic: -10.195314215078833
p-value: 6.1684446281750876e-18
Log_GDP is stationary.

ADF Test for VIX_Daily_Returns:
Test Statistic: -5.5623393181480765
p-value: 1.531755278462938e-06
VIX_Daily_Returns is stationary.

ADF Test for S&P500_Daily_Returns:
Test Statistic: -5.014015857617888
p-value: 2.0818465715938263e-05
S&P500_Daily_Returns is stationary.
```

In [20]:

```
df_diff = df_diff[columns_to_select]

# 3. Volatility modeling (ARCH/GARCH)
sp500_returns = df_diff["S&P500_Daily_Returns"]
model = arch_model(sp500_returns, vol="Garch", p=1, q=1)
arch_fit = model.fit()
arch_fit.summary()
```

```
Iteration:      1,   Func. Count:      6,   Neg. LLF: 136608.70940141147
Iteration:      2,   Func. Count:     16,   Neg. LLF: 1763.350475866455
Iteration:      3,   Func. Count:     22,   Neg. LLF: -95.55925677059157
Iteration:      4,   Func. Count:     29,   Neg. LLF: -124.73907520285715
Iteration:      5,   Func. Count:     35,   Neg. LLF: -120.24342785410447
Iteration:      6,   Func. Count:     41,   Neg. LLF: -124.49758095670303
Iteration:      7,   Func. Count:     47,   Neg. LLF: -121.18818862300303
Iteration:      8,   Func. Count:     54,   Neg. LLF: -125.32411244320214
Iteration:      9,   Func. Count:     59,   Neg. LLF: -125.32466405053462
Iteration:     10,   Func. Count:     64,   Neg. LLF: -125.32466888508088
Iteration:     11,   Func. Count:     68,   Neg. LLF: -125.32466888507855
Optimization terminated successfully    (Exit mode 0)
            Current function value: -125.32466888508088
            Iterations: 11
            Function evaluations: 68
            Gradient evaluations: 11
```

Out[20]:

Constant Mean - GARCH Model Results

Dep. Variable:	S&P500_Daily_Returns	**R-squared:**	0.000
Mean Model:	Constant Mean	**Adj. R-squared:**	0.000
Vol Model:	GARCH	**Log-Likelihood:**	125.325
Distribution:	Normal	**AIC:**	-242.649
Method:	Maximum Likelihood	**BIC:**	-232.562
		No. Observations:	92
Date:	Wed, Dec 11 2024	**Df Residuals:**	91
Time:	19:58:00	**Df Model:**	1

Mean Model

	coef	std err	t	P>|t|	95.0% Conf. Int.
mu	1.8156e-03	5.028e-03	0.361	0.718	[-8.039e-03,1.167e-02]

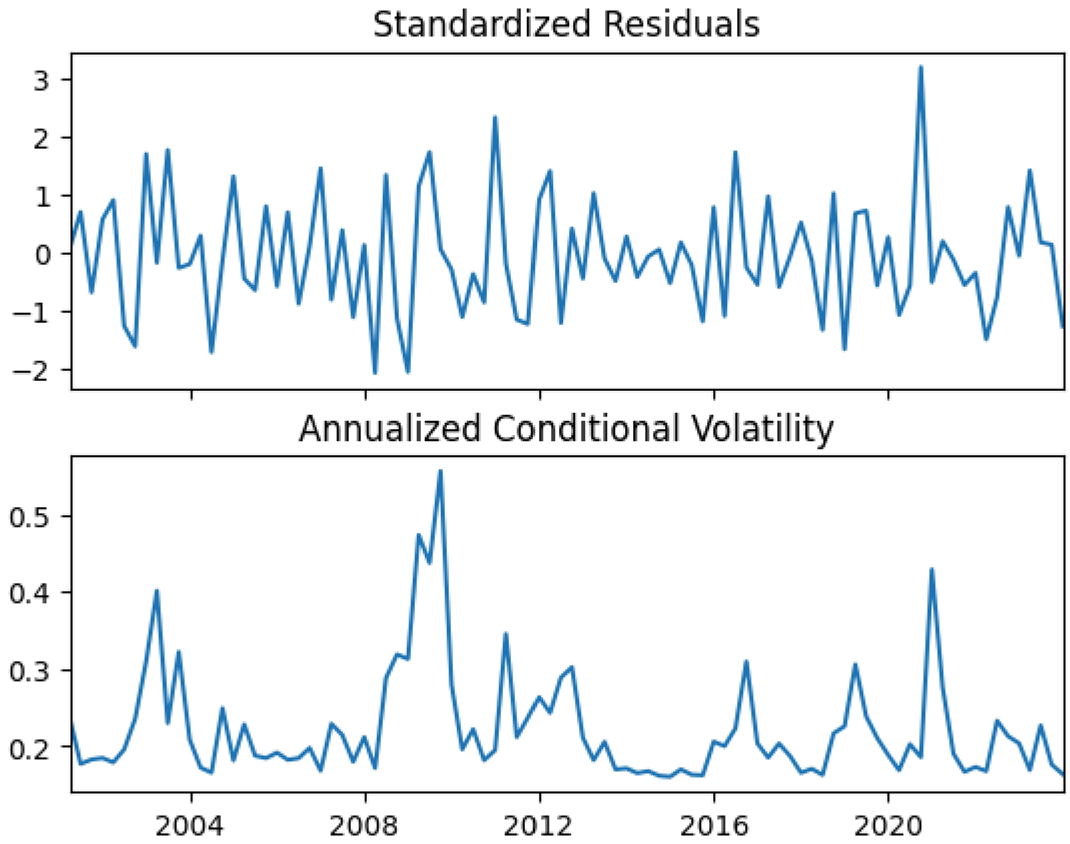
Volatility Model

	coef	std err	t	P>|t|	95.0% Conf. Int.
omega	1.7465e-03	6.749e-04	2.588	9.658e-03	[4.237e-04,3.069e-03]
alpha[1]	0.4452	0.159	2.808	4.984e-03	[0.134, 0.756]
beta[1]	0.1843	0.140	1.318	0.187	[-8.970e-02, 0.458]

Covariance estimator: robust

In [21]:

```
# Plot volatility
arch_fit.plot(annualize="M")
plt.show()
```



In [22]:
```
# 4. VAR modeling
# Selecting appropriate lag length
model_var = VAR(df_diff)
lag_selection = model_var.select_order(maxlags=5)
print("VAR Lag Order Selection Criteria:")
lag_selection.summary()
```

```
VAR Lag Order Selection Criteria:
```

Out[22]: VAR Order Selection (* highlights the minimums)

	AIC	BIC	FPE	HQIC
0	19.10	19.44*	1.982e+08	19.24
1	15.22	19.65	4.200e+06	17.00*
2	14.96	23.46	3.825e+06	18.38
3	14.30	26.89	3.256e+06	19.37
4	12.55	29.22	1.681e+06*	19.26
5	10.75*	31.49	2.644e+06	19.10

In [23]:
```
# Fit VAR model
lag_order = lag_selection.selected_orders["aic"]
var_model = model_var.fit(lag_order)
var_model.summary()
```

```
Out[23]:   Summary of Regression Results
==================================
Model:                         VAR
Method:                        OLS
Date:           Wed, 11, Dec, 2024
Time:                     19:58:00
--------------------------------------------------------------------
No. of Equations:         12.0000    BIC:                    31.4938
Nobs:                     87.0000    HQIC:                   19.1006
Log likelihood:          -1216.83    FPE:                2.64442e+06
AIC:                      10.7462    Det(Omega_mle):         4502.16
--------------------------------------------------------------------
Results for equation S&P500_Adj_Close
==================================================================================================
                                    coefficient       std. error           t-stat            prob
--------------------------------------------------------------------------------------------------
const                                110.150603        43.389250            2.539           0.011
L1.S&P500_Adj_Close                    0.664598         0.293155            2.267           0.023
L1.VIX_Adj_Close                      -7.075072         6.107002           -1.159           0.247
L1.USD_EUR_Exchange_Rate            1182.788845      1139.033498            1.038           0.299
L1.Effective_Federal_Funds_Rate       19.579049        59.688113            0.328           0.743
L1.S&P500_Volume                       0.000000         0.000000            0.666           0.505
L1.US_Dollar_Index                    19.637875        18.033197            1.089           0.276
L1.CPI_All_Items                    -114.589375        72.436168           -1.582           0.114
L1.Consumer_Sentiment_Index          -14.764499        50.513121           -0.292           0.770
L1.Unemployment_Rate                  18.162302        36.324162            0.500           0.617
L1.Log_GDP                          1608.197523      2929.922525            0.549           0.583
L1.VIX_Daily_Returns               39923.161225     22213.258215            1.797           0.072
L1.S&P500_Daily_Returns            -1710.390102       774.266998           -2.209           0.027
L2.S&P500_Adj_Close                    0.028024         0.394506            0.071           0.943
L2.VIX_Adj_Close                       1.402232         6.451821            0.217           0.828
L2.USD_EUR_Exchange_Rate             843.493180      1197.487964            0.704           0.481
L2.Effective_Federal_Funds_Rate       43.474069        84.886446            0.512           0.609
L2.S&P500_Volume                       0.000000         0.000000            1.492           0.136
L2.US_Dollar_Index                     0.520323        19.125466            0.027           0.978
L2.CPI_All_Items                    -149.985070       121.860058           -1.231           0.218
L2.Consumer_Sentiment_Index            7.807256        42.145739            0.185           0.853
L2.Unemployment_Rate                 -36.735343        42.586090           -0.863           0.388
L2.Log_GDP                         -4696.310063      3218.981154           -1.459           0.145
L2.VIX_Daily_Returns               35700.828367     35548.680251            1.004           0.315
L2.S&P500_Daily_Returns             -779.048764       940.330869           -0.828           0.407
L3.S&P500_Adj_Close                    0.297803         0.342239            0.870           0.384
L3.VIX_Adj_Close                      -2.444962         6.429473           -0.380           0.704
L3.USD_EUR_Exchange_Rate           -1711.592795      1073.286081           -1.595           0.111
```

```
L3.Effective_Federal_Funds_Rate       222.566137        87.058838            2.557           0.011
L3.S&P500_Volume                       -0.000000         0.000000           -0.267           0.790
L3.US_Dollar_Index                    -15.577037        17.062593           -0.913           0.361
L3.CPI_All_Items                     -234.854572       143.389281           -1.638           0.101
L3.Consumer_Sentiment_Index           -39.046763        42.148203           -0.926           0.354
L3.Unemployment_Rate                   27.652101        39.033031            0.708           0.479
L3.Log_GDP                          -1225.122751      2647.579817           -0.463           0.644
L3.VIX_Daily_Returns                 9606.864196     40230.299262            0.239           0.811
L3.S&P500_Daily_Returns              -806.025121      1104.876868           -0.730           0.466
L4.S&P500_Adj_Close                    -0.165536         0.403252           -0.411           0.681
L4.VIX_Adj_Close                        2.403775         5.951558            0.404           0.686
L4.USD_EUR_Exchange_Rate            -1888.884394      1126.730486           -1.676           0.094
L4.Effective_Federal_Funds_Rate      -111.881636       113.052378           -0.990           0.322
L4.S&P500_Volume                        0.000000         0.000000            1.259           0.208
L4.US_Dollar_Index                    -44.134291        17.666308           -2.498           0.012
L4.CPI_All_Items                     -181.680154       120.966906           -1.502           0.133
L4.Consumer_Sentiment_Index           -19.557641        39.931240           -0.490           0.624
L4.Unemployment_Rate                  -75.984255        33.718603           -2.253           0.024
L4.Log_GDP                          -7133.582004      2631.486131           -2.711           0.007
L4.VIX_Daily_Returns                16482.591137     34810.115084            0.474           0.636
L4.S&P500_Daily_Returns               182.029975       811.159241            0.224           0.822
L5.S&P500_Adj_Close                     0.218998         0.337735            0.648           0.517
L5.VIX_Adj_Close                        7.068083         4.367973            1.618           0.106
L5.USD_EUR_Exchange_Rate              364.181138      1136.867236            0.320           0.749
L5.Effective_Federal_Funds_Rate       -52.743164        97.967935           -0.538           0.590
L5.S&P500_Volume                       -0.000000         0.000000           -2.854           0.004
L5.US_Dollar_Index                     16.351193        17.411999            0.939           0.348
L5.CPI_All_Items                      -68.244927        69.168979           -0.987           0.324
L5.Consumer_Sentiment_Index           -38.982201        40.972101           -0.951           0.341
L5.Unemployment_Rate                   46.933086        38.919740            1.206           0.228
L5.Log_GDP                            430.736603      2647.654168            0.163           0.871
L5.VIX_Daily_Returns                -8561.281651     19329.558728           -0.443           0.658
L5.S&P500_Daily_Returns               448.343622       359.994183            1.245           0.213
==================================================================================================

Results for equation VIX_Adj_Close
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                                     coefficient       std. error           t-stat            prob
--------------------------------------------------------------------------------------------------
const                                  -5.563256         2.817540           -1.975           0.048
L1.S&P500_Adj_Close                     0.017469         0.019036            0.918           0.359
L1.VIX_Adj_Close                       -0.448541         0.396566           -1.131           0.258
L1.USD_EUR_Exchange_Rate             -108.751522        73.964680           -1.470           0.141
L1.Effective_Federal_Funds_Rate        -1.207828         3.875928           -0.312           0.755
```

L1.S&P500_Volume	0.000000	0.000000	1.531	0.126
L1.US_Dollar_Index	-1.893047	1.171010	-1.617	0.106
L1.CPI_All_Items	4.437546	4.703741	0.943	0.345
L1.Consumer_Sentiment_Index	0.633244	3.280138	0.193	0.847
L1.Unemployment_Rate	-0.197565	2.358759	-0.084	0.933
L1.Log_GDP	38.952517	190.258481	0.205	0.838
L1.VIX_Daily_Returns	-766.798021	1442.447959	-0.532	0.595
L1.S&P500_Daily_Returns	5.186628	50.278074	0.103	0.918
L2.S&P500_Adj_Close	-0.013977	0.025618	-0.546	0.585
L2.VIX_Adj_Close	0.150548	0.418958	0.359	0.719
L2.USD_EUR_Exchange_Rate	-4.427602	77.760500	-0.057	0.955
L2.Effective_Federal_Funds_Rate	-1.193360	5.512216	-0.216	0.829
L2.S&P500_Volume	-0.000000	0.000000	-0.955	0.339
L2.US_Dollar_Index	0.342496	1.241938	0.276	0.783
L2.CPI_All_Items	11.369208	7.913148	1.437	0.151
L2.Consumer_Sentiment_Index	2.201974	2.736791	0.805	0.421
L2.Unemployment_Rate	0.543849	2.765385	0.197	0.844
L2.Log_GDP	32.527066	209.028894	0.156	0.876
L2.VIX_Daily_Returns	-2349.194130	2308.401621	-1.018	0.309
L2.S&P500_Daily_Returns	51.349543	61.061657	0.841	0.400
L3.S&P500_Adj_Close	-0.016698	0.022224	-0.751	0.452
L3.VIX_Adj_Close	-0.046149	0.417507	-0.111	0.912
L3.USD_EUR_Exchange_Rate	71.752812	69.695283	1.030	0.303
L3.Effective_Federal_Funds_Rate	-16.573326	5.653283	-2.932	0.003
L3.S&P500_Volume	-0.000000	0.000000	-0.023	0.981
L3.US_Dollar_Index	0.993515	1.107983	0.897	0.370
L3.CPI_All_Items	17.639818	9.311177	1.894	0.058
L3.Consumer_Sentiment_Index	2.485017	2.736951	0.908	0.364
L3.Unemployment_Rate	0.282285	2.534663	0.111	0.911
L3.Log_GDP	74.367921	171.924175	0.433	0.665
L3.VIX_Daily_Returns	-2523.113199	2612.408881	-0.966	0.334
L3.S&P500_Daily_Returns	59.601357	71.746673	0.831	0.406
L4.S&P500_Adj_Close	0.014455	0.026186	0.552	0.581
L4.VIX_Adj_Close	-0.279953	0.386472	-0.724	0.469
L4.USD_EUR_Exchange_Rate	130.092784	73.165768	1.778	0.075
L4.Effective_Federal_Funds_Rate	7.454708	7.341209	1.015	0.310
L4.S&P500_Volume	-0.000000	0.000000	-1.302	0.193
L4.US_Dollar_Index	2.784360	1.147186	2.427	0.015
L4.CPI_All_Items	15.502181	7.855150	1.974	0.048
L4.Consumer_Sentiment_Index	-0.603796	2.592989	-0.233	0.816
L4.Unemployment_Rate	2.989419	2.189563	1.365	0.172
L4.Log_GDP	242.592598	170.879110	1.420	0.156
L4.VIX_Daily_Returns	-2292.243793	2260.441893	-1.014	0.311
L4.S&P500_Daily_Returns	-8.450449	52.673722	-0.160	0.873

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L5.S&P500_Adj_Close                  -0.018027         0.021931           -0.822           0.411
L5.VIX_Adj_Close                     -0.348891         0.283640           -1.230           0.219
L5.USD_EUR_Exchange_Rate             21.506826        73.824011            0.291           0.771
L5.Effective_Federal_Funds_Rate       5.863478         6.361680            0.922           0.357
L5.S&P500_Volume                      0.000000         0.000000            1.044           0.297
L5.US_Dollar_Index                    0.212180         1.130672            0.188           0.851
L5.CPI_All_Items                      8.858829         4.491581            1.972           0.049
L5.Consumer_Sentiment_Index           0.545543         2.660579            0.205           0.838
L5.Unemployment_Rate                  1.213334         2.527306            0.480           0.631
L5.Log_GDP                          232.804380       171.929004            1.354           0.176
L5.VIX_Daily_Returns               -351.109675      1255.191033           -0.280           0.780
L5.S&P500_Daily_Returns             -41.798918        23.376709           -1.788           0.074
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Results for equation USD_EUR_Exchange_Rate
==================================================================================================
                                   coefficient       std. error           t-stat            prob
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const                                -0.016685         0.028594           -0.584           0.560
L1.S&P500_Adj_Close                  -0.000047         0.000193           -0.244           0.808
L1.VIX_Adj_Close                     -0.003174         0.004025           -0.789           0.430
L1.USD_EUR_Exchange_Rate              0.864930         0.750628            1.152           0.249
L1.Effective_Federal_Funds_Rate      -0.080975         0.039335           -2.059           0.040
L1.S&P500_Volume                      0.000000         0.000000            1.529           0.126
L1.US_Dollar_Index                    0.000242         0.011884            0.020           0.984
L1.CPI_All_Items                     -0.025240         0.047736           -0.529           0.597
L1.Consumer_Sentiment_Index           0.017610         0.033288            0.529           0.597
L1.Unemployment_Rate                 -0.011237         0.023938           -0.469           0.639
L1.Log_GDP                            0.857768         1.930831            0.444           0.657
L1.VIX_Daily_Returns                 14.344949        14.638632            0.980           0.327
L1.S&P500_Daily_Returns              -0.383164         0.510245           -0.751           0.453
L2.S&P500_Adj_Close                   0.000046         0.000260            0.176           0.860
L2.VIX_Adj_Close                      0.008652         0.004252            2.035           0.042
L2.USD_EUR_Exchange_Rate              0.953921         0.789150            1.209           0.227
L2.Effective_Federal_Funds_Rate       0.109808         0.055941            1.963           0.050
L2.S&P500_Volume                      0.000000         0.000000            0.391           0.695
L2.US_Dollar_Index                    0.024628         0.012604            1.954           0.051
L2.CPI_All_Items                      0.031625         0.080306            0.394           0.694
L2.Consumer_Sentiment_Index           0.045844         0.027774            1.651           0.099
L2.Unemployment_Rate                  0.014926         0.028064            0.532           0.595
L2.Log_GDP                           -0.417620         2.121322           -0.197           0.844
L2.VIX_Daily_Returns                 26.473569        23.426732            1.130           0.258
L2.S&P500_Daily_Returns              -0.250419         0.619682           -0.404           0.686
L3.S&P500_Adj_Close                  -0.000146         0.000226           -0.647           0.518
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L3.VIX_Adj_Close                     -0.002427         0.004237           -0.573           0.567
L3.USD_EUR_Exchange_Rate             -0.940130         0.707300           -1.329           0.184
L3.Effective_Federal_Funds_Rate      -0.005588         0.057372           -0.097           0.922
L3.S&P500_Volume                     -0.000000         0.000000           -0.945           0.345
L3.US_Dollar_Index                   -0.017733         0.011244           -1.577           0.115
L3.CPI_All_Items                      0.043945         0.094494            0.465           0.642
L3.Consumer_Sentiment_Index          -0.004815         0.027776           -0.173           0.862
L3.Unemployment_Rate                  0.022726         0.025723            0.883           0.377
L3.Log_GDP                            0.618464         1.744766            0.354           0.723
L3.VIX_Daily_Returns                 24.109515        26.511939            0.909           0.363
L3.S&P500_Daily_Returns              -0.467123         0.728119           -0.642           0.521
L4.S&P500_Adj_Close                   0.000320         0.000266            1.204           0.229
L4.VIX_Adj_Close                     -0.001350         0.003922           -0.344           0.731
L4.USD_EUR_Exchange_Rate             -1.141400         0.742520           -1.537           0.124
L4.Effective_Federal_Funds_Rate      -0.022486         0.074502           -0.302           0.763
L4.S&P500_Volume                      0.000000         0.000000            0.918           0.359
L4.US_Dollar_Index                   -0.013790         0.011642           -1.184           0.236
L4.CPI_All_Items                      0.003047         0.079718            0.038           0.970
L4.Consumer_Sentiment_Index          -0.013871         0.026315           -0.527           0.598
L4.Unemployment_Rate                  0.005315         0.022221            0.239           0.811
L4.Log_GDP                            1.273994         1.734161            0.735           0.463
L4.VIX_Daily_Returns                 32.901963        22.940015            1.434           0.151
L4.S&P500_Daily_Returns              -0.650275         0.534557           -1.216           0.224
L5.S&P500_Adj_Close                  -0.000266         0.000223           -1.195           0.232
L5.VIX_Adj_Close                      0.001968         0.002879            0.684           0.494
L5.USD_EUR_Exchange_Rate              0.701880         0.749200            0.937           0.349
L5.Effective_Federal_Funds_Rate      -0.024622         0.064561           -0.381           0.703
L5.S&P500_Volume                     -0.000000         0.000000           -1.585           0.113
L5.US_Dollar_Index                    0.008961         0.011475            0.781           0.435
L5.CPI_All_Items                      0.008825         0.045583            0.194           0.846
L5.Consumer_Sentiment_Index           0.003008         0.027001            0.111           0.911
L5.Unemployment_Rate                 -0.005120         0.025648           -0.200           0.842
L5.Log_GDP                           -0.329846         1.744815           -0.189           0.850
L5.VIX_Daily_Returns                 12.867731        12.738262            1.010           0.312
L5.S&P500_Daily_Returns               0.062571         0.237238            0.264           0.792
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Results for equation Effective_Federal_Funds_Rate
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                                   coefficient       std. error           t-stat            prob
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const                                 0.072276         0.184081            0.393           0.695
L1.S&P500_Adj_Close                  -0.001344         0.001244           -1.081           0.280
L1.VIX_Adj_Close                      0.016424         0.025909            0.634           0.526
```

L1.USD_EUR_Exchange_Rate	4.306332	4.832393	0.891	0.373
L1.Effective_Federal_Funds_Rate	0.833301	0.253229	3.291	0.001
L1.S&P500_Volume	-0.000000	0.000000	-1.652	0.099
L1.US_Dollar_Index	0.094826	0.076507	1.239	0.215
L1.CPI_All_Items	-0.081983	0.307313	-0.267	0.790
L1.Consumer_Sentiment_Index	-0.039724	0.214304	-0.185	0.853
L1.Unemployment_Rate	0.261854	0.154107	1.699	0.089
L1.Log_GDP	11.702914	12.430308	0.941	0.346
L1.VIX_Daily_Returns	110.684493	94.240593	1.174	0.240
L1.S&P500_Daily_Returns	-2.173656	3.284857	-0.662	0.508
L2.S&P500_Adj_Close	-0.000886	0.001674	-0.530	0.596
L2.VIX_Adj_Close	-0.026514	0.027372	-0.969	0.333
L2.USD_EUR_Exchange_Rate	4.208884	5.080388	0.828	0.407
L2.Effective_Federal_Funds_Rate	-0.278724	0.360134	-0.774	0.439
L2.S&P500_Volume	-0.000000	0.000000	-0.235	0.814
L2.US_Dollar_Index	0.052062	0.081141	0.642	0.521
L2.CPI_All_Items	-0.378563	0.516996	-0.732	0.464
L2.Consumer_Sentiment_Index	0.154470	0.178805	0.864	0.388
L2.Unemployment_Rate	0.062015	0.180673	0.343	0.731
L2.Log_GDP	6.695376	13.656650	0.490	0.624
L2.VIX_Daily_Returns	257.739094	150.816629	1.709	0.087
L2.S&P500_Daily_Returns	-5.758360	3.989390	-1.443	0.149
L3.S&P500_Adj_Close	0.002305	0.001452	1.588	0.112
L3.VIX_Adj_Close	-0.019280	0.027277	-0.707	0.480
L3.USD_EUR_Exchange_Rate	-0.223669	4.553457	-0.049	0.961
L3.Effective_Federal_Funds_Rate	0.650854	0.369350	1.762	0.078
L3.S&P500_Volume	-0.000000	0.000000	-0.303	0.762
L3.US_Dollar_Index	-0.016757	0.072389	-0.231	0.817
L3.CPI_All_Items	-0.655829	0.608334	-1.078	0.281
L3.Consumer_Sentiment_Index	-0.229889	0.178815	-1.286	0.199
L3.Unemployment_Rate	0.001691	0.165599	0.010	0.992
L3.Log_GDP	-9.823079	11.232458	-0.875	0.382
L3.VIX_Daily_Returns	259.560305	170.678576	1.521	0.128
L3.S&P500_Daily_Returns	-7.029707	4.687482	-1.500	0.134
L4.S&P500_Adj_Close	0.000997	0.001711	0.583	0.560
L4.VIX_Adj_Close	-0.018276	0.025250	-0.724	0.469
L4.USD_EUR_Exchange_Rate	-5.489455	4.780197	-1.148	0.251
L4.Effective_Federal_Funds_Rate	-0.009978	0.479629	-0.021	0.983
L4.S&P500_Volume	0.000000	0.000000	0.993	0.321
L4.US_Dollar_Index	-0.106253	0.074950	-1.418	0.156
L4.CPI_All_Items	-0.677607	0.513207	-1.320	0.187
L4.Consumer_Sentiment_Index	0.023960	0.169410	0.141	0.888
L4.Unemployment_Rate	-0.138031	0.143052	-0.965	0.335
L4.Log_GDP	-16.946470	11.164180	-1.518	0.129

L4.VIX_Daily_Returns	246.496236	147.683238	1.669	0.095
L4.S&P500_Daily_Returns	-5.518224	3.441374	-1.603	0.109
L5.S&P500_Adj_Close	-0.000102	0.001433	-0.071	0.943
L5.VIX_Adj_Close	-0.007395	0.018531	-0.399	0.690
L5.USD_EUR_Exchange_Rate	-1.095912	4.823203	-0.227	0.820
L5.Effective_Federal_Funds_Rate	-0.410514	0.415633	-0.988	0.323
L5.S&P500_Volume	0.000000	0.000000	0.883	0.377
L5.US_Dollar_Index	-0.015923	0.073871	-0.216	0.829
L5.CPI_All_Items	-0.514740	0.293452	-1.754	0.079
L5.Consumer_Sentiment_Index	-0.088797	0.173826	-0.511	0.609
L5.Unemployment_Rate	-0.003265	0.165118	-0.020	0.984
L5.Log_GDP	-1.045751	11.232774	-0.093	0.926
L5.VIX_Daily_Returns	109.473703	82.006389	1.335	0.182
L5.S&P500_Daily_Returns	-0.900731	1.527289	-0.590	0.555

Results for equation S&P500_Volume

	coefficient	std. error	t-stat	prob
const	-33638215851.079086	16247403291.703226	-2.070	0.038
L1.S&P500_Adj_Close	-24602693.894114	109773853.702537	-0.224	0.823
L1.VIX_Adj_Close	280744110.059936	2286808980.160672	0.123	0.902
L1.USD_EUR_Exchange_Rate	-444086746424.570251	426518932686.571533	-1.041	0.298
L1.Effective_Federal_Funds_Rate	-10363966359.084850	22350624582.736496	-0.464	0.643
L1.S&P500_Volume	-0.420126	0.334231	-1.257	0.209
L1.US_Dollar_Index	-8193179988.246278	6752654822.800894	-1.213	0.225
L1.CPI_All_Items	-19779090533.503643	27124221636.335922	-0.729	0.466
L1.Consumer_Sentiment_Index	-15944251067.848707	18914985675.513439	-0.843	0.399
L1.Unemployment_Rate	172746517.356087	13601832362.740089	0.013	0.990
L1.Log_GDP	842626461503.231445	1097129654362.665161	0.768	0.442
L1.VIX_Daily_Returns	-9911761889418.236328	8317907417822.830078	-1.192	0.233
L1.S&P500_Daily_Returns	363715732766.930298	289929606035.919617	1.254	0.210
L2.S&P500_Adj_Close	41448674.483292	147725505.400786	0.281	0.779
L2.VIX_Adj_Close	597751617.704056	2415928653.321924	0.247	0.805
L2.USD_EUR_Exchange_Rate	-101023038838.971375	448407609728.259460	-0.225	0.822
L2.Effective_Federal_Funds_Rate	-35145627954.153397	31786313857.500065	-1.106	0.269
L2.S&P500_Volume	-0.170380	0.301966	-0.564	0.573
L2.US_Dollar_Index	567116427.882553	7161662554.974048	0.079	0.937
L2.CPI_All_Items	-4908902806.195312	45631337343.521210	-0.108	0.914
L2.Consumer_Sentiment_Index	6432158703.552612	15781761942.299753	0.408	0.684
L2.Unemployment_Rate	-14173462498.797272	15946654412.204693	-0.889	0.374
L2.Log_GDP	103817524682.629456	1205369647200.395508	0.086	0.931
L2.VIX_Daily_Returns	-20657041274457.824219	13311447977943.035156	-1.552	0.121

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L2.S&P500_Daily_Returns             375650111091.591858   352113365752.142395            1.067            0.286
L3.S&P500_Adj_Close                   -106641474.173096      128153642.730664           -0.832            0.405
L3.VIX_Adj_Close                      2666129579.658936     2407560533.527014            1.107            0.268
L3.USD_EUR_Exchange_Rate            578337539607.146240   401899359739.360168            1.439            0.150
L3.Effective_Federal_Funds_Rate     -47344232671.075134    32599781210.684715           -1.452            0.146
L3.S&P500_Volume                               0.083130              0.280082            0.297            0.767
L3.US_Dollar_Index                    6936212708.227905     6389205513.583070            1.086            0.278
L3.CPI_All_Items                     30777955249.062622    53693103276.230583            0.573            0.566
L3.Consumer_Sentiment_Index          19973972517.639526    15782684856.120832            1.266            0.206
L3.Unemployment_Rate                  5196936669.319824    14616186960.387352            0.356            0.722
L3.Log_GDP                          418497444714.865784   991404484121.403931            0.422            0.673
L3.VIX_Daily_Returns              -19555836180813.773438 15064512437152.291016           -1.298            0.194
L3.S&P500_Daily_Returns             542701512972.219482   413728747316.038574            1.312            0.190
L4.S&P500_Adj_Close                     43529976.490234      151000381.518096            0.288            0.773
L4.VIX_Adj_Close                      -701761906.808105     2228601972.804062           -0.315            0.753
L4.USD_EUR_Exchange_Rate            419203645793.391418   421911985062.136841            0.994            0.320
L4.Effective_Federal_Funds_Rate      17696341749.645020    42333240973.515221            0.418            0.676
L4.S&P500_Volume                               0.120605              0.264520            0.456            0.648
L4.US_Dollar_Index                   10225835982.181885     6615270600.590680            1.546            0.122
L4.CPI_All_Items                     59406670472.966553    45296890455.256096            1.311            0.190
L4.Consumer_Sentiment_Index          13430052401.293457    14952527666.935390            0.898            0.369
L4.Unemployment_Rate                 21080216707.269531    12626162843.979939            1.670            0.095
L4.Log_GDP                         1729892602124.720215   985378092525.698730            1.756            0.079
L4.VIX_Daily_Returns              -14827976786167.078125 13034887168235.695312           -1.138            0.255
L4.S&P500_Daily_Returns             123335335946.886261   303744160373.442383            0.406            0.685
L5.S&P500_Adj_Close                   -115019029.333008      126467012.677202           -0.909            0.363
L5.VIX_Adj_Close                     -3425481364.346680     1635617483.828185           -2.094            0.036
L5.USD_EUR_Exchange_Rate           -177763985246.409851   425707760893.209351           -0.418            0.676
L5.Effective_Federal_Funds_Rate      45860935121.572632    36684767492.143494            1.250            0.211
L5.S&P500_Volume                               0.527344              0.281137            1.876            0.061
L5.US_Dollar_Index                   -2419786236.320312     6520042773.526702           -0.371            0.711
L5.CPI_All_Items                     59907103548.233398    25900800055.136703            2.313            0.021
L5.Consumer_Sentiment_Index            325996004.784180    15342285196.286528            0.021            0.983
L5.Unemployment_Rate                  5623732348.238281    14573764374.071356            0.386            0.700
L5.Log_GDP                         1118896633503.303955   991432325208.699341            1.129            0.259
L5.VIX_Daily_Returns               -4090412112309.626953  7238086298073.827148           -0.565            0.572
L5.S&P500_Daily_Returns            -214614145748.962769   134802299603.209747           -1.592            0.111
===============================================================================================================

Results for equation US_Dollar_Index
==================================================================================================
                                 coefficient       std. error           t-stat            prob
--------------------------------------------------------------------------------------------------
const                               0.817103         1.703332            0.480           0.631
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L1.S&P500_Adj_Close                    0.000837      0.011508      0.073      0.942
L1.VIX_Adj_Close                       0.340556      0.239743      1.421      0.155
L1.USD_EUR_Exchange_Rate             -17.287404     44.715041     -0.387      0.699
L1.Effective_Federal_Funds_Rate        4.543369      2.343176      1.939      0.053
L1.S&P500_Volume                      -0.000000      0.000000     -2.307      0.021
L1.US_Dollar_Index                     0.599869      0.707929      0.847      0.397
L1.CPI_All_Items                       1.271343      2.843627      0.447      0.655
L1.Consumer_Sentiment_Index           -0.985451      1.982994     -0.497      0.619
L1.Unemployment_Rate                   0.056399      1.425978      0.040      0.968
L1.Log_GDP                          -132.626755    115.019976     -1.153      0.249
L1.VIX_Daily_Returns                -967.599492    872.025937     -1.110      0.267
L1.S&P500_Daily_Returns               36.498337     30.395402      1.201      0.230
L2.S&P500_Adj_Close                   -0.002956      0.015487     -0.191      0.849
L2.VIX_Adj_Close                      -0.619022      0.253279     -2.444      0.015
L2.USD_EUR_Exchange_Rate             -76.394496     47.009788     -1.625      0.104
L2.Effective_Federal_Funds_Rate       -6.917204      3.332387     -2.076      0.038
L2.S&P500_Volume                      -0.000000      0.000000     -0.414      0.679
L2.US_Dollar_Index                    -1.857414      0.750808     -2.474      0.013
L2.CPI_All_Items                      -3.633615      4.783861     -0.760      0.448
L2.Consumer_Sentiment_Index           -3.522564      1.654515     -2.129      0.033
L2.Unemployment_Rate                   0.197755      1.671802      0.118      0.906
L2.Log_GDP                           136.469320    126.367552      1.080      0.280
L2.VIX_Daily_Returns               -1703.024546   1395.534635     -1.220      0.222
L2.S&P500_Daily_Returns               17.051401     36.914571      0.462      0.644
L3.S&P500_Adj_Close                    0.019079      0.013435      1.420      0.156
L3.VIX_Adj_Close                       0.187109      0.252402      0.741      0.459
L3.USD_EUR_Exchange_Rate              71.675574     42.133995      1.701      0.089
L3.Effective_Federal_Funds_Rate        1.969866      3.417669      0.576      0.564
L3.S&P500_Volume                       0.000000      0.000000      1.517      0.129
L3.US_Dollar_Index                     1.390374      0.669826      2.076      0.038
L3.CPI_All_Items                      -4.332297      5.629033     -0.770      0.442
L3.Consumer_Sentiment_Index            0.440809      1.654612      0.266      0.790
L3.Unemployment_Rate                  -2.208559      1.532320     -1.441      0.149
L3.Log_GDP                           -64.661352    103.936048     -0.622      0.534
L3.VIX_Daily_Returns                -871.424656   1579.320965     -0.552      0.581
L3.S&P500_Daily_Returns               10.937210     43.374154      0.252      0.801
L4.S&P500_Adj_Close                   -0.029952      0.015830     -1.892      0.058
L4.VIX_Adj_Close                       0.044625      0.233640      0.191      0.849
L4.USD_EUR_Exchange_Rate              60.422031     44.232062      1.366      0.172
L4.Effective_Federal_Funds_Rate        0.112984      4.438098      0.025      0.980
L4.S&P500_Volume                      -0.000000      0.000000     -0.906      0.365
L4.US_Dollar_Index                     0.568738      0.693526      0.820      0.412
L4.CPI_All_Items                      -2.387907      4.748798     -0.503      0.615
L4.Consumer_Sentiment_Index            0.787652      1.567581      0.502      0.615
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L4.Unemployment_Rate                   -0.084738         1.323691           -0.064           0.949
L4.Log_GDP                            -55.633705       103.304258           -0.539           0.590
L4.VIX_Daily_Returns                -1532.138679      1366.540781           -1.121           0.262
L4.S&P500_Daily_Returns                40.195503        31.843680            1.262           0.207
L5.S&P500_Adj_Close                     0.023077         0.013258            1.741           0.082
L5.VIX_Adj_Close                       -0.158684         0.171474           -0.925           0.355
L5.USD_EUR_Exchange_Rate              -57.158615        44.630000           -1.281           0.200
L5.Effective_Federal_Funds_Rate         1.665640         3.845927            0.433           0.665
L5.S&P500_Volume                        0.000000         0.000000            2.372           0.018
L5.US_Dollar_Index                     -0.689572         0.683543           -1.009           0.313
L5.CPI_All_Items                       -1.893956         2.715367           -0.697           0.485
L5.Consumer_Sentiment_Index             0.506230         1.608442            0.315           0.753
L5.Unemployment_Rate                   -0.047219         1.527872           -0.031           0.975
L5.Log_GDP                             -2.070303       103.938967           -0.020           0.984
L5.VIX_Daily_Returns                 -385.484911       758.820538           -0.508           0.611
L5.S&P500_Daily_Returns                -6.569781        14.132293           -0.465           0.642
==================================================================================================

Results for equation CPI_All_Items
==================================================================================================
                                     coefficient       std. error           t-stat            prob
--------------------------------------------------------------------------------------------------
const                                  -0.049101         0.162939           -0.301           0.763
L1.S&P500_Adj_Close                     0.000308         0.001101            0.280           0.780
L1.VIX_Adj_Close                       -0.015988         0.022934           -0.697           0.486
L1.USD_EUR_Exchange_Rate                6.365894         4.277394            1.488           0.137
L1.Effective_Federal_Funds_Rate        -0.425266         0.224146           -1.897           0.058
L1.S&P500_Volume                        0.000000         0.000000            1.342           0.180
L1.US_Dollar_Index                      0.068601         0.067720            1.013           0.311
L1.CPI_All_Items                       -1.186626         0.272018           -4.362           0.000
L1.Consumer_Sentiment_Index            -0.012092         0.189691           -0.064           0.949
L1.Unemployment_Rate                   -0.079576         0.136408           -0.583           0.560
L1.Log_GDP                              0.775857        11.002690            0.071           0.944
L1.VIX_Daily_Returns                   48.494965        83.417084            0.581           0.561
L1.S&P500_Daily_Returns                -0.564652         2.907592           -0.194           0.846
L2.S&P500_Adj_Close                     0.000685         0.001481            0.463           0.644
L2.VIX_Adj_Close                        0.005545         0.024228            0.229           0.819
L2.USD_EUR_Exchange_Rate               -1.113840         4.496907           -0.248           0.804
L2.Effective_Federal_Funds_Rate         0.509553         0.318773            1.598           0.110
L2.S&P500_Volume                        0.000000         0.000000            0.958           0.338
L2.US_Dollar_Index                      0.002009         0.071822            0.028           0.978
L2.CPI_All_Items                       -1.104914         0.457619           -2.414           0.016
L2.Consumer_Sentiment_Index            -0.018148         0.158269           -0.115           0.909
L2.Unemployment_Rate                   -0.034217         0.159923           -0.214           0.831
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L2.Log_GDP                               -7.785498        12.088187           -0.644           0.520
L2.VIX_Daily_Returns                     52.673549       133.495375            0.395           0.693
L2.S&P500_Daily_Returns                   0.584463         3.531209            0.166           0.869
L3.S&P500_Adj_Close                      -0.000355         0.001285           -0.276           0.783
L3.VIX_Adj_Close                         -0.028142         0.024144           -1.166           0.244
L3.USD_EUR_Exchange_Rate                 -2.426822         4.030494           -0.602           0.547
L3.Effective_Federal_Funds_Rate           0.318548         0.326931            0.974           0.330
L3.S&P500_Volume                          0.000000         0.000000            0.581           0.561
L3.US_Dollar_Index                       -0.040082         0.064075           -0.626           0.532
L3.CPI_All_Items                         -1.133510         0.538467           -2.105           0.035
L3.Consumer_Sentiment_Index              -0.138636         0.158278           -0.876           0.381
L3.Unemployment_Rate                      0.061009         0.146580            0.416           0.677
L3.Log_GDP                                2.483234         9.942413            0.250           0.803
L3.VIX_Daily_Returns                     80.241595       151.076182            0.531           0.595
L3.S&P500_Daily_Returns                   0.903427         4.149126            0.218           0.828
L4.S&P500_Adj_Close                       0.001898         0.001514            1.253           0.210
L4.VIX_Adj_Close                         -0.008508         0.022350           -0.381           0.703
L4.USD_EUR_Exchange_Rate                 -6.147762         4.231192           -1.453           0.146
L4.Effective_Federal_Funds_Rate          -0.228419         0.424544           -0.538           0.591
L4.S&P500_Volume                          0.000000         0.000000            1.425           0.154
L4.US_Dollar_Index                       -0.094367         0.066342           -1.422           0.155
L4.CPI_All_Items                         -0.472132         0.454265           -1.039           0.299
L4.Consumer_Sentiment_Index               0.185133         0.149953            1.235           0.217
L4.Unemployment_Rate                      0.013126         0.126623            0.104           0.917
L4.Log_GDP                               -1.263259         9.881977           -0.128           0.898
L4.VIX_Daily_Returns                    143.659491       130.721853            1.099           0.272
L4.S&P500_Daily_Returns                  -2.431566         3.046133           -0.798           0.425
L5.S&P500_Adj_Close                      -0.000027         0.001268           -0.021           0.983
L5.VIX_Adj_Close                         -0.002437         0.016403           -0.149           0.882
L5.USD_EUR_Exchange_Rate                  5.447394         4.269259            1.276           0.202
L5.Effective_Federal_Funds_Rate          -0.452227         0.367897           -1.229           0.219
L5.S&P500_Volume                         -0.000000         0.000000           -1.050           0.294
L5.US_Dollar_Index                        0.081549         0.065387            1.247           0.212
L5.CPI_All_Items                         -0.105118         0.259749           -0.405           0.686
L5.Consumer_Sentiment_Index               0.073679         0.153862            0.479           0.632
L5.Unemployment_Rate                      0.010169         0.146155            0.070           0.945
L5.Log_GDP                               -0.655704         9.942692           -0.066           0.947
L5.VIX_Daily_Returns                     46.863714        72.587974            0.646           0.519
L5.S&P500_Daily_Returns                  -1.226810         1.351880           -0.907           0.364
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Results for equation Consumer_Sentiment_Index
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                                       coefficient       std. error           t-stat            prob
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----------------------------------------------------------------------------------------------------
const                                   0.751854         0.227280            3.308           0.001
L1.S&P500_Adj_Close                    -0.002513         0.001536           -1.636           0.102
L1.VIX_Adj_Close                       -0.009679         0.031989           -0.303           0.762
L1.USD_EUR_Exchange_Rate                0.651382         5.966447            0.109           0.913
L1.Effective_Federal_Funds_Rate         0.928412         0.312656            2.969           0.003
L1.S&P500_Volume                       -0.000000         0.000000           -2.242           0.025
L1.US_Dollar_Index                      0.052183         0.094461            0.552           0.581
L1.CPI_All_Items                       -0.954922         0.379433           -2.517           0.012
L1.Consumer_Sentiment_Index            -0.349100         0.264596           -1.319           0.187
L1.Unemployment_Rate                    0.083131         0.190272            0.437           0.662
L1.Log_GDP                             10.078794        15.347421            0.657           0.511
L1.VIX_Daily_Returns                  198.642130       116.356737            1.707           0.088
L1.S&P500_Daily_Returns                -3.440092         4.055739           -0.848           0.396
L2.S&P500_Adj_Close                     0.000401         0.002066            0.194           0.846
L2.VIX_Adj_Close                       -0.010622         0.033796           -0.314           0.753
L2.USD_EUR_Exchange_Rate                3.673390         6.272641            0.586           0.558
L2.Effective_Federal_Funds_Rate        -0.803911         0.444649           -1.808           0.071
L2.S&P500_Volume                       -0.000000         0.000000           -0.744           0.457
L2.US_Dollar_Index                     -0.037923         0.100182           -0.379           0.705
L2.CPI_All_Items                       -2.027807         0.638323           -3.177           0.001
L2.Consumer_Sentiment_Index             0.001847         0.220766            0.008           0.993
L2.Unemployment_Rate                   -0.017480         0.223073           -0.078           0.938
L2.Log_GDP                             16.965847        16.861558            1.006           0.314
L2.VIX_Daily_Returns                  359.684270       186.209894            1.932           0.053
L2.S&P500_Daily_Returns                -8.174617         4.925609           -1.660           0.097
L3.S&P500_Adj_Close                     0.002131         0.001793            1.189           0.235
L3.VIX_Adj_Close                        0.007543         0.033679            0.224           0.823
L3.USD_EUR_Exchange_Rate                0.001333         5.622051            0.000           1.000
L3.Effective_Federal_Funds_Rate         0.405173         0.456029            0.888           0.374
L3.S&P500_Volume                       -0.000000         0.000000           -0.601           0.548
L3.US_Dollar_Index                     -0.019634         0.089377           -0.220           0.826
L3.CPI_All_Items                       -1.987075         0.751097           -2.646           0.008
L3.Consumer_Sentiment_Index            -0.018400         0.220779           -0.083           0.934
L3.Unemployment_Rate                   -0.596397         0.204461           -2.917           0.004
L3.Log_GDP                            -49.971773        13.868463           -3.603           0.000
L3.VIX_Daily_Returns                  239.425596       210.732992            1.136           0.256
L3.S&P500_Daily_Returns                -6.519277         5.787529           -1.126           0.260
L4.S&P500_Adj_Close                    -0.000917         0.002112           -0.434           0.664
L4.VIX_Adj_Close                       -0.016175         0.031175           -0.519           0.604
L4.USD_EUR_Exchange_Rate              -12.185125         5.902001           -2.065           0.039
L4.Effective_Federal_Funds_Rate         0.118876         0.592187            0.201           0.841
L4.S&P500_Volume                        0.000000         0.000000            1.225           0.221
L4.US_Dollar_Index                     -0.207966         0.092539           -2.247           0.025
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L4.CPI_All_Items                       -1.917123         0.633645           -3.026           0.002
L4.Consumer_Sentiment_Index            -0.235643         0.209166           -1.127           0.260
L4.Unemployment_Rate                   -0.219800         0.176624           -1.244           0.213
L4.Log_GDP                            -32.855937        13.784162           -2.384           0.017
L4.VIX_Daily_Returns                   39.804548       182.341166            0.218           0.827
L4.S&P500_Daily_Returns                 0.133435         4.248987            0.031           0.975
L5.S&P500_Adj_Close                     0.000548         0.001769            0.310           0.757
L5.VIX_Adj_Close                        0.028329         0.022880            1.238           0.216
L5.USD_EUR_Exchange_Rate                1.488957         5.955099            0.250           0.803
L5.Effective_Federal_Funds_Rate         0.105257         0.513172            0.205           0.837
L5.S&P500_Volume                        0.000000         0.000000            0.708           0.479
L5.US_Dollar_Index                      0.032701         0.091207            0.359           0.720
L5.CPI_All_Items                       -1.191814         0.362319           -3.289           0.001
L5.Consumer_Sentiment_Index            -0.125723         0.214619           -0.586           0.558
L5.Unemployment_Rate                   -0.131416         0.203868           -0.645           0.519
L5.Log_GDP                            -18.115876        13.868852           -1.306           0.191
L5.VIX_Daily_Returns                  -21.094076       101.251440           -0.208           0.835
L5.S&P500_Daily_Returns                 4.641600         1.885709            2.461           0.014
==================================================================================================

Results for equation Unemployment_Rate
==================================================================================================
                                     coefficient       std. error           t-stat            prob
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const                                  -0.263320         0.639498           -0.412           0.681
L1.S&P500_Adj_Close                    -0.003108         0.004321           -0.719           0.472
L1.VIX_Adj_Close                        0.167790         0.090009            1.864           0.062
L1.USD_EUR_Exchange_Rate               -7.281486        16.787782           -0.434           0.664
L1.Effective_Federal_Funds_Rate         0.617059         0.879720            0.701           0.483
L1.S&P500_Volume                       -0.000000         0.000000           -0.401           0.689
L1.US_Dollar_Index                     -0.142189         0.265784           -0.535           0.593
L1.CPI_All_Items                       -0.112896         1.067609           -0.106           0.916
L1.Consumer_Sentiment_Index            -0.250442         0.744494           -0.336           0.737
L1.Unemployment_Rate                   -0.942046         0.535368           -1.760           0.078
L1.Log_GDP                            -67.817849        43.183014           -1.570           0.116
L1.VIX_Daily_Returns                 -609.698340       327.392767           -1.862           0.063
L1.S&P500_Daily_Returns                32.397536        11.411627            2.839           0.005
L2.S&P500_Adj_Close                     0.002473         0.005814            0.425           0.671
L2.VIX_Adj_Close                       -0.031044         0.095091           -0.326           0.744
L2.USD_EUR_Exchange_Rate              -16.785907        17.649320           -0.951           0.342
L2.Effective_Federal_Funds_Rate        -1.358683         1.251109           -1.086           0.277
L2.S&P500_Volume                       -0.000000         0.000000           -0.057           0.955
L2.US_Dollar_Index                     -0.185610         0.281883           -0.658           0.510
L2.CPI_All_Items                        0.276398         1.796049            0.154           0.878
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L2.Consumer_Sentiment_Index          -0.284904        0.621170           -0.459           0.646
L2.Unemployment_Rate                 -0.572984        0.627660           -0.913           0.361
L2.Log_GDP                          -36.901172       47.443339           -0.778           0.437
L2.VIX_Daily_Returns              -1242.961690      523.938481           -2.372           0.018
L2.S&P500_Daily_Returns              32.497158       13.859179            2.345           0.019
L3.S&P500_Adj_Close                  -0.000137        0.005044           -0.027           0.978
L3.VIX_Adj_Close                      0.056513        0.094762            0.596           0.551
L3.USD_EUR_Exchange_Rate              5.128130       15.818755            0.324           0.746
L3.Effective_Federal_Funds_Rate      -0.398583        1.283127           -0.311           0.756
L3.S&P500_Volume                      0.000000        0.000000            0.967           0.334
L3.US_Dollar_Index                    0.053798        0.251479            0.214           0.831
L3.CPI_All_Items                      0.920401        2.113360            0.436           0.663
L3.Consumer_Sentiment_Index           0.362087        0.621206            0.583           0.560
L3.Unemployment_Rate                  0.606243        0.575293            1.054           0.292
L3.Log_GDP                           60.351328       39.021672            1.547           0.122
L3.VIX_Daily_Returns              -1072.728356      592.939084           -1.809           0.070
L3.S&P500_Daily_Returns              25.562404       16.284360            1.570           0.116
L4.S&P500_Adj_Close                  -0.002709        0.005943           -0.456           0.649
L4.VIX_Adj_Close                      0.051560        0.087718            0.588           0.557
L4.USD_EUR_Exchange_Rate             23.906385       16.606452            1.440           0.150
L4.Effective_Federal_Funds_Rate       0.226356        1.666236            0.136           0.892
L4.S&P500_Volume                     -0.000000        0.000000           -1.480           0.139
L4.US_Dollar_Index                    0.468449        0.260377            1.799           0.072
L4.CPI_All_Items                      1.700625        1.782885            0.954           0.340
L4.Consumer_Sentiment_Index           0.139467        0.588531            0.237           0.813
L4.Unemployment_Rate                  0.940075        0.496966            1.892           0.059
L4.Log_GDP                           73.099064       38.784473            1.885           0.059
L4.VIX_Daily_Returns               -887.436940      513.053050           -1.730           0.084
L4.S&P500_Daily_Returns              14.650406       11.955368            1.225           0.220
L5.S&P500_Adj_Close                  -0.001357        0.004978           -0.273           0.785
L5.VIX_Adj_Close                     -0.069743        0.064378           -1.083           0.279
L5.USD_EUR_Exchange_Rate             -8.132453       16.755854           -0.485           0.627
L5.Effective_Federal_Funds_Rate       0.803066        1.443912            0.556           0.578
L5.S&P500_Volume                      0.000000        0.000000            0.652           0.514
L5.US_Dollar_Index                   -0.158646        0.256629           -0.618           0.536
L5.CPI_All_Items                      1.935924        1.019455            1.899           0.058
L5.Consumer_Sentiment_Index          -0.165952        0.603872           -0.275           0.783
L5.Unemployment_Rate                  0.000863        0.573623            0.002           0.999
L5.Log_GDP                           13.795363       39.022768            0.354           0.724
L5.VIX_Daily_Returns               -206.188491      284.891016           -0.724           0.469
L5.S&P500_Daily_Returns              -3.418011        5.305817           -0.644           0.519
================================================================================================

Results for equation Log_GDP
```

```
====================================================================================================
                                       coefficient       std. error           t-stat            prob
----------------------------------------------------------------------------------------------------
const                                     0.007908         0.007576            1.044           0.297
L1.S&P500_Adj_Close                       0.000058         0.000051            1.132           0.258
L1.VIX_Adj_Close                         -0.001701         0.001066           -1.595           0.111
L1.USD_EUR_Exchange_Rate                  0.146434         0.198886            0.736           0.462
L1.Effective_Federal_Funds_Rate          -0.004236         0.010422           -0.406           0.684
L1.S&P500_Volume                          0.000000         0.000000            0.415           0.678
L1.US_Dollar_Index                        0.002340         0.003149            0.743           0.457
L1.CPI_All_Items                         -0.000835         0.012648           -0.066           0.947
L1.Consumer_Sentiment_Index               0.004539         0.008820            0.515           0.607
L1.Unemployment_Rate                      0.014786         0.006343            2.331           0.020
L1.Log_GDP                                0.817011         0.511593            1.597           0.110
L1.VIX_Daily_Returns                      7.038522         3.878653            1.815           0.070
L1.S&P500_Daily_Returns                  -0.365448         0.135195           -2.703           0.007
L2.S&P500_Adj_Close                      -0.000026         0.000069           -0.371           0.710
L2.VIX_Adj_Close                          0.000043         0.001127            0.038           0.970
L2.USD_EUR_Exchange_Rate                  0.153740         0.209093            0.735           0.462
L2.Effective_Federal_Funds_Rate           0.015017         0.014822            1.013           0.311
L2.S&P500_Volume                          0.000000         0.000000            0.798           0.425
L2.US_Dollar_Index                        0.001782         0.003339            0.534           0.594
L2.CPI_All_Items                         -0.000282         0.021278           -0.013           0.989
L2.Consumer_Sentiment_Index              -0.000100         0.007359           -0.014           0.989
L2.Unemployment_Rate                      0.003248         0.007436            0.437           0.662
L2.Log_GDP                                0.196906         0.562066            0.350           0.726
L2.VIX_Daily_Returns                     13.732542         6.207148            2.212           0.027
L2.S&P500_Daily_Returns                  -0.329964         0.164191           -2.010           0.044
L3.S&P500_Adj_Close                      -0.000005         0.000060           -0.076           0.939
L3.VIX_Adj_Close                         -0.001111         0.001123           -0.989           0.322
L3.USD_EUR_Exchange_Rate                 -0.120063         0.187406           -0.641           0.522
L3.Effective_Federal_Funds_Rate           0.019394         0.015201            1.276           0.202
L3.S&P500_Volume                         -0.000000         0.000000           -0.603           0.547
L3.US_Dollar_Index                       -0.001923         0.002979           -0.645           0.519
L3.CPI_All_Items                         -0.014989         0.025037           -0.599           0.549
L3.Consumer_Sentiment_Index              -0.010567         0.007359           -1.436           0.151
L3.Unemployment_Rate                     -0.003934         0.006816           -0.577           0.564
L3.Log_GDP                               -0.465166         0.462293           -1.006           0.314
L3.VIX_Daily_Returns                     13.437182         7.024605            1.913           0.056
L3.S&P500_Daily_Returns                  -0.284697         0.192922           -1.476           0.140
L4.S&P500_Adj_Close                       0.000038         0.000070            0.547           0.585
L4.VIX_Adj_Close                         -0.000049         0.001039           -0.047           0.963
L4.USD_EUR_Exchange_Rate                 -0.260412         0.196738           -1.324           0.186
L4.Effective_Federal_Funds_Rate          -0.010956         0.019740           -0.555           0.579
```

```
L4.S&P500_Volume                        0.000000         0.000000            1.483           0.138
L4.US_Dollar_Index                     -0.005637         0.003085           -1.827           0.068
L4.CPI_All_Items                       -0.022597         0.021122           -1.070           0.285
L4.Consumer_Sentiment_Index             0.004153         0.006972            0.596           0.551
L4.Unemployment_Rate                   -0.008358         0.005888           -1.420           0.156
L4.Log_GDP                             -0.669361         0.459483           -1.457           0.145
L4.VIX_Daily_Returns                   12.500462         6.078188            2.057           0.040
L4.S&P500_Daily_Returns                -0.145750         0.141636           -1.029           0.303
L5.S&P500_Adj_Close                     0.000039         0.000059            0.668           0.504
L5.VIX_Adj_Close                        0.000921         0.000763            1.207           0.227
L5.USD_EUR_Exchange_Rate                0.079927         0.198508            0.403           0.687
L5.Effective_Federal_Funds_Rate        -0.016137         0.017106           -0.943           0.345
L5.S&P500_Volume                       -0.000000         0.000000           -1.199           0.230
L5.US_Dollar_Index                      0.001584         0.003040            0.521           0.602
L5.CPI_All_Items                       -0.018797         0.012078           -1.556           0.120
L5.Consumer_Sentiment_Index             0.001226         0.007154            0.171           0.864
L5.Unemployment_Rate                   -0.000216         0.006796           -0.032           0.975
L5.Log_GDP                             -0.070010         0.462306           -0.151           0.880
L5.VIX_Daily_Returns                    3.220580         3.375131            0.954           0.340
L5.S&P500_Daily_Returns                 0.027959         0.062859            0.445           0.656
==================================================================================================

Results for equation VIX_Daily_Returns
==================================================================================================
                                     coefficient       std. error           t-stat            prob
--------------------------------------------------------------------------------------------------
const                                   0.001652         0.000803            2.057           0.040
L1.S&P500_Adj_Close                     0.000002         0.000005            0.321           0.748
L1.VIX_Adj_Close                        0.000063         0.000113            0.560           0.575
L1.USD_EUR_Exchange_Rate               -0.004025         0.021080           -0.191           0.849
L1.Effective_Federal_Funds_Rate         0.001513         0.001105            1.369           0.171
L1.S&P500_Volume                       -0.000000         0.000000           -0.096           0.924
L1.US_Dollar_Index                     -0.000061         0.000334           -0.183           0.855
L1.CPI_All_Items                       -0.001468         0.001341           -1.095           0.273
L1.Consumer_Sentiment_Index            -0.000999         0.000935           -1.069           0.285
L1.Unemployment_Rate                   -0.000297         0.000672           -0.442           0.658
L1.Log_GDP                             -0.018355         0.054223           -0.339           0.735
L1.VIX_Daily_Returns                   -1.346767         0.411094           -3.276           0.001
L1.S&P500_Daily_Returns                 0.011212         0.014329            0.782           0.434
L2.S&P500_Adj_Close                    -0.000002         0.000007           -0.275           0.784
L2.VIX_Adj_Close                        0.000027         0.000119            0.230           0.818
L2.USD_EUR_Exchange_Rate               -0.005481         0.022162           -0.247           0.805
L2.Effective_Federal_Funds_Rate         0.000055         0.001571            0.035           0.972
L2.S&P500_Volume                        0.000000         0.000000            0.729           0.466
```

```
L2.US_Dollar_Index                     -0.000139         0.000354         -0.393          0.695
L2.CPI_All_Items                       -0.002827         0.002255         -1.254          0.210
L2.Consumer_Sentiment_Index            -0.001278         0.000780         -1.638          0.101
L2.Unemployment_Rate                   -0.001179         0.000788         -1.496          0.135
L2.Log_GDP                             -0.087620         0.059573         -1.471          0.141
L2.VIX_Daily_Returns                   -1.724920         0.657889         -2.622          0.009
L2.S&P500_Daily_Returns                 0.031787         0.017402          1.827          0.068
L3.S&P500_Adj_Close                     0.000005         0.000006          0.865          0.387
L3.VIX_Adj_Close                        0.000045         0.000119          0.378          0.706
L3.USD_EUR_Exchange_Rate               -0.017409         0.019863         -0.876          0.381
L3.Effective_Federal_Funds_Rate         0.002121         0.001611          1.316          0.188
L3.S&P500_Volume                        0.000000         0.000000          0.334          0.739
L3.US_Dollar_Index                     -0.000208         0.000316         -0.658          0.510
L3.CPI_All_Items                       -0.003213         0.002654         -1.211          0.226
L3.Consumer_Sentiment_Index            -0.000152         0.000780         -0.195          0.845
L3.Unemployment_Rate                    0.000104         0.000722          0.143          0.886
L3.Log_GDP                             -0.026673         0.048998         -0.544          0.586
L3.VIX_Daily_Returns                   -1.736822         0.744530         -2.333          0.020
L3.S&P500_Daily_Returns                 0.019659         0.020448          0.961          0.336
L4.S&P500_Adj_Close                    -0.000005         0.000007         -0.609          0.543
L4.VIX_Adj_Close                        0.000122         0.000110          1.104          0.270
L4.USD_EUR_Exchange_Rate               -0.021289         0.020852         -1.021          0.307
L4.Effective_Federal_Funds_Rate        -0.000187         0.002092         -0.089          0.929
L4.S&P500_Volume                        0.000000         0.000000          0.106          0.915
L4.US_Dollar_Index                     -0.000467         0.000327         -1.427          0.154
L4.CPI_All_Items                       -0.002391         0.002239         -1.068          0.285
L4.Consumer_Sentiment_Index            -0.000059         0.000739         -0.080          0.936
L4.Unemployment_Rate                   -0.000206         0.000624         -0.330          0.742
L4.Log_GDP                             -0.025847         0.048700         -0.531          0.596
L4.VIX_Daily_Returns                   -1.002095         0.644221         -1.556          0.120
L4.S&P500_Daily_Returns                 0.020014         0.015012          1.333          0.182
L5.S&P500_Adj_Close                     0.000000         0.000006          0.054          0.957
L5.VIX_Adj_Close                        0.000067         0.000081          0.831          0.406
L5.USD_EUR_Exchange_Rate               -0.003683         0.021040         -0.175          0.861
L5.Effective_Federal_Funds_Rate        -0.001121         0.001813         -0.618          0.537
L5.S&P500_Volume                       -0.000000         0.000000         -1.254          0.210
L5.US_Dollar_Index                     -0.000019         0.000322         -0.059          0.953
L5.CPI_All_Items                       -0.000551         0.001280         -0.430          0.667
L5.Consumer_Sentiment_Index            -0.000469         0.000758         -0.619          0.536
L5.Unemployment_Rate                   -0.000164         0.000720         -0.228          0.819
L5.Log_GDP                             -0.013778         0.048999         -0.281          0.779
L5.VIX_Daily_Returns                   -0.404325         0.357727         -1.130          0.258
L5.S&P500_Daily_Returns                 0.008670         0.006662          1.301          0.193
==================================================================================================
```

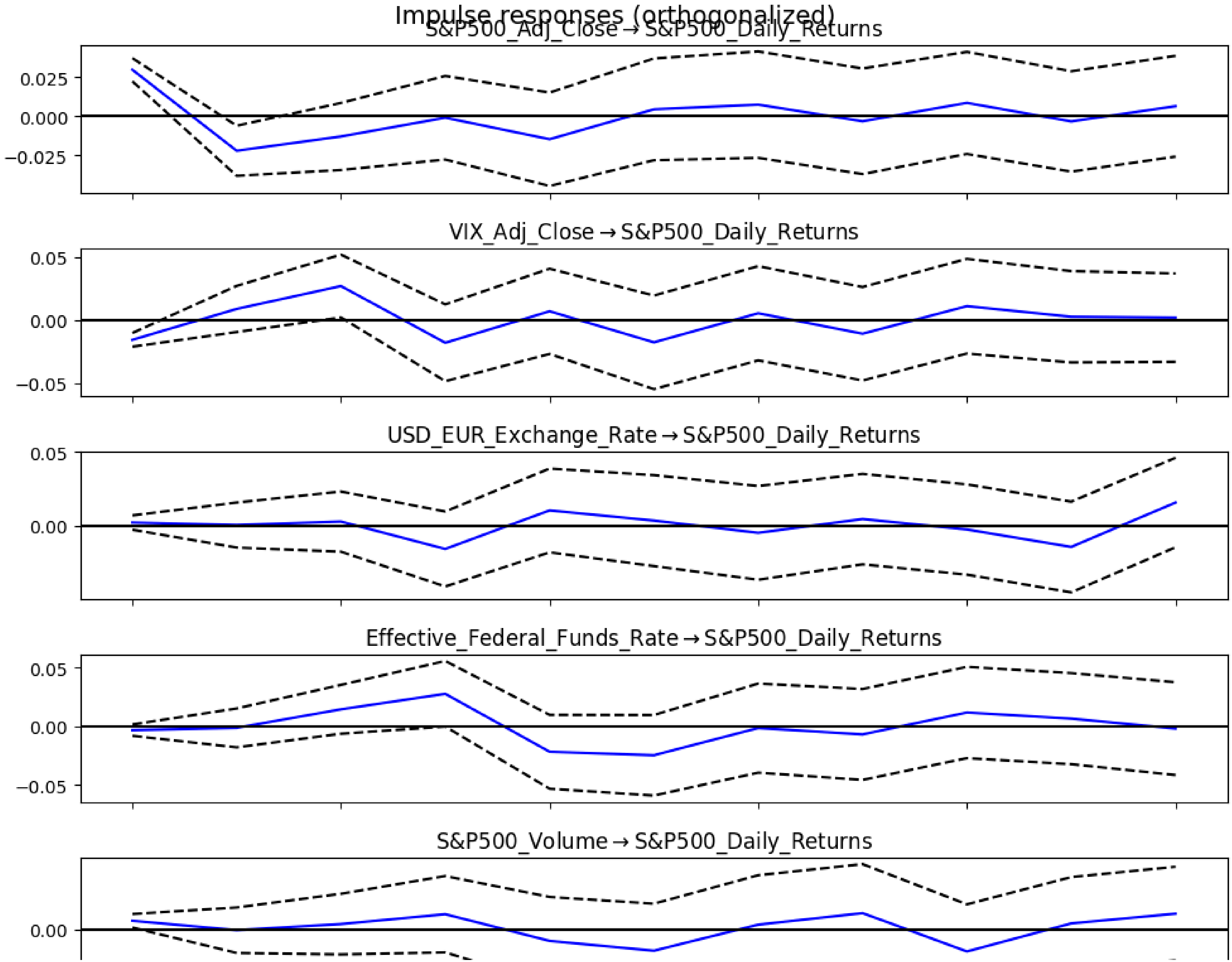
```
Results for equation S&P500_Daily_Returns
======================================================================================================
                                      coefficient       std. error           t-stat              prob
------------------------------------------------------------------------------------------------------
const                                    0.064457         0.023749            2.714             0.007
L1.S&P500_Adj_Close                     -0.000162         0.000160           -1.010             0.312
L1.VIX_Adj_Close                         0.001190         0.003343            0.356             0.722
L1.USD_EUR_Exchange_Rate                 0.607364         0.623447            0.974             0.330
L1.Effective_Federal_Funds_Rate          0.024489         0.032670            0.750             0.454
L1.S&P500_Volume                        -0.000000         0.000000           -0.402             0.687
L1.US_Dollar_Index                       0.009311         0.009870            0.943             0.346
L1.CPI_All_Items                        -0.082670         0.039648           -2.085             0.037
L1.Consumer_Sentiment_Index             -0.020201         0.027648           -0.731             0.465
L1.Unemployment_Rate                     0.000482         0.019882            0.024             0.981
L1.Log_GDP                               0.758913         1.603686            0.473             0.636
L1.VIX_Daily_Returns                    18.351253        12.158374            1.509             0.131
L1.S&P500_Daily_Returns                 -0.702524         0.423793           -1.658             0.097
L2.S&P500_Adj_Close                     -0.000023         0.000216           -0.106             0.916
L2.VIX_Adj_Close                         0.000078         0.003531            0.022             0.982
L2.USD_EUR_Exchange_Rate                 0.171364         0.655442            0.261             0.794
L2.Effective_Federal_Funds_Rate         -0.001841         0.046462           -0.040             0.968
L2.S&P500_Volume                         0.000000         0.000000            1.113             0.266
L2.US_Dollar_Index                      -0.001163         0.010468           -0.111             0.912
L2.CPI_All_Items                        -0.133204         0.066700           -1.997             0.046
L2.Consumer_Sentiment_Index             -0.029318         0.023068           -1.271             0.204
L2.Unemployment_Rate                    -0.038536         0.023309           -1.653             0.098
L2.Log_GDP                              -2.799599         1.761902           -1.589             0.112
L2.VIX_Daily_Returns                     8.855129        19.457486            0.455             0.649
L2.S&P500_Daily_Returns                 -0.077641         0.514688           -0.151             0.880
L3.S&P500_Adj_Close                      0.000440         0.000187            2.348             0.019
L3.VIX_Adj_Close                         0.000932         0.003519            0.265             0.791
L3.USD_EUR_Exchange_Rate                -1.207455         0.587461           -2.055             0.040
L3.Effective_Federal_Funds_Rate          0.173971         0.047651            3.651             0.000
L3.S&P500_Volume                         0.000000         0.000000            0.439             0.661
L3.US_Dollar_Index                      -0.014630         0.009339           -1.566             0.117
L3.CPI_All_Items                        -0.181818         0.078484           -2.317             0.021
L3.Consumer_Sentiment_Index             -0.012075         0.023070           -0.523             0.601
L3.Unemployment_Rate                     0.002216         0.021365            0.104             0.917
L3.Log_GDP                              -1.679814         1.449147           -1.159             0.246
L3.VIX_Daily_Returns                     3.317019        22.019959            0.151             0.880
L3.S&P500_Daily_Returns                 -0.496816         0.604752           -0.822             0.411
L4.S&P500_Adj_Close                     -0.000168         0.000221           -0.763             0.446
L4.VIX_Adj_Close                         0.002098         0.003258            0.644             0.520
```

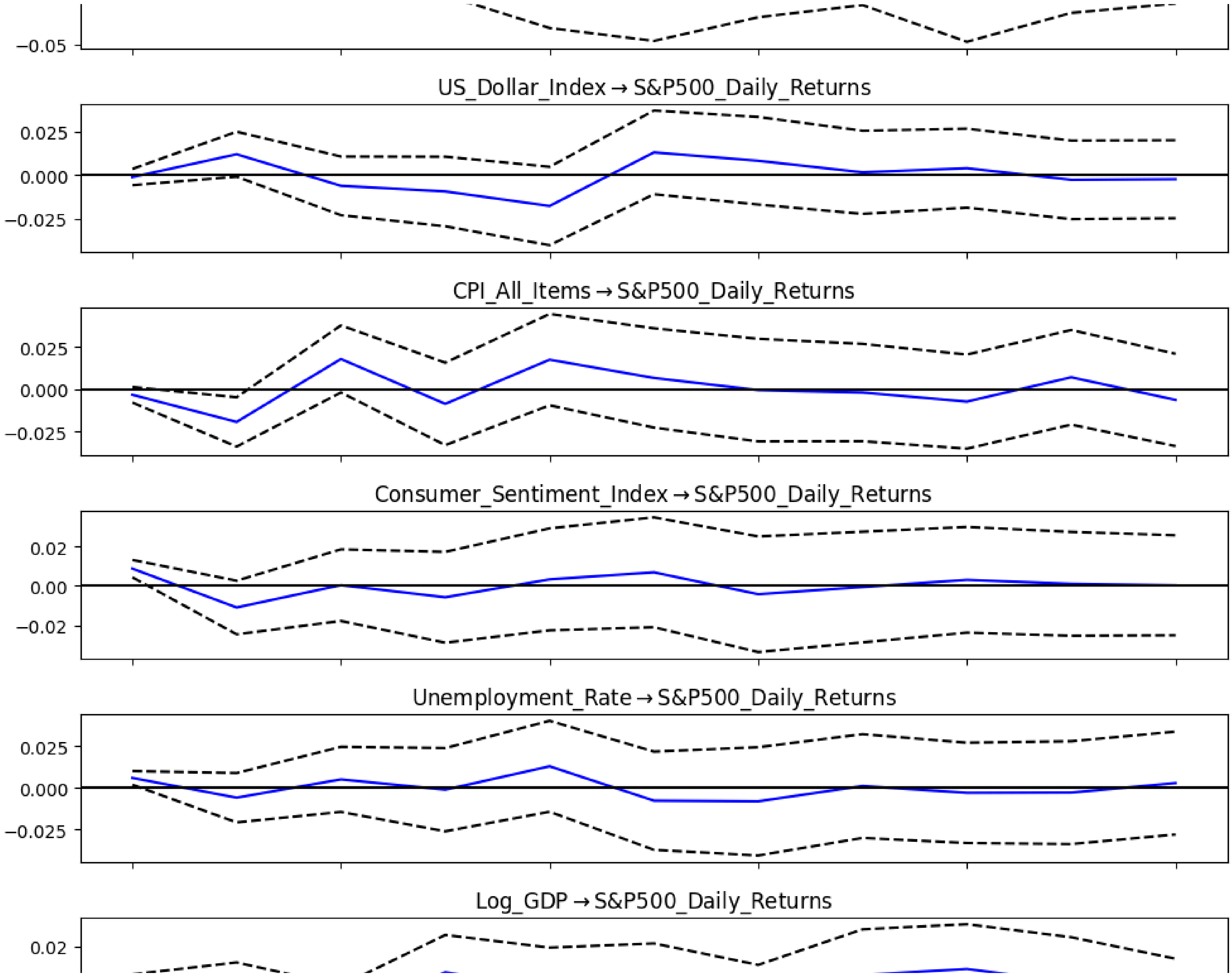
```
L4.USD_EUR_Exchange_Rate             -1.166324         0.616713           -1.891           0.059
L4.Effective_Federal_Funds_Rate      -0.098160         0.061879           -1.586           0.113
L4.S&P500_Volume                      0.000000         0.000000            1.406           0.160
L4.US_Dollar_Index                   -0.027898         0.009670           -2.885           0.004
L4.CPI_All_Items                     -0.140355         0.066211           -2.120           0.034
L4.Consumer_Sentiment_Index          -0.001031         0.021856           -0.047           0.962
L4.Unemployment_Rate                 -0.036155         0.018456           -1.959           0.050
L4.Log_GDP                           -2.880006         1.440338           -2.000           0.046
L4.VIX_Daily_Returns                  8.928950        19.053234            0.469           0.639
L4.S&P500_Daily_Returns               0.089435         0.443986            0.201           0.840
L5.S&P500_Adj_Close                  -0.000027         0.000185           -0.148           0.882
L5.VIX_Adj_Close                      0.001832         0.002391            0.766           0.444
L5.USD_EUR_Exchange_Rate             -0.002406         0.622262           -0.004           0.997
L5.Effective_Federal_Funds_Rate      -0.035490         0.053623           -0.662           0.508
L5.S&P500_Volume                     -0.000000         0.000000           -1.733           0.083
L5.US_Dollar_Index                    0.006021         0.009530            0.632           0.528
L5.CPI_All_Items                     -0.045126         0.037859           -1.192           0.233
L5.Consumer_Sentiment_Index          -0.022505         0.022426           -1.004           0.316
L5.Unemployment_Rate                  0.009582         0.021303            0.450           0.653
L5.Log_GDP                           -0.190344         1.449187           -0.131           0.896
L5.VIX_Daily_Returns                 -3.624580        10.579988           -0.343           0.732
L5.S&P500_Daily_Returns               0.226534         0.197042            1.150           0.250
==================================================================================================

Correlation matrix of residuals
                                S&P500_Adj_Close  VIX_Adj_Close  USD_EUR_Exchange_Rate  Effective_Federal_Funds_Rate  S&P500_Vol
ume  US_Dollar_Index  CPI_All_Items  Consumer_Sentiment_Index  Unemployment_Rate   Log_GDP  VIX_Daily_Returns  S&P500_Daily_Retu
rns
S&P500_Adj_Close                        1.000000      -0.556350               0.524885                      0.135357      -0.339
326        -0.438350       0.086064                  0.215585           0.170334  0.051451           0.418701              0.724
635
VIX_Adj_Close                          -0.556350       1.000000              -0.331635                     -0.297112       0.687
172         0.268238      -0.357495                 -0.320660           0.101081 -0.340165          -0.508960             -0.727
956
USD_EUR_Exchange_Rate                   0.524885      -0.331635               1.000000                      0.080366      -0.472
950        -0.975263       0.297432                 -0.235560           0.039791  0.131577           0.253364              0.439
838
Effective_Federal_Funds_Rate            0.135357      -0.297112               0.080366                      1.000000      -0.069
703        -0.053349       0.234248                  0.512782          -0.462486  0.517144          -0.163037              0.124
292
S&P500_Volume                          -0.339326       0.687172              -0.472950                     -0.069703       1.000
000         0.391842      -0.445426                 -0.146011           0.356750 -0.512318          -0.210202             -0.416
676
US_Dollar_Index                        -0.438350       0.268238              -0.975263                     -0.053349       0.391
```

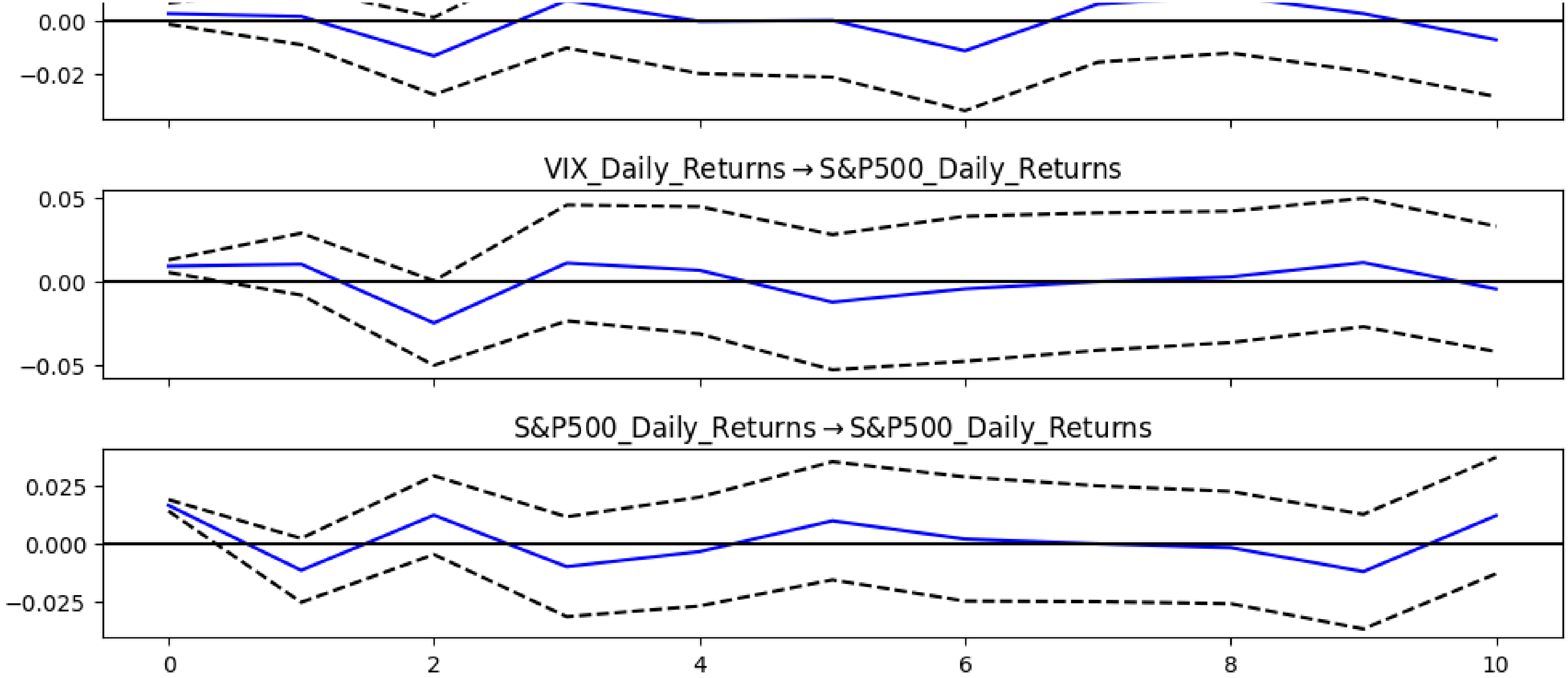
```
842          1.000000      -0.316832                    0.265139          -0.103566 -0.056132          -0.249806              -0.388
365
CPI_All_Items                               0.086064      -0.357495                 0.297432                        0.234248      -0.445
426         -0.316832       1.000000                   -0.135738          -0.278916  0.361102          -0.116698               0.122
233
Consumer_Sentiment_Index                    0.215585      -0.320660                -0.235560                        0.512782      -0.146
011          0.265139      -0.135738                    1.000000          -0.384825  0.472038          -0.019039               0.327
238
Unemployment_Rate                           0.170334       0.101081                 0.039791                       -0.462486       0.356
750         -0.103566      -0.278916                   -0.384825           1.000000 -0.924234           0.414131               0.189
031
Log_GDP                                     0.051451      -0.340165                 0.131577                        0.517144      -0.512
318         -0.056132       0.361102                    0.472038          -0.924234  1.000000          -0.243057               0.079
240
VIX_Daily_Returns                           0.418701      -0.508960                 0.253364                       -0.163037      -0.210
202         -0.249806      -0.116698                   -0.019039           0.414131 -0.243057           1.000000               0.666
719
S&P500_Daily_Returns                        0.724635      -0.727956                 0.439838                        0.124292      -0.416
676         -0.388365       0.122233                    0.327238           0.189031  0.079240           0.666719               1.000
000
```

In [41]:

```
# Impulse response functions (IRF)
irf = var_model.irf(10)  # Forecast 10 periods
irf.plot(orth=True, response="S&P500_Daily_Returns", figsize=(10, 20))
plt.tight_layout()
plt.show()
```


Impulse responses (orthogonalized)
S&P500_Adj_Close → S&P500_Daily_Returns
0.025
0.000
−0.025
VIX_Adj_Close → S&P500_Daily_Returns
0.05
0.00
−0.05
USD_EUR_Exchange_Rate → S&P500_Daily_Returns
0.05
0.00
Effective_Federal_Funds_Rate → S&P500_Daily_Returns
0.05
0.00
−0.05
S&P500_Volume → S&P500_Daily_Returns
0.00


−0.05
US_Dollar_Index → S&P500_Daily_Returns
0.025
0.000
−0.025
CPI_All_Items → S&P500_Daily_Returns
0.025
0.000
−0.025
Consumer_Sentiment_Index → S&P500_Daily_Returns
0.02
0.00
−0.02
Unemployment_Rate → S&P500_Daily_Returns
0.025
0.000
−0.025
Log_GDP → S&P500_Daily_Returns
0.02



In [34]:

```
# fevd
fevd = var_model.fevd(5)
for i in range(len(df_diff.columns)):
    print(f"\nFEVD for {df_diff.columns[i]}:")
    print(fevd.decomp[i])
```

```
FEVD for S&P500_Adj_Close:
[[1.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00]
 [6.61041199e-01 3.81452132e-04 1.64897635e-02 8.58070366e-03
  3.48714486e-02 2.55081710e-02 9.29953510e-02 4.78643614e-02
  4.11661517e-04 6.86933403e-04 3.89116197e-02 7.22573354e-02]
 [4.56092782e-01 1.68566313e-01 1.40814162e-02 3.47077858e-02
  3.68441128e-02 1.69609957e-02 5.86542270e-02 4.22214046e-02
  3.15297439e-02 3.19103249e-02 6.28381630e-02 4.55927312e-02]
 [3.59432034e-01 1.33350566e-01 2.16057878e-02 1.38572713e-01
  5.95377069e-02 1.33395855e-02 8.07357693e-02 5.23690072e-02
  2.72288430e-02 2.64330778e-02 5.07451222e-02 3.66497879e-02]
 [3.38213847e-01 1.32234790e-01 1.79425291e-02 1.17848592e-01
  5.24830779e-02 4.46580213e-02 6.75304672e-02 4.40985835e-02
  8.61828449e-02 2.48811351e-02 4.38429332e-02 3.00831784e-02]]

FEVD for VIX_Adj_Close:
[[3.09525314e-01 6.90474686e-01 0.00000000e+00 0.00000000e+00
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00]
 [2.74148319e-01 5.36291722e-01 1.03663075e-03 2.25888019e-02
  3.95323928e-02 4.55811345e-02 5.01543900e-02 8.53378746e-03
  7.82509267e-03 3.68965134e-04 1.37002935e-02 2.38469689e-04]
 [2.12393190e-01 5.17063957e-01 4.26972437e-03 2.43270947e-02
  9.02913784e-02 3.37876210e-02 3.94851700e-02 2.11020441e-02
  1.70991214e-02 2.74498349e-02 1.17780453e-02 9.52818784e-04]
 [1.37856565e-01 3.82478186e-01 4.98819890e-03 2.78280431e-01
  5.82784630e-02 2.59280111e-02 3.64684663e-02 2.51954726e-02
  1.13728219e-02 2.43921069e-02 1.25336904e-02 2.22758743e-03]
 [1.63768900e-01 3.21764092e-01 1.35823641e-02 2.17389170e-01
  5.60741413e-02 7.79620310e-02 4.63487857e-02 2.25472460e-02
  2.31786556e-02 1.92425315e-02 2.76516062e-02 1.04904772e-02]]

FEVD for USD_EUR_Exchange_Rate:
[[0.27550374 0.00227286 0.7222234  0.         0.         0.
  0.         0.         0.         0.         0.         0.        ]
 [0.20814788 0.00151279 0.61092203 0.0487034  0.01692774 0.00337843
  0.02266858 0.00616312 0.04538349 0.00165274 0.02399958 0.01054022]
 [0.18269777 0.07216675 0.52934584 0.05814246 0.01899077 0.00686431
  0.02269526 0.02039113 0.04046023 0.00333032 0.03025793 0.01465723]
 [0.16542633 0.06893925 0.47901082 0.11639669 0.02021196 0.00816876
  0.02107946 0.02276411 0.04795339 0.00599688 0.02953224 0.01452012]
 [0.17065069 0.06345949 0.44037222 0.10854056 0.02010177 0.04913809
```

```
  0.01914933 0.02398057 0.04478494 0.01809061 0.02836555 0.01336618]]

FEVD for Effective_Federal_Funds_Rate:
[[1.83214804e-02 7.12521783e-02 1.60717369e-05 9.10410270e-01
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00]
 [1.24835396e-02 1.17221576e-01 3.98820778e-04 6.82365767e-01
  2.79695747e-03 3.92500359e-03 2.11860068e-02 2.98595953e-02
  6.90230478e-02 9.51918635e-03 4.27737948e-02 8.44670447e-03]
 [3.14964592e-02 8.85750697e-02 1.48256312e-02 5.54432831e-01
  3.37658108e-03 5.00846226e-03 3.09947753e-02 2.49841780e-02
  1.81247456e-01 1.23494763e-02 4.33312566e-02 9.37782317e-03]
 [2.69204624e-02 1.16021387e-01 1.23317870e-02 4.41798546e-01
  2.34368990e-03 5.07292970e-03 3.43728324e-02 8.20283447e-02
  1.92511041e-01 2.38648277e-02 2.98451058e-02 3.28890457e-02]
 [2.91589036e-02 1.22500385e-01 1.06265489e-02 3.88842232e-01
  1.45434131e-02 1.01859922e-02 3.53990000e-02 1.02454792e-01
  1.90720672e-01 2.33262128e-02 4.39143672e-02 2.83274814e-02]]

FEVD for S&P500_Volume:
[[1.15142205e-01 3.59738371e-01 9.81530160e-02 2.00395569e-02
  4.06926851e-01 0.00000000e+00 0.00000000e+00 0.00000000e+00
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00]
 [9.15957863e-02 2.82869196e-01 1.34950332e-01 1.40919058e-02
  3.69807363e-01 1.68509062e-04 1.90962192e-04 1.44376881e-02
  2.20666152e-02 9.34970071e-03 2.86490707e-02 3.18228704e-02]
 [7.70851662e-02 2.29273323e-01 1.43002903e-01 2.66991603e-02
  3.00159800e-01 1.08539262e-03 1.89976798e-02 3.58315189e-02
  6.81156530e-02 1.46929600e-02 2.26322233e-02 6.24242202e-02]
 [9.79253292e-02 1.91123829e-01 1.15287660e-01 1.45550874e-01
  2.39056716e-01 1.57406666e-03 2.20882245e-02 2.74656898e-02
  7.40102477e-02 1.12072689e-02 2.81316333e-02 4.65784610e-02]
 [1.16115310e-01 1.59027674e-01 9.88766778e-02 1.56467875e-01
  2.04099928e-01 1.74312167e-02 3.35391098e-02 2.38407973e-02
  1.01875765e-01 1.31487534e-02 3.53690152e-02 4.02078776e-02]]

FEVD for US_Dollar_Index:
[[1.92150737e-01 8.59609990e-04 7.65983908e-01 1.16581018e-04
  6.19581504e-03 3.46933489e-02 0.00000000e+00 0.00000000e+00
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00]
 [1.51219834e-01 3.54722636e-03 6.01363993e-01 1.67105849e-02
  6.10469831e-02 2.13996535e-02 1.43440564e-02 5.96559823e-03
  6.73341915e-02 1.05745504e-02 2.10125867e-02 2.54807414e-02]
 [1.39992704e-01 8.20854205e-02 5.11883534e-01 3.76284045e-02
```

```
  5.48159857e-02 2.02892987e-02 1.24473691e-02 2.03378384e-02
  5.70843531e-02 9.32655332e-03 2.38942302e-02 3.02143082e-02]
 [1.35473377e-01 7.91544503e-02 4.78332800e-01 6.36948511e-02
  5.91824073e-02 2.03942205e-02 1.16315578e-02 2.02471591e-02
  7.14728603e-02 9.30684672e-03 2.23915098e-02 2.87179593e-02]
 [1.51229504e-01 7.17635196e-02 4.29950844e-01 6.55151355e-02
  5.34929023e-02 5.52109143e-02 1.04429737e-02 2.39682067e-02
  6.84158218e-02 2.05057088e-02 2.25648005e-02 2.69396690e-02]]

FEVD for CPI_All_Items:
[[7.40707518e-03 1.38832282e-01 7.61366824e-02 1.69560876e-02
  3.82312799e-02 5.45011813e-02 6.67935412e-01 0.00000000e+00
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00]
 [1.33700352e-02 1.20271827e-01 3.20016723e-02 8.30214060e-02
  5.64462028e-02 9.32208956e-02 5.80950893e-01 3.01546694e-04
  1.30824551e-02 5.06970750e-05 6.88686197e-03 3.95506793e-04]
 [1.21291080e-02 1.14331664e-01 3.55048393e-02 1.24773591e-01
  5.12019886e-02 9.30074508e-02 5.28989653e-01 7.68441720e-04
  1.58046846e-02 3.64903509e-03 1.73167085e-02 2.52283654e-03]
 [1.17064308e-02 1.55809788e-01 3.06807192e-02 1.39293755e-01
  5.11495303e-02 8.01740213e-02 4.55127893e-01 5.77504340e-03
  1.37826979e-02 2.10369904e-02 3.08949544e-02 4.56817667e-03]
 [1.63863976e-02 1.85791850e-01 2.92950346e-02 1.18498182e-01
  4.34543956e-02 1.03087195e-01 3.95920639e-01 1.06473125e-02
  3.86402148e-02 2.07074904e-02 2.46474407e-02 1.29238483e-02]]

FEVD for Consumer_Sentiment_Index:
[[4.64771542e-02 5.83489888e-02 1.79679027e-01 1.91388562e-01
  3.70019127e-02 1.67812379e-02 9.51915079e-02 3.75131609e-01
  0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00]
 [4.60744145e-02 1.76554896e-01 8.54171654e-02 1.11141477e-01
  3.51833267e-02 3.66619624e-02 2.03767744e-01 2.23617679e-01
  3.91981866e-06 3.45095413e-03 6.82283310e-02 9.89812932e-03]
 [6.22226950e-02 1.90365228e-01 7.94925788e-02 9.50180298e-02
  4.61717740e-02 3.20071077e-02 1.81675892e-01 1.90719537e-01
  4.86824950e-02 2.93996081e-03 5.74238405e-02 1.32808617e-02]
 [6.52921444e-02 1.63929432e-01 7.04914330e-02 1.10340892e-01
  4.42887402e-02 3.79206215e-02 1.57175244e-01 1.82277994e-01
  4.27888583e-02 6.56932475e-02 4.89786808e-02 1.08227123e-02]
 [1.57244292e-01 1.43384550e-01 6.23969422e-02 9.56346910e-02
  4.10509602e-02 3.89256151e-02 1.36737292e-01 1.72810887e-01
  3.65681658e-02 6.19011727e-02 4.38087195e-02 9.53671312e-03]]

FEVD for Unemployment_Rate:
```

```
[[0.02901357 0.05555019 0.0020393  0.19635983 0.2544282  0.02742307
  0.00856301 0.05441531 0.37220751 0.         0.         0.        ]
 [0.04633285 0.11603285 0.01046793 0.170905   0.1627404  0.01560915
  0.01136824 0.07231638 0.21425998 0.01339508 0.03173868 0.13483346]
 [0.07272127 0.15754335 0.0214526  0.15710361 0.12997753 0.01351424
  0.01153364 0.0634862  0.22353319 0.01271483 0.0285481  0.10787143]
 [0.06694559 0.14338248 0.02011576 0.16637256 0.12677292 0.01241544
  0.01390999 0.08529715 0.20384595 0.03619468 0.02605462 0.09869286]
 [0.09632983 0.14609777 0.02025561 0.15250549 0.12883911 0.0135878
  0.01498934 0.07982662 0.18962954 0.03302361 0.03303147 0.09188381]]

FEVD for Log_GDP:
[[0.00264721 0.14056572 0.01040728 0.18510194 0.21959743 0.0182567
  0.0079176  0.08658154 0.26448364 0.06444094 0.         0.        ]
 [0.10075924 0.10474836 0.01108612 0.15836772 0.16136488 0.00949416
  0.02136803 0.08634241 0.16629134 0.04485825 0.0278798  0.10743969]
 [0.10216134 0.16132841 0.01728136 0.16766451 0.12933287 0.01014084
  0.01676994 0.0728903  0.15979593 0.04385896 0.02484756 0.09392798]
 [0.08988223 0.15044899 0.01583772 0.17698149 0.13425886 0.00951962
  0.03146613 0.10193621 0.1392876  0.04448898 0.02538399 0.08050816]
 [0.09288019 0.1395604  0.01837107 0.16581957 0.1428539  0.02178871
  0.03060762 0.10518778 0.1334906  0.04453959 0.02885978 0.07604079]]

FEVD for VIX_Daily_Returns:
[[1.75309609e-01 1.10335706e-01 4.36687571e-04 1.04397390e-01
  8.26468322e-02 4.23575164e-03 5.93931966e-02 1.22013670e-02
  1.50173106e-02 1.11201600e-03 4.34914134e-01 0.00000000e+00]
 [1.37251291e-01 1.63263277e-01 2.82801073e-04 1.69269000e-01
  5.77807161e-02 1.28511694e-02 2.99062025e-02 5.37438959e-03
  1.61631018e-02 2.08591652e-03 3.99196969e-01 6.57516555e-03]
 [1.28875632e-01 1.53133648e-01 1.02479102e-03 1.75580062e-01
  8.02948241e-02 1.59399454e-02 2.90453355e-02 5.22858849e-03
  1.71269684e-02 3.43735160e-03 3.83804444e-01 6.50840989e-03]
 [1.20159086e-01 1.48939367e-01 6.05148277e-03 1.89372330e-01
  8.57471558e-02 1.96587045e-02 2.71150946e-02 7.46846715e-03
  1.98879760e-02 6.17076540e-03 3.56795250e-01 1.26343206e-02]
 [1.16095290e-01 1.38862895e-01 1.20995257e-02 1.92241683e-01
  8.01202522e-02 2.27171463e-02 2.52669462e-02 1.04000431e-02
  2.45176045e-02 5.98685806e-03 3.55629239e-01 1.60625167e-02]]

FEVD for S&P500_Daily_Returns:
[[0.52509641 0.15279102 0.00231086 0.00667218 0.02002978 0.00076925
  0.00676232 0.04572447 0.02175945 0.00395915 0.04967874 0.16444636]
 [0.43149582 0.10427256 0.00125203 0.0041441  0.01079451 0.04545599
```

```
 0.12420731 0.06258969 0.02255602 0.00286217 0.06016598 0.13020382]
[0.27234456 0.18666106 0.00193991 0.04001265 0.00825628 0.03229578
 0.12713703 0.03522416 0.01739329 0.03391571 0.14459328 0.10022629]
[0.2021206  0.18276168 0.0352664  0.13199186 0.020338   0.03553492
 0.10449048 0.030604   0.01305511 0.03273126 0.12332483 0.08778086]
[0.18690847 0.15304072 0.03984019 0.15816859 0.02367499 0.06220756
 0.11766473 0.02597446 0.02870676 0.02655417 0.10476213 0.07249723]]
```

In [35]:

```
# 5. Granger causality tests
def my_granger_tests(data, max_lag):
    for column in data.columns:
        if column != "S&P500_Daily_Returns":
            print(f"Granger Causality Test: {column} -> S&P500_Daily_Returns")
            grangercausalitytests(data[["S&P500_Daily_Returns", column]], maxlag=max_lag)
            print()
```

In [36]:

```
my_granger_tests(df_diff, 4)
```

```
Granger Causality Test: S&P500_Adj_Close -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=19.3565 , p=0.0000  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=20.0164 , p=0.0000  , df=1
likelihood ratio test: chi2=18.0925 , p=0.0000  , df=1
parameter F test:         F=19.3565 , p=0.0000  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=6.7790  , p=0.0019  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=14.3554 , p=0.0008  , df=2
likelihood ratio test: chi2=13.3194 , p=0.0013  , df=2
parameter F test:         F=6.7790  , p=0.0019  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=4.9781  , p=0.0032  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=16.2090 , p=0.0010  , df=3
likelihood ratio test: chi2=14.8908 , p=0.0019  , df=3
parameter F test:         F=4.9781  , p=0.0032  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=3.9026  , p=0.0061  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=17.3890 , p=0.0016  , df=4
likelihood ratio test: chi2=15.8683 , p=0.0032  , df=4
parameter F test:         F=3.9026  , p=0.0061  , df_denom=79, df_num=4

Granger Causality Test: VIX_Adj_Close -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=2.0228  , p=0.1585  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=2.0917  , p=0.1481  , df=1
likelihood ratio test: chi2=2.0680  , p=0.1504  , df=1
parameter F test:         F=2.0228  , p=0.1585  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=10.6923 , p=0.0001  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=22.6425 , p=0.0000  , df=2
likelihood ratio test: chi2=20.1968 , p=0.0000  , df=2
```

```
parameter F test:         F=10.6923 , p=0.0001  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=6.8472  , p=0.0004  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=22.2952 , p=0.0001  , df=3
likelihood ratio test: chi2=19.8959 , p=0.0002  , df=3
parameter F test:         F=6.8472  , p=0.0004  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=4.3313  , p=0.0032  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=19.2989 , p=0.0007  , df=4
likelihood ratio test: chi2=17.4487 , p=0.0016  , df=4
parameter F test:         F=4.3313  , p=0.0032  , df_denom=79, df_num=4

Granger Causality Test: USD_EUR_Exchange_Rate -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=0.0243  , p=0.8765  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=0.0251  , p=0.8741  , df=1
likelihood ratio test: chi2=0.0251  , p=0.8741  , df=1
parameter F test:         F=0.0243  , p=0.8765  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=3.3642  , p=0.0393  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=7.1243  , p=0.0284  , df=2
likelihood ratio test: chi2=6.8563  , p=0.0324  , df=2
parameter F test:         F=3.3642  , p=0.0393  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=2.9875  , p=0.0358  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=9.7277  , p=0.0210  , df=3
likelihood ratio test: chi2=9.2319  , p=0.0264  , df=3
parameter F test:         F=2.9875  , p=0.0358  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=1.5373  , p=0.1995  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=6.8498  , p=0.1440  , df=4
likelihood ratio test: chi2=6.5963  , p=0.1588  , df=4
```

```
parameter F test:         F=1.5373  , p=0.1995  , df_denom=79, df_num=4

Granger Causality Test: Effective_Federal_Funds_Rate -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=0.6097  , p=0.4370  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=0.6305  , p=0.4272  , df=1
likelihood ratio test: chi2=0.6283  , p=0.4280  , df=1
parameter F test:         F=0.6097  , p=0.4370  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=0.6349  , p=0.5325  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=1.3444  , p=0.5106  , df=2
likelihood ratio test: chi2=1.3345  , p=0.5131  , df=2
parameter F test:         F=0.6349  , p=0.5325  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=0.8935  , p=0.4482  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=2.9094  , p=0.4058  , df=3
likelihood ratio test: chi2=2.8629  , p=0.4133  , df=3
parameter F test:         F=0.8935  , p=0.4482  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=2.6633  , p=0.0385  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=11.8671 , p=0.0184  , df=4
likelihood ratio test: chi2=11.1323 , p=0.0251  , df=4
parameter F test:         F=2.6633  , p=0.0385  , df_denom=79, df_num=4

Granger Causality Test: S&P500_Volume -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=0.4166  , p=0.5203  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=0.4308  , p=0.5116  , df=1
likelihood ratio test: chi2=0.4298  , p=0.5121  , df=1
parameter F test:         F=0.4166  , p=0.5203  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=2.8006  , p=0.0664  , df_denom=85, df_num=2
```

```
ssr based chi2 test:   chi2=5.9306  , p=0.0515  , df=2
likelihood ratio test: chi2=5.7434  , p=0.0566  , df=2
parameter F test:         F=2.8002  , p=0.0664  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=2.1725  , p=0.0975  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=7.0737  , p=0.0696  , df=3
likelihood ratio test: chi2=6.8067  , p=0.0783  , df=3
parameter F test:         F=2.1729  , p=0.0974  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=2.3690  , p=0.0596  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=10.5554 , p=0.0320  , df=4
likelihood ratio test: chi2=9.9689  , p=0.0410  , df=4
parameter F test:         F=2.3687  , p=0.0596  , df_denom=79, df_num=4

Granger Causality Test: US_Dollar_Index -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=0.0047  , p=0.9453  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=0.0049  , p=0.9442  , df=1
likelihood ratio test: chi2=0.0049  , p=0.9442  , df=1
parameter F test:         F=0.0047  , p=0.9453  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=1.4889  , p=0.2314  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=3.1530  , p=0.2067  , df=2
likelihood ratio test: chi2=3.0991  , p=0.2123  , df=2
parameter F test:         F=1.4889  , p=0.2314  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=2.0476  , p=0.1136  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=6.6671  , p=0.0833  , df=3
likelihood ratio test: chi2=6.4292  , p=0.0925  , df=3
parameter F test:         F=2.0476  , p=0.1136  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=1.1040  , p=0.3606  , df_denom=79, df_num=4
```

```
ssr based chi2 test:   chi2=4.9189  , p=0.2957  , df=4
likelihood ratio test: chi2=4.7864  , p=0.3099  , df=4
parameter F test:         F=1.1040  , p=0.3606  , df_denom=79, df_num=4

Granger Causality Test: CPI_All_Items -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=0.1663  , p=0.6844  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=0.1720  , p=0.6784  , df=1
likelihood ratio test: chi2=0.1718  , p=0.6785  , df=1
parameter F test:         F=0.1663  , p=0.6844  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=0.4442  , p=0.6428  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=0.9406  , p=0.6248  , df=2
likelihood ratio test: chi2=0.9357  , p=0.6263  , df=2
parameter F test:         F=0.4442  , p=0.6428  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=1.0730  , p=0.3652  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=3.4937  , p=0.3216  , df=3
likelihood ratio test: chi2=3.4269  , p=0.3304  , df=3
parameter F test:         F=1.0730  , p=0.3652  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=2.6785  , p=0.0376  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=11.9345 , p=0.0178  , df=4
likelihood ratio test: chi2=11.1917 , p=0.0245  , df=4
parameter F test:         F=2.6785  , p=0.0376  , df_denom=79, df_num=4

Granger Causality Test: Consumer_Sentiment_Index -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=4.6023  , p=0.0347  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=4.7592  , p=0.0291  , df=1
likelihood ratio test: chi2=4.6389  , p=0.0313  , df=1
parameter F test:         F=4.6023  , p=0.0347  , df_denom=88, df_num=1

Granger Causality
```

```
number of lags (no zero) 2
ssr based F test:         F=0.6736  , p=0.5125  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=1.4265  , p=0.4900  , df=2
likelihood ratio test: chi2=1.4153  , p=0.4928  , df=2
parameter F test:         F=0.6736  , p=0.5125  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=0.3950  , p=0.7570  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=1.2860  , p=0.7325  , df=3
likelihood ratio test: chi2=1.2768  , p=0.7346  , df=3
parameter F test:         F=0.3950  , p=0.7570  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=1.5740  , p=0.1894  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=7.0135  , p=0.1352  , df=4
likelihood ratio test: chi2=6.7480  , p=0.1498  , df=4
parameter F test:         F=1.5740  , p=0.1894  , df_denom=79, df_num=4

Granger Causality Test: Unemployment_Rate -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=9.4614  , p=0.0028  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=9.7839  , p=0.0018  , df=1
likelihood ratio test: chi2=9.2929  , p=0.0023  , df=1
parameter F test:         F=9.4614  , p=0.0028  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=4.2416  , p=0.0175  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=8.9821  , p=0.0112  , df=2
likelihood ratio test: chi2=8.5617  , p=0.0138  , df=2
parameter F test:         F=4.2416  , p=0.0175  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=3.5859  , p=0.0172  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=11.6761 , p=0.0086  , df=3
likelihood ratio test: chi2=10.9712 , p=0.0119  , df=3
parameter F test:         F=3.5859  , p=0.0172  , df_denom=82, df_num=3

Granger Causality
```

```
number of lags (no zero) 4
ssr based F test:         F=2.7277  , p=0.0350  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=12.1536 , p=0.0162  , df=4
likelihood ratio test: chi2=11.3844 , p=0.0226  , df=4
parameter F test:         F=2.7277  , p=0.0350  , df_denom=79, df_num=4

Granger Causality Test: Log_GDP -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=13.2944 , p=0.0005  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=13.7476 , p=0.0002  , df=1
likelihood ratio test: chi2=12.8032 , p=0.0003  , df=1
parameter F test:         F=13.2944 , p=0.0005  , df_denom=88, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=7.1046  , p=0.0014  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=15.0450 , p=0.0005  , df=2
likelihood ratio test: chi2=13.9121 , p=0.0010  , df=2
parameter F test:         F=7.1046  , p=0.0014  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=4.7206  , p=0.0043  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=15.3706 , p=0.0015  , df=3
likelihood ratio test: chi2=14.1788 , p=0.0027  , df=3
parameter F test:         F=4.7206  , p=0.0043  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=3.3169  , p=0.0145  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=14.7789 , p=0.0052  , df=4
likelihood ratio test: chi2=13.6614 , p=0.0085  , df=4
parameter F test:         F=3.3169  , p=0.0145  , df_denom=79, df_num=4

Granger Causality Test: VIX_Daily_Returns -> S&P500_Daily_Returns

Granger Causality
number of lags (no zero) 1
ssr based F test:         F=12.5046 , p=0.0007  , df_denom=88, df_num=1
ssr based chi2 test:   chi2=12.9309 , p=0.0003  , df=1
likelihood ratio test: chi2=12.0908 , p=0.0005  , df=1
parameter F test:         F=12.5046 , p=0.0007  , df_denom=88, df_num=1
```

```
Granger Causality
number of lags (no zero) 2
ssr based F test:         F=5.7252  , p=0.0046  , df_denom=85, df_num=2
ssr based chi2 test:   chi2=12.1240 , p=0.0023  , df=2
likelihood ratio test: chi2=11.3740 , p=0.0034  , df=2
parameter F test:         F=5.7252  , p=0.0046  , df_denom=85, df_num=2

Granger Causality
number of lags (no zero) 3
ssr based F test:         F=5.0399  , p=0.0030  , df_denom=82, df_num=3
ssr based chi2 test:   chi2=16.4104 , p=0.0009  , df=3
likelihood ratio test: chi2=15.0610 , p=0.0018  , df=3
parameter F test:         F=5.0399  , p=0.0030  , df_denom=82, df_num=3

Granger Causality
number of lags (no zero) 4
ssr based F test:         F=4.1505  , p=0.0042  , df_denom=79, df_num=4
ssr based chi2 test:   chi2=18.4932 , p=0.0010  , df=4
likelihood ratio test: chi2=16.7855 , p=0.0021  , df=4
parameter F test:         F=4.1505  , p=0.0042  , df_denom=79, df_num=4
```

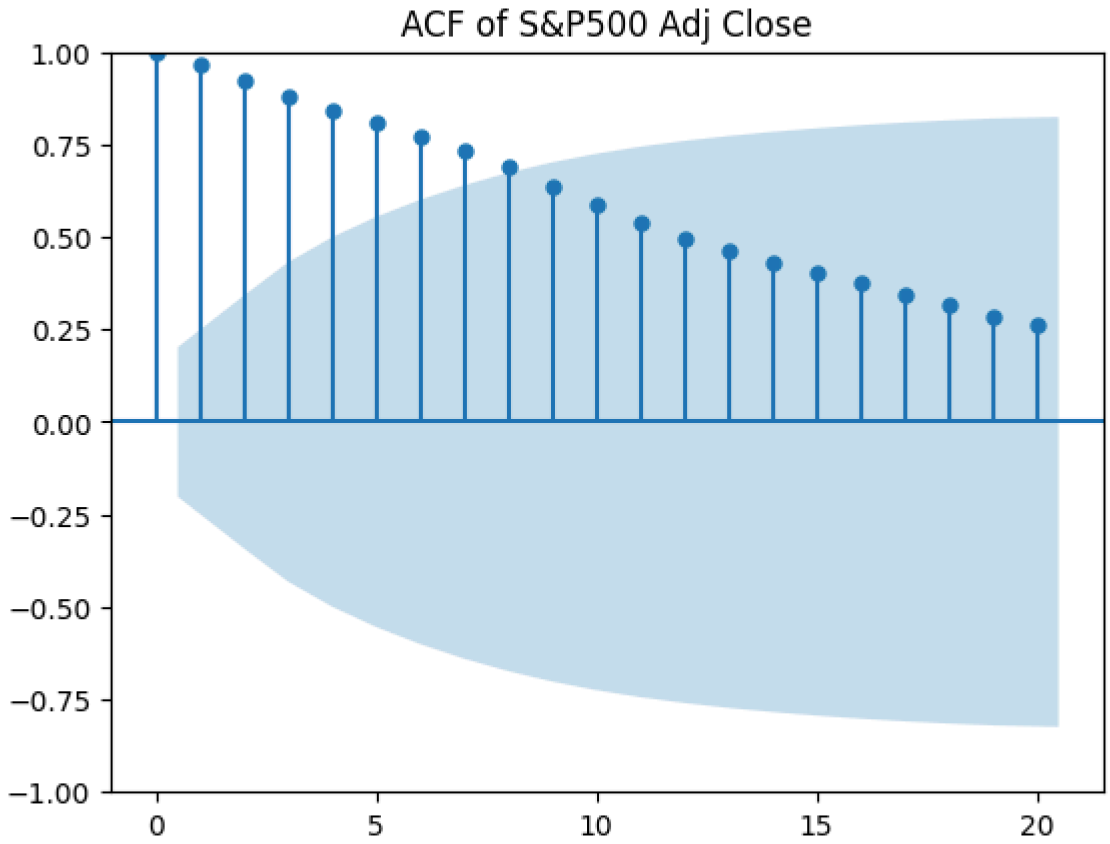
In [27]:

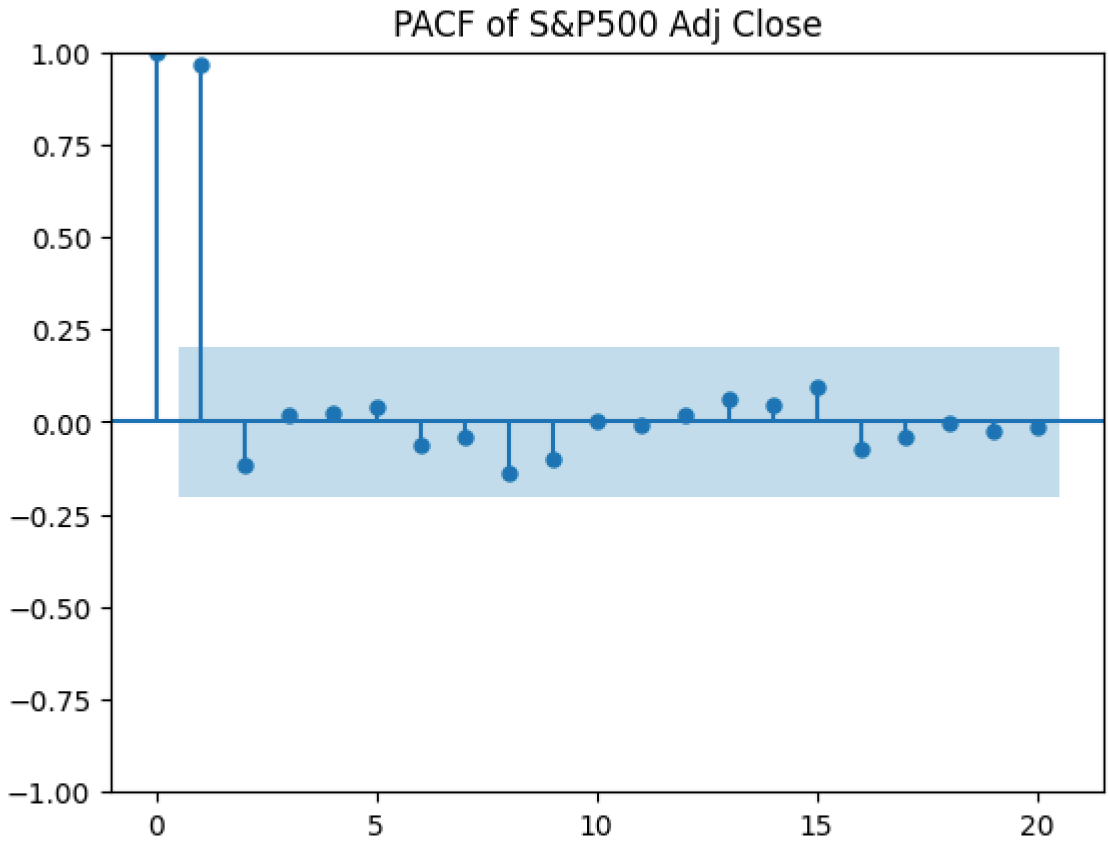
```python
# 6. Cointegration analysis
for column in columns_to_select:
    if column != "S&P500_Adj_Close":
        try:
            score, p_value, _ = coint(df["S&P500_Adj_Close"], df[column])
            print(f"Cointegration Test: {column}")
            print(f"t-statistic: {score}, p-value: {p_value}")
        except:
            print(f"Error with {column} column.")
```

```
Cointegration Test: VIX_Adj_Close
t-statistic: 0.9329050820882765, p-value: 1.0
Cointegration Test: USD_EUR_Exchange_Rate
t-statistic: -0.44983845012404067, p-value: 0.9677169764998029
Cointegration Test: Effective_Federal_Funds_Rate
t-statistic: 0.3568354618599289, p-value: 0.9914894347573544
Cointegration Test: S&P500_Volume
t-statistic: 0.10835450526367843, p-value: 0.988124024101249
Cointegration Test: US_Dollar_Index
t-statistic: -0.9728435070428844, p-value: 0.9078777984501641
Cointegration Test: CPI_All_Items
t-statistic: -0.19510927867016628, p-value: 0.980179664372054
Cointegration Test: Consumer_Sentiment_Index
t-statistic: 0.4471074554485779, p-value: 0.9922738312560463
Cointegration Test: Unemployment_Rate
t-statistic: -0.4442003878183708, p-value: 0.9680750879894606
Cointegration Test: Log_GDP
t-statistic: -2.1984242221701575, p-value: 0.425176256972372
Cointegration Test: VIX_Daily_Returns
t-statistic: 0.28304513124015734, p-value: 0.9906952731974714
Error with S&P500_Daily_Returns column.
```

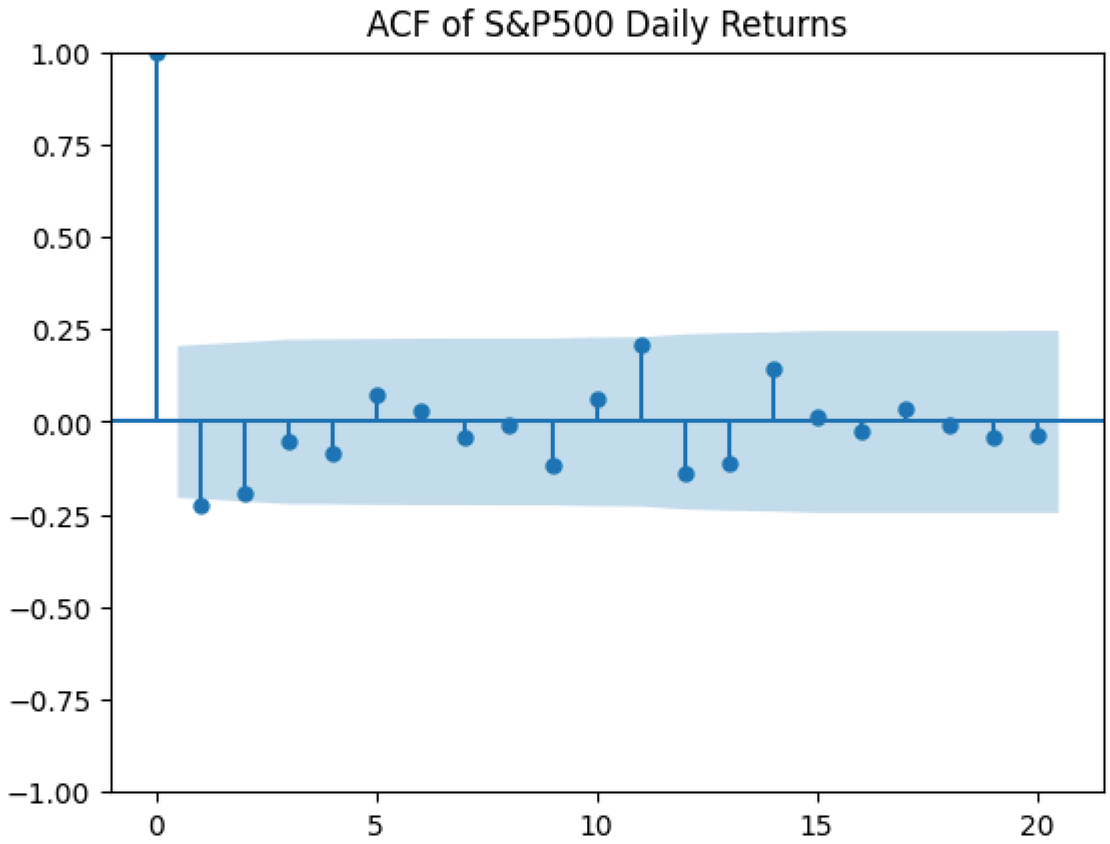
In [28]:

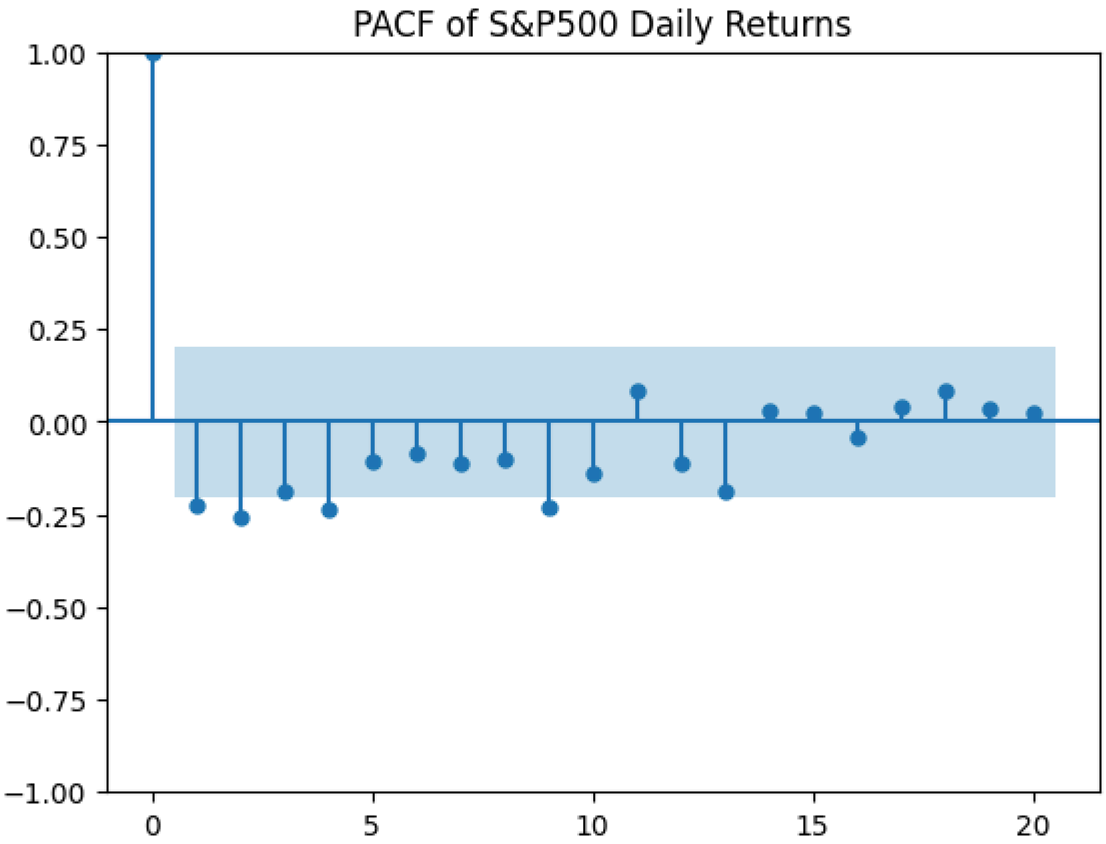
```
# Additional Visualizations: Autocorrelation
plot_acf(df["S&P500_Adj_Close"].dropna(), title="ACF of S&P500 Adj Close")
plot_pacf(df["S&P500_Adj_Close"].dropna(), title="PACF of S&P500 Adj Close")
plt.show()
```


ACF of S&P500 Adj Close
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20

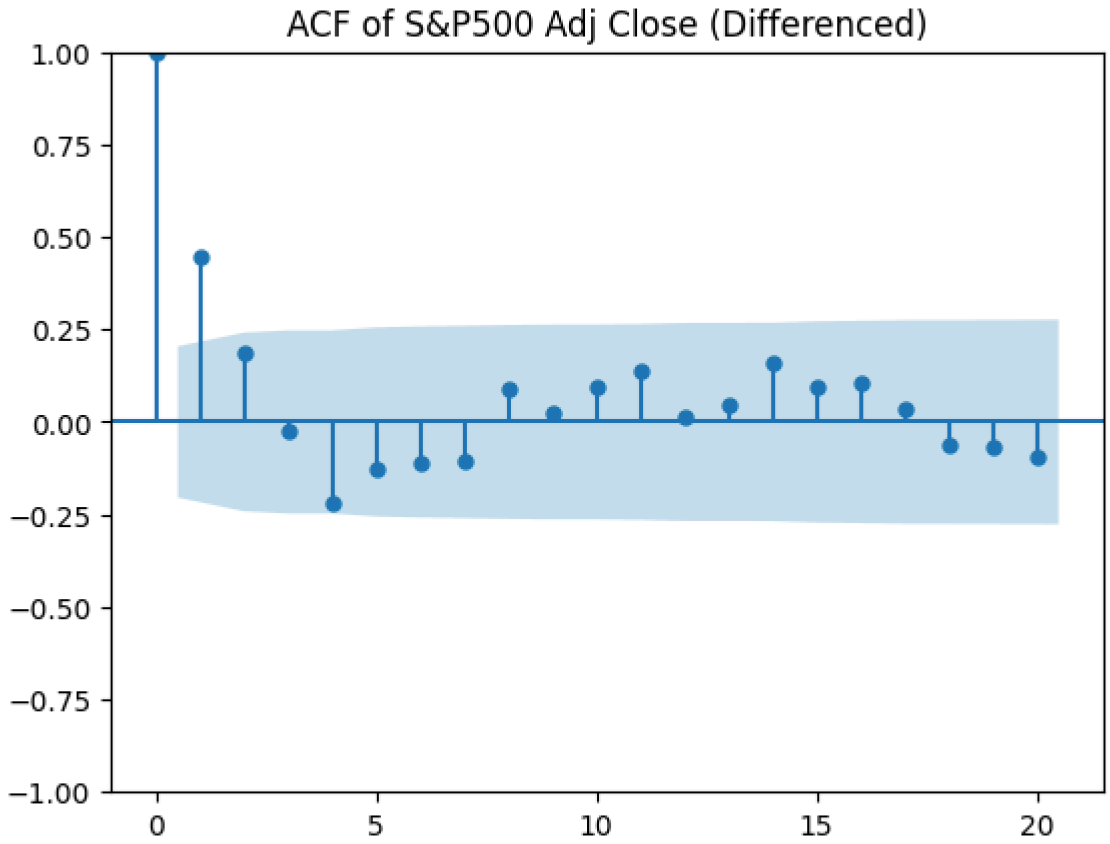


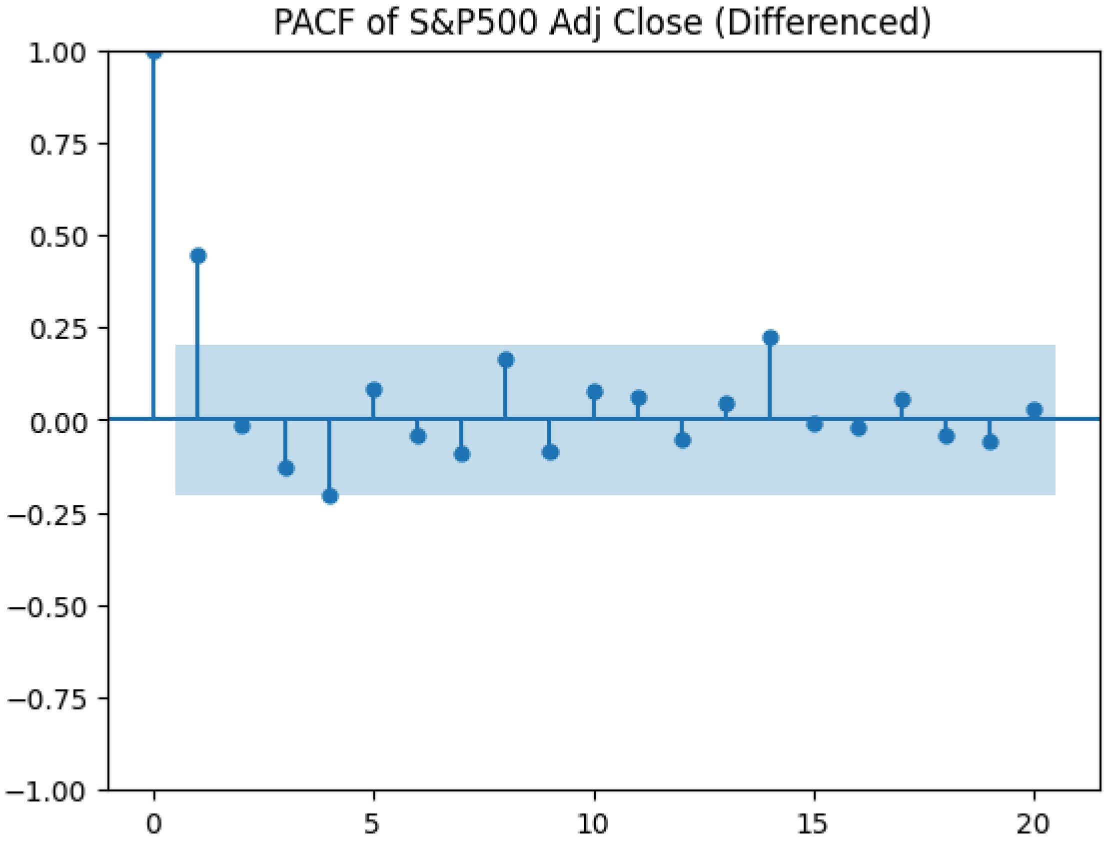
In [29]:
```
plot_acf(df_diff["S&P500_Daily_Returns"].dropna(), title="ACF of S&P500 Daily Returns")
plot_pacf(df_diff["S&P500_Daily_Returns"].dropna(), title="PACF of S&P500 Daily Returns")
plt.show()
```


ACF of S&P500 Daily Returns
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20



In [30]:
```
plot_acf(df_diff['S&P500_Adj_Close'].dropna(), title="ACF of S&P500 Adj Close (Differenced)")
plot_pacf(df_diff['S&P500_Adj_Close'].dropna(), title="PACF of S&P500 Adj Close (Differenced)")
plt.show()
```


ACF of S&P500 Adj Close (Differenced)
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20


PACF of S&P500 Adj Close (Differenced)
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20