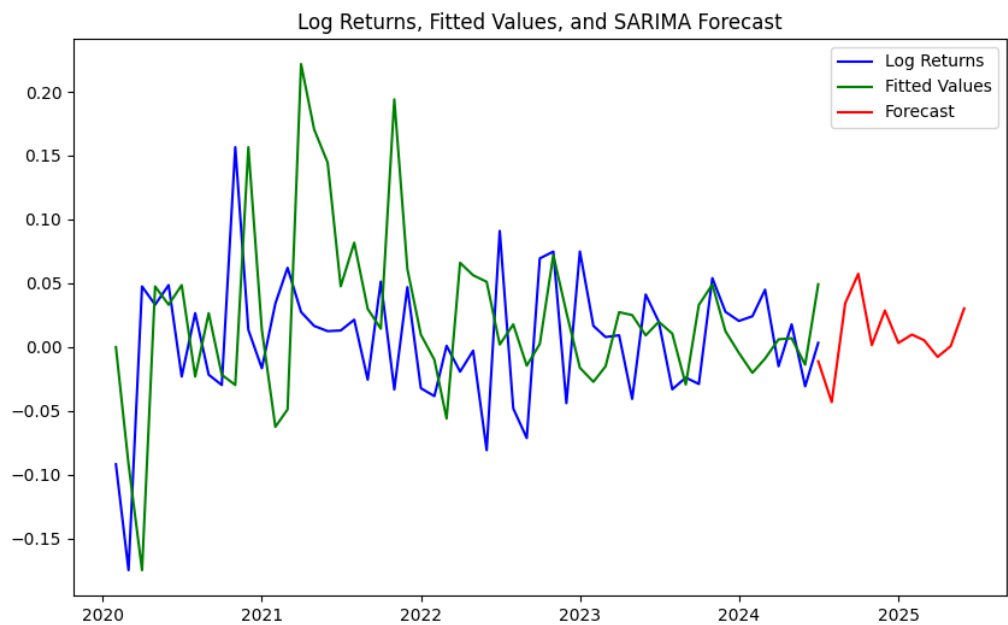


# Impact on Stock Indices:

EU:

Time Series Analysis:



Tit = total number of iterations

Tnf = total number of function evaluations

Tnint = total number of segments explored during Cauchy searches

Skip = number of BFGS updates skipped

Nact = number of active bounds at final generalized Cauchy point

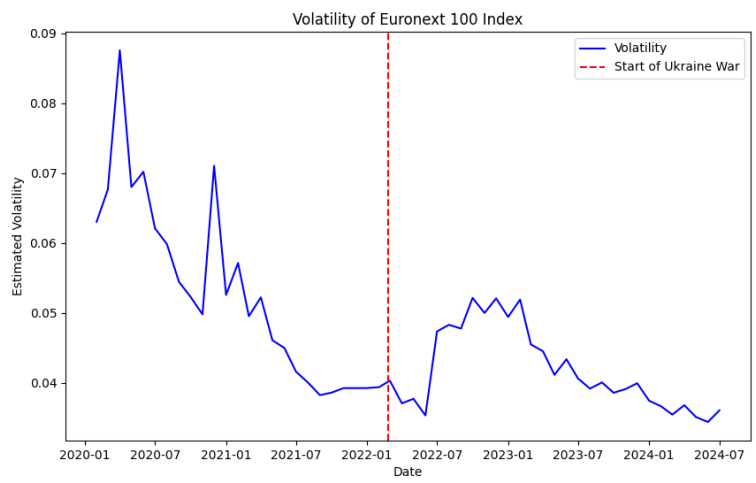
Projg = norm of the final projected gradient

F = final function value

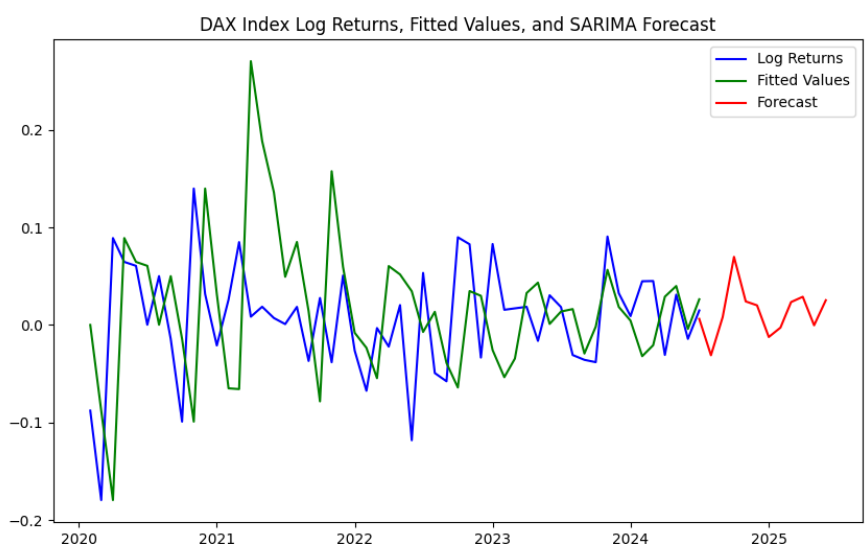
\*\*\*

N	Tit	Tnf	Tnint	Skip	Nact	Projg	F
5	48	93	1	0	0	2.405D-03	-9.560D-01
F = -0.95599133183230545							

## Volatility Analysis



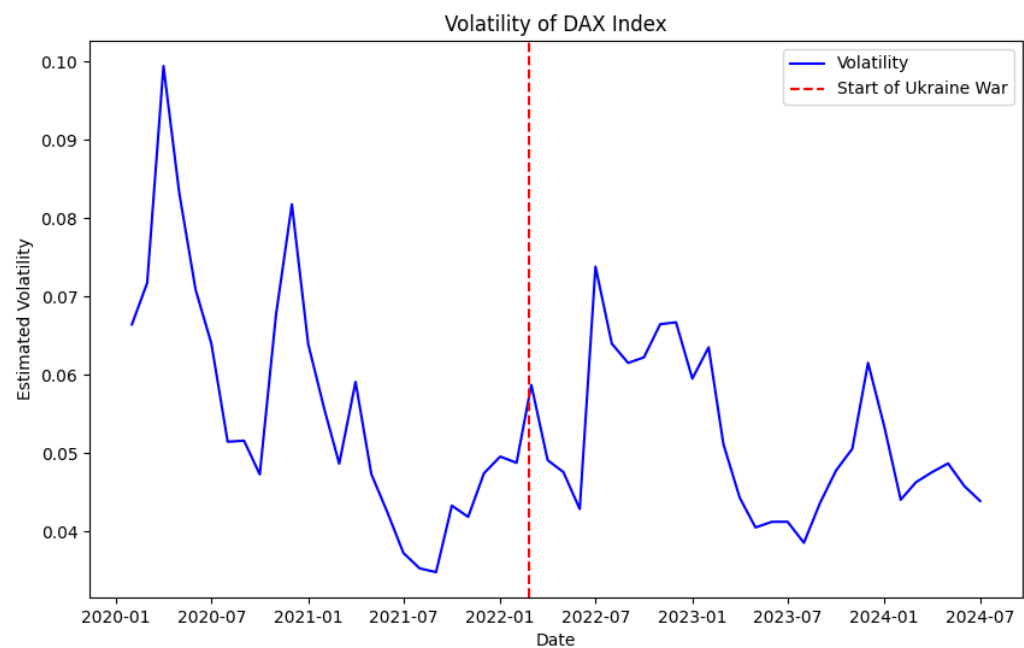
Constant Mean - GARCH Model Results					
=====					
Dep. Variable:	Log>Returns	R-squared:	0.000		
Mean Model:	Constant Mean	Adj. R-squared:	0.000		
Vol Model:	GARCH	Log-Likelihood:	87.4860		
Distribution:	Normal	AIC:	-162.972		
Method:	Maximum Likelihood	BIC:	-151.038		
		No. Observations:	54		
Date:	Tue, Sep 10 2024	Df Residuals:	53		
Time:	23:24:12	Df Model:	1		
=====					
Mean Model					
	coef	std err	t	P> t	95.0% Conf. Int.
mu	7.8463e-03	6.418e-03	1.223	0.221	[-4.732e-03, 2.042e-02]
=====					
Volatility Model					
	coef	std err	t	P> t	95.0% Conf. Int.
omega	2.3462e-04	4.588e-04	0.511	0.609	[-6.645e-04, 1.134e-03]
alpha[1]	0.1322	0.285	0.464	0.643	[ -0.427, 0.691]
alpha[2]	0.0000	0.133	0.000	1.000	[ -0.261, 0.261]
beta[1]	0.2913	0.384	0.760	0.447	[ -0.460, 1.043]
beta[2]	0.4254	0.416	1.022	0.307	[ -0.390, 1.241]
=====					



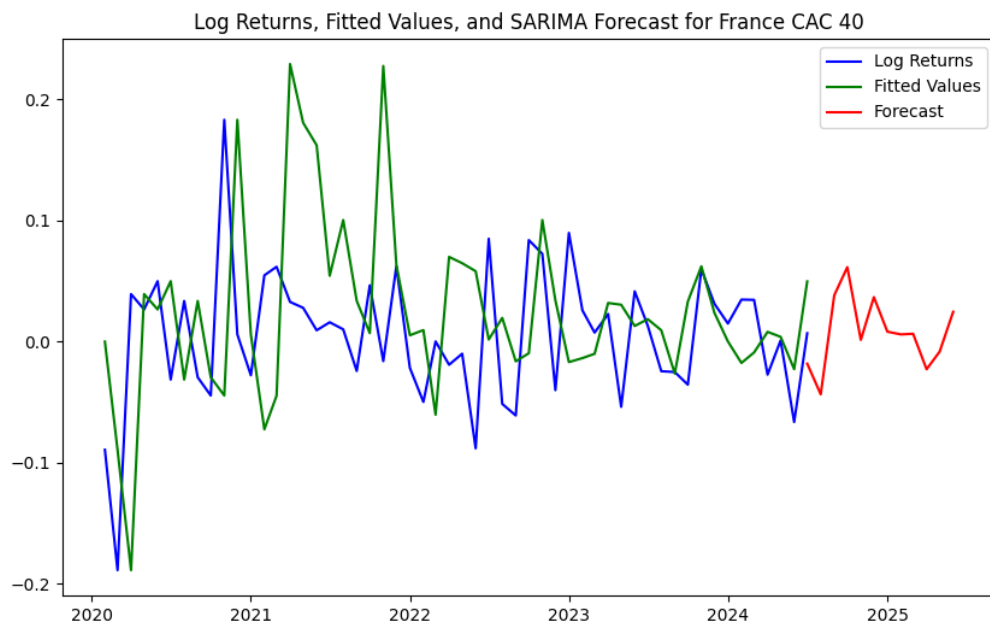
N Tit Tnf Tnint Skip Nact Projg F

5 45 76 1 0 0 6.889D-03 -8.640D-01

F = -0.86404446340007945



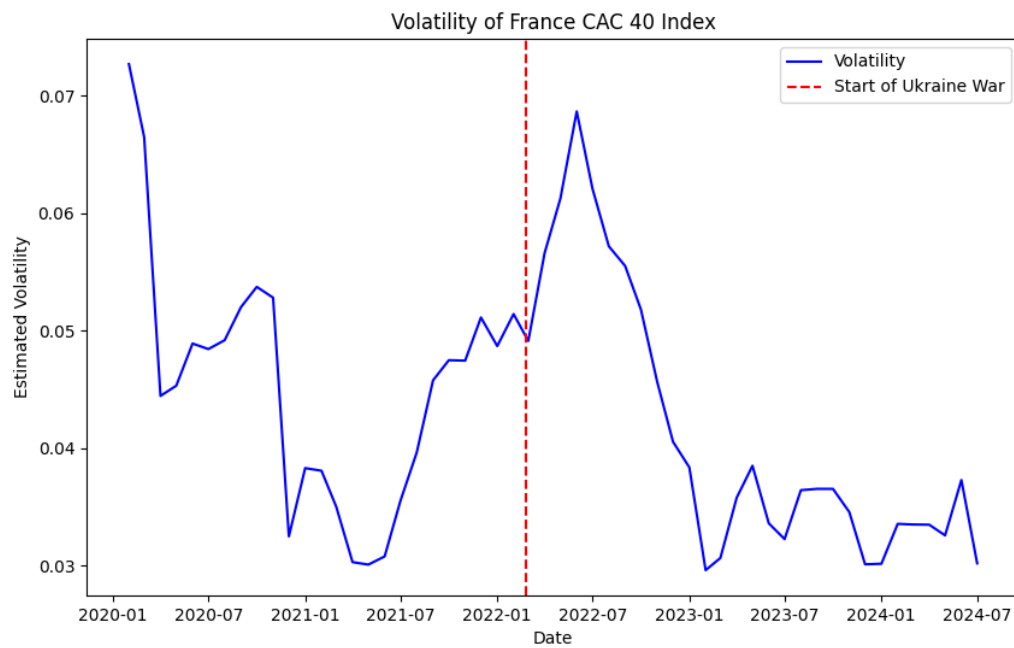
Constant Mean - EGARCH Model Results					
=====					
Dep. Variable:	Log>Returns	R-squared:	0.000		
Mean Model:	Constant Mean	Adj. R-squared:	0.000		
Vol Model:	EGARCH	Log-Likelihood:	81.5276		
Distribution:	Normal	AIC:	-155.055		
Method:	Maximum Likelihood	BIC:	-147.099		
		No. Observations:	54		
Date:	Wed, Sep 11 2024	Df Residuals:	53		
Time:	00:10:01	Df Model:	1		
Mean Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
mu	7.9257e-03	5.509e-03	1.439	0.150	[-2.871e-03,1.872e-02]
Volatility Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
omega	-1.6268	3.439	-0.473	0.636	[ -8.366, 5.113]
alpha[1]	0.4620	0.808	0.572	0.568	[ -1.122, 2.046]
beta[1]	0.7266	0.595	1.222	0.222	[ -0.439, 1.892]
=====					



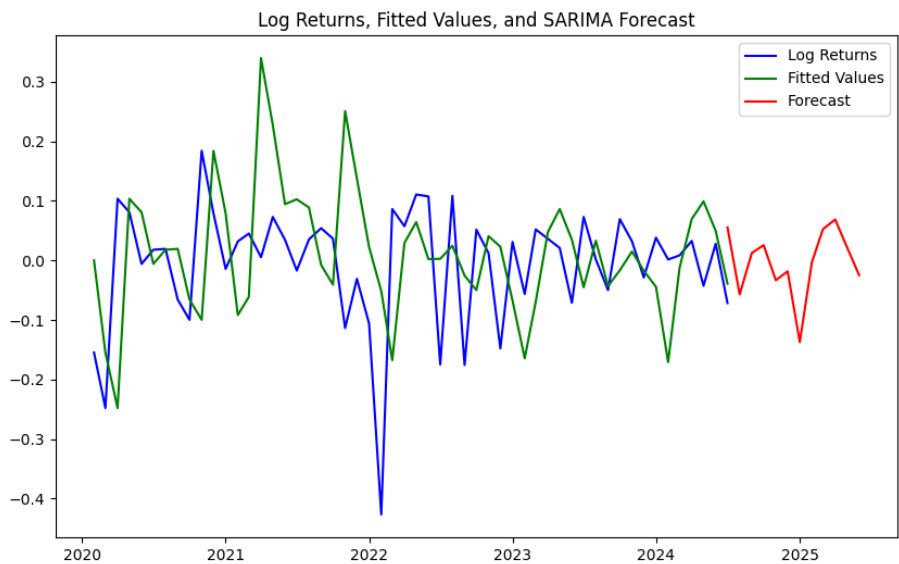
N Tit Tnf Tnint Skip Nact Projg F

5 38 53 1 0 0 5.613D-03 -8.964D-01

F = -0.89642472085984504



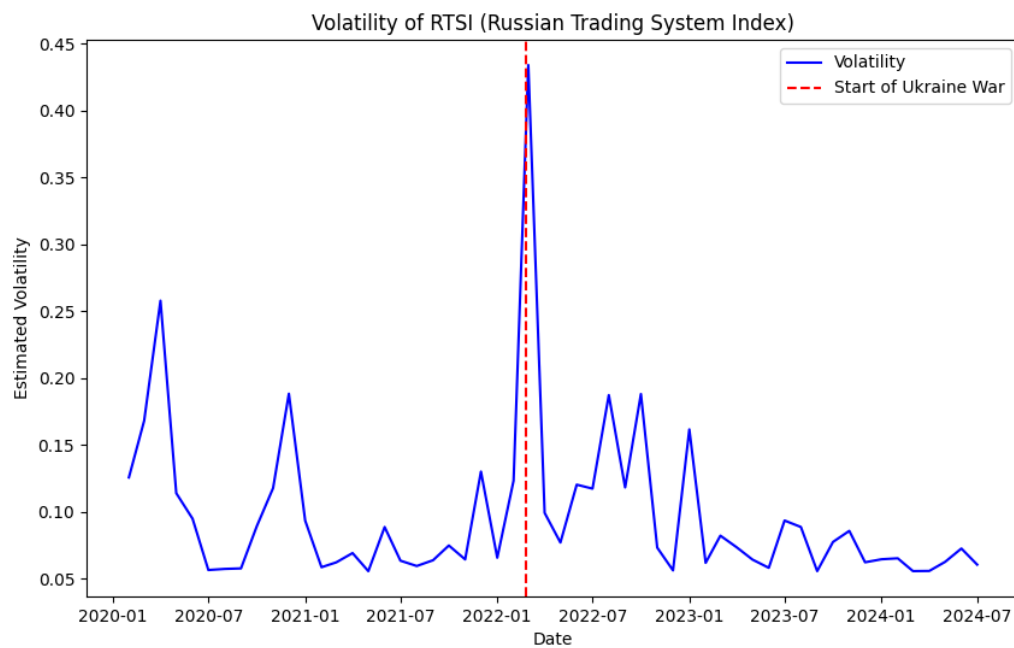
Constant Mean - EGARCH Model Results					
=====					
Dep. Variable:	Log>Returns	R-squared:	0.000		
Mean Model:	Constant Mean	Adj. R-squared:	0.000		
Vol Model:	EGARCH	Log-Likelihood:	87.2810		
Distribution:	Normal	AIC:	-166.562		
Method:	Maximum Likelihood	BIC:	-158.606		
		No. Observations:	54		
Date:	Wed, Sep 11 2024	Df Residuals:	53		
Time:	00:07:00	Df Model:	1		
Mean Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
mu	5.9368e-03	7.274e-05	81.621	0.000	[5.794e-03,6.079e-03]
Volatility Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
omega	0.0201	2.100e-03	9.555	1.237e-21	[1.595e-02,2.418e-02]
alpha[1]	-0.3872	7.375e-03	-52.496	0.000	[ -0.402, -0.373]
beta[1]	1.0000	2.784e-08	3.592e+07	0.000	[ 1.000, 1.000]
=====					



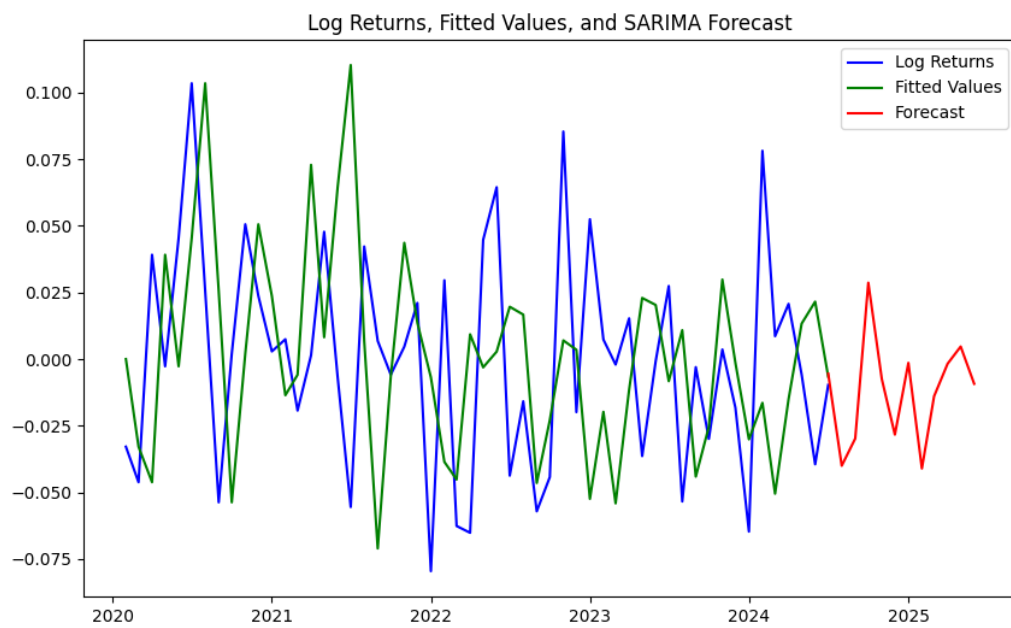
N Tit Tnf Tnint Skip Nact Projg F

5 23 36 1 0 0 7.497D-04 -4.624D-01

F = -0.46241001547123350



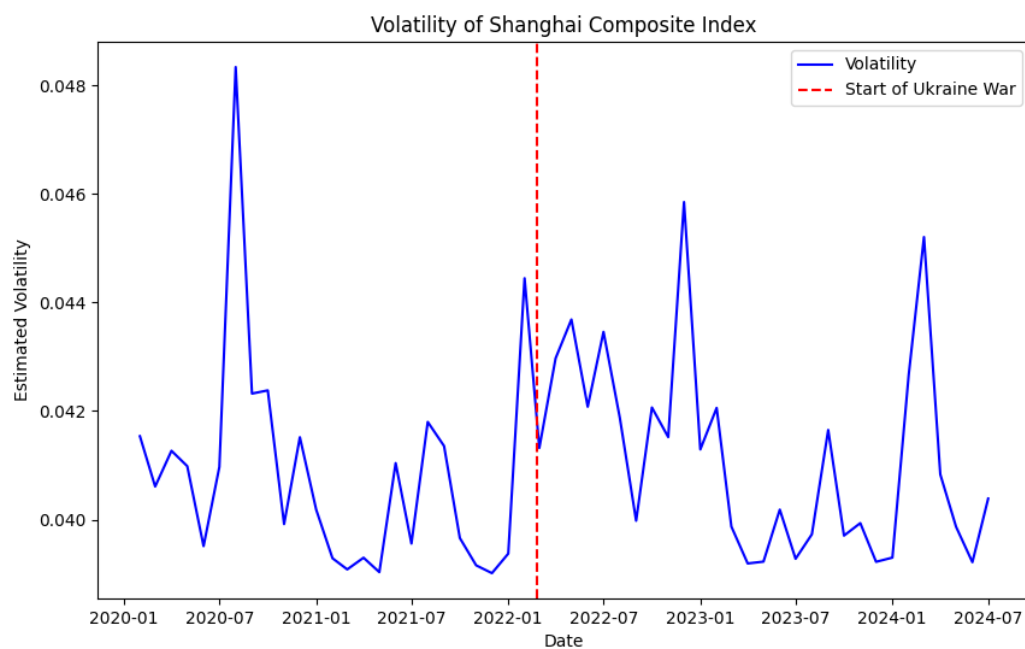
Constant Mean - GARCH Model Results					
=====					
Dep. Variable:	Log>Returns	R-squared:	0.000		
Mean Model:	Constant Mean	Adj. R-squared:	0.000		
Vol Model:	GARCH	Log-Likelihood:	54.7047		
Distribution:	Normal	AIC:	-101.409		
Method:	Maximum Likelihood	BIC:	-93.4534		
		No. Observations:	54		
Date:	Wed, Sep 11 2024	Df Residuals:	53		
Time:	00:29:43	Df Model:	1		
Mean Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
mu	4.0143e-03	7.118e-03	0.564	0.573	[-9.936e-03,1.796e-02]
Volatility Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
omega	3.0955e-03	1.120e-03	2.764	5.715e-03	[9.002e-04,5.291e-03]
alpha[1]	1.0000	0.458	2.183	2.900e-02	[ 0.102, 1.898]
beta[1]	0.0000	6.593e-02	0.000	1.000	[ -0.129, 0.129]
=====					



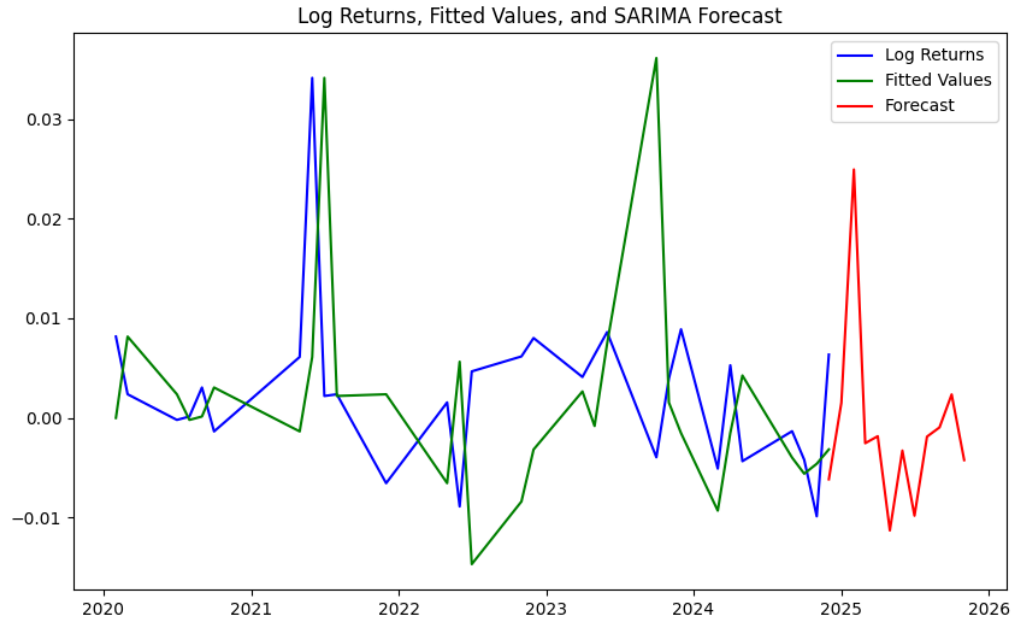
N Tit Tnf Tnint Skip Nact Projg F

5 48 87 1 0 0 5.616D-04 -1.128D+00

F = -1.1283052446601831



Constant Mean - GARCH Model Results					
=====					
Dep. Variable:	Log>Returns	R-squared:	0.000		
Mean Model:	Constant Mean	Adj. R-squared:	0.000		
Vol Model:	GARCH	Log-Likelihood:	95.9317		
Distribution:	Normal	AIC:	-183.863		
Method:	Maximum Likelihood	BIC:	-175.907		
		No. Observations:	54		
Date:	Wed, Sep 11 2024	Df Residuals:	53		
Time:	00:39:20	Df Model:	1		
Mean Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
mu	-4.0736e-04	5.541e-03	-7.352e-02	0.941	[-1.127e-02,1.045e-02]
Volatility Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
omega	1.0955e-03	6.428e-04	1.704	8.832e-02	[-1.643e-04,2.355e-03]
alpha[1]	0.0720	0.352	0.205	0.838	[ -0.617, 0.761]
beta[1]	0.2769	0.378	0.732	0.464	[ -0.464, 1.018]
=====					

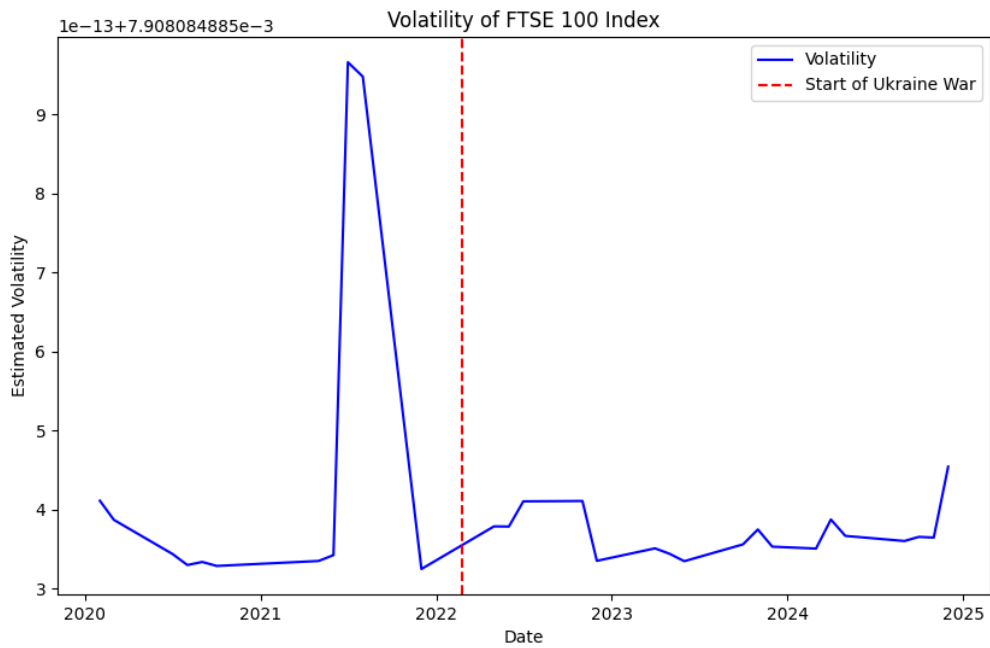


N Tit Tnf Tnint Skip Nact Projg F

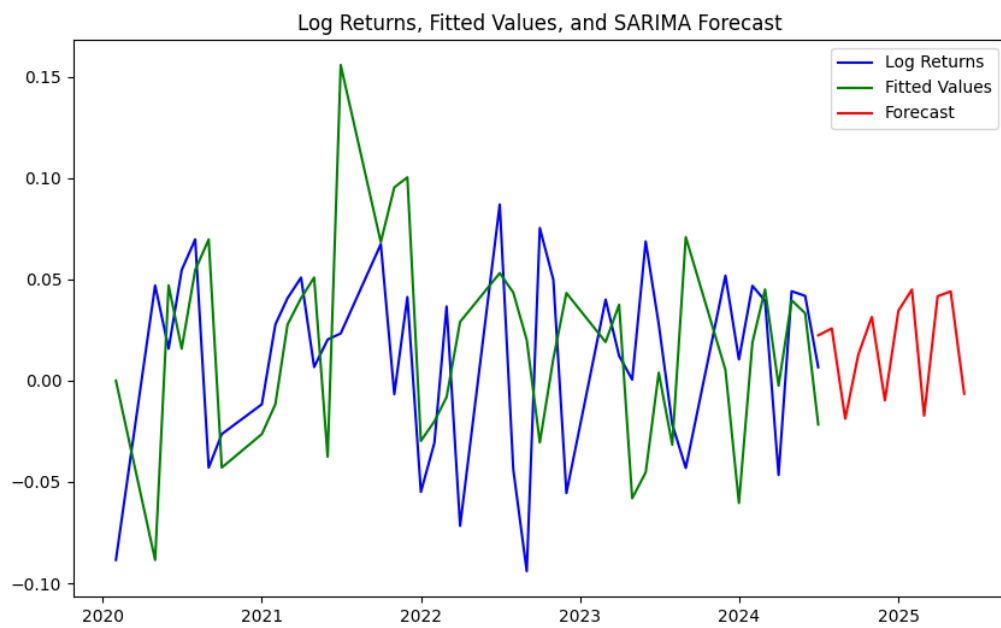
5 28 148 4 2 0 7.002D-02 -1.672D+00

F = -1.6718396854758384





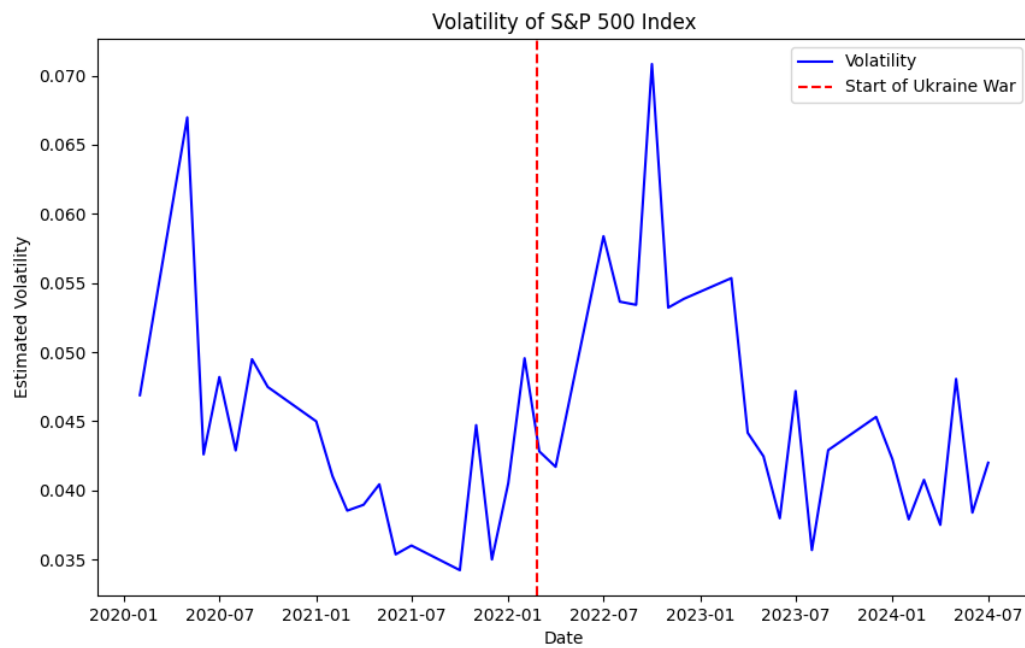
Constant Mean - GARCH Model Results					
=====					
Dep. Variable:	Log>Returns	R-squared:	0.000		
Mean Model:	Constant Mean	Adj. R-squared:	0.000		
Vol Model:	GARCH	Log-Likelihood:	99.2055		
Distribution:	Normal	AIC:	-186.411		
Method:	Maximum Likelihood	BIC:	-178.207		
		No. Observations:	29		
Date:	Wed, Sep 11 2024	Df Residuals:	28		
Time:	12:29:35	Df Model:	1		
Mean Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
mu	2.6483e-03	1.531e-03	1.730	8.361e-02	[-3.518e-04,5.648e-03]
Volatility Model					
=====					
	coef	std err	t	P> t	95.0% Conf. Int.
-----					
omega	6.2538e-05	1.606e-05	3.893	9.890e-05	[3.105e-05,9.402e-05]
alpha[1]	1.0113e-11	5.032e-02	2.010e-10	1.000	[-9.862e-02,9.862e-02]
alpha[2]	9.9413e-12	3.322e-02	2.993e-10	1.000	[-6.511e-02,6.511e-02]
beta[1]	0.0000	0.649	0.000	1.000	[ -1.272, 1.272]
beta[2]	0.0000	0.879	0.000	1.000	[ -1.724, 1.724]
=====					



N Tit Tnf Tnint Skip Nact Projg F

5 37 56 1 0 0 9.792D-03 -9.075D-01

F = -0.90748689725770415



```

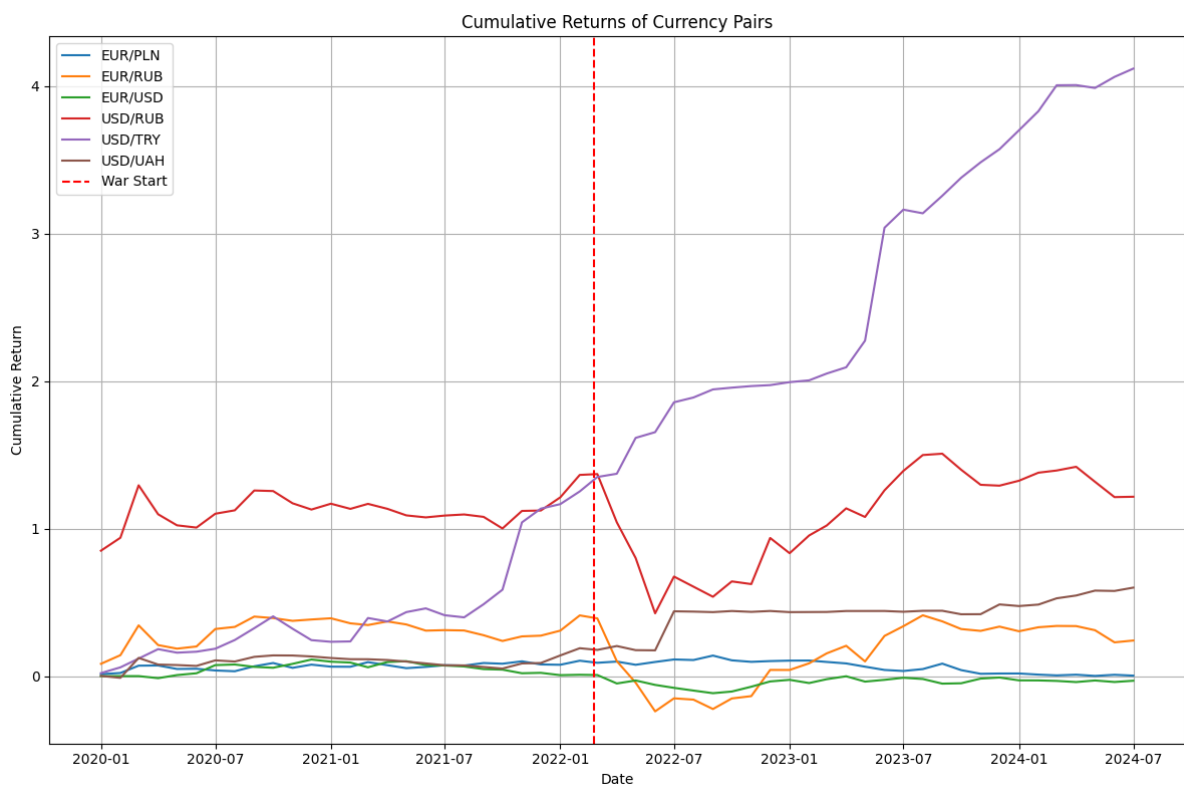
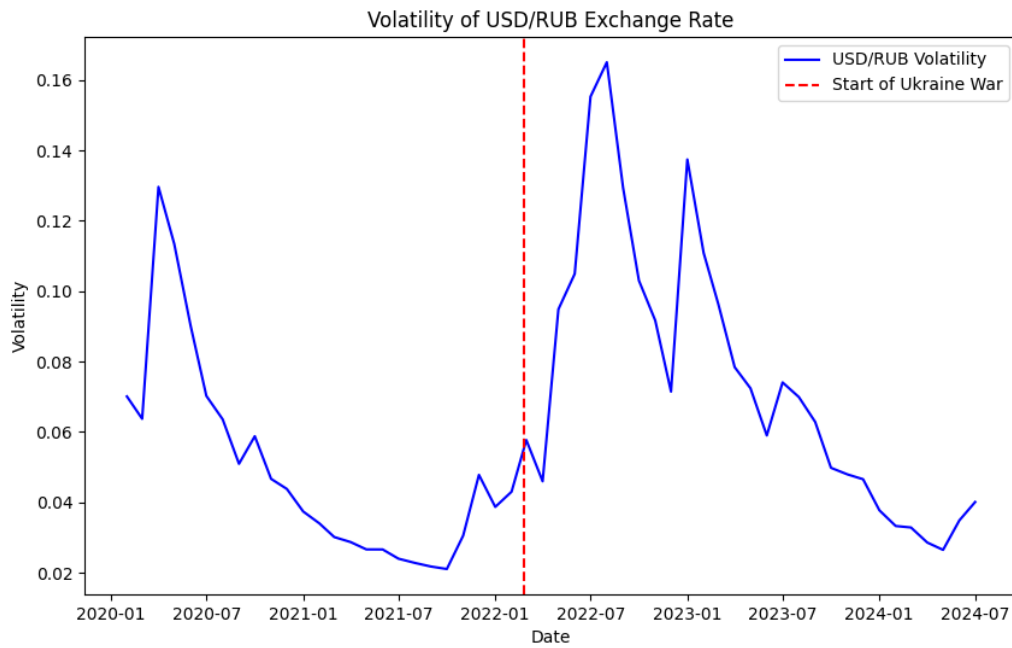
Constant Mean - GARCH Model Results
=====
Dep. Variable:          Log>Returns      R-squared:          0.000
Mean Model:            Constant Mean    Adj. R-squared:     0.000
Vol Model:             GARCH            Log-Likelihood:     70.7052
Distribution:          Normal           AIC:               -129.410
Method:               Maximum Likelihood BIC:               -118.984
                                           No. Observations:   42
Date:                 Wed, Sep 11 2024   Df Residuals:       41
Time:                 13:25:03           Df Model:           1
                                          
                        Mean Model
=====
              coef      std err          t      P>|t|      95.0% Conf. Int.
-----
mu              0.0131   5.444e-03       2.405   1.615e-02 [2.425e-03,2.376e-02]
                                          
                        Volatility Model
=====
              coef      std err          t      P>|t|      95.0% Conf. Int.
-----
omega           6.8597e-04  5.739e-04       1.195     0.232 [-4.388e-04,1.811e-03]
alpha[1]         0.2861      0.339        0.843     0.399 [ -0.379,  0.951]
alpha[2]         0.0000      0.278        0.000     1.000 [ -0.544,  0.544]
beta[1]          0.0000      0.556        0.000     1.000 [ -1.089,  1.089]
beta[2]          0.3647      0.195        1.866   6.200e-02 [-1.830e-02,  0.748]
=====

```

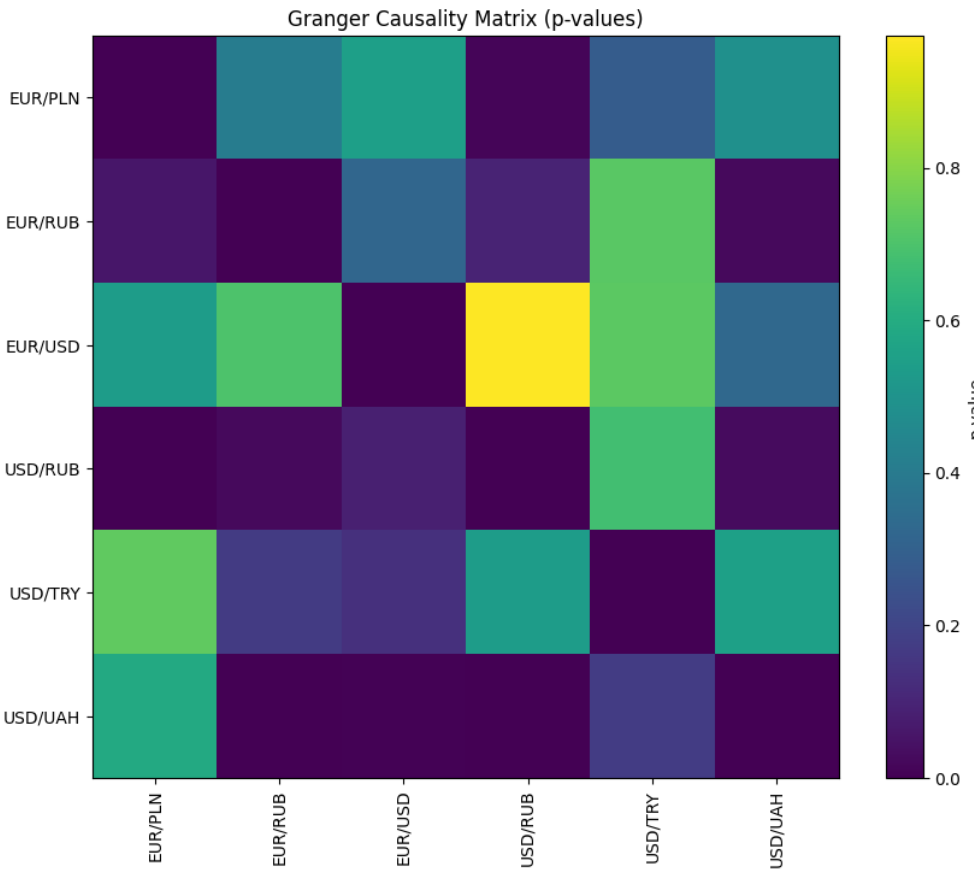
Impact on exchange rates:

Volatility:

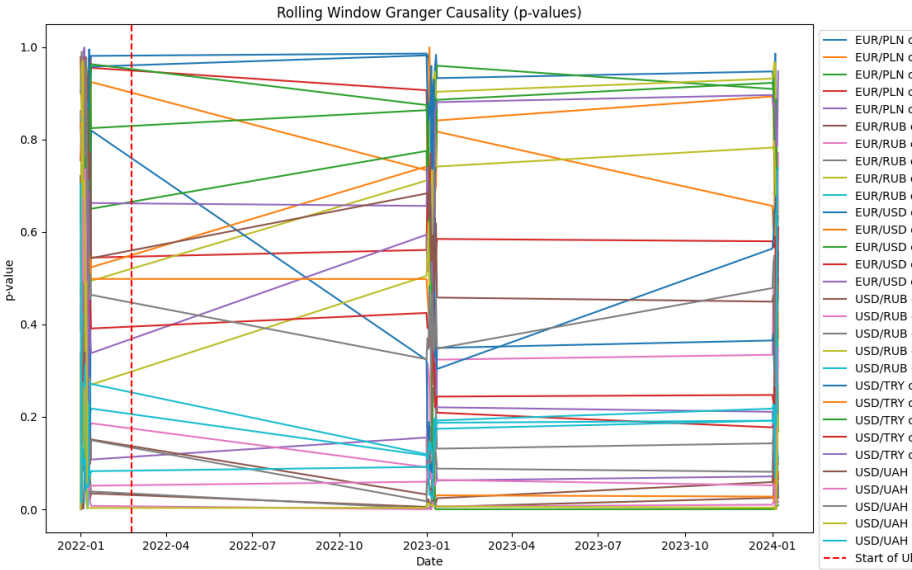
USD/RUB:



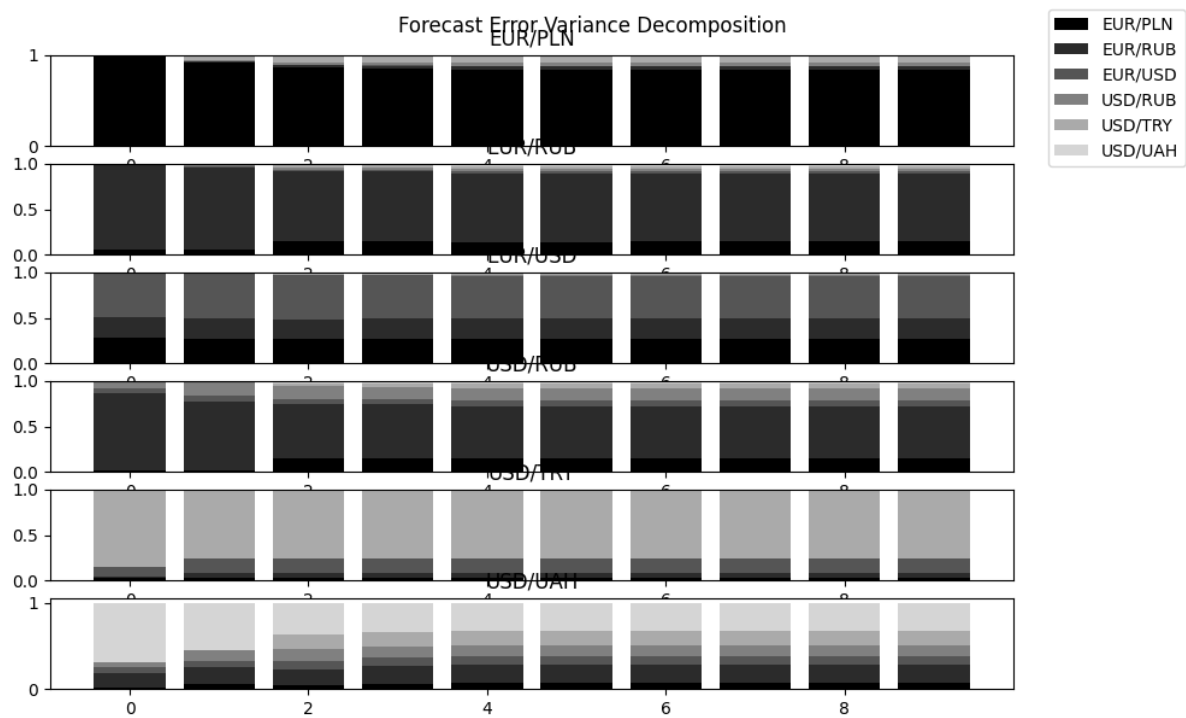
# Granger Causality Test Implementation



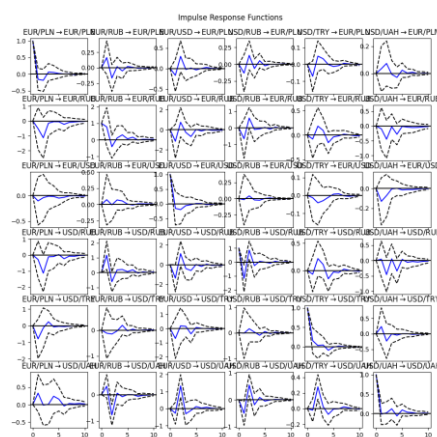
## aRolling Window Granger Causality Analysis

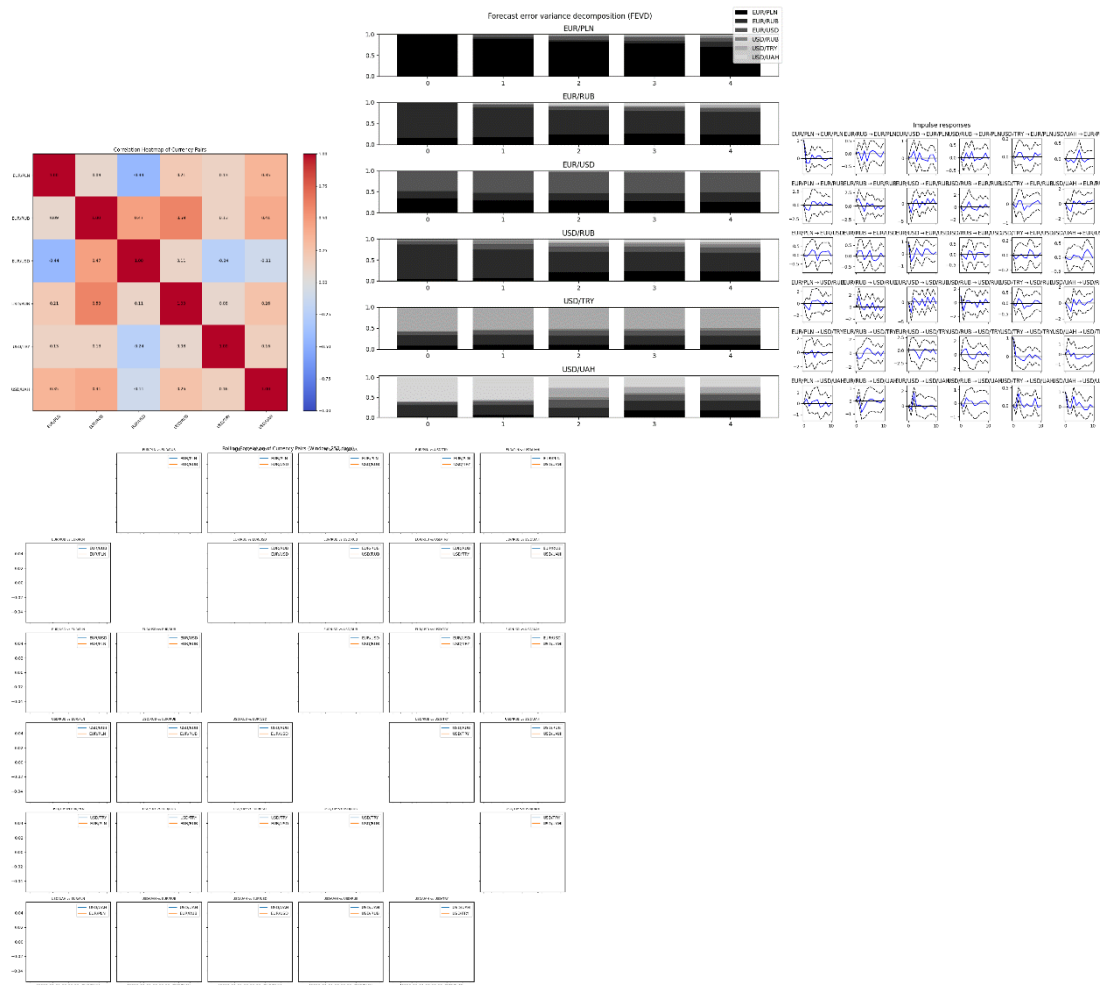


## Variance Decomposition Analysis (FEVD)



## Impulse Response Function (IRF) Analysis

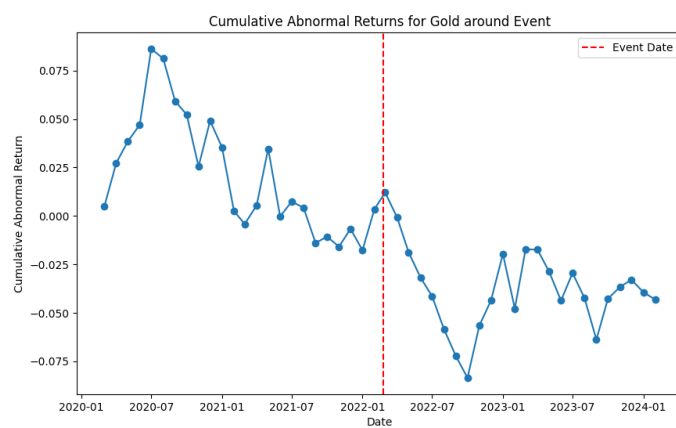




# Commodity Prices

## Gold:

T-statistic: -0.3489069250431538, P-value: 0.7287174673991046



Crudent Oil: T-statistic: -0.44303883278864725, P-value: 0.6597702220133946

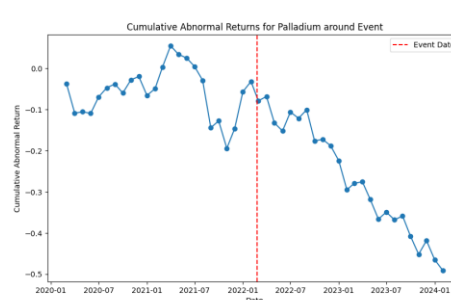
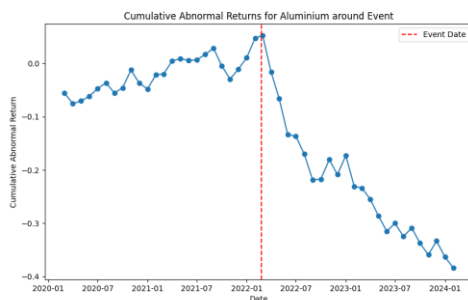
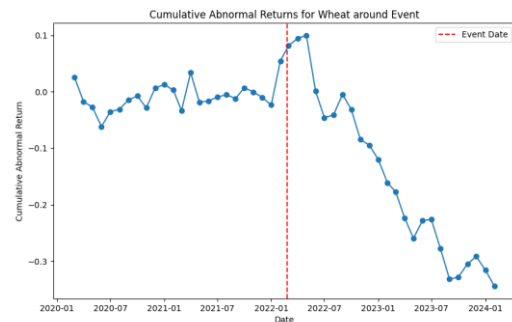
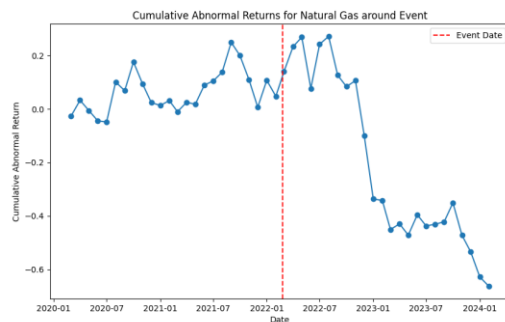
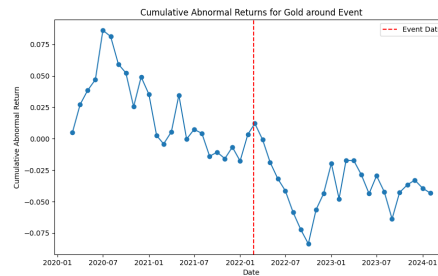
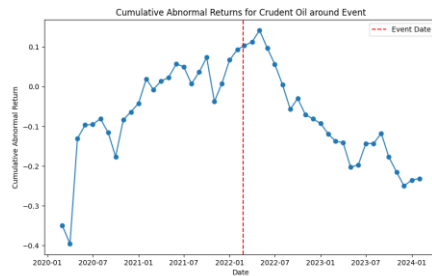
Gold: T-statistic: -0.3489069250431538, P-value: 0.7287174673991046

Natural Gas: T-statistic: -1.0890329455276144, P-value: 0.28169198806184387

Wheat: T-statistic: -1.4907543757127297, P-value: 0.14270735362890952

Aluminium: T-statistic: -1.9669541424224095, P-value: 0.05510772960512915

Palladium: T-statistic: -1.7246998361545731, P-value: 0.09115312004054907



Regression results for Crudent Oil:

### OLS Regression Results

=====

==

Dep. Variable: Crudent Oil R-squared: 0.008

Model: OLS Adj. R-squared: -0.010

Method: Least Squares F-statistic: 0.4489

Date: Sat, 31 Aug 2024 Prob (F-statistic): 0.506



Time: 22:58:29 Log-Likelihood: 67.993  
No. Observations: 55 AIC: -132.0  
Df Residuals: 53 BIC: -128.0  
Df Model: 1  
Covariance Type: nonrobust

=====  
==

	coef	std err	t	P> t	[0.025	0.975]
const	-1.501e-18	0.014	-1.07e-16	1.000	-0.028	0.028
Event	-0.0130	0.019	-0.670	0.506	-0.052	0.026

=====  
==

Omnibus: 37.496 Durbin-Watson: 1.748  
Prob(Omnibus): 0.000 Jarque-Bera (JB): 348.650  
Skew: -1.289 Prob(JB): 1.96e-76  
Kurtosis: 15.062 Cond. No. 2.69

=====  
==

#### Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Crudent Oil - Pre-Event Volatility: 0.09895692843184935, Post-Event Volatility:  
0.03255424041701208

Crudent Oil - Post-Event Sharpe Ratio: -0.41912230660443206

#### Regression results for Gold:

##### OLS Regression Results

=====  
==

Dep. Variable: Gold R-squared: 0.000  
Model: OLS Adj. R-squared: -0.018  
Method: Least Squares F-statistic: 0.02080  
Date: Sat, 31 Aug 2024 Prob (F-statistic): 0.886

Time: 22:58:30 Log-Likelihood: 144.45  
No. Observations: 55 AIC: -284.9  
Df Residuals: 53 BIC: -280.9  
Df Model: 1  
Covariance Type: nonrobust

=====

coef std err t P>|t| [0.025 0.975]  
-----  
const -9.098e-19 0.003 -2.6e-16 1.000 -0.007 0.007  
Event 0.0007 0.005 0.144 0.886 -0.009 0.010

=====

Omnibus: 1.797 Durbin-Watson: 2.071  
Prob(Omnibus): 0.407 Jarque-Bera (JB): 1.366  
Skew: 0.175 Prob(JB): 0.505  
Kurtosis: 2.312 Cond. No. 2.69

=====

#### Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Gold - Pre-Event Volatility: 0.018747287178190297, Post-Event Volatility:  
0.01653231621966373

Gold - Post-Event Sharpe Ratio: -0.5196035380561289

#### Regression results for Natural Gas:

##### OLS Regression Results

=====

Dep. Variable: Natural Gas R-squared: 0.025  
Model: OLS Adj. R-squared: 0.007  
Method: Least Squares F-statistic: 1.370  
Date: Sat, 31 Aug 2024 Prob (F-statistic): 0.247

Time: 22:58:31 Log-Likelihood: 58.380  
No. Observations: 55 AIC: -112.8  
Df Residuals: 53 BIC: -108.7  
Df Model: 1  
Covariance Type: nonrobust

=====  
==

	coef	std err	t	P> t	[0.025	0.975]
const	-4.479e-18	0.017	-2.68e-16	1.000	-0.034	0.034
Event	-0.0270	0.023	-1.170	0.247	-0.073	0.019

=====  
==

Omnibus: 0.184 Durbin-Watson: 2.073  
Prob(Omnibus): 0.912 Jarque-Bera (JB): 0.204  
Skew: -0.125 Prob(JB): 0.903  
Kurtosis: 2.836 Cond. No. 2.69

=====  
==

#### Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Natural Gas - Pre-Event Volatility: 0.06760634421727457, Post-Event Volatility:  
0.10213495739794161

Natural Gas - Post-Event Sharpe Ratio: -0.23697689426448806

#### Regression results for Wheat:

##### OLS Regression Results

=====  
==

Dep. Variable: Wheat R-squared: 0.051  
Model: OLS Adj. R-squared: 0.033  
Method: Least Squares F-statistic: 2.867  
Date: Sat, 31 Aug 2024 Prob (F-statistic): 0.0963

Time: 22:58:33 Log-Likelihood: 108.06  
No. Observations: 55 AIC: -212.1  
Df Residuals: 53 BIC: -208.1  
Df Model: 1  
Covariance Type: nonrobust

=====

coef std err t P>|t| [0.025 0.975]  
-----  
const -1.914e-19 0.007 -2.82e-17 1.000 -0.014 0.014  
Event -0.0158 0.009 -1.693 0.096 -0.035 0.003

=====

Omnibus: 1.005 Durbin-Watson: 2.140  
Prob(Omnibus): 0.605 Jarque-Bera (JB): 0.404  
Skew: 0.142 Prob(JB): 0.817  
Kurtosis: 3.310 Cond. No. 2.69

=====

#### Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Wheat - Pre-Event Volatility: 0.030707649492994663, Post-Event Volatility:  
0.033565679709307635

Wheat - Post-Event Sharpe Ratio: -0.5536160793087455

#### Regression results for Aluminium:

##### OLS Regression Results

=====

Dep. Variable: Aluminium R-squared: 0.085  
Model: OLS Adj. R-squared: 0.068  
Method: Least Squares F-statistic: 4.925  
Date: Sat, 31 Aug 2024 Prob (F-statistic): 0.0308

Time: 22:58:34 Log-Likelihood: 121.43  
No. Observations: 55 AIC: -238.9  
Df Residuals: 53 BIC: -234.8  
Df Model: 1  
Covariance Type: nonrobust

=====  
==

	coef	std err	t	P> t	[0.025	0.975]
const	-3.302e-19	0.005	-6.21e-17	1.000	-0.011	0.011
Event	-0.0162	0.007	-2.219	0.031	-0.031	-0.002

=====  
==

Omnibus: 0.758 Durbin-Watson: 1.783  
Prob(Omnibus): 0.684 Jarque-Bera (JB): 0.770  
Skew: -0.030 Prob(JB): 0.680  
Kurtosis: 2.424 Cond. No. 2.69

=====  
==

#### Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Aluminium - Pre-Event Volatility: 0.02269188801722223, Post-Event Volatility: 0.030134986625370053

Aluminium - Post-Event Sharpe Ratio: -0.5800580529194781

#### Regression results for Palladium:

##### OLS Regression Results

=====  
==

Dep. Variable: Palladium R-squared: 0.042  
Model: OLS Adj. R-squared: 0.024  
Method: Least Squares F-statistic: 2.320  
Date: Sat, 31 Aug 2024 Prob (F-statistic): 0.134

Time: 22:58:35 Log-Likelihood: 100.41  
 No. Observations: 55 AIC: -196.8  
 Df Residuals: 53 BIC: -192.8  
 Df Model: 1  
 Covariance Type: nonrobust

=====

	coef	std err	t	P> t	[0.025	0.975]
const	-6.616e-20	0.008	-8.5e-18	1.000	-0.016	0.016
Event	-0.0163	0.011	-1.523	0.134	-0.038	0.005

=====

Omnibus: 1.189 Durbin-Watson: 2.111  
 Prob(Omnibus): 0.552 Jarque-Bera (JB): 0.757  
 Skew: -0.284 Prob(JB): 0.685  
 Kurtosis: 3.090 Cond. No. 2.69

=====

#### Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Palladium - Pre-Event Volatility: 0.04544822191212596, Post-Event Volatility:  
 0.033982968601187206

Palladium - Post-Event Sharpe Ratio: -0.8153177255296855

# Bond Yields:

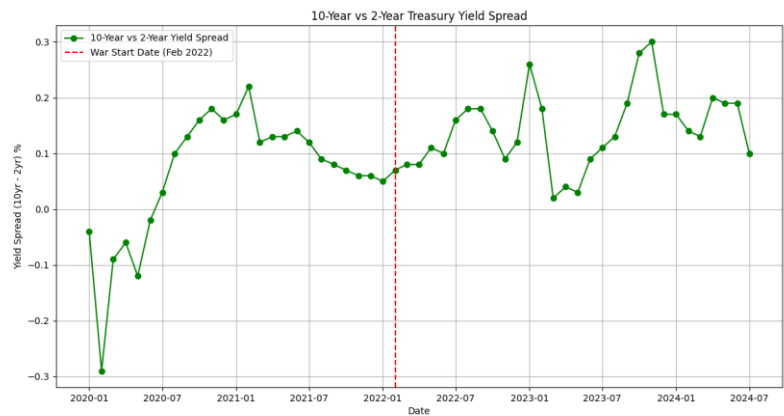
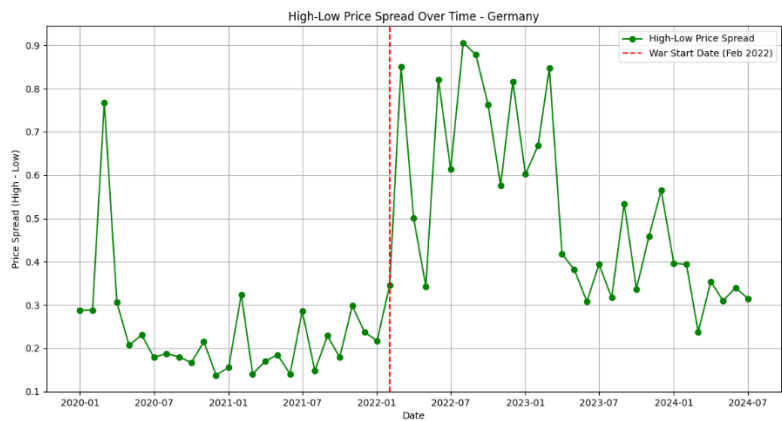
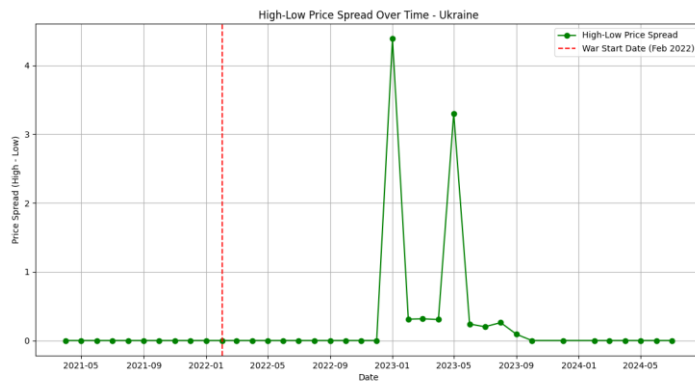
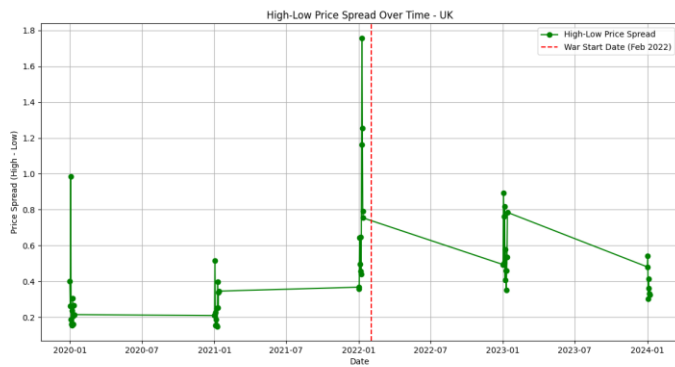
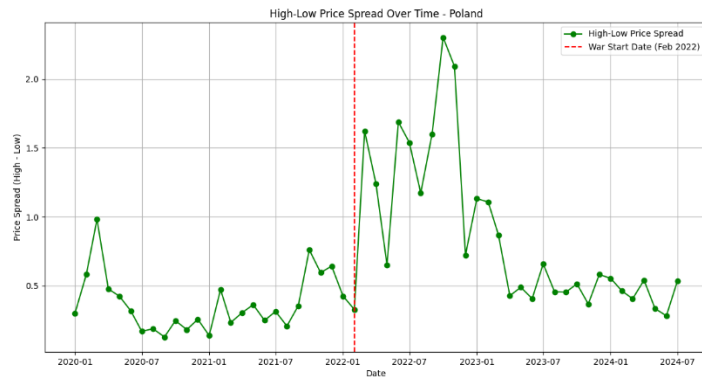
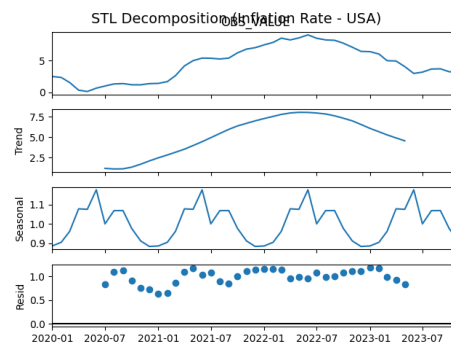
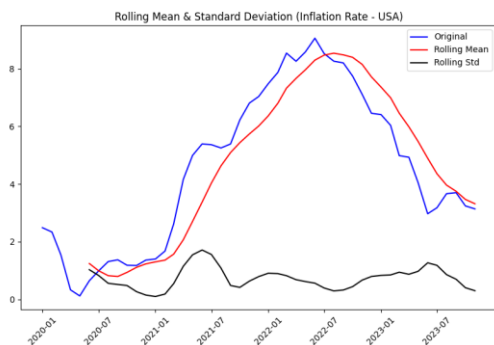


Figure 1USA

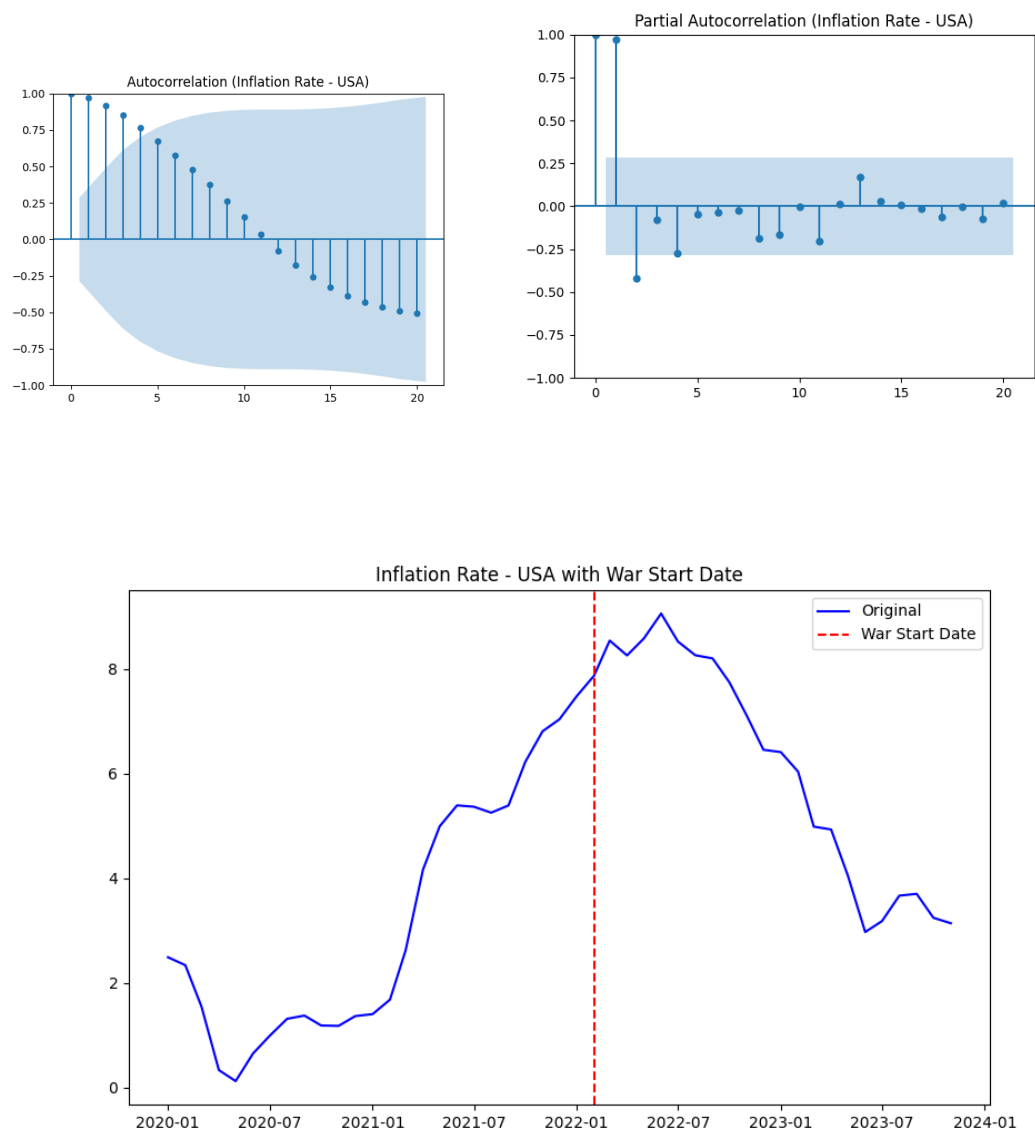




## Inflation Rate:







## Results:

ADF Statistic: -4.0335185413289585

p-value: 0.0012448183441705863

RUNNING THE L-BFGS-B CODE

\* \* \*

Machine precision = 2.220D-16

N = 5 M = 10

At X0     0 variables are exactly at the bounds

At iterate   0   f= 6.02623D-01   |proj g|= 1.58219D+00

At iterate   5   f= 4.96751D-01   |proj g|= 3.32861D-02

At iterate   10   f= 4.94567D-01   |proj g|= 5.12658D-03

At iterate   15   f= 4.94149D-01   |proj g|= 7.65786D-03

Bad direction in the line search;  
refresh the lbfgs memory and restart the iteration.

At iterate   20   f= 4.94121D-01   |proj g|= 7.70080D-05

\* \* \*

Tit   = total number of iterations

Tnf   = total number of function evaluations

Tnint = total number of segments explored during Cauchy searches

Skip   = number of BFGS updates skipped

Nact   = number of active bounds at final generalized Cauchy point

Projg = norm of the final projected gradient

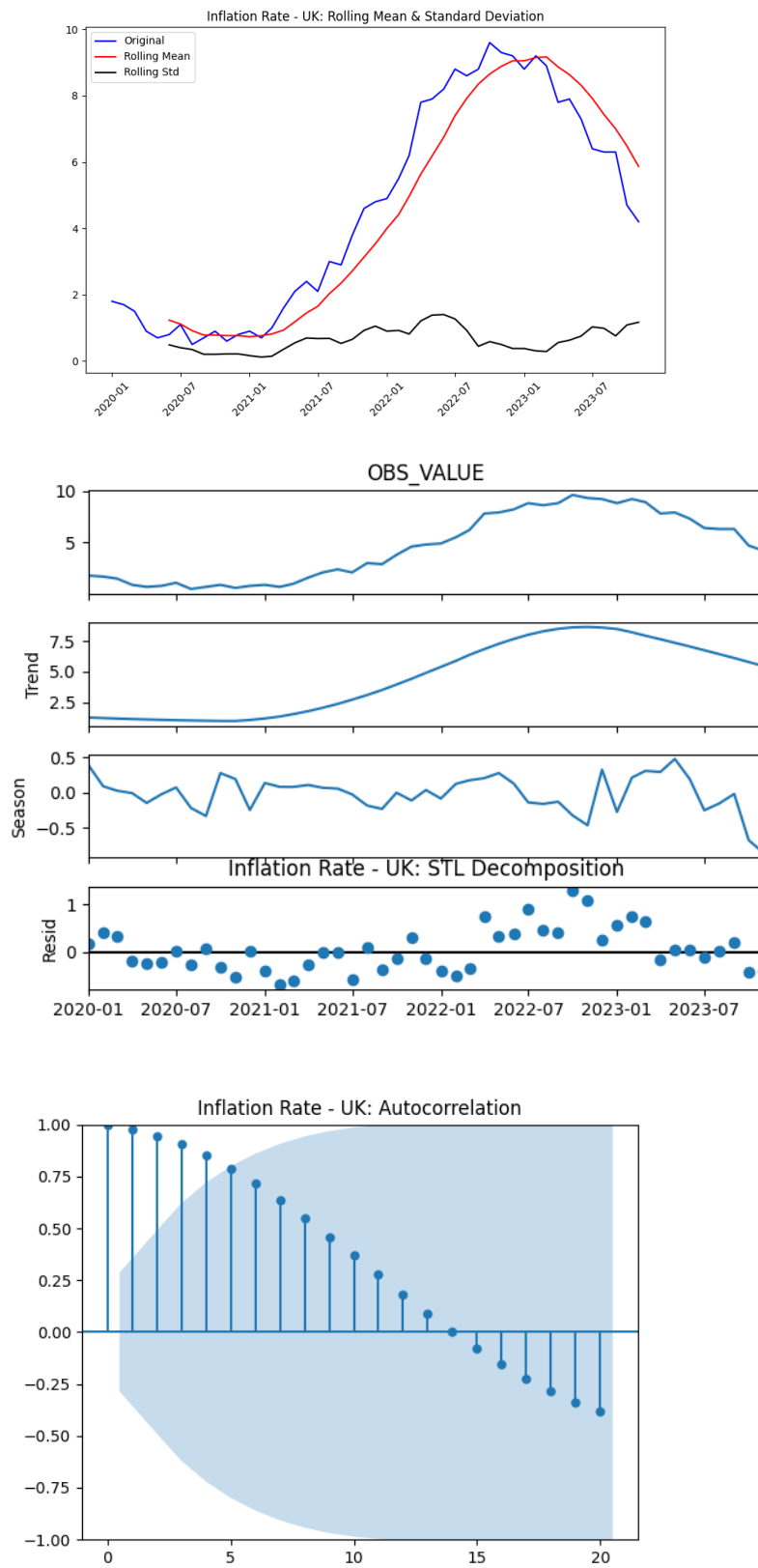
F     = final function value

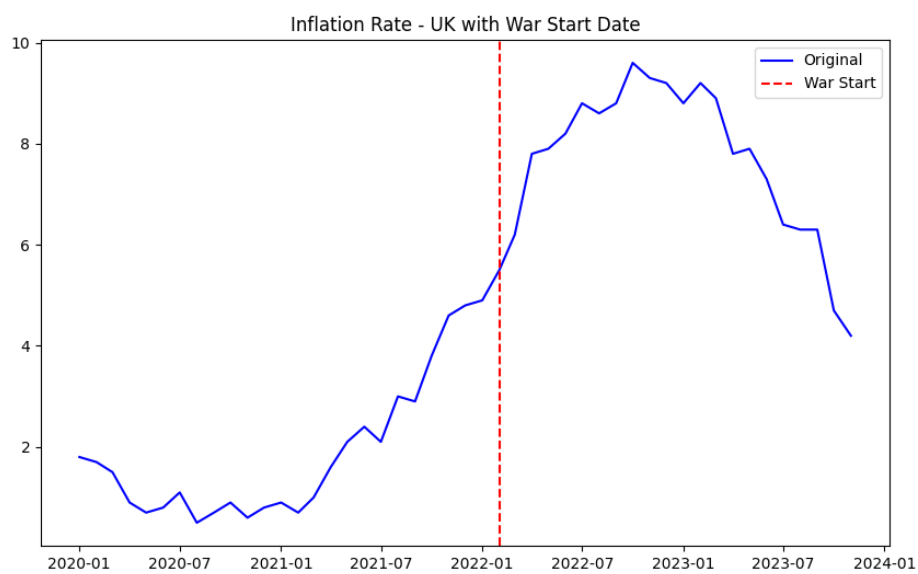
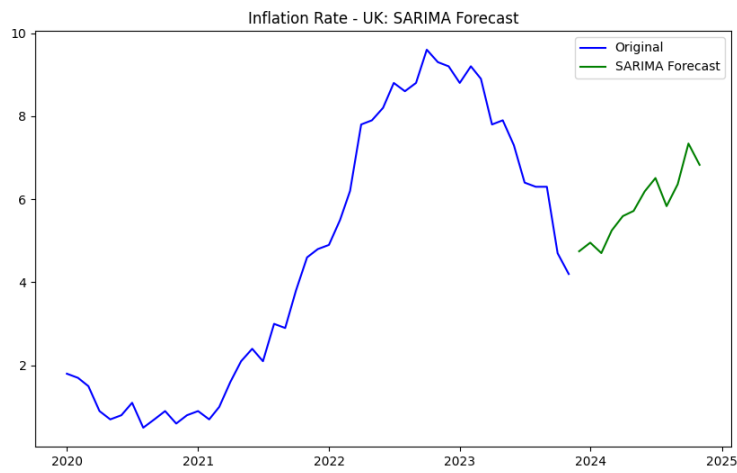
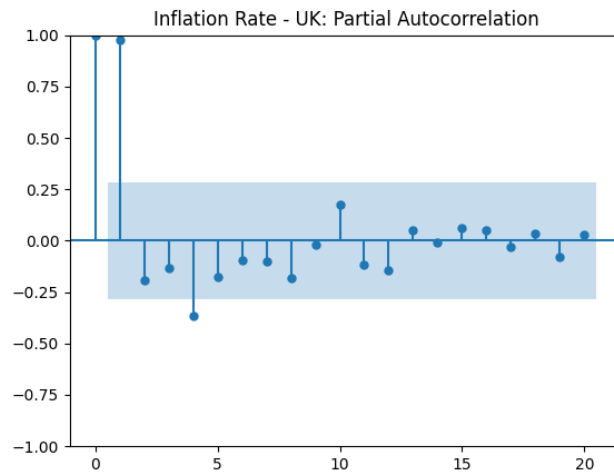
\* \* \*

N	Tit	Tnf	Tnint	Skip	Nact	Projg	F
5	20	46	2	0	0	7.701D-05	4.941D-01

F = 0.49412089915601637

CONVERGENCE: REL\_REDUCTION\_OF\_F\_<=\_FACTR\*EPSMCH





ADF Statistic: -2.2051973287981017

p-value: 0.20436453712486147

estimate starting parameters%s.'

RUNNING THE L-BFGS-B CODE

\* \* \*

Machine precision = 2.220D-16

N = 5 M = 10

At X0 0 variables are exactly at the bounds

At iterate 0 f= 3.5668D-01 |proj g|= 1.72271D+00

This problem is unconstrained.

At iterate 5 f= 2.30942D-01 |proj g|= 3.93318D-02

At iterate 10 f= 2.23685D-01 |proj g|= 4.74601D-02

At iterate 15 f= 2.21127D-01 |proj g|= 1.88160D-02

At iterate 20 f= 2.20638D-01 |proj g|= 1.92178D-02

At iterate 25 f= 2.20506D-01 |proj g|= 1.21113D-02

Warning: more than 10 function and gradient  
evaluations in the last line search. Termination  
may possibly be caused by a bad search direction.

At iterate 30 f= 2.20485D-01 |proj g|= 5.53901D-04

\* \* \*

Tit = total number of iterations

Tnf = total number of function evaluations

Tnint = total number of segments explored during Cauchy searches

Skip = number of BFGS updates skipped

Nact = number of active bounds at final generalized Cauchy point

Projg = norm of the final projected gradient

F = final function value

\* \* \*

N	Tit	Tnf	Tnint	Skip	Nact	Projg	F
5	30	49	1	0	0	5.539D-04	2.205D-01

F = 0.22048457512917424

CONVERGENCE: REL\_REDUCTION\_OF\_F\_<=\_FACTR\*EPSMCH