

```
In [1]: # import datetime
import os
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from datlib.FRED import *
from datlib.plots import *
import pandas_datareader.data as web

%matplotlib inline

# Import Statsmodels

from statsmodels.tsa.api import VAR
from statsmodels.tsa.stattools import adfuller
from statsmodels.tools.eval_measures import rmse, aic
```

```

In [2]: #FRED.py
# . . .
def bil_to_mil(series):
    return series* 10**3
# . . .
#fedProject.py
# . . .
data_codes = {# Assets
    "Balance Sheet: Total Assets ($ Mil)": "WALCL",
    "Balance Sheet Securities, Prem-Disc, Repos, and Loans ($ Mil)": "WALSL",
    "Balance Sheet: Securities Held Outright ($ Mil)": "WSHOSHO",
    ### breakdown of securities holdings ###
    "Balance Sheet: U.S. Treasuries Held Outright ($ Mil)": "WSHOTSL",
    "Balance Sheet: Federal Agency Debt Securities ($ Mil)": "WSHOFAD",
    "Balance Sheet: Mortgage-Backed Securities ($ Mil)": "WSHOMCB",
    # other forms of lending
    "Balance Sheet: Repos ($ Mil)": "WORAL",
    "Balance Sheet: Central Bank Liquidity Swaps ($ Mil)": "SWPT",
    "Balance Sheet: Direct Lending ($ Mil)": "WLCFLL",
    # unamortized value of securities held (due to changes in interest rates)
    "Balance Sheet: Unamortized Security Premiums ($ Mil)": "WUPSHO",
    # Liabilities
    "Balance Sheet: Total Liabilities ($ Mil)": "WLTLECL",
    "Balance Sheet: Federal Reserve Notes Outstanding ($ Mil)": "WLFN",
    "Balance Sheet: Reverse Repos ($ Mil)": "WLRRAL",
    ### Major share of deposits
    "Balance Sheet: Deposits from Dep. Institutions ($ Mil)": "WLODLL",
    "Balance Sheet: U.S. Treasury General Account ($ Mil)": "WDTGAL",
    "Balance Sheet: Other Deposits ($ Mil)": "WOTHLB",
    "Balance Sheet: All Deposits ($ Mil)": "WLDLCL",
    # Capital
    "Balance Sheet: Total Capital": "WCTCL",
    # Interest Rates
    "Unemployment Rate": "UNRATE",
    "Nominal GDP ($ Bil)": "GDP",
    "Real GDP ($ Bil)": "GDPC1",
    "GDP Deflator": "GDPDEF",
    "CPI": "CPIAUCSL",
    "Core PCE": "PCEPILFE",
    "Private Investment": "GPDI",
    "Base: Total ($ Mil)": "BOGMBASE",
    "Base: Currency in Circulation ($ Bil)": "WCURCIR",
    "1 Month Treasury Rate (%)": "DGS1MO",
    "3 Month Treasury Rate (%)": "DGS3MO",
    "1 Year Treasury Rate (%)": "DGS1",
    "2 Year Treasury Rate (%)": "DGS2",
    "10 Year Treasury Rate (%)": "DGS10",
    "30 Year Treasury Rate (%)": "DGS30",
    "Effective Federal Funds Rate (%)": "DFF",
    "Federal Funds Target Rate (Pre-crisis)": "DFEDTAR",
    "Federal Funds Upper Target": "DFEDTARU",
    "Federal Funds Lower Target": "DFEDTARL",
    "Interest on Reserves (%)": "IOER",
    "VIX": "VIXCLS",
    "5 Year Forward Rate": "T5YIFR"
}

```

```

inflation_target = 2

unemployment_target = 4
# Select start and end dates
start = datetime.datetime(2000, 1, 1)
end = datetime.datetime.today()

## year variable automatically adjusts the number of periods
# per year in light of data frequency
annual_div = {"Q":4,
              "W":52,
              "M":12}
### choose frequency
freq = "M"
### set periods per year
year = annual_div[freq]

```

```
In [15]: data=pd.read_csv("data m.csv")
```

```
In [16]: data
```

```
Out[16]:
```

	Date	Log M4 including Treasuries	Log Total Assets	Effective Federal Funds Rate (%)	Loss Function	Log Currency in Circulation (\$ Bil)
0	12/31/2002	6.763	13.495	1.238	-4.053	6.52
1	1/31/2003	6.769	13.494	1.235	-3.288	6.52
2	2/28/2003	6.774	13.489	1.262	-3.684	6.52
3	3/31/2003	6.778	13.492	1.253	-3.664	6.53
4	4/30/2003	6.782	13.510	1.258	-4.162	6.53
...	...	...	...	...	...	...
220	4/30/2021	7.691	15.867	0.069	-2.828	7.68
221	5/31/2021	7.700	15.878	0.058	-1.116	7.68
222	6/30/2021	7.698	15.898	0.078	-1.094	7.69
223	7/31/2021	7.696	15.918	0.098	0.611	7.69
224	8/31/2021	7.700	15.931	0.092	1.117	7.69

225 rows × 6 columns

```
In [17]: data = data.set_index('Date')
```

In [18]: data

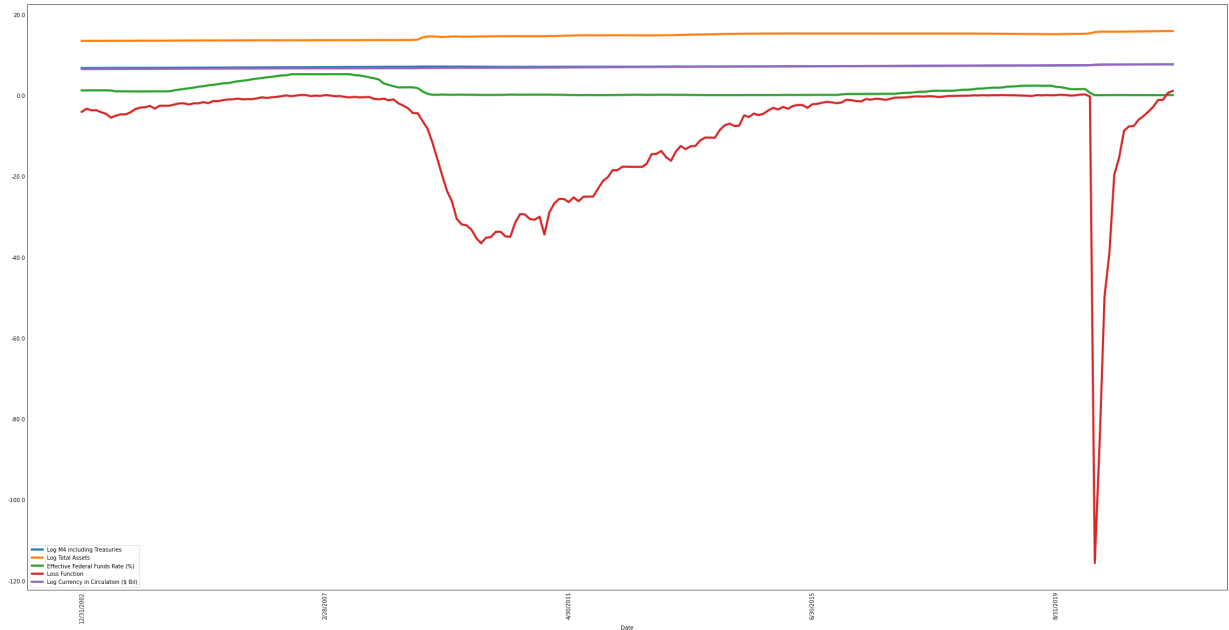
Out[18]:

	Log M4 including Treasures	Log Total Assets	Effective Federal Funds Rate (%)	Loss Function	Log Currency in Circulation (\$ Bil)
Date					
12/31/2002	6.763	13.495	1.238	-4.053	6.52
1/31/2003	6.769	13.494	1.235	-3.288	6.52
2/28/2003	6.774	13.489	1.262	-3.684	6.52
3/31/2003	6.778	13.492	1.253	-3.664	6.53
4/30/2003	6.782	13.510	1.258	-4.162	6.53
...	...	...	...	...	...
4/30/2021	7.691	15.867	0.069	-2.828	7.68
5/31/2021	7.700	15.878	0.058	-1.116	7.68
6/30/2021	7.698	15.898	0.078	-1.094	7.69
7/31/2021	7.696	15.918	0.098	0.611	7.69
8/31/2021	7.700	15.931	0.092	1.117	7.69

225 rows × 5 columns

```
In [19]: from datlib.plots import *
plot_variables = ["Log M4 including Treasuries", "Log Total Assets", "Effective F
plot_lines(data[plot_variables], linewidth=4)
```

C:\Users\prona.gupta\Desktop\jupyter\_practice\ML Tutorial\datlib\plots.py:21: UserWarning: FixedFormatter should only be used together with FixedLocator  
 ax.set\_yticklabels([round(x,2) for x in vals])



```
In [20]: ## ADF test
```

```

In [23]: X = data["Log M4 including Treasuries"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data["Effective Federal Funds Rate (%)"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data["Log Total Assets"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data["Log Currency in Circulation ($ Bil)"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

```

```

X = data["Loss Function"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

```

```

ADF Statistic: 1.074702
p-value: 0.994995
Critical Values:
    1%: -3.460
    5%: -2.875
   10%: -2.574
Failed to Reject Ho - Time Series is Non-Stationary
ADF Statistic: -2.985840
p-value: 0.036238
Critical Values:
    1%: -3.461
    5%: -2.875
   10%: -2.574
Reject Ho - Time Series is Stationary
ADF Statistic: -0.476791
p-value: 0.896467
Critical Values:
    1%: -3.460
    5%: -2.875
   10%: -2.574
Failed to Reject Ho - Time Series is Non-Stationary
ADF Statistic: 2.119026
p-value: 0.998809
Critical Values:
    1%: -3.462
    5%: -2.875
   10%: -2.574
Failed to Reject Ho - Time Series is Non-Stationary
ADF Statistic: -4.705669
p-value: 0.000082
Critical Values:
    1%: -3.460
    5%: -2.875
   10%: -2.574
Reject Ho - Time Series is Stationary

```

```
In [24]: data_diff = data.diff(year).dropna()  
data_diff
```

```
Out[24]:
```

	Log M4 including Treasures	Log Total Assets	Effective Federal Funds Rate (%)	Loss Function	Log Currency in Circulation (\$ Bil)
Date					
12/31/2003	0.038	0.046	-0.254	1.032	0.05
1/31/2004	0.037	0.047	-0.238	0.369	0.05
2/29/2004	0.039	0.044	-0.255	1.102	0.05
3/31/2004	0.044	0.043	-0.251	0.405	0.04
4/30/2004	0.047	0.034	-0.254	1.602	0.04
...	...	...	...	...	...
4/30/2021	0.116	0.211	0.020	112.840	0.14
5/31/2021	0.069	0.124	0.008	84.519	0.11
6/30/2021	0.046	0.118	0.000	48.659	0.11
7/31/2021	0.040	0.162	0.005	39.538	0.10
8/31/2021	0.045	0.173	-0.003	20.729	0.09

213 rows × 5 columns



```

In [25]: X = data_diff["Log M4 including Treasuries"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data_diff["Effective Federal Funds Rate (%)"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data_diff["Log Total Assets"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data_diff["Log Currency in Circulation ($ Bil)"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

```

```

X = data_diff["Loss Function"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print("Reject Ho - Time Series is Stationary")
else:
    print("Failed to Reject Ho - Time Series is Non-Stationary")

```

```

ADF Statistic: -1.390630
p-value: 0.586760
Critical Values:
    1%: -3.464
    5%: -2.876
   10%: -2.575
Failed to Reject Ho - Time Series is Non-Stationary
ADF Statistic: -2.945570
p-value: 0.040300
Critical Values:
    1%: -3.464
    5%: -2.876
   10%: -2.575
Reject Ho - Time Series is Stationary
ADF Statistic: -2.947258
p-value: 0.040122
Critical Values:
    1%: -3.464
    5%: -2.876
   10%: -2.575
Reject Ho - Time Series is Stationary
ADF Statistic: -1.429323
p-value: 0.568140
Critical Values:
    1%: -3.463
    5%: -2.876
   10%: -2.575
Failed to Reject Ho - Time Series is Non-Stationary
ADF Statistic: -3.184943
p-value: 0.020873
Critical Values:
    1%: -3.463
    5%: -2.876
   10%: -2.575
Reject Ho - Time Series is Stationary

```

```
In [26]: data_new = data_diff.diff(year).dropna()
```

In [27]: data\_new

Out[27]:

	Log M4 including Treasures	Log Total Assets	Effective Federal Funds Rate (%)	Loss Function	Log Currency in Circulation (\$ Bil)
Date					
12/31/2004	0.032	0.017	1.426	0.033	-8.881784e-16
1/31/2005	0.026	0.013	1.520	0.889	-8.881784e-16
2/28/2005	0.021	0.016	1.750	-0.450	-8.881784e-16
3/31/2005	0.009	0.017	1.878	1.479	1.000000e-02
4/30/2005	0.004	0.019	2.035	-0.470	1.000000e-02
...	...	...	...	...	...
4/30/2021	-0.084	-0.260	2.395	228.572	5.000000e-02
5/31/2021	-0.182	-0.461	2.349	170.165	-8.881784e-16
6/30/2021	-0.220	-0.500	2.300	98.492	-1.000000e-02
7/31/2021	-0.226	-0.442	2.315	78.484	-2.000000e-02
8/31/2021	-0.213	-0.442	2.028	40.409	-4.000000e-02

201 rows × 5 columns

```

In [28]: X = data_new["Log M4 including Treasuries"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data_new["Effective Federal Funds Rate (%)"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data_new["Log Total Assets"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

X = data_new["Log Currency in Circulation ($ Bil)"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")

```

```

X = data_new["Loss Function"].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))

if result[0] < result[4]["5%"]:
    print("Reject Ho - Time Series is Stationary")
else:
    print("Failed to Reject Ho - Time Series is Non-Stationary")

```

```

ADF Statistic: -3.320076
p-value: 0.014005
Critical Values:
    1%: -3.466
    5%: -2.877
   10%: -2.575
Reject Ho - Time Series is Stationary
ADF Statistic: -3.094704
p-value: 0.026948
Critical Values:
    1%: -3.466
    5%: -2.877
   10%: -2.575
Reject Ho - Time Series is Stationary
ADF Statistic: -3.259120
p-value: 0.016808
Critical Values:
    1%: -3.466
    5%: -2.877
   10%: -2.575
Reject Ho - Time Series is Stationary
ADF Statistic: -3.227653
p-value: 0.018439
Critical Values:
    1%: -3.466
    5%: -2.877
   10%: -2.575
Reject Ho - Time Series is Stationary
ADF Statistic: -2.885514
p-value: 0.047059
Critical Values:
    1%: -3.466
    5%: -2.877
   10%: -2.575
Reject Ho - Time Series is Stationary

```

```
In [31]: df = data_new
df
```

Out[31]:

	Log M4 including Treasures	Log Total Assets	Effective Federal Funds Rate (%)	Loss Function	Log Currency in Circulation (\$ Bil)
Date					
12/31/2004	0.032	0.017	1.426	0.033	-8.881784e-16
1/31/2005	0.026	0.013	1.520	0.889	-8.881784e-16
2/28/2005	0.021	0.016	1.750	-0.450	-8.881784e-16
3/31/2005	0.009	0.017	1.878	1.479	1.000000e-02
4/30/2005	0.004	0.019	2.035	-0.470	1.000000e-02
...	...	...	...	...	...
4/30/2021	-0.084	-0.260	2.395	228.572	5.000000e-02
5/31/2021	-0.182	-0.461	2.349	170.165	-8.881784e-16
6/30/2021	-0.220	-0.500	2.300	98.492	-1.000000e-02
7/31/2021	-0.226	-0.442	2.315	78.484	-2.000000e-02
8/31/2021	-0.213	-0.442	2.028	40.409	-4.000000e-02

201 rows × 5 columns

In [32]: *## Johansen test*

```
from statsmodels.tsa.vector_ar.vecm import coint_johansen

def cointegration_test(df, alpha=0.05):
    """Perform Johanson's Cointegration Test and Report Summary"""
    out = coint_johansen(df, -1, 5)
    d = {'0.90':0, '0.95':1, '0.99':2}
    traces = out.lr1
    cvts = out.cvt[:, d[str(1-alpha)]]
    def adjust(val, length= 6): return str(val).ljust(length)

    # Summary
    print('Name    :: Test Stat > C(95%)    =>   Signif \n', '--'*20)
    for col, trace, cvt in zip(df.columns, traces, cvts):
        print(adjust(col), ':: ', adjust(round(trace,2), 9), ">", adjust(cvt, 8),

cointegration_test(df)
```

```
Name    :: Test Stat > C(95%)    =>   Signif
-----
Log M4 including Treasuries :: 137.55    > 60.0627    =>   True
Log Total Assets :: 76.88    > 40.1749    =>   True
Effective Federal Funds Rate (%) :: 46.16    > 24.2761    =>   True
Loss Function :: 25.2    > 12.3212    =>   True
Log Currency in Circulation ($ Bil) :: 8.28    > 4.1296    =>   True
```

In [ ]: *# test for autocorrelation*

```
from statsmodels.stats.stattools import durbin_watson

# calculate the lag, optional
lag = min(10, (len(X)//5))
print('The number of lags will be {}'.format(lag))
print('-'*100)

# run the Ljung-Box test for no autocorrelation of residuals
# test_results = diag.acorr_breusch_godfrey(est, nlags = lag, store = True)
test_results = diag.acorr_ljungbox(est.resid, lags = lag)

# grab the p-values and the test statistics
ibvalue, p_val = test_results

# print the results of the test
if min(p_val) > 0.05:
    print("The lowest p-value found was {:.4}".format(min(p_val)))
    print("We fail to reject the null hypthoesis, so there is no autocorrelation.")
    print('-'*100)
else:
    print("The lowest p-value found was {:.4}".format(min(p_val)))
    print("We reject the null hypthoesis, so there is autocorrelation.")
    print('-'*100)

# plot autocorrelation
sm.graphics.tsa.plot_acf(est.resid)
plt.show()
```

In [35]: *##Testing Causation using Granger's Causality Test*

```
from statsmodels.tsa.stattools import grangercausalitytests
maxlag=12
test = 'ssr_chi2test'
def grangers_causation_matrix(data_new, variables, test='ssr_chi2test', verbose=False):
    df = pd.DataFrame(np.zeros((len(variables), len(variables))), columns=variables)
    for c in df.columns:
        for r in df.index:
            test_result = grangercausalitytests(data_new[[r, c]], maxlag=maxlag,
            p_values = [round(test_result[i+1][0][test][1],4) for i in range(maxlag)]
            if verbose: print(f'Y = {r}, X = {c}, P Values = {p_values}')
            min_p_value = np.min(p_values)
            df.loc[r, c] = min_p_value
    df.columns = [var + '_x' for var in variables]
    df.index = [var + '_y' for var in variables]
    return df

grangers_causation_matrix(df, variables = df.columns)
```

Out[35]:

	Log M4 including Treasuries_x	Log Total Assets_x	Effective Federal Funds Rate (%)_x	Loss Function_x	Log Currency in Circulation (\$ Bil)_x
Log M4 including Treasuries_y	1.0000	0.0104	0.0	0.0000	0.0000
Log Total Assets_y	0.0005	1.0000	0.0	0.1794	0.0005
Effective Federal Funds Rate (%)_y	0.0000	0.0000	1.0	0.0000	0.0000
Loss Function_y	0.0000	0.1287	0.0	1.0000	0.0001
Log Currency in Circulation (\$ Bil)_y	0.0000	0.0000	0.0	0.0002	1.0000



In [36]: *## How to Select the Order (P) of VAR model*

```
model = VAR(df)
for i in [1,2,3,4,5,6,7,8,9]:
    result = model.fit(i)
    print('Lag Order =', i)
    print('AIC : ', result.aic)
    print('BIC : ', result.bic)
    print('FPE : ', result.fpe)
    print('HQIC: ', result.hqic, '\n')
```

Lag Order = 1  
AIC : -19.438910903783636  
BIC : -18.94416329880143  
FPE : 3.6126623073302754e-09  
HQIC: -19.2386941161412

Lag Order = 2  
AIC : -20.214568469671942  
BIC : -19.304358593491806  
FPE : 1.6640616443838457e-09  
HQIC: -19.846183012628252

Lag Order = 3  
AIC : -20.49255931911732  
BIC : -19.16396657944276  
FPE : 1.2617155587772446e-09  
HQIC: -19.95478913830256

Lag Order = 4  
AIC : -20.47762538177679  
BIC : -18.727694460368216  
FPE : 1.283647899653554e-09  
HQIC: -19.769240290871345

Lag Order = 5  
AIC : -20.74505187604012  
BIC : -18.570792153081104  
FPE : 9.861745346364814e-10  
HQIC: -19.86480733482736

Lag Order = 6  
AIC : -20.94477640598707  
BIC : -18.343161372256915  
FPE : 8.122790814172788e-10  
HQIC: -19.891413294100317

Lag Order = 7  
AIC : -21.039893033364812  
BIC : -18.007859689903995  
FPE : 7.446239746544957e-10  
HQIC: -19.812137419631966

Lag Order = 8  
AIC : -21.361411336800174  
BIC : -17.89585958174576  
FPE : 5.459134354693993e-10

HQIC: -19.95797424408711

Lag Order = 9

AIC : -21.94267744676544

BIC : -18.040469449023824

FPE : 3.0977015767931744e-10

HQIC: -20.36225461221684

C:\Users\poma.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\base\tsa\_model.py:524: ValueWarning: No frequency information was provided, so inferred frequency M will be used.

warnings.warn('No frequency information was'

```
In [42]: x = model.select_order(maxlags=29)
x.summary()
```

Out[42]: VAR Order Selection (\* highlights the minimums)

	AIC	BIC	FPE	HQIC
0	-9.058	-8.966	0.0001165	-9.021
1	-18.93	-18.38	5.997e-09	-18.71
2	-19.81	-18.80	2.496e-09	-19.40
3	-20.10	-18.64	1.871e-09	-19.51
4	-20.09	-18.17	1.888e-09	-19.31
5	-20.42	-18.04	1.365e-09	-19.46
6	-20.69	-17.86	1.050e-09	-19.54
7	-20.86	-17.56	9.029e-10	-19.52
8	-21.15	-17.40	6.819e-10	-19.63
9	-21.94	-17.73	3.172e-10	-20.23
10	-22.29	-17.63	2.280e-10	-20.40
11	-22.74	-17.61	1.509e-10	-20.66
12	-23.64	-18.06	6.335e-11	-21.38
13	-24.68	-18.64	2.357e-11	-22.23
14	-24.82	-18.33	2.150e-11	-22.19
15	-25.10	-18.15	1.742e-11	-22.28
16	-25.18	-17.77	1.742e-11	-22.17
17	-25.33	-17.46	1.635e-11	-22.14
18	-25.33	-17.00	1.821e-11	-21.95
19	-25.88	-17.10	1.178e-11	-22.32
20	-26.29	-17.05	9.034e-12	-22.54
21	-26.89	-17.19	5.865e-12	-22.95
22	-27.63	-17.47	3.405e-12	-23.50
23	-28.05	-17.43	2.798e-12	-23.74
24	-28.48	-17.40	2.369e-12	-23.98
25	-29.23	-17.70	1.522e-12	-24.55
26	-30.62	-18.63	5.478e-13	-25.75
27	-31.44	-19.00	3.740e-13	-26.39
28	-33.16	-20.26	1.149e-13	-27.92
29	-35.28*	-21.93*	2.673e-14*	-29.86*

```
In [70]: model_fitted = model.fit(12)
model_fitted.summary()
```

Out[70]: Summary of Regression Results

```
=====
Model:                VAR
Method:               OLS
Date:                Wed, 23, Mar, 2022
Time:                11:33:23
-----
```

```
No. of Equations:      5.00000    BIC:                -18.5031
Nobs:                 177.000    HQIC:              -21.7565
Log likelihood:       1171.13    FPE:               4.47876e-11
AIC:                  -23.9762    Det(Omega_mle):    1.01892e-11
-----
```

Results for equation Log M4 including Treasuries

```
=====
=====
```

	t-stat	prob	coefficient	std. error
const	-0.075	0.941	-0.000075	0.001003
L1.Log M4 including Treasuries	9.814	0.000	1.208628	0.123157
L1.Log Total Assets	-1.241	0.215	-0.035120	0.028299
L1.Effective Federal Funds Rate (%)	-4.748	0.000	-0.035305	0.007435
L1.Loss Function	-1.865	0.062	-0.000340	0.000182
L1.Log Currency in Circulation (\$ Bil)	1.040	0.298	0.138932	0.133619
L2.Log M4 including Treasuries	-2.636	0.008	-0.457300	0.173503
L2.Log Total Assets	0.704	0.482	0.035182	0.049990
L2.Effective Federal Funds Rate (%)	4.885	0.000	0.062275	0.012749
L2.Loss Function	0.692	0.489	0.000133	0.000192
L2.Log Currency in Circulation (\$ Bil)	-0.204	0.838	-0.029431	0.143936
L3.Log M4 including Treasuries	1.614	0.107	0.270763	0.167801
L3.Log Total Assets	0.459	0.646	0.023851	0.051971
L3.Effective Federal Funds Rate (%)	-3.073	0.002	-0.041782	0.013599
L3.Loss Function	-0.167	0.868	-0.000032	0.000193
L3.Log Currency in Circulation (\$ Bil)	-0.595	0.552	-0.088647	0.149072
L4.Log M4 including Treasuries	-0.384	0.701	-0.066738	0.173771
L4.Log Total Assets			-0.025827	0.042836

-0.603	0.547		
L4.Effective Federal Funds Rate (%)		0.028163	0.013898
2.026	0.043		
L4.Loss Function		0.000179	0.000196
0.912	0.362		
L4.Log Currency in Circulation (\$ Bil)		-0.056657	0.139029
-0.408	0.684		
L5.Log M4 including Treasuries		-0.149294	0.176053
-0.848	0.396		
L5.Log Total Assets		0.046696	0.035971
1.298	0.194		
L5.Effective Federal Funds Rate (%)		-0.028324	0.014322
-1.978	0.048		
L5.Loss Function		-0.000221	0.000638
-0.347	0.728		
L5.Log Currency in Circulation (\$ Bil)		0.113555	0.139501
0.814	0.416		
L6.Log M4 including Treasuries		0.125259	0.183761
0.682	0.495		
L6.Log Total Assets		-0.096140	0.039379
-2.441	0.015		
L6.Effective Federal Funds Rate (%)		0.010569	0.014658
0.721	0.471		
L6.Loss Function		-0.000408	0.000711
-0.574	0.566		
L6.Log Currency in Circulation (\$ Bil)		0.019523	0.141348
0.138	0.890		
L7.Log M4 including Treasuries		-0.067849	0.185886
-0.365	0.715		
L7.Log Total Assets		0.065333	0.039956
1.635	0.102		
L7.Effective Federal Funds Rate (%)		-0.012051	0.014285
-0.844	0.399		
L7.Loss Function		0.000802	0.000691
1.161	0.246		
L7.Log Currency in Circulation (\$ Bil)		-0.055493	0.140444
-0.395	0.693		
L8.Log M4 including Treasuries		0.059831	0.182123
0.329	0.743		
L8.Log Total Assets		-0.012490	0.037657
-0.332	0.740		
L8.Effective Federal Funds Rate (%)		0.002535	0.013549
0.187	0.852		
L8.Loss Function		-0.000365	0.000632
-0.576	0.564		
L8.Log Currency in Circulation (\$ Bil)		-0.120980	0.140677
-0.860	0.390		
L9.Log M4 including Treasuries		-0.195089	0.172913
-1.128	0.259		
L9.Log Total Assets		-0.042058	0.037847
-1.111	0.266		
L9.Effective Federal Funds Rate (%)		0.027312	0.015423
1.771	0.077		
L9.Loss Function		0.000510	0.000633
0.806	0.420		
L9.Log Currency in Circulation (\$ Bil)		0.104547	0.145906
0.717	0.474		

L10.Log M4 including Treasuries	0.385997	0.180692
2.136            0.033		
L10.Log Total Assets	0.053175	0.045339
1.173            0.241		
L10.Effective Federal Funds Rate (%)	-0.020808	0.019785
-1.052           0.293		
L10.Loss Function	0.000167	0.000626
0.266            0.790		
L10.Log Currency in Circulation (\$ Bil)	-0.023304	0.147338
-0.158           0.874		
L11.Log M4 including Treasuries	-0.141487	0.184835
-0.765           0.444		
L11.Log Total Assets	-0.015244	0.044248
-0.345           0.730		
L11.Effective Federal Funds Rate (%)	0.018463	0.020027
0.922            0.357		
L11.Loss Function	0.000831	0.000612
1.358            0.175		
L11.Log Currency in Circulation (\$ Bil)	0.007709	0.151391
0.051            0.959		
L12.Log M4 including Treasuries	-0.078759	0.134365
-0.586           0.558		
L12.Log Total Assets	0.004267	0.025281
0.169            0.866		
L12.Effective Federal Funds Rate (%)	-0.012909	0.012472
-1.035           0.301		
L12.Loss Function	-0.001253	0.000552
-2.269           0.023		
L12.Log Currency in Circulation (\$ Bil)	0.141766	0.126854
1.118            0.264		

Results for equation Log Total Assets

t-stat	prob	coefficient	std. error
const		0.000863	0.003596
0.240            0.810			
L1.Log M4 including Treasuries		0.106088	0.441350
0.240            0.810			
L1.Log Total Assets		1.470866	0.101414
14.504           0.000			
L1.Effective Federal Funds Rate (%)		-0.067283	0.026646
-2.525           0.012			
L1.Loss Function		-0.000479	0.000653
-0.734           0.463			
L1.Log Currency in Circulation (\$ Bil)		-0.336934	0.478841
-0.704           0.482			
L2.Log M4 including Treasuries		-0.606972	0.621769
-0.976           0.329			
L2.Log Total Assets		-0.709436	0.179146
-3.960           0.000			
L2.Effective Federal Funds Rate (%)		0.179578	0.045687

3.931	0.000		
L2.Loss Function		0.001466	0.000689
2.126	0.033		
L2.Log Currency in Circulation (\$ Bil)		0.301671	0.515814
0.585	0.559		
L3.Log M4 including Treasuries		2.093286	0.601337
3.481	0.000		
L3.Log Total Assets		0.301513	0.186246
1.619	0.105		
L3.Effective Federal Funds Rate (%)		-0.120150	0.048732
-2.466	0.014		
L3.Loss Function		-0.000285	0.000693
-0.411	0.681		
L3.Log Currency in Circulation (\$ Bil)		0.286777	0.534219
0.537	0.591		
L4.Log M4 including Treasuries		-2.602133	0.622730
-4.179	0.000		
L4.Log Total Assets		0.139926	0.153507
0.912	0.362		
L4.Effective Federal Funds Rate (%)		0.106944	0.049805
2.147	0.032		
L4.Loss Function		0.000028	0.000703
0.039	0.969		
L4.Log Currency in Circulation (\$ Bil)		-0.320867	0.498230
-0.644	0.520		
L5.Log M4 including Treasuries		1.519801	0.630907
2.409	0.016		
L5.Log Total Assets		-0.071487	0.128907
-0.555	0.579		
L5.Effective Federal Funds Rate (%)		-0.223193	0.051325
-4.349	0.000		
L5.Loss Function		-0.001607	0.002286
-0.703	0.482		
L5.Log Currency in Circulation (\$ Bil)		-0.162330	0.499921
-0.325	0.745		
L6.Log M4 including Treasuries		-1.121113	0.658531
-1.702	0.089		
L6.Log Total Assets		-0.231218	0.141120
-1.638	0.101		
L6.Effective Federal Funds Rate (%)		0.175589	0.052530
3.343	0.001		
L6.Loss Function		-0.000037	0.002546
-0.014	0.989		
L6.Log Currency in Circulation (\$ Bil)		-0.335190	0.506537
-0.662	0.508		
L7.Log M4 including Treasuries		1.983405	0.666147
2.977	0.003		
L7.Log Total Assets		-0.030710	0.143187
-0.214	0.830		
L7.Effective Federal Funds Rate (%)		-0.091208	0.051194
-1.782	0.075		
L7.Loss Function		0.002538	0.002476
1.025	0.305		
L7.Log Currency in Circulation (\$ Bil)		0.805546	0.503300
1.601	0.109		
L8.Log M4 including Treasuries		-0.424442	0.652660
-0.650	0.515		

L8.Log Total Assets	-0.528992	0.134947
-3.920            0.000		
L8.Effective Federal Funds Rate (%)	-0.291722	0.048554
-6.008            0.000		
L8.Loss Function	0.000482	0.002267
0.213            0.832		
L8.Log Currency in Circulation (\$ Bil)	-0.472001	0.504134
-0.936            0.349		
L9.Log M4 including Treasuries	-0.629502	0.619654
-1.016            0.310		
L9.Log Total Assets	0.915088	0.135630
6.747            0.000		
L9.Effective Federal Funds Rate (%)	0.464246	0.055269
8.400            0.000		
L9.Loss Function	-0.000919	0.002269
-0.405            0.685		
L9.Log Currency in Circulation (\$ Bil)	0.790022	0.522871
1.511            0.131		
L10.Log M4 including Treasuries	-0.524918	0.647533
-0.811            0.418		
L10.Log Total Assets	-0.459882	0.162479
-2.830            0.005		
L10.Effective Federal Funds Rate (%)	-0.143489	0.070901
-2.024            0.043		
L10.Loss Function	-0.001894	0.002243
-0.844            0.398		
L10.Log Currency in Circulation (\$ Bil)	-0.977205	0.528004
-1.851            0.064		
L11.Log M4 including Treasuries	1.188407	0.662381
1.794            0.073		
L11.Log Total Assets	0.265494	0.158570
1.674            0.094		
L11.Effective Federal Funds Rate (%)	0.122702	0.071769
1.710            0.087		
L11.Loss Function	0.000650	0.002194
0.296            0.767		
L11.Log Currency in Circulation (\$ Bil)	1.221910	0.542528
2.252            0.024		
L12.Log M4 including Treasuries	-0.642577	0.481514
-1.334            0.182		
L12.Log Total Assets	-0.114109	0.090599
-1.260            0.208		
L12.Effective Federal Funds Rate (%)	-0.122815	0.044694
-2.748            0.006		
L12.Loss Function	-0.000627	0.001979
-0.317            0.751		
L12.Log Currency in Circulation (\$ Bil)	-0.958114	0.454598
-2.108            0.035		

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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	-0.018130	0.013602
-1.333            0.183		
L1.Log M4 including Treasuries	-1.207407	1.669426
-0.723            0.470		
L1.Log Total Assets	-0.362805	0.383602
-0.946            0.344		
L1.Effective Federal Funds Rate (%)	1.459988	0.100788
14.486            0.000		
L1.Loss Function	-0.002533	0.002468
-1.026            0.305		
L1.Log Currency in Circulation (\$ Bil)	2.907034	1.811238
1.605            0.108		
L2.Log M4 including Treasuries	0.740922	2.351868
0.315            0.753		
L2.Log Total Assets	1.421345	0.677630
2.098            0.036		
L2.Effective Federal Funds Rate (%)	-0.554114	0.172815
-3.206            0.001		
L2.Loss Function	-0.000111	0.002608
-0.043            0.966		
L2.Log Currency in Circulation (\$ Bil)	3.103770	1.951089
1.591            0.112		
L3.Log M4 including Treasuries	-2.776037	2.274584
-1.220            0.222		
L3.Log Total Assets	-1.410761	0.704485
-2.003            0.045		
L3.Effective Federal Funds Rate (%)	0.221917	0.184331
1.204            0.229		
L3.Loss Function	0.003418	0.002622
1.304            0.192		
L3.Log Currency in Circulation (\$ Bil)	-2.072181	2.020706
-1.025            0.305		
L4.Log M4 including Treasuries	1.682673	2.355505
0.714            0.475		
L4.Log Total Assets	1.062157	0.580647
1.829            0.067		
L4.Effective Federal Funds Rate (%)	-0.656863	0.188389
-3.487            0.000		
L4.Loss Function	-0.005113	0.002658
-1.924            0.054		
L4.Log Currency in Circulation (\$ Bil)	0.618126	1.884578
0.328            0.743		
L5.Log M4 including Treasuries	-0.489722	2.386434
-0.205            0.837		
L5.Log Total Assets	-1.911552	0.487597
-3.920            0.000		
L5.Effective Federal Funds Rate (%)	0.762771	0.194139
3.929            0.000		
L5.Loss Function	0.013505	0.008646
1.562            0.118		
L5.Log Currency in Circulation (\$ Bil)	0.579745	1.890974
0.307            0.759		
L6.Log M4 including Treasuries	1.746469	2.490925
0.701            0.483		
L6.Log Total Assets	1.053548	0.533791
1.974            0.048		

L6.Effective Federal Funds Rate (%)	-0.548646	0.198697
-2.761            0.006		
L6.Loss Function	-0.011640	0.009631
-1.209            0.227		
L6.Log Currency in Circulation (\$ Bil)	-0.435844	1.916000
-0.227            0.820		
L7.Log M4 including Treasuries	-2.596751	2.519732
-1.031            0.303		
L7.Log Total Assets	0.469187	0.541611
0.866            0.386		
L7.Effective Federal Funds Rate (%)	0.595698	0.193643
3.076            0.002		
L7.Loss Function	0.000756	0.009364
0.081            0.936		
L7.Log Currency in Circulation (\$ Bil)	-3.000851	1.903755
-1.576            0.115		
L8.Log M4 including Treasuries	2.344086	2.468714
0.950            0.342		
L8.Log Total Assets	-0.187172	0.510443
-0.367            0.714		
L8.Effective Federal Funds Rate (%)	-0.027374	0.183657
-0.149            0.882		
L8.Loss Function	0.006649	0.008573
0.775            0.438		
L8.Log Currency in Circulation (\$ Bil)	2.525979	1.906911
1.325            0.185		
L9.Log M4 including Treasuries	2.507188	2.343871
1.070            0.285		
L9.Log Total Assets	-1.005646	0.513026
-1.960            0.050		
L9.Effective Federal Funds Rate (%)	-0.301782	0.209056
-1.444            0.149		
L9.Loss Function	-0.007209	0.008582
-0.840            0.401		
L9.Log Currency in Circulation (\$ Bil)	-1.558823	1.977785
-0.788            0.431		
L10.Log M4 including Treasuries	-4.988533	2.449322
-2.037            0.042		
L10.Log Total Assets	1.783193	0.614584
2.901            0.004		
L10.Effective Federal Funds Rate (%)	0.213445	0.268186
0.796            0.426		
L10.Loss Function	0.009717	0.008486
1.145            0.252		
L10.Log Currency in Circulation (\$ Bil)	2.678673	1.997197
1.341            0.180		
L11.Log M4 including Treasuries	2.659375	2.505487
1.061            0.288		
L11.Log Total Assets	-1.363966	0.599797
-2.274            0.023		
L11.Effective Federal Funds Rate (%)	-0.348854	0.271468
-1.285            0.199		
L11.Loss Function	-0.004315	0.008300
-0.520            0.603		
L11.Log Currency in Circulation (\$ Bil)	-5.377922	2.052138
-2.621            0.009		
L12.Log M4 including Treasuries	0.042043	1.821348

0.023	0.982		
L12.Log Total Assets		0.259647	0.342693
0.758	0.449		
L12.Effective Federal Funds Rate (%)		0.136782	0.169056
0.809	0.418		
L12.Loss Function		-0.001964	0.007485
-0.262	0.793		
L12.Log Currency in Circulation (\$ Bil)		4.722815	1.719537
2.747	0.006		

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#### Results for equation Loss Function

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t-stat	prob	coefficient	std. error
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-----			
const		-0.058749	0.665331
-0.088	0.930		
L1.Log M4 including Treasuries		-288.655856	81.660068
-3.535	0.000		
L1.Log Total Assets		19.947921	18.763927
1.063	0.288		
L1.Effective Federal Funds Rate (%)		20.852338	4.930067
4.230	0.000		
L1.Loss Function		0.428063	0.120732
3.546	0.000		
L1.Log Currency in Circulation (\$ Bil)		-86.589975	88.596775
-0.977	0.328		
L2.Log M4 including Treasuries		346.031381	115.041745
3.008	0.003		
L2.Log Total Assets		-30.536742	33.146284
-0.921	0.357		
L2.Effective Federal Funds Rate (%)		-31.283284	8.453244
-3.701	0.000		
L2.Loss Function		-0.142517	0.127562
-1.117	0.264		
L2.Log Currency in Circulation (\$ Bil)		-38.420419	95.437613
-0.403	0.687		
L3.Log M4 including Treasuries		-219.878566	111.261408
-1.976	0.048		
L3.Log Total Assets		-25.605763	34.459934
-0.743	0.457		
L3.Effective Federal Funds Rate (%)		16.917188	9.016563
1.876	0.061		
L3.Loss Function		-0.101362	0.128240
-0.790	0.429		
L3.Log Currency in Circulation (\$ Bil)		-55.315430	98.842943
-0.560	0.576		
L4.Log M4 including Treasuries		-84.177391	115.219623
-0.731	0.465		
L4.Log Total Assets		13.903395	28.402391
0.490	0.624		
L4.Effective Federal Funds Rate (%)		-21.182932	9.215078
-2.299	0.022		

L4.Loss Function	-0.455935	0.130021
-3.507            0.000		
L4.Log Currency in Circulation (\$ Bil)	0.436941	92.184219
0.005            0.996		
L5.Log M4 including Treasuries	-4.065230	116.732535
-0.035            0.972		
L5.Log Total Assets	-5.738391	23.850849
-0.241            0.810		
L5.Effective Federal Funds Rate (%)	21.903739	9.496308
2.307            0.021		
L5.Loss Function	0.479482	0.422920
1.134            0.257		
L5.Log Currency in Circulation (\$ Bil)	58.604724	92.497062
0.634            0.526		
L6.Log M4 including Treasuries	-35.893050	121.843710
-0.295            0.768		
L6.Log Total Assets	50.809448	26.110428
1.946            0.052		
L6.Effective Federal Funds Rate (%)	11.742629	9.719297
1.208            0.227		
L6.Loss Function	0.360952	0.471115
0.766            0.444		
L6.Log Currency in Circulation (\$ Bil)	-85.286050	93.721215
-0.910            0.363		
L7.Log M4 including Treasuries	101.176856	123.252827
0.821            0.412		
L7.Log Total Assets	-54.163053	26.492916
-2.044            0.041		
L7.Effective Federal Funds Rate (%)	-14.168374	9.472071
-1.496            0.135		
L7.Loss Function	-0.050213	0.458065
-0.110            0.913		
L7.Log Currency in Circulation (\$ Bil)	107.170404	93.122274
1.151            0.250		
L8.Log M4 including Treasuries	-103.081477	120.757283
-0.854            0.393		
L8.Log Total Assets	30.706061	24.968350
1.230            0.219		
L8.Effective Federal Funds Rate (%)	-6.103181	8.983598
-0.679            0.497		
L8.Loss Function	0.337386	0.419372
0.805            0.421		
L8.Log Currency in Circulation (\$ Bil)	-150.591804	93.276632
-1.614            0.106		
L9.Log M4 including Treasuries	33.614670	114.650538
0.293            0.769		
L9.Log Total Assets	-17.875061	25.094674
-0.712            0.476		
L9.Effective Federal Funds Rate (%)	-8.491853	10.225992
-0.830            0.406		
L9.Loss Function	0.014682	0.419810
0.035            0.972		
L9.Log Currency in Circulation (\$ Bil)	-78.394681	96.743438
-0.810            0.418		
L10.Log M4 including Treasuries	100.000631	119.808725
0.835            0.404		
L10.Log Total Assets	-25.577272	30.062422

-0.851	0.395		
L10.Effective Federal Funds Rate (%)		21.636917	13.118316
1.649	0.099		
L10.Loss Function		0.662669	0.415096
1.596	0.110		
L10.Log Currency in Circulation (\$ Bil)		223.219611	97.692998
2.285	0.022		
L11.Log M4 including Treasuries		94.374795	122.555998
0.770	0.441		
L11.Log Total Assets		18.338773	29.339087
0.625	0.532		
L11.Effective Federal Funds Rate (%)		-20.167339	13.278873
-1.519	0.129		
L11.Loss Function		-0.221632	0.406017
-0.546	0.585		
L11.Log Currency in Circulation (\$ Bil)		-36.364289	100.380433
-0.362	0.717		
L12.Log M4 including Treasuries		-95.019056	89.091346
-1.067	0.286		
L12.Log Total Assets		2.086795	16.762845
0.124	0.901		
L12.Effective Federal Funds Rate (%)		9.291909	8.269391
1.124	0.261		
L12.Loss Function		-0.190767	0.366142
-0.521	0.602		
L12.Log Currency in Circulation (\$ Bil)		-84.136011	84.111241
-1.000	0.317		

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Results for equation Log Currency in Circulation (\$ Bil)

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t-stat	prob	coefficient	std. error
-----			
const		0.000933	0.000661
1.411	0.158		
L1.Log M4 including Treasuries		0.373229	0.081170
4.598	0.000		
L1.Log Total Assets		0.012213	0.018651
0.655	0.513		
L1.Effective Federal Funds Rate (%)		0.001661	0.004901
0.339	0.735		
L1.Loss Function		0.000073	0.000120
0.606	0.545		
L1.Log Currency in Circulation (\$ Bil)		0.383769	0.088065
4.358	0.000		
L2.Log M4 including Treasuries		-0.106981	0.114352
-0.936	0.350		
L2.Log Total Assets		0.060896	0.032948
1.848	0.065		
L2.Effective Federal Funds Rate (%)		0.017348	0.008403
2.065	0.039		
L2.Loss Function		0.000302	0.000127
2.381	0.017		

L2.Log Currency in Circulation (\$ Bil)	0.226273	0.094865
2.385            0.017		
L3.Log M4 including Treasuries	-0.063610	0.110594
-0.575            0.565		
L3.Log Total Assets	-0.016338	0.034253
-0.477            0.633		
L3.Effective Federal Funds Rate (%)	-0.018380	0.008962
-2.051            0.040		
L3.Loss Function	0.000251	0.000127
1.966            0.049		
L3.Log Currency in Circulation (\$ Bil)	0.083191	0.098250
0.847            0.397		
L4.Log M4 including Treasuries	-0.041187	0.114529
-0.360            0.719		
L4.Log Total Assets	0.006391	0.028232
0.226            0.821		
L4.Effective Federal Funds Rate (%)	0.004483	0.009160
0.489            0.625		
L4.Loss Function	0.000038	0.000129
0.292            0.770		
L4.Log Currency in Circulation (\$ Bil)	0.205600	0.091631
2.244            0.025		
L5.Log M4 including Treasuries	-0.135442	0.116033
-1.167            0.243		
L5.Log Total Assets	-0.055278	0.023708
-2.332            0.020		
L5.Effective Federal Funds Rate (%)	-0.016043	0.009439
-1.700            0.089		
L5.Loss Function	-0.000375	0.000420
-0.893            0.372		
L5.Log Currency in Circulation (\$ Bil)	-0.103736	0.091942
-1.128            0.259		
L6.Log M4 including Treasuries	0.071169	0.121113
0.588            0.557		
L6.Log Total Assets	0.017096	0.025954
0.659            0.510		
L6.Effective Federal Funds Rate (%)	0.002212	0.009661
0.229            0.819		
L6.Loss Function	0.000008	0.000468
0.017            0.987		
L6.Log Currency in Circulation (\$ Bil)	0.027043	0.093159
0.290            0.772		
L7.Log M4 including Treasuries	-0.105831	0.122514
-0.864            0.388		
L7.Log Total Assets	-0.007105	0.026334
-0.270            0.787		
L7.Effective Federal Funds Rate (%)	0.004726	0.009415
0.502            0.616		
L7.Loss Function	0.000138	0.000455
0.304            0.761		
L7.Log Currency in Circulation (\$ Bil)	-0.115014	0.092564
-1.243            0.214		
L8.Log M4 including Treasuries	0.222430	0.120033
1.853            0.064		
L8.Log Total Assets	-0.039460	0.024819
-1.590            0.112		
L8.Effective Federal Funds Rate (%)	-0.002222	0.008930

-0.249	0.804		
L8.Loss Function		0.000002	0.000417
0.005	0.996		
L8.Log Currency in Circulation (\$ Bil)		0.149420	0.092717
1.612	0.107		
L9.Log M4 including Treasuries		-0.214281	0.113963
-1.880	0.060		
L9.Log Total Assets		0.053324	0.024944
2.138	0.033		
L9.Effective Federal Funds Rate (%)		0.011648	0.010165
1.146	0.252		
L9.Loss Function		0.000068	0.000417
0.163	0.870		
L9.Log Currency in Circulation (\$ Bil)		0.231814	0.096163
2.411	0.016		
L10.Log M4 including Treasuries		0.004787	0.119090
0.040	0.968		
L10.Log Total Assets		0.023231	0.029882
0.777	0.437		
L10.Effective Federal Funds Rate (%)		0.002131	0.013040
0.163	0.870		
L10.Loss Function		0.000108	0.000413
0.262	0.793		
L10.Log Currency in Circulation (\$ Bil)		0.012343	0.097107
0.127	0.899		
L11.Log M4 including Treasuries		0.039367	0.121821
0.323	0.747		
L11.Log Total Assets		-0.021331	0.029163
-0.731	0.465		
L11.Effective Federal Funds Rate (%)		0.003501	0.013199
0.265	0.791		
L11.Loss Function		-0.000196	0.000404
-0.486	0.627		
L11.Log Currency in Circulation (\$ Bil)		-0.009924	0.099778
-0.099	0.921		
L12.Log M4 including Treasuries		0.034111	0.088557
0.385	0.700		
L12.Log Total Assets		0.000621	0.016662
0.037	0.970		
L12.Effective Federal Funds Rate (%)		-0.010933	0.008220
-1.330	0.183		
L12.Loss Function		-0.000183	0.000364
-0.503	0.615		
L12.Log Currency in Circulation (\$ Bil)		-0.370537	0.083607
-4.432	0.000		
=====			
=====			

# Correlation matrix of residuals

	Log M4 including Treasuries	Log Total Assets	Effective Federal Funds Rate (%)	Loss Function	Log Currency in Circulation (\$ Bil)
Log M4 including Treasuries					
15745	-0.275477	-0.634943			
0.288451					
Log Total Assets					
00000	-0.374642	-0.247550			

0.058501			
Effective Federal Funds Rate (%)		-0.275477	-0.3
74642	1.000000	-0.009764	
-0.023964			
Loss Function		-0.634943	-0.2
47550	-0.009764	1.000000	
-0.157866			
Log Currency in Circulation (\$ Bil)		0.288451	0.0
58501	-0.023964	-0.157866	
1.000000			

In [ ]:

In [38]: `var = VAR(df)`

C:\Users\proma.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\base\tsa\_model.py:524: ValueWarning: No frequency information was provided, so inferred frequency M will be used.  
 warnings.warn('No frequency information was')

In [39]: `x= var.select_order()  
x.summary()`

Out[39]: VAR Order Selection (\* highlights the minimums)

	AIC	BIC	FPE	HQIC
0	-9.407	-9.321	8.213e-05	-9.372
1	-19.26	-18.74	4.338e-09	-19.05
2	-20.10	-19.15*	1.860e-09	-19.72
3	-20.37	-18.99	1.421e-09	-19.81
4	-20.37	-18.55	1.436e-09	-19.63
5	-20.67	-18.42	1.065e-09	-19.76
6	-20.93	-18.25	8.285e-10	-19.84
7	-21.04	-17.93	7.479e-10	-19.78
8	-21.34	-17.79	5.622e-10	-19.90
9	-22.00	-18.03	2.938e-10	-20.39
10	-22.31	-17.91	2.185e-10	-20.53
11	-22.72	-17.89	1.486e-10	-20.76
12	-23.45	-18.18	7.394e-11	-21.32
13	-24.39	-18.69	2.998e-11	-22.08*
14	-24.45*	-18.32	2.927e-11*	-21.97



```
In [68]: results = var.fit(12)
#We can check the summary of the model by.
results.summary()
```

Out[68]: Summary of Regression Results

```
=====
Model:                                VAR
Method:                               OLS
Date:                Wed, 23, Mar, 2022
Time:                10:43:52
-----
No. of Equations:      5.00000      BIC:                -18.1874
Nobs:                  189.000      HQIC:               -21.2995
Log likelihood:        1177.18      FPE:                7.60829e-11
AIC:                   -23.4188      Det(Omega_mle):     1.87887e-11
-----
Results for equation Log M4 including Treasuries
=====
=====
```

	t-stat	prob	coefficient	std. error
const			0.000002	0.001008
0.002	0.998			
L1.Log M4 including Treasuries			1.267084	0.112847
11.228	0.000			
L1.Log Total Assets			-0.034431	0.028103
-1.225	0.221			
L1.Effective Federal Funds Rate (%)			-0.043128	0.006810
-6.333	0.000			
L1.Loss Function			-0.000128	0.000116
-1.109	0.267			
L1.Log Currency in Circulation (\$ Bil)			0.151344	0.134287
1.127	0.260			
L2.Log M4 including Treasuries			-0.535577	0.170876
-3.134	0.002			
L2.Log Total Assets			0.040352	0.049292
0.819	0.413			
L2.Effective Federal Funds Rate (%)			0.074694	0.011953
6.249	0.000			
L2.Loss Function			0.000022	0.000123
0.176	0.860			
L2.Log Currency in Circulation (\$ Bil)			-0.062587	0.143920
-0.435	0.664			
L3.Log M4 including Treasuries			0.309840	0.164199
1.887	0.059			
L3.Log Total Assets			0.036069	0.051132
0.705	0.481			
L3.Effective Federal Funds Rate (%)			-0.043716	0.013583
-3.218	0.001			
L3.Loss Function			0.000093	0.000119
0.784	0.433			
L3.Log Currency in Circulation (\$ Bil)			-0.038694	0.149336
-0.259	0.796			
L4.Log M4 including Treasuries			-0.103256	0.169108
-0.611	0.541			

L4.Log Total Assets	-0.033796	0.041700
-0.810            0.418		
L4.Effective Federal Funds Rate (%)	0.026400	0.013938
1.894            0.058		
L4.Loss Function	0.000184	0.000125
1.468            0.142		
L4.Log Currency in Circulation (\$ Bil)	-0.086007	0.140700
-0.611            0.541		
L5.Log M4 including Treasuries	-0.114173	0.170580
-0.669            0.503		
L5.Log Total Assets	0.034172	0.035878
0.952            0.341		
L5.Effective Federal Funds Rate (%)	-0.033246	0.014009
-2.373            0.018		
L5.Loss Function	-0.000296	0.000172
-1.717            0.086		
L5.Log Currency in Circulation (\$ Bil)	0.155105	0.140064
1.107            0.268		
L6.Log M4 including Treasuries	0.213026	0.171736
1.240            0.215		
L6.Log Total Assets	-0.101106	0.039721
-2.545            0.011		
L6.Effective Federal Funds Rate (%)	0.015183	0.014379
1.056            0.291		
L6.Loss Function	0.000278	0.000179
1.550            0.121		
L6.Log Currency in Circulation (\$ Bil)	0.010421	0.140731
0.074            0.941		
L7.Log M4 including Treasuries	-0.100882	0.172166
-0.586            0.558		
L7.Log Total Assets	0.070993	0.040370
1.759            0.079		
L7.Effective Federal Funds Rate (%)	-0.012964	0.014073
-0.921            0.357		
L7.Loss Function	-0.000163	0.000184
-0.884            0.377		
L7.Log Currency in Circulation (\$ Bil)	-0.029157	0.138801
-0.210            0.834		
L8.Log M4 including Treasuries	0.018468	0.171415
0.108            0.914		
L8.Log Total Assets	0.001343	0.037804
0.036            0.972		
L8.Effective Federal Funds Rate (%)	0.004434	0.013266
0.334            0.738		
L8.Loss Function	-0.000278	0.000194
-1.429            0.153		
L8.Log Currency in Circulation (\$ Bil)	-0.200878	0.139923
-1.436            0.151		
L9.Log M4 including Treasuries	-0.250765	0.161875
-1.549            0.121		
L9.Log Total Assets	-0.048769	0.037387
-1.304            0.192		
L9.Effective Federal Funds Rate (%)	0.029238	0.014753
1.982            0.047		
L9.Loss Function	-0.000071	0.000190
-0.374            0.708		
L9.Log Currency in Circulation (\$ Bil)	0.178896	0.143155

1.250	0.211		
L10.Log M4 including Treasuries		0.323372	0.163791
1.974	0.048		
L10.Log Total Assets		0.061300	0.043803
1.399	0.162		
L10.Effective Federal Funds Rate (%)		-0.027112	0.018218
-1.488	0.137		
L10.Loss Function		-0.000032	0.000189
-0.172	0.864		
L10.Log Currency in Circulation (\$ Bil)		-0.125333	0.143808
-0.872	0.383		
L11.Log M4 including Treasuries		-0.327837	0.167560
-1.957	0.050		
L11.Log Total Assets		-0.023175	0.042393
-0.547	0.585		
L11.Effective Federal Funds Rate (%)		0.018974	0.018551
1.023	0.306		
L11.Loss Function		0.000354	0.000179
1.979	0.048		
L11.Log Currency in Circulation (\$ Bil)		0.003073	0.149560
0.021	0.984		
L12.Log M4 including Treasuries		0.133967	0.113270
1.183	0.237		
L12.Log Total Assets		0.000093	0.024529
0.004	0.997		
L12.Effective Federal Funds Rate (%)		-0.010725	0.011302
-0.949	0.343		
L12.Loss Function		0.000202	0.000162
1.249	0.212		
L12.Log Currency in Circulation (\$ Bil)		0.176353	0.124379
1.418	0.156		

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# Results for equation Log Total Assets

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t-stat	prob	coefficient	std. error
-----			
const		0.000793	0.003464
0.229	0.819		
L1.Log M4 including Treasuries		-0.065171	0.387796
-0.168	0.867		
L1.Log Total Assets		1.475389	0.096575
15.277	0.000		
L1.Effective Federal Funds Rate (%)		-0.084228	0.023401
-3.599	0.000		
L1.Loss Function		-0.000769	0.000397
-1.935	0.053		
L1.Log Currency in Circulation (\$ Bil)		-0.334993	0.461477
-0.726	0.468		
L2.Log M4 including Treasuries		-0.867098	0.587212
-1.477	0.140		
L2.Log Total Assets		-0.736905	0.169391
-4.350	0.000		

L2.Effective Federal Funds Rate (%)	0.204070	0.041076
4.968            0.000		
L2.Loss Function	0.000547	0.000423
1.295            0.195		
L2.Log Currency in Circulation (\$ Bil)	0.322856	0.494580
0.653            0.514		
L3.Log M4 including Treasuries	2.162354	0.564267
3.832            0.000		
L3.Log Total Assets	0.379450	0.175716
2.159            0.031		
L3.Effective Federal Funds Rate (%)	-0.129601	0.046678
-2.776            0.005		
L3.Loss Function	0.000228	0.000408
0.558            0.577		
L3.Log Currency in Circulation (\$ Bil)	0.254468	0.513191
0.496            0.620		
L4.Log M4 including Treasuries	-2.502468	0.581136
-4.306            0.000		
L4.Log Total Assets	0.043854	0.143300
0.306            0.760		
L4.Effective Federal Funds Rate (%)	0.116266	0.047898
2.427            0.015		
L4.Loss Function	-0.000011	0.000431
-0.026            0.979		
L4.Log Currency in Circulation (\$ Bil)	-0.358412	0.483515
-0.741            0.459		
L5.Log M4 including Treasuries	1.530837	0.586197
2.611            0.009		
L5.Log Total Assets	-0.057911	0.123295
-0.470            0.639		
L5.Effective Federal Funds Rate (%)	-0.241637	0.048141
-5.019            0.000		
L5.Loss Function	-0.000369	0.000592
-0.623            0.533		
L5.Log Currency in Circulation (\$ Bil)	-0.175387	0.481329
-0.364            0.716		
L6.Log M4 including Treasuries	-1.142111	0.590167
-1.935            0.053		
L6.Log Total Assets	-0.224529	0.136500
-1.645            0.100		
L6.Effective Federal Funds Rate (%)	0.187331	0.049413
3.791            0.000		
L6.Loss Function	-0.000437	0.000617
-0.708            0.479		
L6.Log Currency in Circulation (\$ Bil)	-0.263632	0.483620
-0.545            0.586		
L7.Log M4 including Treasuries	1.912740	0.591647
3.233            0.001		
L7.Log Total Assets	-0.019805	0.138730
-0.143            0.886		
L7.Effective Federal Funds Rate (%)	-0.082935	0.048363
-1.715            0.086		
L7.Loss Function	0.002285	0.000633
3.607            0.000		
L7.Log Currency in Circulation (\$ Bil)	0.868421	0.476987
1.821            0.069		
L8.Log M4 including Treasuries	-0.494461	0.589063

-0.839	0.401		
L8.Log Total Assets		-0.523455	0.129912
-4.029	0.000		
L8.Effective Federal Funds Rate (%)		-0.286270	0.045587
-6.280	0.000		
L8.Loss Function		-0.001080	0.000668
-1.616	0.106		
L8.Log Currency in Circulation (\$ Bil)		-0.652578	0.480845
-1.357	0.175		
L9.Log M4 including Treasuries		-0.770180	0.556279
-1.385	0.166		
L9.Log Total Assets		0.895614	0.128479
6.971	0.000		
L9.Effective Federal Funds Rate (%)		0.445398	0.050698
8.785	0.000		
L9.Loss Function		-0.000563	0.000652
-0.863	0.388		
L9.Log Currency in Circulation (\$ Bil)		0.713419	0.491949
1.450	0.147		
L10.Log M4 including Treasuries		-0.564387	0.562864
-1.003	0.316		
L10.Log Total Assets		-0.485262	0.150529
-3.224	0.001		
L10.Effective Federal Funds Rate (%)		-0.167846	0.062607
-2.681	0.007		
L10.Loss Function		-0.002114	0.000649
-3.258	0.001		
L10.Log Currency in Circulation (\$ Bil)		-1.165293	0.494195
-2.358	0.018		
L11.Log M4 including Treasuries		1.102550	0.575817
1.915	0.056		
L11.Log Total Assets		0.297450	0.145683
2.042	0.041		
L11.Effective Federal Funds Rate (%)		0.174459	0.063750
2.737	0.006		
L11.Loss Function		0.002926	0.000616
4.753	0.000		
L11.Log Currency in Circulation (\$ Bil)		1.331846	0.513960
2.591	0.010		
L12.Log M4 including Treasuries		-0.337642	0.389250
-0.867	0.386		
L12.Log Total Assets		-0.136480	0.084295
-1.619	0.105		
L12.Effective Federal Funds Rate (%)		-0.148323	0.038837
-3.819	0.000		
L12.Loss Function		-0.000408	0.000556
-0.734	0.463		
L12.Log Currency in Circulation (\$ Bil)		-0.896118	0.427428
-2.097	0.036		

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Results for equation Effective Federal Funds Rate (%)

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		coefficient	std. error
t-stat	prob		

const		-0.019403	0.013215
-1.468	0.142		
L1.Log M4 including Treasuries		-0.313812	1.479531
-0.212	0.832		
L1.Log Total Assets		-0.409062	0.368454
-1.110	0.267		
L1.Effective Federal Funds Rate (%)		1.468996	0.089281
16.454	0.000		
L1.Loss Function		-0.000694	0.001516
-0.458	0.647		
L1.Log Currency in Circulation (\$ Bil)		3.475786	1.760638
1.974	0.048		
L2.Log M4 including Treasuries		0.272506	2.240347
0.122	0.903		
L2.Log Total Assets		1.557196	0.646265
2.410	0.016		
L2.Effective Federal Funds Rate (%)		-0.592554	0.156713
-3.781	0.000		
L2.Loss Function		-0.000625	0.001612
-0.388	0.698		
L2.Log Currency in Circulation (\$ Bil)		2.393527	1.886936
1.268	0.205		
L3.Log M4 including Treasuries		-1.382948	2.152806
-0.642	0.521		
L3.Log Total Assets		-1.610758	0.670396
-2.403	0.016		
L3.Effective Federal Funds Rate (%)		0.267092	0.178087
1.500	0.134		
L3.Loss Function		0.004791	0.001556
3.080	0.002		
L3.Log Currency in Circulation (\$ Bil)		-1.892079	1.957940
-0.966	0.334		
L4.Log M4 including Treasuries		0.670840	2.217164
0.303	0.762		
L4.Log Total Assets		1.406724	0.546723
2.573	0.010		
L4.Effective Federal Funds Rate (%)		-0.644528	0.182743
-3.527	0.000		
L4.Loss Function		-0.003474	0.001644
-2.113	0.035		
L4.Log Currency in Circulation (\$ Bil)		0.869889	1.844718
0.472	0.637		
L5.Log M4 including Treasuries		-0.605167	2.236473
-0.271	0.787		
L5.Log Total Assets		-2.065468	0.470399
-4.391	0.000		
L5.Effective Federal Funds Rate (%)		0.733187	0.183668
3.992	0.000		
L5.Loss Function		0.001188	0.002257
0.526	0.599		
L5.Log Currency in Circulation (\$ Bil)		0.311897	1.836377
0.170	0.865		
L6.Log M4 including Treasuries		1.726153	2.251619
0.767	0.443		
L6.Log Total Assets		1.012686	0.520778

1.945	0.052		
L6.Effective Federal Funds Rate (%)		-0.570274	0.188522
-3.025	0.002		
L6.Loss Function		-0.003123	0.002353
-1.327	0.184		
L6.Log Currency in Circulation (\$ Bil)		-0.363435	1.845119
-0.197	0.844		
L7.Log M4 including Treasuries		-2.665135	2.257268
-1.181	0.238		
L7.Log Total Assets		0.408881	0.529286
0.773	0.440		
L7.Effective Federal Funds Rate (%)		0.551743	0.184516
2.990	0.003		
L7.Loss Function		-0.000866	0.002417
-0.358	0.720		
L7.Log Currency in Circulation (\$ Bil)		-2.903034	1.819812
-1.595	0.111		
L8.Log M4 including Treasuries		2.787352	2.247410
1.240	0.215		
L8.Log Total Assets		-0.137601	0.495643
-0.278	0.781		
L8.Effective Federal Funds Rate (%)		0.050564	0.173926
0.291	0.771		
L8.Loss Function		0.002844	0.002550
1.115	0.265		
L8.Log Currency in Circulation (\$ Bil)		2.501295	1.834532
1.363	0.173		
L9.Log M4 including Treasuries		1.535888	2.122331
0.724	0.469		
L9.Log Total Assets		-0.939698	0.490176
-1.917	0.055		
L9.Effective Federal Funds Rate (%)		-0.315617	0.193425
-1.632	0.103		
L9.Loss Function		0.001087	0.002488
0.437	0.662		
L9.Log Currency in Circulation (\$ Bil)		-1.106077	1.876898
-0.589	0.556		
L10.Log M4 including Treasuries		-3.838067	2.147454
-1.787	0.074		
L10.Log Total Assets		1.899529	0.574304
3.308	0.001		
L10.Effective Federal Funds Rate (%)		0.299944	0.238859
1.256	0.209		
L10.Loss Function		0.003023	0.002476
1.221	0.222		
L10.Log Currency in Circulation (\$ Bil)		2.028691	1.885466
1.076	0.282		
L11.Log M4 including Treasuries		0.856426	2.196870
0.390	0.697		
L11.Log Total Assets		-1.556841	0.555813
-2.801	0.005		
L11.Effective Federal Funds Rate (%)		-0.513828	0.243219
-2.113	0.035		
L11.Loss Function		-0.016157	0.002349
-6.879	0.000		
L11.Log Currency in Circulation (\$ Bil)		-5.451473	1.960873
-2.780	0.005		

L12.Log M4 including Treasuries	0.660628	1.485077
0.445                      0.656		
L12.Log Total Assets	0.317271	0.321605
0.987                      0.324		
L12.Effective Federal Funds Rate (%)	0.225792	0.148174
1.524                      0.128		
L12.Loss Function	0.010973	0.002121
5.174                      0.000		
L12.Log Currency in Circulation (\$ Bil)	5.299868	1.630735
3.250                      0.001		

Results for equation Loss Function

t-stat	prob	coefficient	std. error
const		-0.161506	0.822174
-0.196                      0.844			
L1.Log M4 including Treasuries		-181.424367	92.046670
-1.971                      0.049			
L1.Log Total Assets		19.793282	22.922803
0.863                      0.388			
L1.Effective Federal Funds Rate (%)		38.930818	5.554450
7.009                      0.000			
L1.Loss Function		0.438655	0.094311
4.651                      0.000			
L1.Log Currency in Circulation (\$ Bil)		-85.028249	109.535303
-0.776                      0.438			
L2.Log M4 including Treasuries		458.013174	139.379663
3.286                      0.001			
L2.Log Total Assets		-25.983923	40.206359
-0.646                      0.518			
L2.Effective Federal Funds Rate (%)		-57.092724	9.749666
-5.856                      0.000			
L2.Loss Function		0.115890	0.100292
1.156                      0.248			
L2.Log Currency in Circulation (\$ Bil)		-66.559079	117.392743
-0.567                      0.571			
L3.Log M4 including Treasuries		-205.951984	133.933440
-1.538                      0.124			
L3.Log Total Assets		-63.996605	41.707616
-1.534                      0.125			
L3.Effective Federal Funds Rate (%)		24.681147	11.079429
2.228                      0.026			
L3.Loss Function		0.038208	0.096776
0.395                      0.693			
L3.Log Currency in Circulation (\$ Bil)		-95.050051	121.810123
-0.780                      0.435			
L4.Log M4 including Treasuries		-20.136470	137.937350
-0.146                      0.884			
L4.Log Total Assets		60.304953	34.013518
1.773                      0.076			
L4.Effective Federal Funds Rate (%)		-21.244969	11.369096



-1.869	0.062		
L4.Loss Function		-0.213295	0.102270
-2.086	0.037		
L4.Log Currency in Circulation (\$ Bil)		51.898514	114.766210
0.452	0.651		
L5.Log M4 including Treasuries		42.926033	139.138620
0.309	0.758		
L5.Log Total Assets		-8.216479	29.265118
-0.281	0.779		
L5.Effective Federal Funds Rate (%)		31.649078	11.426614
2.770	0.006		
L5.Loss Function		0.216955	0.140419
1.545	0.122		
L5.Log Currency in Circulation (\$ Bil)		19.086716	114.247295
0.167	0.867		
L6.Log M4 including Treasuries		-72.251898	140.080916
-0.516	0.606		
L6.Log Total Assets		68.413479	32.399378
2.112	0.035		
L6.Effective Federal Funds Rate (%)		0.381651	11.728607
0.033	0.974		
L6.Loss Function		-0.038610	0.146395
-0.264	0.792		
L6.Log Currency in Circulation (\$ Bil)		-93.970994	114.791146
-0.819	0.413		
L7.Log M4 including Treasuries		182.929880	140.432339
1.303	0.193		
L7.Log Total Assets		-60.230892	32.928673
-1.829	0.067		
L7.Effective Federal Funds Rate (%)		-14.834340	11.479377
-1.292	0.196		
L7.Loss Function		0.285190	0.150346
1.897	0.058		
L7.Log Currency in Circulation (\$ Bil)		145.900145	113.216705
1.289	0.198		
L8.Log M4 including Treasuries		-105.647292	139.819030
-0.756	0.450		
L8.Log Total Assets		29.779364	30.835656
0.966	0.334		
L8.Effective Federal Funds Rate (%)		-5.239108	10.820559
-0.484	0.628		
L8.Loss Function		0.103241	0.158622
0.651	0.515		
L8.Log Currency in Circulation (\$ Bil)		-51.525569	114.132476
-0.451	0.652		
L9.Log M4 including Treasuries		-33.059286	132.037483
-0.250	0.802		
L9.Log Total Assets		-14.707754	30.495522
-0.482	0.630		
L9.Effective Federal Funds Rate (%)		-16.094311	12.033614
-1.337	0.181		
L9.Loss Function		-0.202035	0.154798
-1.305	0.192		
L9.Log Currency in Circulation (\$ Bil)		-144.286815	116.768230
-1.236	0.217		
L10.Log M4 including Treasuries		125.874676	133.600436
0.942	0.346		

L10.Log Total Assets	-26.539711	35.729395
-0.743            0.458		
L10.Effective Federal Funds Rate (%)	33.117846	14.860245
2.229            0.026		
L10.Loss Function	0.374425	0.154047
2.431            0.015		
L10.Log Currency in Circulation (\$ Bil)	361.829693	117.301301
3.085            0.002		
L11.Log M4 including Treasuries	193.566635	136.674788
1.416            0.157		
L11.Log Total Assets	2.976189	34.579003
0.086            0.931		
L11.Effective Federal Funds Rate (%)	-36.157532	15.131500
-2.390            0.017		
L11.Loss Function	0.000240	0.146122
0.002            0.999		
L11.Log Currency in Circulation (\$ Bil)	-48.174029	121.992590
-0.395            0.693		
L12.Log M4 including Treasuries	-305.493189	92.391691
-3.307            0.001		
L12.Log Total Assets	26.666958	20.008118
1.333            0.183		
L12.Effective Federal Funds Rate (%)	26.040650	9.218385
2.825            0.005		
L12.Loss Function	-0.925420	0.131939
-7.014            0.000		
L12.Log Currency in Circulation (\$ Bil)	-67.696927	101.453588
-0.667            0.505		

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Results for equation Log Currency in Circulation (\$ Bil)

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t-stat	prob	coefficient	std. error
-----			
const		0.000836	0.000625
1.337            0.181			
L1.Log M4 including Treasuries		0.351708	0.069966
5.027            0.000			
L1.Log Total Assets		0.016590	0.017424
0.952            0.341			
L1.Effective Federal Funds Rate (%)		0.002151	0.004222
0.510            0.610			
L1.Loss Function		0.000010	0.000072
0.144            0.885			
L1.Log Currency in Circulation (\$ Bil)		0.377248	0.083260
4.531            0.000			
L2.Log M4 including Treasuries		-0.113265	0.105945
-1.069            0.285			
L2.Log Total Assets		0.059115	0.030562
1.934            0.053			
L2.Effective Federal Funds Rate (%)		0.017649	0.007411
2.382            0.017			
L2.Loss Function		0.000309	0.000076

4.047	0.000		
L2.Log Currency in Circulation (\$ Bil)		0.229642	0.089232
2.574	0.010		
L3.Log M4 including Treasuries		-0.085964	0.101805
-0.844	0.398		
L3.Log Total Assets		-0.022268	0.031703
-0.702	0.482		
L3.Effective Federal Funds Rate (%)		-0.018892	0.008422
-2.243	0.025		
L3.Loss Function		0.000122	0.000074
1.662	0.097		
L3.Log Currency in Circulation (\$ Bil)		0.082826	0.092590
0.895	0.371		
L4.Log M4 including Treasuries		-0.059024	0.104848
-0.563	0.573		
L4.Log Total Assets		0.009383	0.025854
0.363	0.717		
L4.Effective Federal Funds Rate (%)		0.002908	0.008642
0.336	0.737		
L4.Loss Function		0.000030	0.000078
0.380	0.704		
L4.Log Currency in Circulation (\$ Bil)		0.184904	0.087236
2.120	0.034		
L5.Log M4 including Treasuries		-0.097889	0.105762
-0.926	0.355		
L5.Log Total Assets		-0.063685	0.022245
-2.863	0.004		
L5.Effective Federal Funds Rate (%)		-0.014858	0.008686
-1.711	0.087		
L5.Loss Function		-0.000232	0.000107
-2.177	0.030		
L5.Log Currency in Circulation (\$ Bil)		-0.103640	0.086841
-1.193	0.233		
L6.Log M4 including Treasuries		0.083577	0.106478
0.785	0.432		
L6.Log Total Assets		0.020955	0.024627
0.851	0.395		
L6.Effective Federal Funds Rate (%)		0.003496	0.008915
0.392	0.695		
L6.Loss Function		0.000175	0.000111
1.571	0.116		
L6.Log Currency in Circulation (\$ Bil)		0.028227	0.087255
0.323	0.746		
L7.Log M4 including Treasuries		-0.109536	0.106745
-1.026	0.305		
L7.Log Total Assets		-0.002544	0.025030
-0.102	0.919		
L7.Effective Federal Funds Rate (%)		0.005291	0.008726
0.606	0.544		
L7.Loss Function		-0.000121	0.000114
-1.059	0.289		
L7.Log Currency in Circulation (\$ Bil)		-0.118848	0.086058
-1.381	0.167		
L8.Log M4 including Treasuries		0.193637	0.106279
1.822	0.068		
L8.Log Total Assets		-0.037427	0.023439
-1.597	0.110		

L8.Effective Federal Funds Rate (%)	-0.003177	0.008225
-0.386            0.699		
L8.Loss Function	-0.000022	0.000121
-0.183            0.854		
L8.Log Currency in Circulation (\$ Bil)	0.159680	0.086754
1.841            0.066		
L9.Log M4 including Treasuries	-0.235413	0.100364
-2.346            0.019		
L9.Log Total Assets	0.054181	0.023180
2.337            0.019		
L9.Effective Federal Funds Rate (%)	0.012390	0.009147
1.355            0.176		
L9.Loss Function	-0.000124	0.000118
-1.056            0.291		
L9.Log Currency in Circulation (\$ Bil)	0.199162	0.088757
2.244            0.025		
L10.Log M4 including Treasuries	-0.020872	0.101552
-0.206            0.837		
L10.Log Total Assets	0.017203	0.027158
0.633            0.526		
L10.Effective Federal Funds Rate (%)	-0.000627	0.011296
-0.056            0.956		
L10.Loss Function	-0.000054	0.000117
-0.460            0.646		
L10.Log Currency in Circulation (\$ Bil)	0.015904	0.089163
0.178            0.858		
L11.Log M4 including Treasuries	0.027932	0.103889
0.269            0.788		
L11.Log Total Assets	-0.025339	0.026284
-0.964            0.335		
L11.Effective Federal Funds Rate (%)	0.000962	0.011502
0.084            0.933		
L11.Loss Function	0.000133	0.000111
1.198            0.231		
L11.Log Currency in Circulation (\$ Bil)	-0.019782	0.092729
-0.213            0.831		
L12.Log M4 including Treasuries	0.072495	0.070228
1.032            0.302		
L12.Log Total Assets	0.001584	0.015208
0.104            0.917		
L12.Effective Federal Funds Rate (%)	-0.007051	0.007007
-1.006            0.314		
L12.Loss Function	0.000030	0.000100
0.296            0.768		
L12.Log Currency in Circulation (\$ Bil)	-0.359070	0.077117
-4.656            0.000		

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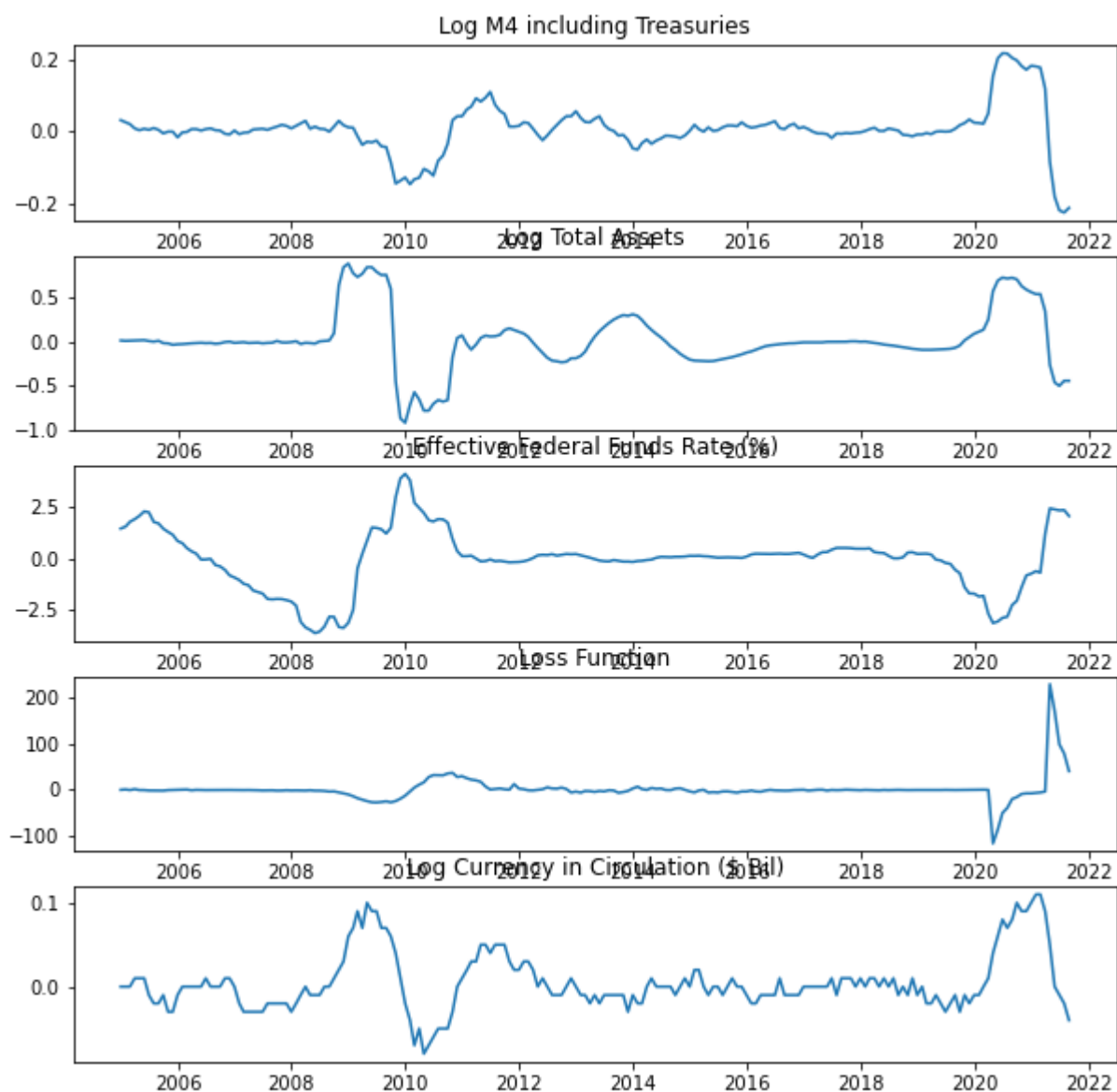
# Correlation matrix of residuals

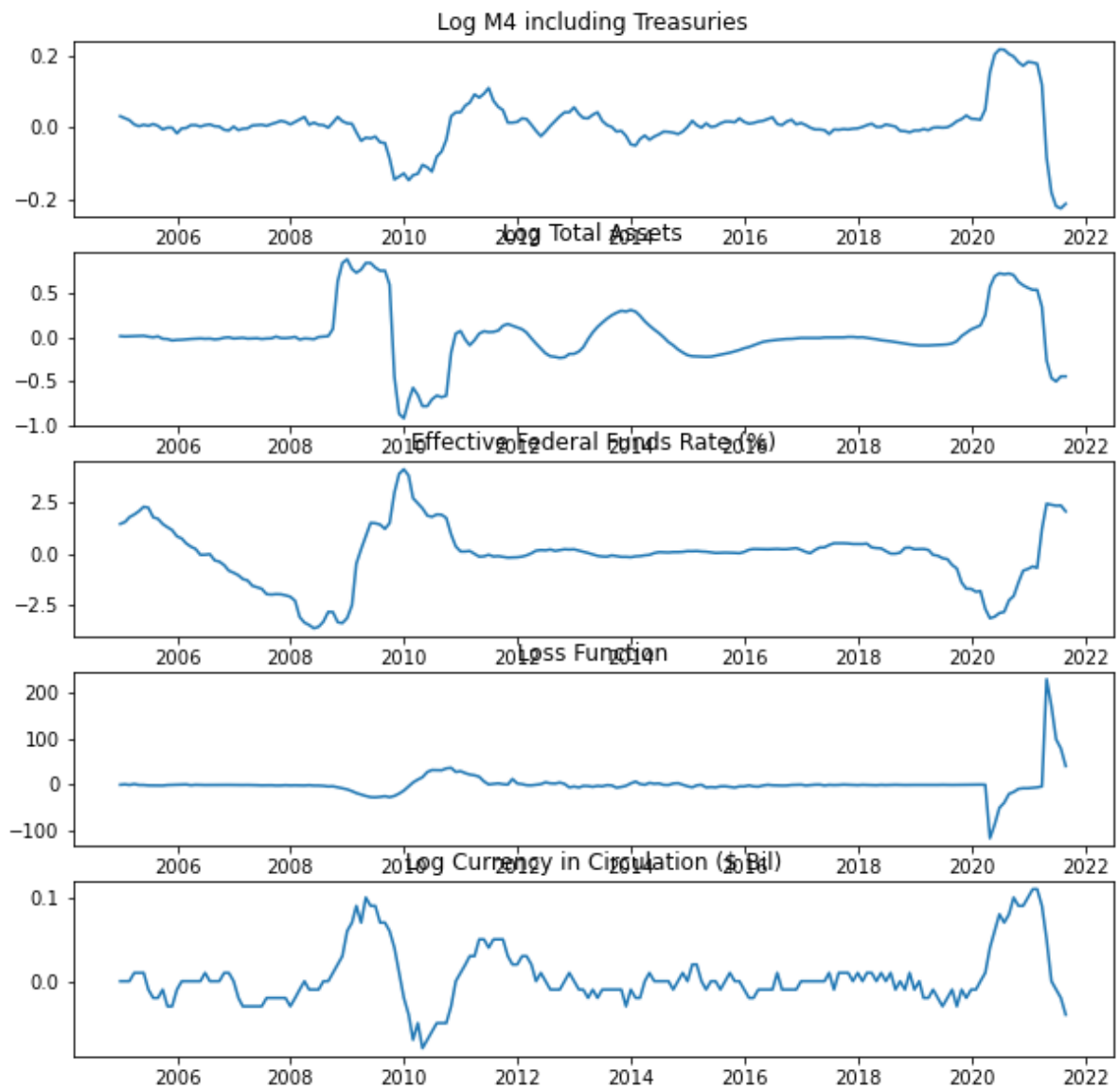
	Log M4 including Treasuries	Log Total Assets	Effective Federal Funds Rate (%)	Loss Function	Log Currency in Circulation (\$ Bil)
Log M4 including Treasuries	1.000000	0.3			
99215	-0.200819	-0.591747			
0.267881					
Log Total Assets		0.399215			1.0

00000	-0.354422	-0.239759		
0.051560				
Effective Federal Funds Rate (%)			-0.200819	-0.3
54422	1.000000	0.013916		
-0.025826				
Loss Function			-0.591747	-0.2
39759	0.013916	1.000000		
-0.102543				
Log Currency in Circulation (\$ Bil)			0.267881	0.0
51560	-0.025826	-0.102543		
1.000000				

```
In [44]: results.plot()
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Out[44]:
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```
In [48]: train_df=df[:-12]
         test_df=df[-12:]
```

```
In [49]: print(test_df.shape)

(12, 5)
```

```
In [50]: model = VAR(train_df)
```

C:\Users\prama.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\base\tsa\_model.py:524: ValueWarning: No frequency information was provided, so inferred frequency M will be used.  
 warnings.warn('No frequency information was'

```
In [69]: from statsmodels.tsa.statespace.varmax import VARMAX
```

```
var_model = VARMAX(train_df, order=(12,0),enforce_stationarity= True)
fitted_model = var_model.fit(dispatch=False)
print(fitted_model.summary())
```

```
C:\Users\prama.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:524: ValueWarning: No frequency information was provided, so inferred frequency M will be used.
```

```
warnings.warn('No frequency information was')
```

```
C:\Users\prama.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\statespace\varmax.py:374: UserWarning: Non-stationary starting autoregressive parameters found. Using zeros as starting parameters.
```

```
warn('Non-stationary starting autoregressive parameters')
```

```
C:\Users\prama.gupta\Anaconda3\lib\site-packages\statsmodels\base\model.py:566: ConvergenceWarning: Maximum Likelihood optimization failed to converge. Check mle_retvals
```

```
warnings.warn("Maximum Likelihood optimization failed to "
```

#### Statespace Model Results

```
=====
=====
=====
```

```
Dep. Variable:      ['Log M4 including Treasuries', 'Log Total Assets', 'Effective Federal Funds Rate (%)', 'Loss Function', 'Log Currency in Circulation ($ Billions)']
No. Observations:      189
```

```
Model:
```

```
VAR(12)    Log Likelihood      -153.262
```

```
+ intercept    AIC      946.524
```

```
Date:
```

```
Wed, 23 Mar 2022    BIC      1983.883
```

```
Time:
```

```
10:47:21    HQIC      1366.783
```

```
Sample:
```

```
12-31-2004
```

```
- 08-31-2020
```

```
Covariance Type:
```

```
opg
```

```
=====
=====
```

```
Ljung-Box (L1) (Q):      101.19, 118.89, 130.56, 7.93, 92.01    Jarque-Bera (JB):
447.87, 16.54, 24.08, 69383.86, 2096.20
```

```
Prob(Q):      0.00, 0.00, 0.00, 0.00, 0.00    Prob(JB):
```

```
0.00, 0.00, 0.00, 0.00, 0.00
```

```
Heteroskedasticity (H):      1.39, 0.14, 0.31, 10.71, 0.13    Skew:
```

```
1.56, 0.35, -0.01, -8.07, 1.56
```

```
Prob(H) (two-sided):      0.19, 0.00, 0.00, 0.00, 0.00    Kurtosis:
```

```
9.86, 4.26, 4.75, 95.47, 19.02
```

```
Results for equation Log M4 including Treasuries
```

```
=====
=====
```

```
coef    std err          z          P
>|z|    [0.025    0.975]
```

```
-----
```



-----			
intercept	0.0015	0.023	0.064
0.949      -0.044      0.047			
L1.Log M4 including Treasuries	0.0215	1.711	0.013
0.990      -3.332      3.376			
L1.Log Total Assets	-0.0081	0.838	-0.010
0.992      -1.651      1.635			
L1.Effective Federal Funds Rate (%)	0.0008	0.143	0.006
0.996      -0.279      0.281			
L1.Loss Function	-0.0009	0.014	-0.063
0.949      -0.028      0.026			
L1.Log Currency in Circulation (\$ Bil)	0.0047	1.103	0.004
0.997      -2.157      2.166			
L2.Log M4 including Treasuries	0.1426	1.445	0.099
0.921      -2.689      2.974			
L2.Log Total Assets	-0.0026	0.876	-0.003
0.998      -1.719      1.713			
L2.Effective Federal Funds Rate (%)	-0.0025	0.232	-0.011
0.991      -0.457      0.452			
L2.Loss Function	-0.0005	0.011	-0.044
0.965      -0.022      0.021			
L2.Log Currency in Circulation (\$ Bil)	-0.0001	0.779	-0.000
1.000      -1.527      1.526			
L3.Log M4 including Treasuries	0.1054	1.410	0.075
0.940      -2.659      2.870			
L3.Log Total Assets	-0.0042	0.603	-0.007
0.994      -1.186      1.178			
L3.Effective Federal Funds Rate (%)	-0.0043	0.303	-0.014
0.989      -0.599      0.590			
L3.Loss Function	-0.0005	0.012	-0.038
0.969      -0.025      0.024			
L3.Log Currency in Circulation (\$ Bil)	0.0010	0.859	0.001
0.999      -1.682      1.684			
L4.Log M4 including Treasuries	0.0462	1.238	0.037
0.970      -2.381      2.474			
L4.Log Total Assets	-0.0150	0.945	-0.016
0.987      -1.866      1.836			
L4.Effective Federal Funds Rate (%)	-0.0043	0.301	-0.014
0.989      -0.595      0.586			
L4.Loss Function	-0.0004	0.010	-0.043
0.965      -0.019      0.019			
L4.Log Currency in Circulation (\$ Bil)	0.0104	1.081	0.010
0.992      -2.107      2.128			
L5.Log M4 including Treasuries	0.1775	1.476	0.120
0.904      -2.716      3.071			
L5.Log Total Assets	-0.0110	1.055	-0.010
0.992      -2.079      2.057			
L5.Effective Federal Funds Rate (%)	0.0021	0.263	0.008
0.994      -0.512      0.517			
L5.Loss Function	0.0006	0.013	0.050
0.960      -0.024      0.026			
L5.Log Currency in Circulation (\$ Bil)	0.0078	1.055	0.007
0.994      -2.059      2.075			
L6.Log M4 including Treasuries	0.0880	1.605	0.055
0.956      -3.057      3.233			
L6.Log Total Assets	-0.0099	0.866	-0.011
0.991      -1.707      1.687			

L6.Effective Federal Funds Rate (%)	0.0002	0.271	0.001
0.999      -0.531      0.532			
L6.Loss Function	0.0003	0.014	0.022
0.982      -0.028      0.028			
L6.Log Currency in Circulation (\$ Bil)	0.0063	1.109	0.006
0.995      -2.167      2.180			
L7.Log M4 including Treasuries	0.0438	1.863	0.024
0.981      -3.608      3.695			
L7.Log Total Assets	-0.0055	0.659	-0.008
0.993      -1.297      1.286			
L7.Effective Federal Funds Rate (%)	-0.0031	0.221	-0.014
0.989      -0.435      0.429			
L7.Loss Function	0.0002	0.019	0.012
0.990      -0.038      0.038			
L7.Log Currency in Circulation (\$ Bil)	0.0023	1.027	0.002
0.998      -2.011      2.015			
L8.Log M4 including Treasuries	-0.0208	1.252	-0.017
0.987      -2.474      2.433			
L8.Log Total Assets	-0.0046	0.458	-0.010
0.992      -0.902      0.893			
L8.Effective Federal Funds Rate (%)	-0.0046	0.198	-0.023
0.982      -0.393      0.384			
L8.Loss Function	0.0002	0.016	0.010
0.992      -0.031      0.031			
L8.Log Currency in Circulation (\$ Bil)	0.0019	1.031	0.002
0.999      -2.020      2.023			
L9.Log M4 including Treasuries	-0.0195	1.245	-0.016
0.988      -2.460      2.421			
L9.Log Total Assets	-0.0021	0.417	-0.005
0.996      -0.819      0.815			
L9.Effective Federal Funds Rate (%)	-0.0013	0.306	-0.004
0.997      -0.601      0.599			
L9.Loss Function	0.0002	0.010	0.020
0.984      -0.019      0.019			
L9.Log Currency in Circulation (\$ Bil)	0.0008	1.064	0.001
0.999      -2.085      2.087			
L10.Log M4 including Treasuries	-0.0292	1.375	-0.021
0.983      -2.724      2.665			
L10.Log Total Assets	0.0022	0.561	0.004
0.997      -1.097      1.101			
L10.Effective Federal Funds Rate (%)	0.0023	0.245	0.009
0.993      -0.478      0.482			
L10.Loss Function	0.0001	0.013	0.008
0.994      -0.025      0.026			
L10.Log Currency in Circulation (\$ Bil)	-0.0018	1.110	-0.002
0.999      -2.178      2.174			
L11.Log M4 including Treasuries	-0.0568	1.790	-0.032
0.975      -3.565      3.451			
L11.Log Total Assets	0.0009	0.664	0.001
0.999      -1.300      1.302			
L11.Effective Federal Funds Rate (%)	0.0060	0.228	0.026
0.979      -0.441      0.453			
L11.Loss Function	-4.084e-05	0.010	-0.004
0.997      -0.020      0.020			
L11.Log Currency in Circulation (\$ Bil)	0.0005	1.635	0.000
1.000      -3.205      3.206			
L12.Log M4 including Treasuries	-0.1959	1.230	-0.159

0.874	-2.607	2.215			
L12.Log Total Assets			-0.0049	0.498	-0.010
0.992	-0.982	0.972			
L12.Effective Federal Funds Rate (%)			0.0040	0.145	0.028
0.978	-0.279	0.287			
L12.Loss Function			-0.0006	0.009	-0.071
0.944	-0.018	0.017			
L12.Log Currency in Circulation (\$ Bil)			0.0058	1.303	0.004
0.996	-2.548	2.560			

# Results for equation Log Total Assets

=====					
=====					
			coef	std err	z
> z	[0.025	0.975]			P
-----					
intercept			0.0285	1.392	0.020
0.984	-2.699	2.756			
L1.Log M4 including Treasuries			-0.2881	3.360	-0.086
0.932	-6.874	6.297			
L1.Log Total Assets			0.2415	3.656	0.066
0.947	-6.923	7.406			
L1.Effective Federal Funds Rate (%)			-0.0131	2.227	-0.006
0.995	-4.379	4.353			
L1.Loss Function			-0.0008	0.531	-0.002
0.999	-1.042	1.040			
L1.Log Currency in Circulation (\$ Bil)			-0.2012	4.299	-0.047
0.963	-8.627	8.225			
L2.Log M4 including Treasuries			0.0914	3.948	0.023
0.982	-7.647	7.829			
L2.Log Total Assets			0.2732	2.054	0.133
0.894	-3.753	4.300			
L2.Effective Federal Funds Rate (%)			-0.0088	3.406	-0.003
0.998	-6.683	6.666			
L2.Loss Function			-0.0003	0.446	-0.001
0.999	-0.874	0.873			
L2.Log Currency in Circulation (\$ Bil)			-0.2175	3.780	-0.058
0.954	-7.627	7.192			
L3.Log M4 including Treasuries			0.1975	4.133	0.048
0.962	-7.902	8.297			
L3.Log Total Assets			0.1395	2.540	0.055
0.956	-4.839	5.118			
L3.Effective Federal Funds Rate (%)			0.0048	3.489	0.001
0.999	-6.833	6.843			
L3.Loss Function			-0.0009	0.369	-0.003
0.998	-0.725	0.723			
L3.Log Currency in Circulation (\$ Bil)			-0.1061	2.991	-0.035
0.972	-5.968	5.755			
L4.Log M4 including Treasuries			-0.2976	3.074	-0.097
0.923	-6.323	5.728			
L4.Log Total Assets			0.0657	2.660	0.025
0.980	-5.148	5.279			
L4.Effective Federal Funds Rate (%)			-0.0091	3.172	-0.003
0.998	-6.227	6.209			
L4.Loss Function			-0.0020	0.357	-0.006
0.995	-0.702	0.698			
L4.Log Currency in Circulation (\$ Bil)			-0.0475	4.079	-0.012

0.991	-8.042	7.947			
L5.Log M4 including Treasuries			-0.0842	2.616	-0.032
0.974	-5.211	5.042			
L5.Log Total Assets			0.0680	4.091	0.017
0.987	-7.950	8.085			
L5.Effective Federal Funds Rate (%)			-0.0133	2.788	-0.005
0.996	-5.478	5.451			
L5.Loss Function			0.0013	0.653	0.002
0.998	-1.279	1.282			
L5.Log Currency in Circulation (\$ Bil)			-0.0528	3.117	-0.017
0.986	-6.162	6.057			
L6.Log M4 including Treasuries			-0.2648	2.739	-0.097
0.923	-5.632	5.103			
L6.Log Total Assets			0.0131	3.469	0.004
0.997	-6.787	6.813			
L6.Effective Federal Funds Rate (%)			-0.0303	2.821	-0.011
0.991	-5.560	5.499			
L6.Loss Function			0.0008	0.692	0.001
0.999	-1.356	1.358			
L6.Log Currency in Circulation (\$ Bil)			-0.0150	4.534	-0.003
0.997	-8.901	8.871			
L7.Log M4 including Treasuries			-0.0085	3.531	-0.002
0.998	-6.929	6.912			
L7.Log Total Assets			-0.0906	3.716	-0.024
0.981	-7.374	7.193			
L7.Effective Federal Funds Rate (%)			-0.0420	2.328	-0.018
0.986	-4.605	4.520			
L7.Loss Function			0.0010	0.895	0.001
0.999	-1.753	1.755			
L7.Log Currency in Circulation (\$ Bil)			0.0642	3.604	0.018
0.986	-6.999	7.128			
L8.Log M4 including Treasuries			-0.3747	4.545	-0.082
0.934	-9.283	8.534			
L8.Log Total Assets			-0.1359	2.284	-0.059
0.953	-4.612	4.340			
L8.Effective Federal Funds Rate (%)			-0.0677	2.426	-0.028
0.978	-4.822	4.687			
L8.Loss Function			4.49e-05	0.622	7.22e-05
1.000	-1.219	1.219			
L8.Log Currency in Circulation (\$ Bil)			0.0962	4.496	0.021
0.983	-8.716	8.909			
L9.Log M4 including Treasuries			-0.3580	2.696	-0.133
0.894	-5.642	4.926			
L9.Log Total Assets			-0.0084	2.671	-0.003
0.997	-5.243	5.226			
L9.Effective Federal Funds Rate (%)			-0.0423	2.016	-0.021
0.983	-3.994	3.910			
L9.Loss Function			0.0005	0.549	0.001
0.999	-1.075	1.076			
L9.Log Currency in Circulation (\$ Bil)			-0.0068	2.890	-0.002
0.998	-5.672	5.658			
L10.Log M4 including Treasuries			-0.2218	3.262	-0.068
0.946	-6.614	6.171			
L10.Log Total Assets			0.0811	2.747	0.030
0.976	-5.303	5.465			
L10.Effective Federal Funds Rate (%)			0.0059	2.865	0.002
0.998	-5.609	5.621			

L10.Loss Function	0.0002	0.618	0.000
1.000      -1.212      1.212			
L10.Log Currency in Circulation (\$ Bil)	-0.0758	3.170	-0.024
0.981      -6.289      6.138			
L11.Log M4 including Treasuries	0.2589	2.890	0.090
0.929      -5.405      5.922			
L11.Log Total Assets	0.0056	4.247	0.001
0.999      -8.318      8.329			
L11.Effective Federal Funds Rate (%)	0.0614	2.755	0.022
0.982      -5.339      5.461			
L11.Loss Function	-0.0002	0.592	-0.000
1.000      -1.161      1.161			
L11.Log Currency in Circulation (\$ Bil)	-0.0079	3.612	-0.002
0.998      -7.087      7.071			
L12.Log M4 including Treasuries	0.0717	3.203	0.022
0.982      -6.207      6.350			
L12.Log Total Assets	-0.1826	2.814	-0.065
0.948      -5.698      5.332			
L12.Effective Federal Funds Rate (%)	0.0614	2.667	0.023
0.982      -5.166      5.289			
L12.Loss Function	-0.0031	0.543	-0.006
0.995      -1.067      1.061			
L12.Log Currency in Circulation (\$ Bil)	0.1465	3.026	0.048
0.961      -5.784      6.077			

Results for equation Effective Federal Funds Rate

(%)

=====

=====

	coef	std err	z	P
> z       [0.025      0.975]				
-----				
-----				
intercept	-0.0077	0.674	-0.011	
0.991      -1.328      1.313				
L1.Log M4 including Treasuries	2.6489	4.362	0.607	
0.544      -5.901      11.199				
L1.Log Total Assets	0.1775	3.904	0.045	
0.964      -7.475      7.830				
L1.Effective Federal Funds Rate (%)	0.2063	1.848	0.112	
0.911      -3.415      3.828				
L1.Loss Function	0.0132	0.316	0.042	
0.967      -0.606      0.633				
L1.Log Currency in Circulation (\$ Bil)	-0.1001	3.044	-0.033	
0.974      -6.065      5.865				
L2.Log M4 including Treasuries	0.3875	2.483	0.156	
0.876      -4.480      5.254				
L2.Log Total Assets	0.0825	3.593	0.023	
0.982      -6.959      7.124				
L2.Effective Federal Funds Rate (%)	0.2795	1.459	0.192	
0.848      -2.580      3.139				
L2.Loss Function	0.0048	0.229	0.021	
0.983      -0.445      0.454				
L2.Log Currency in Circulation (\$ Bil)	-0.0177	2.757	-0.006	
0.995      -5.422      5.387				
L3.Log M4 including Treasuries	-0.1049	3.254	-0.032	
0.974      -6.483      6.273				
L3.Log Total Assets	0.1706	3.641	0.047	

0.963	-6.966	7.307			
L3.Effective Federal Funds Rate (%)			0.2169	2.329	0.093
0.926	-4.347	4.781			
L3.Loss Function			0.0052	0.123	0.042
0.966	-0.236	0.246			
L3.Log Currency in Circulation (\$ Bil)			-0.0933	3.444	-0.027
0.978	-6.843	6.657			
L4.Log M4 including Treasuries			-0.5637	2.619	-0.215
0.830	-5.698	4.570			
L4.Log Total Assets			0.2818	3.230	0.087
0.930	-6.050	6.613			
L4.Effective Federal Funds Rate (%)			0.1057	2.753	0.038
0.969	-5.290	5.502			
L4.Loss Function			0.0026	0.119	0.022
0.983	-0.231	0.237			
L4.Log Currency in Circulation (\$ Bil)			-0.2025	6.097	-0.033
0.974	-12.153	11.748			
L5.Log M4 including Treasuries			-1.5178	2.747	-0.552
0.581	-6.903	3.867			
L5.Log Total Assets			0.1337	4.120	0.032
0.974	-7.941	8.209			
L5.Effective Federal Funds Rate (%)			0.0148	2.881	0.005
0.996	-5.632	5.662			
L5.Loss Function			-0.0063	0.476	-0.013
0.989	-0.939	0.926			
L5.Log Currency in Circulation (\$ Bil)			-0.0899	4.708	-0.019
0.985	-9.317	9.137			
L6.Log M4 including Treasuries			-0.6213	2.185	-0.284
0.776	-4.905	3.662			
L6.Log Total Assets			0.0838	3.646	0.023
0.982	-7.062	7.230			
L6.Effective Federal Funds Rate (%)			0.0320	2.455	0.013
0.990	-4.779	4.843			
L6.Loss Function			-0.0036	0.376	-0.010
0.992	-0.741	0.734			
L6.Log Currency in Circulation (\$ Bil)			-0.0413	2.609	-0.016
0.987	-5.155	5.073			
L7.Log M4 including Treasuries			-0.3550	3.000	-0.118
0.906	-6.234	5.524			
L7.Log Total Assets			0.1052	4.444	0.024
0.981	-8.606	8.816			
L7.Effective Federal Funds Rate (%)			0.0831	2.819	0.029
0.976	-5.442	5.608			
L7.Loss Function			-0.0033	0.563	-0.006
0.995	-1.107	1.100			
L7.Log Currency in Circulation (\$ Bil)			-0.0511	4.700	-0.011
0.991	-9.262	9.160			
L8.Log M4 including Treasuries			0.6130	3.448	0.178
0.859	-6.145	7.371			
L8.Log Total Assets			0.0785	3.968	0.020
0.984	-7.698	7.855			
L8.Effective Federal Funds Rate (%)			0.1469	2.197	0.067
0.947	-4.160	4.454			
L8.Loss Function			-0.0022	0.376	-0.006
0.995	-0.740	0.735			
L8.Log Currency in Circulation (\$ Bil)			-0.0244	3.020	-0.008
0.994	-5.944	5.896			

L9.Log M4 including Treasuries	0.6276	1.853	0.339
0.735      -3.004      4.259			
L9.Log Total Assets	-0.1248	3.041	-0.041
0.967      -6.085      5.835			
L9.Effective Federal Funds Rate (%)	0.1033	4.173	0.025
0.980      -8.076      8.283			
L9.Loss Function	-0.0033	0.297	-0.011
0.991      -0.586      0.580			
L9.Log Currency in Circulation (\$ Bil)	0.1327	3.776	0.035
0.972      -7.268      7.534			
L10.Log M4 including Treasuries	0.4144	3.390	0.122
0.903      -6.229      7.058			
L10.Log Total Assets	-0.2574	3.474	-0.074
0.941      -7.067      6.552			
L10.Effective Federal Funds Rate (%)	-0.0106	2.568	-0.004
0.997      -5.043      5.022			
L10.Loss Function	-0.0022	0.250	-0.009
0.993      -0.493      0.489			
L10.Log Currency in Circulation (\$ Bil)	0.2213	4.529	0.049
0.961      -8.656      9.099			
L11.Log M4 including Treasuries	-0.0794	3.942	-0.020
0.984      -7.805      7.646			
L11.Log Total Assets	-0.1509	3.661	-0.041
0.967      -7.326      7.024			
L11.Effective Federal Funds Rate (%)	-0.1651	2.945	-0.056
0.955      -5.937      5.607			
L11.Loss Function	6.726e-05	0.253	0.000
1.000      -0.496      0.497			
L11.Log Currency in Circulation (\$ Bil)	0.1053	2.629	0.040
0.968      -5.047      5.258			
L12.Log M4 including Treasuries	0.2338	3.102	0.075
0.940      -5.845      6.313			
L12.Log Total Assets	0.1399	3.327	0.042
0.966      -6.381      6.661			
L12.Effective Federal Funds Rate (%)	-0.2319	1.742	-0.133
0.894      -3.646      3.183			
L12.Loss Function	0.0063	0.279	0.023
0.982      -0.541      0.554			
L12.Log Currency in Circulation (\$ Bil)	-0.1488	2.927	-0.051
0.959      -5.886      5.588			

# Results for equation Loss Function

=====

			coef	std err	z	P
--	--	--	------	---------	---	---

>|z|      [0.025      0.975]

-----

intercept			-1.7400	5.000	-0.348	
0.728      -11.539      8.059						
L1.Log M4 including Treasuries			80.7228	0.136	595.226	
0.000      80.457      80.989						
L1.Log Total Assets			1.0552	0.623	1.693	
0.090      -0.166      2.276						
L1.Effective Federal Funds Rate (%)			2.9951	1.559	1.922	
0.055      -0.060      6.050						
L1.Loss Function			0.5437	3.403	0.160	
0.873      -6.126      7.213						

L1.Log Currency in Circulation (\$ Bil)	0.4028	0.231	1.745
0.081      -0.050      0.855			
L2.Log M4 including Treasuries	1.3289	0.077	17.274
0.000      1.178      1.480			
L2.Log Total Assets	-3.3258	0.685	-4.856
0.000      -4.668      -1.984			
L2.Effective Federal Funds Rate (%)	0.0319	1.726	0.018
0.985      -3.351      3.415			
L2.Loss Function	0.0753	2.399	0.031
0.975      -4.626      4.777			
L2.Log Currency in Circulation (\$ Bil)	2.4529	0.122	20.085
0.000      2.214      2.692			
L3.Log M4 including Treasuries	-2.5695	0.099	-26.083
0.000      -2.763      -2.376			
L3.Log Total Assets	-2.0950	0.491	-4.269
0.000      -3.057      -1.133			
L3.Effective Federal Funds Rate (%)	-0.7720	1.672	-0.462
0.644      -4.048      2.504			
L3.Loss Function	0.0819	4.572	0.018
0.986      -8.880      9.044			
L3.Log Currency in Circulation (\$ Bil)	1.3068	0.198	6.595
0.000      0.918      1.695			
L4.Log M4 including Treasuries	-31.8493	0.128	-249.087
0.000      -32.100      -31.599			
L4.Log Total Assets	-1.9838	0.561	-3.539
0.000      -3.083      -0.885			
L4.Effective Federal Funds Rate (%)	-1.5287	2.234	-0.684
0.494      -5.908      2.850			
L4.Loss Function	-0.0538	4.445	-0.012
0.990      -8.765      8.658			
L4.Log Currency in Circulation (\$ Bil)	1.1290	0.165	6.853
0.000      0.806      1.452			
L5.Log M4 including Treasuries	-8.5093	0.103	-82.358
0.000      -8.712      -8.307			
L5.Log Total Assets	-0.7324	0.400	-1.832
0.067      -1.516      0.051			
L5.Effective Federal Funds Rate (%)	0.2449	1.960	0.125
0.901      -3.597      4.087			
L5.Loss Function	0.0286	3.935	0.007
0.994      -7.683      7.740			
L5.Log Currency in Circulation (\$ Bil)	0.3970	0.132	3.018
0.003      0.139      0.655			
L6.Log M4 including Treasuries	0.1190	0.125	0.951
0.342      -0.126      0.364			
L6.Log Total Assets	-0.7855	0.416	-1.889
0.059      -1.600      0.030			
L6.Effective Federal Funds Rate (%)	1.0483	1.598	0.656
0.512      -2.083      4.179			
L6.Loss Function	0.0173	5.538	0.003
0.998      -10.838      10.872			
L6.Log Currency in Circulation (\$ Bil)	0.5026	0.124	4.039
0.000      0.259      0.747			
L7.Log M4 including Treasuries	-13.6752	0.116	-117.749
0.000      -13.903      -13.448			
L7.Log Total Assets	-2.3468	0.650	-3.613
0.000      -3.620      -1.074			
L7.Effective Federal Funds Rate (%)	-0.5160	1.808	-0.285



0.775	-4.060	3.028			
L7.Loss Function			-0.0036	6.286	-0.001
1.000	-12.324	12.317			
L7.Log Currency in Circulation (\$ Bil)			1.6670	0.129	12.930
0.000	1.414	1.920			
L8.Log M4 including Treasuries			-12.4982	0.135	-92.883
0.000	-12.762	-12.234			
L8.Log Total Assets			-0.6152	1.078	-0.571
0.568	-2.727	1.497			
L8.Effective Federal Funds Rate (%)			-0.3589	1.624	-0.221
0.825	-3.542	2.824			
L8.Loss Function			-0.0163	4.167	-0.004
0.997	-8.183	8.151			
L8.Log Currency in Circulation (\$ Bil)			0.2127	0.163	1.308
0.191	-0.106	0.531			
L9.Log M4 including Treasuries			-9.5634	0.166	-57.474
0.000	-9.890	-9.237			
L9.Log Total Assets			-1.1251	1.255	-0.896
0.370	-3.585	1.335			
L9.Effective Federal Funds Rate (%)			-0.5999	2.451	-0.245
0.807	-5.404	4.205			
L9.Loss Function			-0.0156	3.266	-0.005
0.996	-6.416	6.385			
L9.Log Currency in Circulation (\$ Bil)			0.6389	0.135	4.726
0.000	0.374	0.904			
L10.Log M4 including Treasuries			5.2761	0.168	31.433
0.000	4.947	5.605			
L10.Log Total Assets			-1.7233	1.200	-1.436
0.151	-4.075	0.629			
L10.Effective Federal Funds Rate (%)			-0.1659	2.043	-0.081
0.935	-4.171	3.839			
L10.Loss Function			0.0089	5.245	0.002
0.999	-10.271	10.289			
L10.Log Currency in Circulation (\$ Bil)			1.1990	0.182	6.591
0.000	0.842	1.556			
L11.Log M4 including Treasuries			16.9671	0.189	89.593
0.000	16.596	17.338			
L11.Log Total Assets			-0.4284	1.292	-0.332
0.740	-2.960	2.103			
L11.Effective Federal Funds Rate (%)			0.3843	1.708	0.225
0.822	-2.963	3.732			
L11.Loss Function			0.0312	3.933	0.008
0.994	-7.677	7.739			
L11.Log Currency in Circulation (\$ Bil)			0.1733	0.175	0.992
0.321	-0.169	0.516			
L12.Log M4 including Treasuries			30.5976	0.210	145.669
0.000	30.186	31.009			
L12.Log Total Assets			4.5558	1.062	4.290
0.000	2.474	6.637			
L12.Effective Federal Funds Rate (%)			1.4451	1.879	0.769
0.442	-2.237	5.127			
L12.Loss Function			0.0364	2.741	0.013
0.989	-5.336	5.409			
L12.Log Currency in Circulation (\$ Bil)			-3.8997	0.096	-40.607
0.000	-4.088	-3.711			

Results for equation Log Currency in Circulation (\$ B

il)

=====			coef	std err	z	P
=====						
> z	[0.025	0.975]				
-----						
intercept			0.0081	1.684	0.005	
0.996	-3.292	3.308				
L1.Log M4 including Treasuries			-0.1220	3.566	-0.034	
0.973	-7.110	6.866				
L1.Log Total Assets			0.0115	2.545	0.005	
0.996	-4.977	5.000				
L1.Effective Federal Funds Rate (%)			-0.0095	2.538	-0.004	
0.997	-4.984	4.965				
L1.Loss Function			0.0002	0.602	0.000	
1.000	-1.179	1.179				
L1.Log Currency in Circulation (\$ Bil)			0.0140	2.712	0.005	
0.996	-5.301	5.328				
L2.Log M4 including Treasuries			-0.0842	3.009	-0.028	
0.978	-5.983	5.814				
L2.Log Total Assets			0.0241	3.345	0.007	
0.994	-6.532	6.580				
L2.Effective Federal Funds Rate (%)			-0.0231	3.594	-0.006	
0.995	-7.067	7.021				
L2.Loss Function			-0.0003	0.529	-0.001	
1.000	-1.037	1.036				
L2.Log Currency in Circulation (\$ Bil)			-0.0040	3.696	-0.001	
0.999	-7.248	7.240				
L3.Log M4 including Treasuries			0.0364	3.437	0.011	
0.992	-6.700	6.772				
L3.Log Total Assets			-0.0051	2.226	-0.002	
0.998	-4.367	4.357				
L3.Effective Federal Funds Rate (%)			-0.0154	4.406	-0.004	
0.997	-8.652	8.621				
L3.Loss Function			-0.0003	0.422	-0.001	
0.999	-0.827	0.827				
L3.Log Currency in Circulation (\$ Bil)			0.0164	3.071	0.005	
0.996	-6.002	6.035				
L4.Log M4 including Treasuries			-0.0963	3.439	-0.028	
0.978	-6.837	6.645				
L4.Log Total Assets			-0.0250	3.140	-0.008	
0.994	-6.179	6.129				
L4.Effective Federal Funds Rate (%)			-0.0121	3.766	-0.003	
0.997	-7.394	7.369				
L4.Loss Function			-0.0008	0.421	-0.002	
0.998	-0.826	0.824				
L4.Log Currency in Circulation (\$ Bil)			0.0301	3.209	0.009	
0.993	-6.259	6.319				
L5.Log M4 including Treasuries			0.0749	2.364	0.032	
0.975	-4.559	4.709				
L5.Log Total Assets			-0.0109	2.682	-0.004	
0.997	-5.268	5.246				
L5.Effective Federal Funds Rate (%)			-0.0023	3.570	-0.001	
0.999	-6.999	6.994				
L5.Loss Function			0.0007	0.757	0.001	
0.999	-1.482	1.483				
L5.Log Currency in Circulation (\$ Bil)			0.0162	3.131	0.005	

0.996	-6.121	6.154			
L6.Log M4 including Treasuries			0.0334	2.425	0.014
0.989	-4.719	4.786			
L6.Log Total Assets			-0.0136	6.650	-0.002
0.998	-13.047	13.020			
L6.Effective Federal Funds Rate (%)			-0.0037	3.314	-0.001
0.999	-6.498	6.491			
L6.Loss Function			0.0006	0.809	0.001
0.999	-1.585	1.586			
L6.Log Currency in Circulation (\$ Bil)			0.0134	4.038	0.003
0.997	-7.900	7.927			
L7.Log M4 including Treasuries			0.0367	2.985	0.012
0.990	-5.815	5.888			
L7.Log Total Assets			-0.0455	3.734	-0.012
0.990	-7.364	7.273			
L7.Effective Federal Funds Rate (%)			-0.0157	2.965	-0.005
0.996	-5.828	5.796			
L7.Loss Function			0.0007	1.056	0.001
0.999	-2.068	2.070			
L7.Log Currency in Circulation (\$ Bil)			0.0337	5.000	0.007
0.995	-9.765	9.833			
L8.Log M4 including Treasuries			-0.1695	3.652	-0.046
0.963	-7.327	6.988			
L8.Log Total Assets			-0.0479	2.223	-0.022
0.983	-4.405	4.309			
L8.Effective Federal Funds Rate (%)			-0.0292	3.161	-0.009
0.993	-6.225	6.167			
L8.Loss Function			0.0003	0.728	0.000
1.000	-1.426	1.427			
L8.Log Currency in Circulation (\$ Bil)			0.0308	2.522	0.012
0.990	-4.913	4.974			
L9.Log M4 including Treasuries			-0.1877	2.518	-0.075
0.941	-5.124	4.748			
L9.Log Total Assets			0.0054	2.924	0.002
0.999	-5.725	5.736			
L9.Effective Federal Funds Rate (%)			-0.0232	2.314	-0.010
0.992	-4.559	4.513			
L9.Loss Function			0.0004	0.644	0.001
0.999	-1.262	1.263			
L9.Log Currency in Circulation (\$ Bil)			-0.0148	2.549	-0.006
0.995	-5.010	4.981			
L10.Log M4 including Treasuries			-0.1001	2.861	-0.035
0.972	-5.707	5.507			
L10.Log Total Assets			0.0461	2.820	0.016
0.987	-5.480	5.572			
L10.Effective Federal Funds Rate (%)			-0.0021	2.580	-0.001
0.999	-5.059	5.055			
L10.Loss Function			0.0004	0.698	0.001
1.000	-1.367	1.368			
L10.Log Currency in Circulation (\$ Bil)			-0.0486	3.176	-0.015
0.988	-6.274	6.177			
L11.Log M4 including Treasuries			0.1177	3.425	0.034
0.973	-6.596	6.831			
L11.Log Total Assets			0.0332	2.603	0.013
0.990	-5.069	5.136			
L11.Effective Federal Funds Rate (%)			0.0272	2.950	0.009
0.993	-5.754	5.809			

L11.Loss Function			0.0002	0.674	0.000
1.000	-1.321	1.321			
L11.Log Currency in Circulation (\$ Bil)			-0.0374	2.842	-0.013
0.989	-5.607	5.532			
L12.Log M4 including Treasuries			0.0959	2.886	0.033
0.973	-5.561	5.753			
L12.Log Total Assets			-0.0195	2.696	-0.007
0.994	-5.303	5.265			
L12.Effective Federal Funds Rate (%)			0.0377	3.269	0.012
0.991	-6.370	6.445			
L12.Loss Function			-0.0012	0.624	-0.002
0.998	-1.225	1.222			
L12.Log Currency in Circulation (\$ Bil)			0.0045	3.967	0.001
0.999	-7.771	7.780			

Error covariance m

atrix

=====

=====

coef	std err	z	P> z	[0.025	0.975]
------	---------	---	------	--------	--------

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sqrt.var.Log M4 including Treasuries					
0.0251	0.067	0.377	0.706	-0.105	0.156
sqrt.cov.Log M4 including Treasuries.Log Total Assets					
0.0683	2.532	0.027	0.978	-4.895	5.031
sqrt.var.Log Total Assets					
0.2865	2.028	0.141	0.888	-3.687	4.260
sqrt.cov.Log M4 including Treasuries.Effective Federal Funds Rate (%)					
-0.2227	1.413	-0.158	0.875	-2.993	2.547
sqrt.cov.Log Total Assets.Effective Federal Funds Rate (%)					
-0.0815	4.117	-0.020	0.984	-8.151	7.988
sqrt.var.Effective Federal Funds Rate (%)					
0.3336	0.332	1.004	0.315	-0.317	0.985
sqrt.cov.Log M4 including Treasuries.Loss Function					
-5.0333	2.053	-2.451	0.014	-9.058	-1.009
sqrt.cov.Log Total Assets.Loss Function					
0.0097	1.012	0.010	0.992	-1.974	1.993
sqrt.cov.Effective Federal Funds Rate (%).Loss Function					
-1.4598	3.025	-0.483	0.629	-7.389	4.470
sqrt.var.Loss Function					
6.3545	5.130	1.239	0.215	-3.700	16.409
sqrt.cov.Log M4 including Treasuries.Log Currency in Circulation (\$ Bil)					
0.0376	2.765	0.014	0.989	-5.382	5.457
sqrt.cov.Log Total Assets.Log Currency in Circulation (\$ Bil)					
0.2895	1.220	0.237	0.812	-2.102	2.681
sqrt.cov.Effective Federal Funds Rate (%).Log Currency in Circulation (\$ Bil)					
-0.0084	0.453	-0.019	0.985	-0.897	0.880
sqrt.cov.Loss Function.Log Currency in Circulation (\$ Bil)					
0.0293	0.538	0.054	0.957	-1.026	1.084
sqrt.var.Log Currency in Circulation (\$ Bil)					
0.1091	0.720	0.152	0.880	-1.302	1.520

=====

=====

Warnings:

[1] Covariance matrix calculated using the outer product of gradients (complex-

step).

[2] Covariance matrix is singular or near-singular, with condition number 1.85e+21. Standard errors may be unstable.

```
In [66]: ## KPSS test
```

```
In [58]: import statsmodels.api as sm
```

```
#perform KPSS test
```

```
sm.tsa.stattools.kpss(data_new["Loss Function"], regression='ct')
```

C:\Users\proma.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\stattools.py:1875: FutureWarning: The behavior of using nlags=None will change in release 0.13. Currently nlags=None is the same as nlags="legacy", and so a sample-size lag length is used. After the next release, the default will change to be the same as nlags="auto" which uses an automatic lag length selection method. To silence this warning, either use "auto" or "legacy"

```
warnings.warn(msg, FutureWarning)
```

C:\Users\proma.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\stattools.py:1910: InterpolationWarning: The test statistic is outside of the range of p-values available in the look-up table. The actual p-value is greater than the p-value returned.

```
warnings.warn(
```

```
Out[58]: (0.05738044261634268,
          0.1,
          15,
          {'10%': 0.119, '5%': 0.146, '2.5%': 0.176, '1%': 0.216})
```

```
In [ ]: The p-value is 0.1. Since this value is not less than .05, we fail to reject the
This means we can assume that the time series is trend stationary
```

```
In [59]: sm.tsa.stattools.kpss(data_new["Log Total Assets"], regression='ct')
```

C:\Users\proma.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\stattools.py:1910: InterpolationWarning: The test statistic is outside of the range of p-values available in the look-up table. The actual p-value is greater than the p-value returned.

```
warnings.warn(
```

```
Out[59]: (0.05804293130478858,
          0.1,
          15,
          {'10%': 0.119, '5%': 0.146, '2.5%': 0.176, '1%': 0.216})
```

```
In [63]: sm.tsa.stattools.kpss(data_new["Log Currency in Circulation ($ Bil)"], regression='c')
```

```
C:\Users\proma.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\stattools.py:1910: InterpolationWarning: The test statistic is outside of the range of p-values available in the look-up table. The actual p-value is greater than the p-value returned.
```

```
warnings.warn(
```

```
Out[63]: (0.06787954420174813,
          0.1,
          15,
          {'10%': 0.119, '5%': 0.146, '2.5%': 0.176, '1%': 0.216})
```

```
In [64]: sm.tsa.stattools.kpss(data_new["Log M4 including Treasuries"], regression='ct')
```

```
C:\Users\proma.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\stattools.py:1910: InterpolationWarning: The test statistic is outside of the range of p-values available in the look-up table. The actual p-value is greater than the p-value returned.
```

```
warnings.warn(
```

```
Out[64]: (0.0492085820915457,
          0.1,
          15,
          {'10%': 0.119, '5%': 0.146, '2.5%': 0.176, '1%': 0.216})
```

```
In [65]: sm.tsa.stattools.kpss(data_new["Effective Federal Funds Rate (%)"], regression='c')
```

```
C:\Users\proma.gupta\Anaconda3\lib\site-packages\statsmodels\tsa\stattools.py:1910: InterpolationWarning: The test statistic is outside of the range of p-values available in the look-up table. The actual p-value is greater than the p-value returned.
```

```
warnings.warn(
```

```
Out[65]: (0.05343689789746268,
          0.1,
          15,
          {'10%': 0.119, '5%': 0.146, '2.5%': 0.176, '1%': 0.216})
```

```
In [67]: df.to_csv("M4.csv")
```

```
In [ ]:
```