**Ques no.1**

1. **Plot the data and conduct some descriptive statistics to analyze the nature of the data.**



Graph shows remittance data follows trend and it’s non stationary.

**Descriptive Statistics to analyze the nature of the data**

**. tabstat remittances , stat(mean, p50, min, max, range, var, sd)**

Variable | Mean p50 Min Max Range Variance SD

-------------+----------------------------------------------------------------------

remittances | 1012.831 386.0002 68.51433 4058 3989.486 1404464 1185.101

Here we can see, Mean > median:

* The difference between mean and median is large which indicates the presence of outlier.
* Mean & Median: outliers in the right side of the distribution or we can say right-skewed.

1. **Determine the best-fitting ARIMA, considering the appropriate diagnostics and model selection criteria.**

**By pperron test we can see is the remittance series stationary or not:**

. pperron remittances, trend

Phillips–Perron test for unit root Number of obs = 143

Variable: remittances Newey–West lags = 4

H0: Random walk with or without drift

Dickey–Fuller

Test -------- critical value ---------

statistic 1% 5% 10%

--------------------------------------------------------------

Z(rho) -1.468 -27.687 -20.872 -17.643

Z(t) -0.861 -4.026 -3.444 -3.144

--------------------------------------------------------------

MacKinnon approximate p-value for Z(t) = 0.9601.

**Here, p value is greater than 0.05 means the series is non-stationary. So, to make it stationary we take log and 1st difference of remittance variable to make it stationary.**

**. gen lremit = log(remittances)**

**. gen dlremit = d.lremit**

**. pperron dlremit**

Phillips–Perron test for unit root Number of obs = 142

Variable: dlremit Newey–West lags = 4

H0: Random walk without drift, d = 0

Dickey–Fuller

Test -------- critical value ---------

statistic 1% 5% 10%

--------------------------------------------------------------

Z(rho) -153.792 -19.940 -13.784 -11.056

Z(t) -13.695 -3.496 -2.887 -2.577

--------------------------------------------------------------

MacKinnon approximate p-value for Z(t) = 0.0000.

**Now remittance variable is stationary**



**Which indicates MA (3), MA (12), MA (20), MA (36)**



Here it indicates AR(3), AR(12), AR(20), AR(26), AR(32), AR(36)



Here the cumulative periodogram remains close to 45-degree line and well within the confidence bands. So, the residuals do not exhibit any signs of nonrandom periodicity.

**© Estimate the quarter of the year effect using an ARIMA-X model. Interpret the result.**

So, from b we got the following order of the model:

* AR (3,12,20,26,32,36)
* I (1)
* MA (3,12,20,36)

**. arima dlremit, ar(3,12,20,26,32,36) i(1) ma(3,12,20,36)**

ARIMA regression

Sample: 1980q2 thru 2015q4 Number of obs = 143

Wald chi2(10) = 53.55

Log likelihood = 167.1034 Prob > chi2 = 0.0000

------------------------------------------------------------------------------

| OPG

dlremit | Coefficient std. err. z P>|z| [95% conf. interval]

-------------+----------------------------------------------------------------

dlremit |

\_cons | .0272447 .0079012 3.45 0.001 .0117587 .0427308

-------------+----------------------------------------------------------------

ARMA |

ar |

L3. | -.0382983 .1752622 -0.22 0.827 -.3818059 .3052092

L12. | .0978044 .2047245 0.48 0.633 -.3034481 .499057

L20. | .1222052 .2481238 0.49 0.622 -.3641086 .608519

L26. | .1014924 .0935326 1.09 0.278 -.0818281 .284813

L32. | -.1768418 .1211414 -1.46 0.144 -.4142746 .0605909

L36. | -.2933946 .2020654 -1.45 0.147 -.6894355 .1026463

|

ma |

L3. | -.1051433 .1824401 -0.58 0.564 -.4627194 .2524328

L12. | .1967662 .2167899 0.91 0.364 -.2281342 .6216666

L20. | .2272961 .2650083 0.86 0.391 -.2921107 .7467029

L36. | -.0060911 .2193338 -0.03 0.978 -.4359775 .4237953

-------------+----------------------------------------------------------------

/sigma | .0728792 .0049761 14.65 0.000 .0631263 .0826322

**Ans. To the ques no: 2**

1. **Determine lag length for the specification. Does the ordering of variables make sense?**

**. varsoc repo m2gy inf, maxlag(8)**

Lag-order selection criteria

Sample: 2012m7 thru 2021m9 Number of obs = 111

+---------------------------------------------------------------------------+

| Lag | LL LR df p FPE AIC HQIC SBIC |

|-----+---------------------------------------------------------------------|

| 0 | -537.646 3.4135 9.74137 9.77107 9.8146 |

| 1 | -147.25 780.79 9 0.000 .003538 2.86937 **2.9882\* 3.16229\*** |

| 2 | -144.788 4.9229 9 0.841 .003982 2.98718 3.19513 3.49979 |

| 3 | -128.5 32.577\* 9 0.000 .003495\* **2.85586\*** 3.15293 3.58816 |

| 4 | -123.696 9.6088 9 0.383 .003777 2.93145 3.31765 3.88345 |

| 5 | -121.269 4.8528 9 0.847 .004263 3.0499 3.52521 4.22158 |

| 6 | -115.727 11.085 9 0.270 .004556 3.1122 3.67664 4.50358 |

| 7 | -111.603 8.2476 9 0.509 .005003 3.20006 3.85362 4.81113 |

| 8 | -105.243 12.72 9 0.176 .005287 3.24762 3.99031 5.07838 |

+---------------------------------------------------------------------------+

\* optimal lag

Endogenous: repo m2gy inf

Exogenous: \_cons

**Here we can see, AIC suggested 3 lags. On the other hand, HQIC and SBIC suggested 1 lag.**

Yes, it makes sense because AIC use more information but, in our dataset we have only 111 observation that’s why HQIC and SBIC suggested less ordered lag. We know, lag selection = 0.75\*111^1/3 = 3.6. So the formula also suggesting 3 lag orders would be optimal.

1. **What does the Granger causality test say?**

**Test of causality:** Examines if lagged values of one variable helps to predict other variables in the model.

**Granger test:**

* H0: X does not Granger Cause Y
* Ha: X Granger Cause Y

**Rule of decision:** If p value is:

* < 0.05 = X Granger causes Y at the 5% significance level.
* > 0.05 = X does not Granger cause Y at the 5% significance level.

1. **Estimate a VAR model and interpret the impulse response functions**

**. var repo m2gy inf, lags(1/3) dfk small**

**Vector autoregression**

**Sample: 2012m2 thru 2021m9 Number of obs = 116**

**Log likelihood = -132.2926 AIC = 2.798148**

**FPE = .0032988 HQIC = 3.087235**

**Det(Sigma\_ml) = .0019641 SBIC = 3.510284**

**Equation Parms RMSE R-sq F P > F**

**----------------------------------------------------------------**

**repo 10 .119213 0.9852 781.5925 0.0000**

**m2gy 10 1.54079 0.9167 129.5859 0.0000**

**inf 10 .281567 0.8728 80.81842 0.0000**

**----------------------------------------------------------------**

**------------------------------------------------------------------------------**

**| Coefficient Std. err. t P>|t| [95% conf. interval]**

**-------------+----------------------------------------------------------------**

**repo |**

**repo |**

**L1. | 1.064707 .0924695 11.51 0.000 .8813774 1.248037**

**L2. | -.1076964 .1309136 -0.82 0.413 -.3672454 .1518527**

**L3. | .0461998 .091755 0.50 0.616 -.1357133 .2281129**

**|**

**m2gy |**

**L1. | -.0026236 .007035 -0.37 0.710 -.0165712 .0113241**

**L2. | .0045391 .0095013 0.48 0.634 -.0142981 .0233763**

**L3. | -.0027805 .006884 -0.40 0.687 -.0164287 .0108676**

**|**

**inf |**

**L1. | -.0125799 .0362282 -0.35 0.729 -.0844059 .0592461**

**L2. | .0504951 .0367419 1.37 0.172 -.0223493 .1233394**

**L3. | -.0363507 .0299634 -1.21 0.228 -.095756 .0230546**

**|**

**\_cons | -.0445733 .1007154 -0.44 0.659 -.2442514 .1551047**

**-------------+----------------------------------------------------------------**

**m2gy |**

**repo |**

**L1. | 1.575609 1.195144 1.32 0.190 -.793879 3.945098**

**L2. | -1.888279 1.692024 -1.12 0.267 -5.242882 1.466324**

**L3. | .4354758 1.185909 0.37 0.714 -1.915704 2.786655**

**|**

**m2gy |**

**L1. | .8555422 .090926 9.41 0.000 .6752726 1.035812**

**L2. | .1060434 .1228016 0.86 0.390 -.1374227 .3495094**

**L3. | -.1100625 .0889735 -1.24 0.219 -.2864611 .0663361**

**|**

**inf |**

**L1. | 1.182271 .4682406 2.52 0.013 .2539386 2.110604**

**L2. | .4538024 .4748791 0.96 0.341 -.4876915 1.395296**

**L3. | -1.167395 .3872689 -3.01 0.003 -1.935194 -.3995971**

**|**

**\_cons | -1.693174 1.30172 -1.30 0.196 -4.273961 .8876123**

**-------------+----------------------------------------------------------------**

**inf |**

**repo |**

**L1. | .1024884 .218403 0.47 0.640 -.3305168 .5354935**

**L2. | .164494 .309204 0.53 0.596 -.448533 .777521**

**L3. | -.1488686 .2167154 -0.69 0.494 -.5785279 .2807907**

**|**

**m2gy |**

**L1. | .0062047 .016616 0.37 0.710 -.0267382 .0391475**

**L2. | .0464104 .022441 2.07 0.041 .0019189 .0909019**

**L3. | -.0225916 .0162592 -1.39 0.168 -.0548271 .0096438**

**|**

**inf |**

**L1. | .6524244 .0855672 7.62 0.000 .482779 .8220698**

**L2. | .2747295 .0867804 3.17 0.002 .102679 .44678**

**L3. | -.2507946 .0707703 -3.54 0.001 -.3911036 -.1104856**

**|**

**\_cons | .818857 .237879 3.44 0.001 .3472389 1.290475**

**Impulse response function:**

**repo repo t-1 repo t-2 repo t-3 e1t**

**m2gy = a0 + A1 | m2fy t-1 | + A2 | m2fy t-2 | + A3 | m2fy t-3 | + |e2t**

**inf inf t-1 inf t-1 inf t-3 e3t**

**The following graph shows the impulse response result:**



1. **Estimate a SVAR model using short-run restrictions.**

. matrix list A

A[3,3]

c1 c2 c3

r1 1 0 0

r2 . 1 0

r3 . . 1

. matrix list B

symmetric B[3,3]

c1 c2 c3

r1 .

r2 0 .

r3 0 0 .

**. svar repo m2gy inf, lags(1/3) dfk small aeq(A) beq(B)**

Estimating short-run parameters

Iteration 0: log likelihood = -588.63927

Iteration 1: log likelihood = -465.03218

Iteration 2: log likelihood = -296.26998

Iteration 3: log likelihood = -184.24424

Iteration 4: log likelihood = -150.66248

Iteration 5: log likelihood = -148.03454

Iteration 6: log likelihood = -147.9789

Iteration 7: log likelihood = -147.97889

Structural vector autoregression

( 1) [/A]1\_1 = 1

( 2) [/A]1\_2 = 0

( 3) [/A]1\_3 = 0

( 4) [/A]2\_2 = 1

( 5) [/A]2\_3 = 0

( 6) [/A]3\_3 = 1

( 7) [/B]1\_2 = 0

( 8) [/B]1\_3 = 0

( 9) [/B]2\_1 = 0

(10) [/B]2\_3 = 0

(11) [/B]3\_1 = 0

(12) [/B]3\_2 = 0

Sample: 2012m2 thru 2021m9 Number of obs = 116

Exactly identified model Log likelihood = -147.9789

------------------------------------------------------------------------------

| Coefficient Std. err. t P>|t| [95% conf. interval]

-------------+----------------------------------------------------------------

/A |

1\_1 | 1 (constrained)

2\_1 | .5963574 1.198754 0.50 0.620 -1.779291 2.972006

3\_1 | .4030707 .2155849 1.87 0.064 -.024168 .8303095

1\_2 | 0 (constrained)

2\_2 | 1 (constrained)

3\_2 | -.0133588 .01668 -0.80 0.425 -.0464147 .0196971

1\_3 | 0 (constrained)

2\_3 | 0 (constrained)

3\_3 | 1 (constrained)

-------------+----------------------------------------------------------------

/B |

1\_1 | .1192125 .0078267 15.23 0.000 .1037019 .1347232

2\_1 | 0 (constrained)

3\_1 | 0 (constrained)

1\_2 | 0 (constrained)

2\_2 | 1.53915 .1010501 15.23 0.000 1.338892 1.739407

3\_2 | 0 (constrained)

1\_3 | 0 (constrained)

2\_3 | 0 (constrained)

3\_3 | .2765073 .0181536 15.23 0.000 .2405311 .3124834

Zero restrictions specify that some variables are not affected by a shock. At structural model we have 10 coefficients and to map the reduced model we make 1 coefficient 0 so we got 9 coefficients. To make 1 zero, need to impose zero restriction but economist decides which one coefficient of VAR imposed zero restriction.

**(E) Suppose you want to impose restrictions that inflation does not have a contemporaneous effect on repo rate and m2gy, along with the restriction that m2gy does not affect repo rate contemporaneously. How would you do that?**

**repo A11 0 0 repo t-k**

**m2gy = A21 A22 0 m2gy t-k + etk**

**inf 0 0 A33 inf t-k**

1. **Estimate the SVAR model based on the restrictions stated in (e). Are the impulse response**

**functions different from that of VAR IRFs in (c)?**



They look almost same.