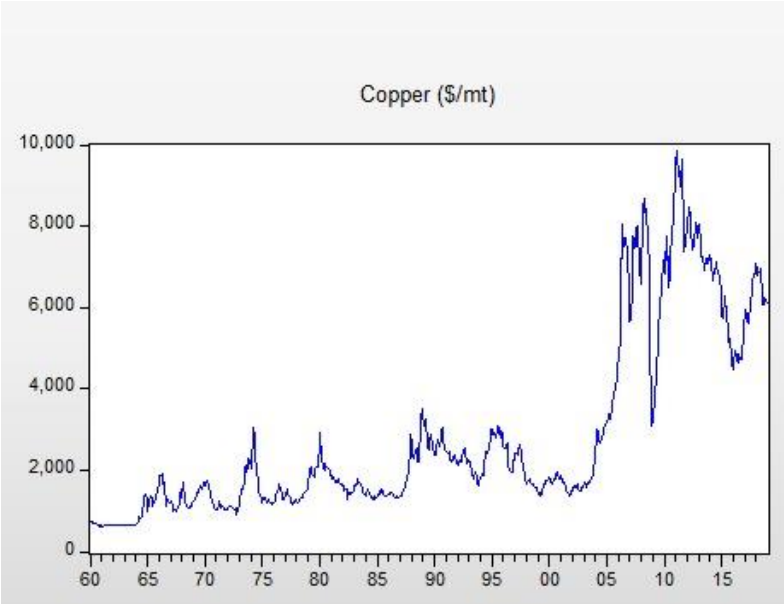
(a)(i)



From the plot above, the series does not look stationary as there is a baseline shift and the average over time spikes up from around 2005.

(a)(ii)

Null Hypothesis: COPPER has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=19)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.733304	0.3988
Test critical values:	1% level	-2.568242	
	5% level	-1.941272	
	10% level	-1.616398	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(COPPER)
Method: Least Squares
Date: 02/13/19 Time: 18:57
Sample (adjusted): 1960M03 2018M12
Included observations: 706 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COPPER(-1)	-0.001762	0.002403	-0.733304	0.4636
D(COPPER(-1))	0.335927	0.035588	9.439353	0.0000

R-squared	0.111507	Mean dependent var	7.573839
Adjusted R-squared	0.110245	S.D. dependent var	243.9988
S.E. of regression	230.1563	Akaike info criterion	13.71822
Sum squared resid	37292239	Schwarz criterion	13.73114
Log likelihood	-4840.533	Hannan-Quinn criter.	13.72321
Durbin-Watson stat	1.964526		

From the results above, the test's null hypothesis is not rejected since the probability of the augmented Dickey-Fuller test t-statistic is -0.7333, which is significantly greater than 0.05. As such, the series is non-stationary.

(a)(iii)

Null Hypothesis: COPPER has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=19)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.292650	0.0683
Test critical values:	1% level	-3.971104	
	5% level	-3.416195	
	10% level	-3.130392	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(COPPER)
Method: Least Squares
Date: 02/13/19 Time: 18:58
Sample (adjusted): 1960M03 2018M12
Included observations: 706 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COPPER(-1)	-0.020058	0.006092	-3.292650	0.0010
D(COPPER(-1))	0.343349	0.035445	9.686863	0.0000
C	-2.992700	17.33630	-0.172626	0.8630
@TREND("1960M01")	0.181759	0.067408	2.696395	0.0072

R-squared	0.124816	Mean dependent var	7.573839
Adjusted R-squared	0.121076	S.D. dependent var	243.9988
S.E. of regression	228.7512	Akaike info criterion	13.70880
Sum squared resid	36733624	Schwarz criterion	13.73463
Log likelihood	-4835.205	Hannan-Quinn criter.	13.71878
F-statistic	33.37245	Durbin-Watson stat	1.971804
Prob(F-statistic)	0.000000		

From the results above, despite adding the trend and intercept, the test's null hypothesis is not rejected since the probability of the augmented Dickey-Fuller test t-statistic is -3.2927, which is significantly greater than 0.05. As such, the series is also non-stationary.

(a)(iv)

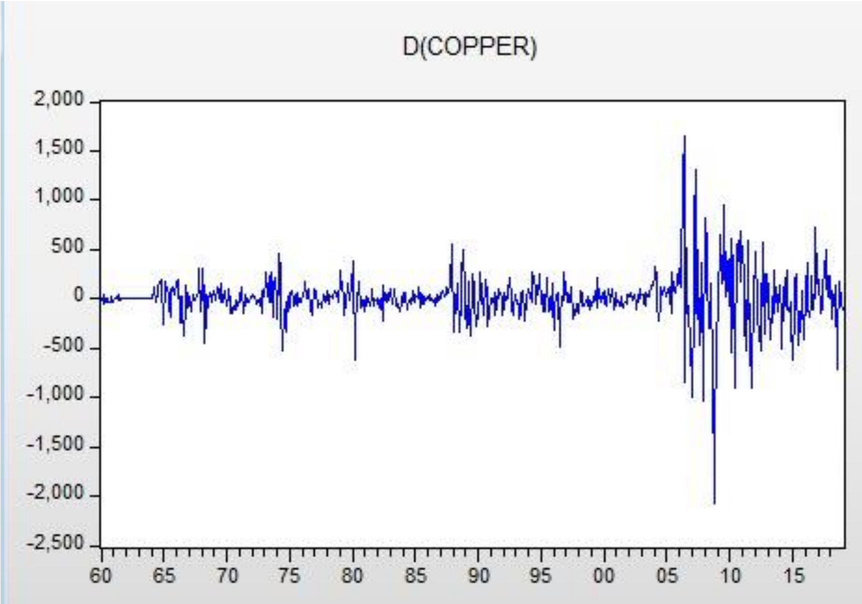
Correlogram of RESID

Date: 02/13/19 Time: 19:04
Sample: 1960M01 2018M12
Included observations: 706

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.014	0.014	0.1372	0.711
		2	-0.030	-0.031	0.7918	0.673
		3	-0.021	-0.020	1.0975	0.778
		4	-0.028	-0.028	1.6539	0.799
		5	0.070	0.070	5.1854	0.394
		6	-0.052	-0.056	7.0883	0.313
		7	0.002	0.007	7.0918	0.419
		8	-0.169	-0.173	27.567	0.001
		9	-0.030	-0.022	28.218	0.001
		10	0.014	-0.006	28.349	0.002
		11	0.180	0.189	51.674	0.000
		12	0.071	0.053	55.268	0.000
		13	-0.104	-0.074	63.049	0.000
		14	-0.003	-0.016	63.054	0.000
		15	0.013	0.017	63.169	0.000
		16	0.005	-0.047	63.185	0.000
		17	0.052	0.059	65.147	0.000
		18	-0.021	-0.006	65.470	0.000
		19	-0.054	0.000	67.624	0.000
		20	-0.003	0.022	67.632	0.000
		21	0.078	0.062	72.074	0.000
		22	0.059	0.008	74.594	0.000
		23	0.054	0.051	76.734	0.000
		24	-0.050	-0.031	78.556	0.000
		25	-0.009	0.024	78.621	0.000
		26	-0.037	-0.068	79.653	0.000
		27	-0.024	-0.019	80.064	0.000
		28	-0.029	-0.055	80.699	0.000
		29	-0.041	-0.009	81.912	0.000
		30	0.036	0.065	82.863	0.000
		31	-0.081	-0.062	87.749	0.000
		32	0.016	-0.031	87.946	0.000
		33	0.020	0.002	88.244	0.000
		34	-0.015	-0.048	88.404	0.000
		35	0.045	0.043	89.927	0.000
		36	0.061	0.082	92.721	0.000

Having tried most of the lag values, we are still unable to reject the null hypothesis as the t-statistic for the Augmented Dickey-Fuller tests have probabilities above 0.05. As the above correlogram does not show any visible forms of patterns, there are no significant trends in the residual.

(a)(v)



Date: 02/13/19 Time: 19:22
Sample: 1960M01 2018M12
Included observations: 707

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.333	0.333	78.954	0.000
		2	0.063	-0.055	81.743	0.000
		3	-0.020	-0.027	82.020	0.000
		4	-0.037	-0.021	82.987	0.000
		5	0.009	0.033	83.043	0.000
		6	-0.081	-0.107	87.696	0.000
		7	-0.098	-0.045	94.588	0.000
		8	-0.205	-0.176	124.70	0.000
		9	-0.090	0.037	130.57	0.000
		10	0.025	0.041	131.02	0.000
		11	0.166	0.160	150.89	0.000
		12	0.074	-0.058	154.87	0.000
		13	-0.082	-0.104	159.68	0.000
		14	-0.040	-0.004	160.86	0.000
		15	-0.012	-0.004	160.96	0.000
		16	-0.002	-0.046	160.96	0.000
		17	0.021	0.053	161.29	0.000
		18	-0.039	-0.037	162.37	0.000
		19	-0.066	0.001	165.51	0.000
		20	-0.007	0.026	165.54	0.000
		21	0.078	0.041	169.93	0.000
		22	0.078	-0.015	174.42	0.000
		23	0.045	0.022	175.94	0.000
		24	-0.049	-0.058	177.73	0.000
		25	-0.054	-0.004	179.85	0.000
		26	-0.076	-0.092	184.05	0.000
		27	-0.073	-0.024	187.94	0.000
		28	-0.075	-0.057	192.07	0.000
		29	-0.071	0.007	195.75	0.000
		30	-0.026	0.021	196.25	0.000
		31	-0.085	-0.104	201.62	0.000
		32	-0.018	-0.027	201.87	0.000
		33	0.004	-0.014	201.88	0.000
		34	0.000	-0.040	201.88	0.000
		35	0.051	0.061	203.82	0.000
		36	0.064	0.042	206.93	0.000

Null Hypothesis: D_COPPER has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=19)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-18.75198	0.0000
Test critical values:	1% level	-2.568242	
	5% level	-1.941272	
	10% level	-1.616398	

*MacKinnon (1996) one-sided p-values.

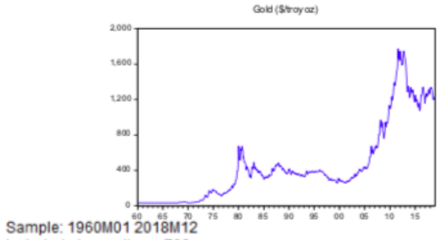
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(D_COPPER)
Method: Least Squares
Date: 02/13/19 Time: 19:27
Sample (adjusted): 1960M03 2018M12
Included observations: 706 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D_COPPER(-1)	-0.665749	0.035503	-18.75198	0.0000

R-squared	0.332788	Mean dependent var	-0.188938
Adjusted R-squared	0.332788	S.D. dependent var	281.6753
S.E. of regression	230.0808	Akaike info criterion	13.71615
Sum squared resid	37320724	Schwarz criterion	13.72261
Log likelihood	-4840.802	Hannan-Quinn criter.	13.71865
Durbin-Watson stat	1.963378		

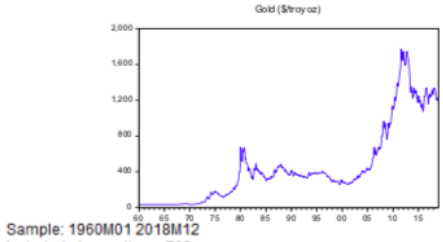
From the unit root tests, the probability is close to 0 and so we can reject the null hypothesis, which implies that the series is stationary. In addition, differenced series has an average around 0 while the correlogram displays a significant drop after the first autocorrelation and partial autocorrelation.

(b)(i)



Sample: 1960M01 2018M12
Included observations: 708

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.995	0.995	704.08	0.000
		2	0.990	-0.052	1401.6	0.000
		3	0.985	0.023	2092.8	0.000
		4	0.980	0.008	2778.1	0.000
		5	0.975	-0.010	3457.1	0.000
		6	0.969	-0.071	4129.2	0.000
		7	0.963	-0.042	4793.6	0.000
		8	0.956	-0.028	5450.1	0.000
		9	0.950	-0.012	6098.5	0.000
		10	0.943	0.008	6739.2	0.000
		11	0.937	-0.005	7372.1	0.000
		12	0.930	-0.043	7996.5	0.000
		13	0.923	0.022	8612.9	0.000
		14	0.916	-0.013	9221.0	0.000
		15	0.909	-0.005	9820.9	0.000
		16	0.902	-0.043	10412.	0.000
		17	0.895	-0.009	10995.	0.000
		18	0.888	0.017	11569.	0.000
		19	0.880	-0.023	12134.	0.000
		20	0.873	0.018	12692.	0.000
		21	0.866	-0.028	13240.	0.000
		22	0.859	0.027	13780.	0.000
		23	0.851	-0.010	14312.	0.000
		24	0.844	0.015	14836.	0.000
		25	0.837	0.006	15353.	0.000
		26	0.830	-0.040	15860.	0.000
		27	0.823	-0.003	16360.	0.000
		28	0.815	-0.064	16851.	0.000
		29	0.807	0.005	17333.	0.000
		30	0.800	0.010	17807.	0.000



Sample: 1960M01 2018M12
Included observations: 708

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.995	0.995	704.08	0.000
		2	0.990	-0.052	1401.6	0.000
		3	0.985	0.023	2092.8	0.000
		4	0.980	0.008	2778.1	0.000
		5	0.975	-0.010	3457.1	0.000
		6	0.969	-0.071	4129.2	0.000
		7	0.963	-0.042	4793.6	0.000
		8	0.956	-0.028	5450.1	0.000
		9	0.950	-0.012	6098.5	0.000
		10	0.943	0.008	6739.2	0.000
		11	0.937	-0.005	7372.1	0.000
		12	0.930	-0.043	7996.5	0.000
		13	0.923	0.022	8612.9	0.000
		14	0.916	-0.013	9221.0	0.000
		15	0.909	-0.005	9820.9	0.000
		16	0.902	-0.043	10412.	0.000
		17	0.895	-0.009	10995.	0.000
		18	0.888	0.017	11569.	0.000
		19	0.880	-0.023	12134.	0.000
		20	0.873	0.018	12692.	0.000
		21	0.866	-0.028	13240.	0.000
		22	0.859	0.027	13780.	0.000
		23	0.851	-0.010	14312.	0.000
		24	0.844	0.015	14836.	0.000
		25	0.837	0.006	15353.	0.000
		26	0.830	-0.040	15860.	0.000
		27	0.823	-0.003	16360.	0.000
		28	0.815	-0.064	16851.	0.000
		29	0.807	0.005	17333.	0.000
		30	0.800	0.010	17807.	0.000

Based on the results above, the presence of a sharp drop after the first partial autocorrelation while autocorrelations remaining close to 1.00 and not dying quickly implies that the series is non-stationary.

(b)(ii)

ARMA(2,0)

Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 20:19
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 3 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003473	0.001795	1.934889	0.0537
AR(1)	0.151000	0.049495	3.050839	0.0024
AR(2)	-0.106442	0.049492	-2.150690	0.0321

R-squared	0.029622	Mean dependent var	0.003484
Adjusted R-squared	0.024818	S.D. dependent var	0.035029
S.E. of regression	0.034591	Akaike info criterion	-3.882991
Sum squared resid	0.483406	Schwarz criterion	-3.853442
Log likelihood	793.1887	Hannan-Quinn criter.	-3.871297
F-statistic	6.166225	Durbin-Watson stat	1.993252
Prob(F-statistic)	0.002302		

Inverted AR Roots	.08-.32i	.08+.32i

ARMA(0,2)

Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 20:21
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 6 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003479	0.001840	1.890931	0.0593
MA(1)	0.152267	0.049625	3.068330	0.0023
MA(2)	-0.079426	0.049625	-1.600517	0.1103

R-squared	0.029432	Mean dependent var	0.003484
Adjusted R-squared	0.024628	S.D. dependent var	0.035029
S.E. of regression	0.034595	Akaike info criterion	-3.882799
Sum squared resid	0.483500	Schwarz criterion	-3.853250
Log likelihood	793.1496	Hannan-Quinn criter.	-3.871105
F-statistic	6.125643	Durbin-Watson stat	1.997577
Prob(F-statistic)	0.002394		

Inverted MA Roots	.22	-.37

ARMA(1,0)

Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 20:23
Sample: 1960M02 2018M12
Included observations: 707
Convergence achieved after 2 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005054	0.002198	2.298982	0.0218
AR(1)	0.262545	0.036346	7.223481	0.0000

R-squared	0.068911	Mean dependent var	0.005047
Adjusted R-squared	0.067590	S.D. dependent var	0.044664
S.E. of regression	0.043128	Akaike info criterion	-3.446353
Sum squared resid	1.311329	Schwarz criterion	-3.433451
Log likelihood	1220.286	Hannan-Quinn criter.	-3.441368
F-statistic	52.17775	Durbin-Watson stat	1.938848
Prob(F-statistic)	0.000000		

Inverted AR Roots .26

ARMA(0,1)

Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 20:24
Sample: 1960M02 2018M12
Included observations: 707
Convergence achieved after 7 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005054	0.002110	2.394999	0.0169
MA(1)	0.310681	0.035805	8.676966	0.0000

R-squared	0.081961	Mean dependent var	0.005047
Adjusted R-squared	0.080658	S.D. dependent var	0.044664
S.E. of regression	0.042825	Akaike info criterion	-3.460426
Sum squared resid	1.292950	Schwarz criterion	-3.447523
Log likelihood	1225.260	Hannan-Quinn criter.	-3.455440
F-statistic	62.94092	Durbin-Watson stat	2.022894
Prob(F-statistic)	0.000000		

Inverted MA Roots -.31

ARMA(1,1)

Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 20:25
Sample: 1960M02 2018M12
Included observations: 707
Convergence achieved after 9 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

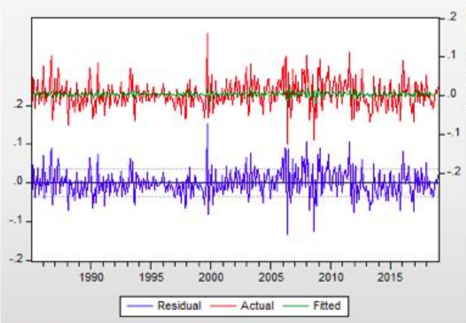
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005054	0.002045	2.470841	0.0137
AR(1)	-0.108232	0.119663	-0.904475	0.3661
MA(1)	0.407584	0.109922	3.707930	0.0002

R-squared	0.083109	Mean dependent var	0.005047
Adjusted R-squared	0.080504	S.D. dependent var	0.044664
S.E. of regression	0.042828	Akaike info criterion	-3.458846
Sum squared resid	1.291333	Schwarz criterion	-3.439492
Log likelihood	1225.702	Hannan-Quinn criter.	-3.451368
F-statistic	31.90612	Durbin-Watson stat	2.001359
Prob(F-statistic)	0.000000		

Inverted AR Roots -.11
Inverted MA Roots -.41

Based on the comparison between all the results, ARMA(2,0) gave the lowest AIC value of -3.882991 among the possible candidates and thus is the best ARMA model among all.

(b)(iii)



Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 20:56
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 3 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003473	0.001795	1.934889	0.0537
AR(1)	0.151000	0.049495	3.050839	0.0024
AR(2)	-0.106442	0.049492	-2.150690	0.0321

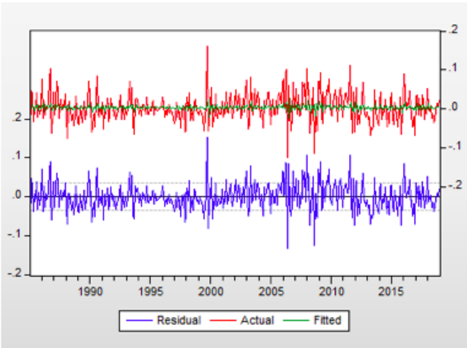
R-squared	0.029622	Mean dependent var	0.003484
Adjusted R-squared	0.024818	S.D. dependent var	0.035029
S.E. of regression	0.034591	Akaike info criterion	-3.882991
Sum squared resid	0.483406	Schwarz criterion	-3.853442
Log likelihood	793.1887	Hannan-Quinn criter.	-3.871297
F-statistic	6.166225	Durbin-Watson stat	1.993252
Prob(F-statistic)	0.002302		

Inverted AR Roots	.08-.32i	.08+.32i

Date: 02/13/19 Time: 21:00
Sample: 1985M01 2018M12
Included observations: 407
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.003	0.003	0.0029	
		2	0.001	0.001	0.0031	
		3	0.023	0.023	0.2232	0.637
		4	0.038	0.038	0.8345	0.659
		5	0.018	0.018	0.9745	0.807
		6	-0.003	-0.003	0.9773	0.913
		7	0.073	0.071	3.1785	0.672
		8	0.016	0.014	3.2896	0.772
		9	0.006	0.004	3.3028	0.856
		10	-0.009	-0.012	3.3375	0.911
		11	0.156	0.151	13.581	0.138
		12	0.011	0.007	13.629	0.191
		13	0.010	0.010	13.669	0.252
		14	0.038	0.028	14.272	0.284
		15	0.037	0.026	14.846	0.317
		16	0.044	0.038	15.658	0.335
		17	0.011	0.012	15.707	0.402
		18	0.067	0.045	17.622	0.346
		19	0.004	-0.005	17.628	0.413
		20	0.088	0.085	20.937	0.283
		21	0.015	0.012	21.038	0.335
		22	0.041	0.013	21.772	0.353
		23	0.029	0.019	22.148	0.391
		24	0.053	0.048	23.356	0.382
		25	-0.006	-0.027	23.373	0.439
		26	0.072	0.065	25.608	0.373

ARMA(2,0)



Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 20:57
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 6 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003479	0.001840	1.890931	0.0593
MA(1)	0.152267	0.049625	3.068330	0.0023
MA(2)	-0.079426	0.049625	-1.600517	0.1103

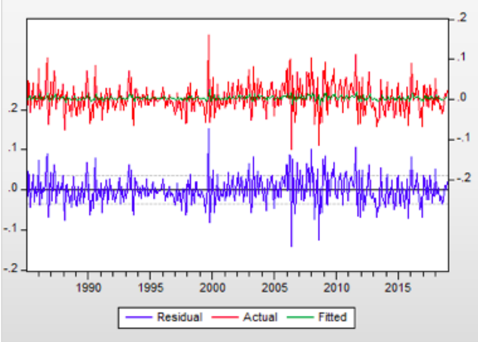
R-squared	0.029432	Mean dependent var	0.003484
Adjusted R-squared	0.024628	S.D. dependent var	0.035029
S.E. of regression	0.034595	Akaike info criterion	-3.882799
Sum squared resid	0.483500	Schwarz criterion	-3.853250
Log likelihood	793.1496	Hannan-Quinn criter.	-3.871105
F-statistic	6.125643	Durbin-Watson stat	1.997577
Prob(F-statistic)	0.002394		

Inverted MA Roots	.22	-.37

Date: 02/13/19 Time: 21:02
Sample: 1985M01 2018M12
Included observations: 407
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.000	0.000	0.0001	
		2	-0.004	-0.004	0.0069	
		3	-0.004	-0.004	0.0151	0.902
		4	0.045	0.045	0.8489	0.654
		5	0.018	0.018	0.9808	0.806
		6	-0.003	-0.003	0.9848	0.912
		7	0.073	0.074	3.1922	0.670
		8	0.012	0.010	3.2501	0.777
		9	0.005	0.004	3.2596	0.860
		10	-0.011	-0.011	3.3143	0.913
		11	0.156	0.150	13.485	0.142
		12	0.010	0.006	13.526	0.196
		13	0.008	0.009	13.553	0.259
		14	0.033	0.032	14.025	0.299
		15	0.036	0.024	14.566	0.335
		16	0.044	0.039	15.382	0.353
		17	0.007	0.011	15.404	0.423
		18	0.066	0.045	17.246	0.370
		19	0.001	-0.005	17.247	0.438
		20	0.087	0.085	20.504	0.305
		21	0.012	0.012	20.563	0.361
		22	0.042	0.014	21.320	0.379
		23	0.025	0.019	21.585	0.424
		24	0.053	0.049	22.818	0.412
		25	-0.008	-0.026	22.844	0.470
		26	0.070	0.066	25.013	0.405

ARMA(0,2)



Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 21:04
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 2 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003486	0.001993	1.748993	0.0810
AR(1)	0.136344	0.049248	2.768527	0.0059

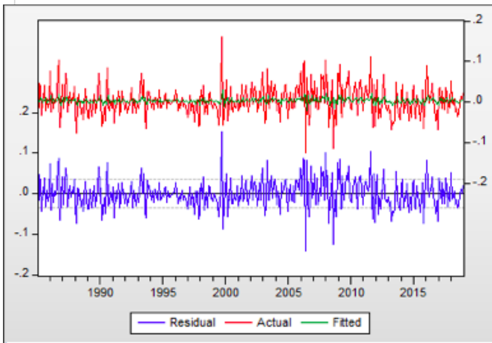
R-squared	0.018565	Mean dependent var	0.003484
Adjusted R-squared	0.016141	S.D. dependent var	0.035029
S.E. of regression	0.034745	Akaike info criterion	-3.876631
Sum squared resid	0.488914	Schwarz criterion	-3.856932
Log likelihood	790.8945	Hannan-Quinn criter.	-3.868836
F-statistic	7.660941	Durbin-Watson stat	1.969945
Prob(F-statistic)	0.005902		

Inverted AR Roots	.14

Date: 02/13/19 Time: 21:05
Sample: 1985M01 2018M12
Included observations: 407
Q-statistic probabilities adjusted for 1 ARMA term

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.014	0.014	0.0844	
		2	-0.107	-0.107	4.8087	0.028
		3	0.005	0.008	4.8188	0.090
		4	0.047	0.035	5.7158	0.126
		5	0.012	0.012	5.7731	0.217
		6	-0.008	0.001	5.7974	0.326
		7	0.071	0.074	7.8895	0.246
		8	0.016	0.011	7.9967	0.333
		9	-0.018	-0.004	8.1306	0.421
		10	-0.010	-0.008	8.1765	0.516
		11	0.155	0.149	18.216	0.051
		12	0.010	0.000	18.259	0.076
		13	-0.010	0.023	18.299	0.107
		14	0.030	0.027	18.687	0.133
		15	0.036	0.026	19.239	0.156
		16	0.034	0.036	19.744	0.182
		17	0.006	0.014	19.761	0.231
		18	0.054	0.040	20.986	0.227
		19	0.002	-0.004	20.988	0.280
		20	0.077	0.088	23.529	0.215
		21	0.012	0.008	23.591	0.261
		22	0.029	0.018	23.942	0.296
		23	0.027	0.023	24.262	0.334
		24	0.042	0.042	25.040	0.348
		25	-0.006	-0.019	25.055	0.403
		26	0.064	0.069	26.860	0.363

ARMA(1,0)



Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 20:58
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 7 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003484	0.002007	1.736294	0.0833
MA(1)	0.168141	0.049007	3.430960	0.0007

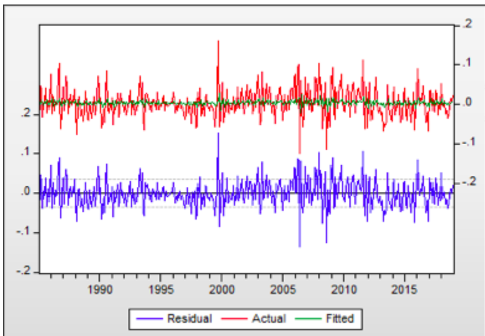
R-squared	0.022957	Mean dependent var	0.003484
Adjusted R-squared	0.020545	S.D. dependent var	0.035029
S.E. of regression	0.034667	Akaike info criterion	-3.881092
Sum squared resid	0.486726	Schwarz criterion	-3.861393
Log likelihood	791.8023	Hannan-Quinn criter.	-3.873297
F-statistic	9.516057	Durbin-Watson stat	2.027007
Prob(F-statistic)	0.002176		

Inverted MA Roots	-.17

Date: 02/13/19 Time: 21:07
Sample: 1985M01 2018M12
Included observations: 407
Q-statistic probabilities adjusted for 1 ARMA term

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.014	-0.014	0.0826	
		2	-0.083	-0.084	2.9407	0.086
		3	0.006	0.004	2.9562	0.228
		4	0.044	0.037	3.7572	0.289
		5	0.012	0.015	3.8212	0.431
		6	-0.009	-0.002	3.8545	0.571
		7	0.071	0.073	5.9501	0.429
		8	0.014	0.013	6.0286	0.536
		9	-0.013	-0.002	6.0963	0.636
		10	-0.014	-0.013	6.1841	0.721
		11	0.155	0.150	16.261	0.092
		12	0.006	0.005	16.276	0.131
		13	-0.007	0.020	16.295	0.178
		14	0.030	0.028	16.687	0.214
		15	0.034	0.025	17.179	0.247
		16	0.035	0.037	17.712	0.278
		17	0.004	0.014	17.720	0.341
		18	0.056	0.042	19.067	0.325
		19	-0.002	-0.006	19.068	0.388
		20	0.079	0.087	21.738	0.297
		21	0.009	0.011	21.775	0.353
		22	0.030	0.016	22.172	0.390
		23	0.025	0.021	22.442	0.434
		24	0.044	0.045	23.291	0.444
		25	-0.009	-0.021	23.329	0.500
		26	0.067	0.069	25.265	0.448

ARMA(0,1)



Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 02/13/19 Time: 21:06
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 8 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003484	0.001922	1.813133	0.0706
AR(1)	-0.331592	0.246073	-1.347533	0.1786
MA(1)	0.491350	0.227199	2.162646	0.0312

R-squared	0.027818	Mean dependent var	0.003484
Adjusted R-squared	0.023006	S.D. dependent var	0.035029
S.E. of regression	0.034623	Akaike info criterion	-3.881146
Sum squared resid	0.484304	Schwarz criterion	-3.851597
Log likelihood	792.8132	Hannan-Quinn criter.	-3.869452
F-statistic	5.780121	Durbin-Watson stat	2.012300
Prob(F-statistic)	0.003349		

Inverted AR Roots	-.33
Inverted MA Roots	-.49

Date: 02/13/19 Time: 21:08
Sample: 1985M01 2018M12
Included observations: 407
Q-statistic probabilities adjusted for 2 ARMA terms

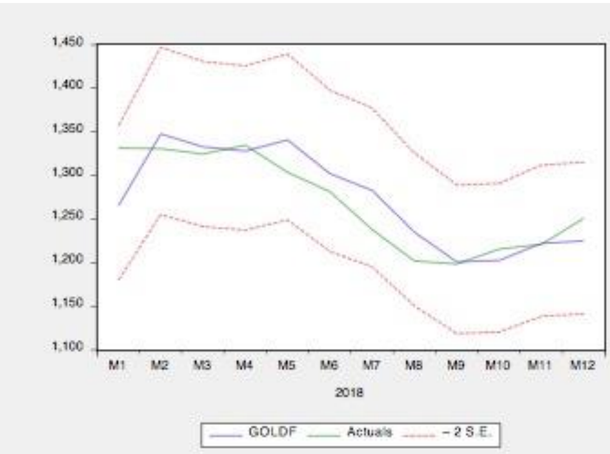
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.007	-0.007	0.0193	
		2	-0.031	-0.031	0.4112	
		3	-0.019	-0.019	0.5526	0.457
		4	0.051	0.050	1.6156	0.446
		5	0.013	0.012	1.6820	0.641
		6	-0.004	-0.001	1.6894	0.793
		7	0.072	0.075	3.8358	0.573
		8	0.010	0.009	3.8768	0.693
		9	-0.001	0.002	3.8776	0.794
		10	-0.014	-0.010	3.9589	0.861
		11	0.155	0.149	14.056	0.120
		12	0.008	0.007	14.082	0.169
		13	0.002	0.012	14.084	0.228
		14	0.030	0.034	14.463	0.272
		15	0.034	0.022	14.968	0.309
		16	0.041	0.040	15.682	0.333
		17	0.004	0.010	15.689	0.403
		18	0.062	0.044	17.336	0.364
		19	-0.001	-0.005	17.336	0.432
		20	0.084	0.086	20.398	0.311
		21	0.008	0.011	20.427	0.369
		22	0.039	0.015	21.088	0.392
		23	0.021	0.020	21.288	0.441
		24	0.051	0.048	22.420	0.435
		25	-0.009	-0.024	22.458	0.493
		26	0.069	0.067	24.514	0.433

ARMA(1,1)

As the residual plots for all the ARMA models have almost the same pattern, it is hard to determine whether the residuals look random.

However, from the correlogram plots, only ARMA(2,0) shows a sharp drop after the first ACF and PACF. The remaining models have ACF and PACF remaining close to zero throughout. As such, the residuals seems to be random for only ARMA(2,0).

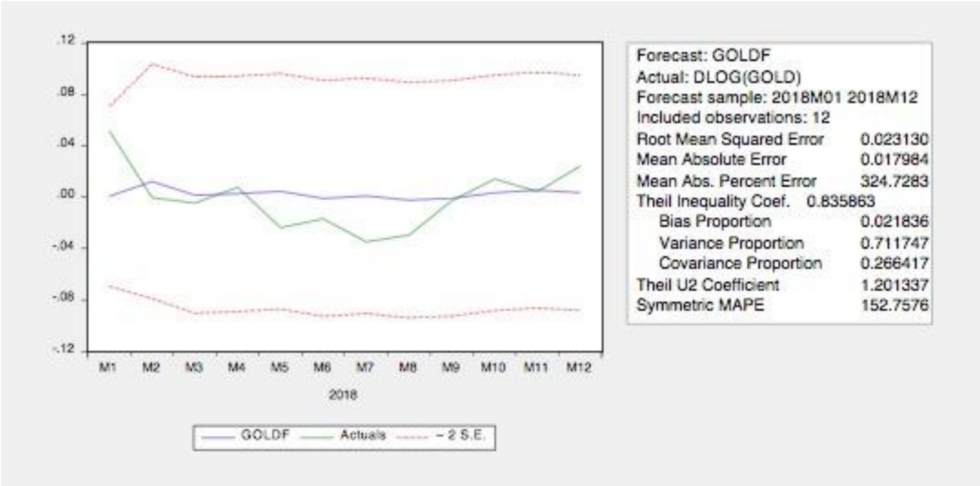
(b)(v)



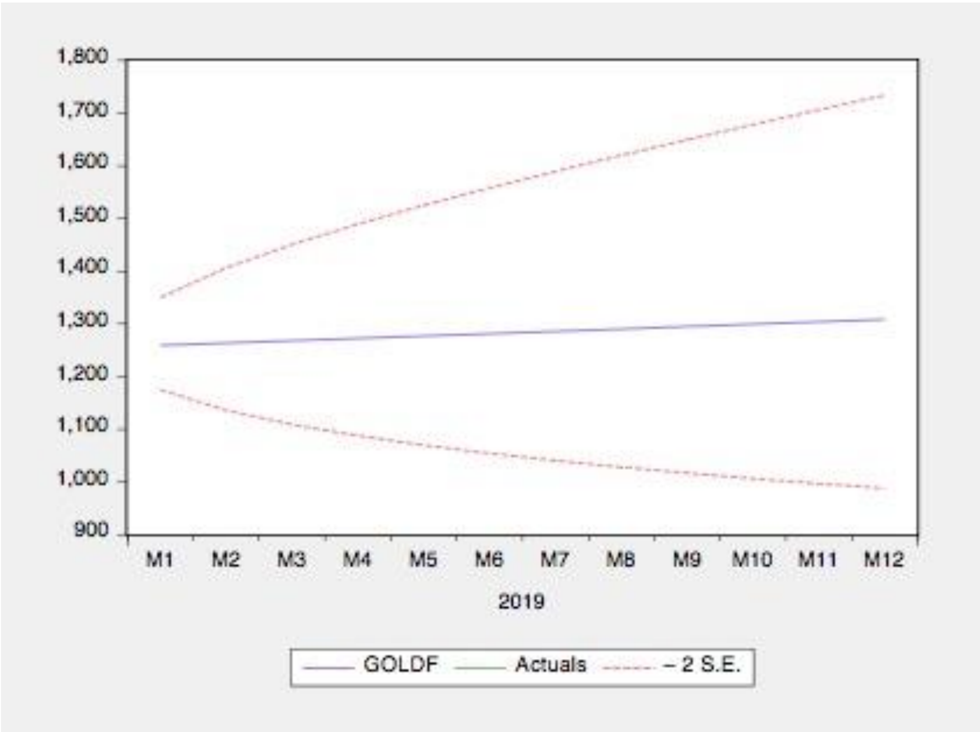
Forecast: GOLDF
Actual: GOLD
Forecast sample: 2018M01 2018M12
Included observations: 12

Root Mean Squared Error	29.60927
Mean Absolute Error	22.96403
Mean Abs. Percent Error	1.799097
Theil Inequality Coef.	0.011634
Bias Proportion	0.022067
Variance Proportion	0.002446
Covariance Proportion	0.975487
Theil U2 Coefficient	1.000932
Symmetric MAPE	1.798209

Based on the results above, we can say that the fit for the above forecast is relatively good as it falls within the standard deviation band. Also, the error percentage of 2% is significantly small.



Based on the results above, the fit for the above forecast is comparatively worse. While it falls within the standard deviation band, the fit seems to display the mean rather than the trend of the actual DLOG(GOLD) values.



From the 12 month prediction interval graph above, we can expect the gold price to increase gradually over time. However, we need to take note that there exists a risk whereby if the price falls on a particular period, it will result in a drop for the subsequent prices.

We cannot use static forecast because it only predicts one-step ahead whereas for dynamic, the predication interval is flexible.