Workshop 4: Stationarity and ARIMA

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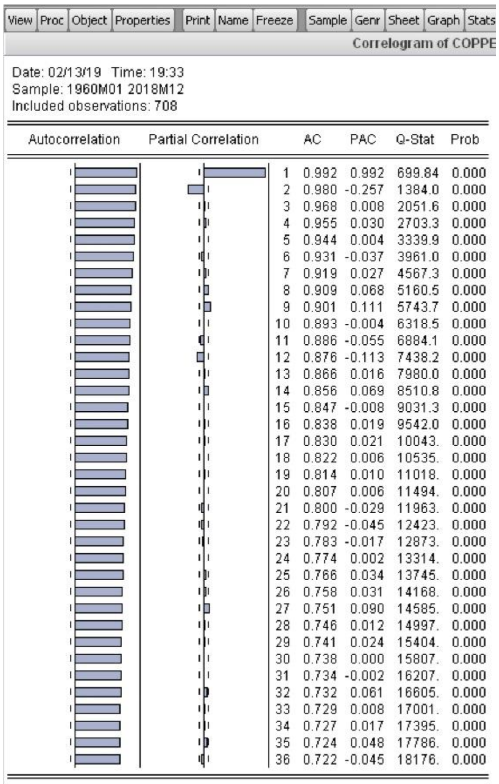
(a) Dickey-Fuller Tests

Does the series look stationary?



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Correlogram of COPPE

Date: 02/13/19 Time: 19:33
Sample: 1960M01 2018M12
Included observations: 708

Lag	AC	PAC	Q-Stat	Prob
1	0.992	0.992	699.84	0.000
2	0.980	-0.257	1384.0	0.000
3	0.968	0.008	2051.6	0.000
4	0.955	0.030	2703.3	0.000
5	0.944	0.004	3339.9	0.000
6	0.931	-0.037	3961.0	0.000
7	0.919	0.027	4567.3	0.000
8	0.909	0.068	5160.5	0.000
9	0.901	0.111	5743.7	0.000
10	0.893	-0.004	6318.5	0.000
11	0.886	-0.055	6884.1	0.000
12	0.876	-0.113	7438.2	0.000
13	0.866	0.016	7980.0	0.000
14	0.856	0.069	8510.8	0.000
15	0.847	-0.008	9031.3	0.000
16	0.838	0.019	9542.0	0.000
17	0.830	0.021	10043.	0.000
18	0.822	0.006	10535.	0.000
19	0.814	0.010	11018.	0.000
20	0.807	0.006	11494.	0.000
21	0.800	-0.029	11963.	0.000
22	0.792	-0.045	12423.	0.000
23	0.783	-0.017	12873.	0.000
24	0.774	0.002	13314.	0.000
25	0.766	0.034	13745.	0.000
26	0.758	0.031	14168.	0.000
27	0.751	0.090	14585.	0.000
28	0.746	0.012	14997.	0.000
29	0.741	0.024	15404.	0.000
30	0.738	0.000	15807.	0.000
31	0.734	-0.002	16207.	0.000
32	0.732	0.061	16605.	0.000
33	0.729	0.008	17001.	0.000
34	0.727	0.017	17395.	0.000
35	0.724	0.048	17786.	0.000
36	0.722	-0.045	18176.	0.000

Based on the autocorrelation, the values range from 0.722 to 0.992, thus the series is not stationary

(ii) Carry out a basic Dickey-Fuller test with no constant or trend term:

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Augmented Dickey-Fuller Unit Root Test on COPPER

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: 19:35
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		

The null hypothesis is that there exists unit root which means it is not stationary. From the ADF test above, the probability is above 0.05, therefore we cannot reject null hypothesis, thus it is not stationary.

(iii) Include a constant and a trend in the basic Dickey-Fuller test

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Augmented Dickey-Fuller Unit Root Test on COPPER

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: 19:37
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 ADF test above, the probability is still above 0.05, therefore we cannot reject null hypothesis, thus it is not stationary.

(iv) Carry out Augmented Dickey-Fuller tests, including lagged values of the dependent variable

Series: RESID Workfile: SESSION 4 WORKSHOP::Untitled\

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Correlogram of RESID

Date: 02/13/19 Time: 19:39
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

Series: RESID01 Workfile: SESSION 4 WORKSHOP::Untitled\

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Augmented Dickey-Fuller Unit Root Test on RESID01

Null Hypothesis: RESID01 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=19)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-26.12485	0.0000
Test critical values:	1% level	-3.971123	
	5% level	-3.416204	
	10% level	-3.130397	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID01)
Method: Least Squares
Date: 02/13/19 Time: 19:45
Sample (adjusted): 1960M04 2018M12
Included observations: 705 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.986085	0.037745	-26.12485	0.0000
C	0.178168	17.32039	0.010287	0.9918
@TREND("1960M01")	-0.000387	0.042328	-0.009136	0.9927

R-squared	0.492961	Mean dependent var	-0.118159
Adjusted R-squared	0.491517	S.D. dependent var	320.7579
S.E. of regression	228.7261	Akaike info criterion	13.70717
Sum squared resid	36725585	Schwarz criterion	13.72657
Log likelihood	-4828.779	Hannan-Quinn criter.	13.71467
F-statistic	341.2546	Durbin-Watson stat	1.998558
Prob(F-statistic)	0.000000		

From the ADF test above, the probability is 0, therefore we can reject null hypothesis, the residual series is stationary.

(v) If the series is non-stationary, examine whether the first differences are stationary. Graph the differenced series, plot its correlogram and then perform unit root tests. (The difference operator is D(copper) in EViews.)

Series: D(COPPER) Workfile: SESSION 4 WORKSHOP::Untitled\

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Correlogram of D(COPPER)

Date: 02/13/19 Time: 19:48
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

Series: D(COPPER) Workfile: SESSION 4 WORKSHOP::Untitled\

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Augmented Dickey-Fuller Unit Root Test on D(COPPER)

Null Hypothesis: D(COPPER) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=19)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-18.74024	0.0000
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,2)
Method: Least Squares
Date: 02/13/19 Time: 19:49
Sample (adjusted): 1960M03 2018M12
Included observations: 706 after adjustments

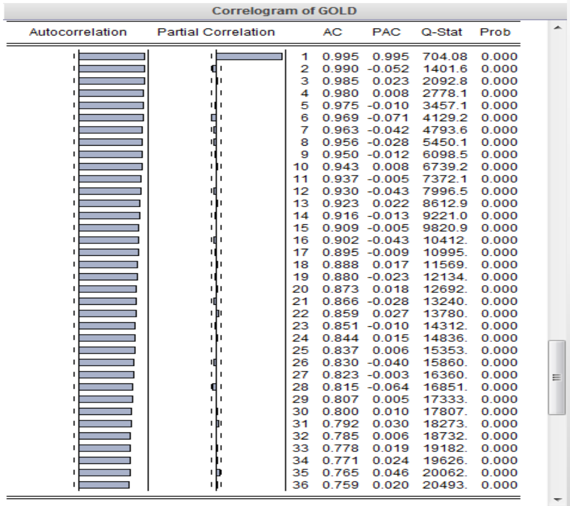
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(COPPER(-1))	-0.666494	0.035565	-18.74024	0.0000
C	1.863961	17.39392	0.107162	0.9147
@TREND("1960M01")	0.008804	0.042540	0.206951	0.8361

R-squared	0.333142	Mean dependent var	-0.188938
Adjusted R-squared	0.331245	S.D. dependent var	281.6753
S.E. of regression	230.3468	Akaike info criterion	13.72129
Sum squared resid	37300931	Schwarz criterion	13.74066
Log likelihood	-4840.615	Hannan-Quinn criter.	13.72878
F-statistic	175.5990	Durbin-Watson stat	1.963010
Prob(F-statistic)	0.000000		

From the correlogram, the autocorrelation pattern indicates that it is stationary, similar result can be observed based on the probability of the ADF test statistics which is 0, shows that we can reject the null hypothesis, and series is stationary.

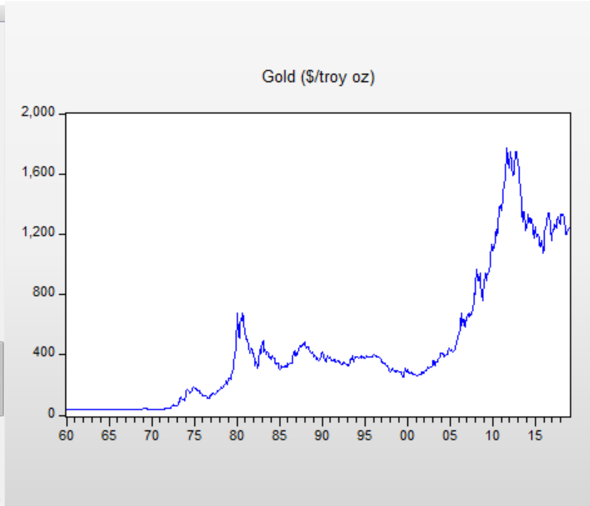
(b) Arima Modelling

(i) Establishing Stationarity

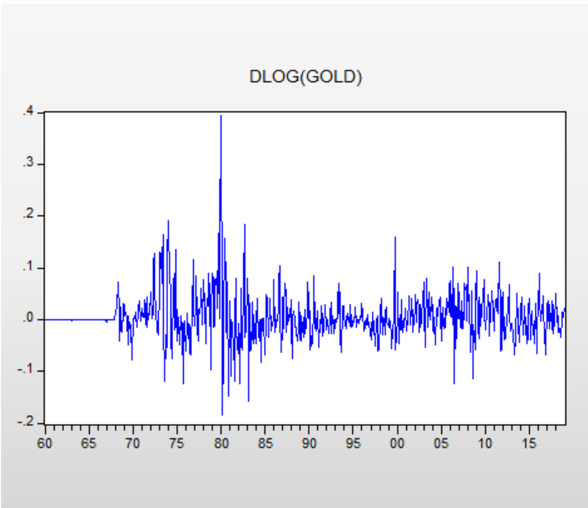


Correlogram of GOLD

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
		31	0.792	0.030	18273.	0.000
		32	0.785	0.006	18732.	0.000
		33	0.778	0.019	19182.	0.000
		34	0.771	0.024	19626.	0.000
		35	0.765	0.046	20062.	0.000
		36	0.759	0.020	20493.	0.000



After Set the new workfile structure type to start from 1985M01:



(ii) Identification

Plot the autocorrelation function (ACF) and partial autocorrelation function (PACF) for the series DLOG (gold).

Correlogram of DLOG(GOLD)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.136	0.136	7.6014	0.006
		2	-0.085	-0.106	10.580	0.005
		3	-0.000	0.028	10.580	0.014
		4	0.047	0.035	11.506	0.021
		5	0.018	0.009	11.647	0.040
		6	0.005	0.009	11.657	0.070
		7	0.072	0.074	13.829	0.054
		8	0.024	0.001	14.060	0.080
		9	-0.013	-0.004	14.130	0.118
		10	0.009	0.013	14.163	0.166
		11	0.154	0.148	24.152	0.012
		12	0.030	-0.017	24.534	0.017
		13	-0.001	0.027	24.534	0.027
		14	0.035	0.027	25.056	0.034
		15	0.045	0.027	25.923	0.039
		16	0.042	0.034	26.664	0.045
		17	0.019	0.015	26.820	0.061
		18	0.057	0.038	28.209	0.059
		19	0.021	0.002	28.390	0.076
		20	0.081	0.089	31.181	0.053
		21	0.027	-0.002	31.496	0.066
		22	0.036	0.020	32.060	0.076
		23	0.037	0.025	32.656	0.087
		24	0.047	0.037	33.608	0.092
		25	0.009	-0.016	33.647	0.116
		26	0.062	0.064	35.321	0.105
		27	-0.010	-0.056	35.367	0.130
		28	0.001	0.013	35.368	0.159
		29	-0.001	-0.030	35.368	0.193
		30	-0.024	-0.031	35.615	0.221
		31	0.052	0.025	36.817	0.218
		32	-0.005	-0.033	36.829	0.255
		33	-0.043	-0.052	37.634	0.265
		34	-0.047	-0.056	38.641	0.268
		35	0.051	0.038	39.790	0.265
		36	-0.032	-0.073	40.258	0.287

(iii) Estimation

Dependent Variable: DLOG(GOLD)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 02/13/19 Time: 19:56
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 16 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003484	0.002086	1.670293	0.0956
MA(1)	0.167650	0.040449	4.144712	0.0000
SIGMASQ	0.001196	6.34E-05	18.84932	0.0000

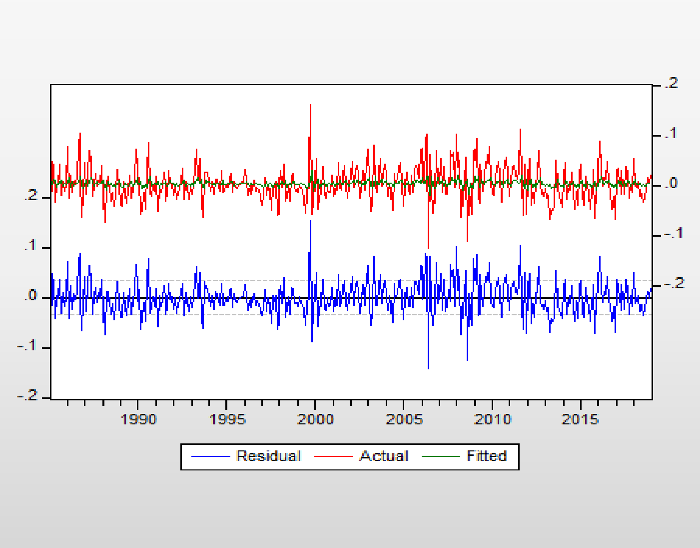
R-squared	0.022957	Mean dependent var	0.003484
Adjusted R-squared	0.018120	S.D. dependent var	0.035029
S.E. of regression	0.034710	Akaike info criterion	-3.876179
Sum squared resid	0.486726	Schwarz criterion	-3.846630
Log likelihood	791.8023	Hannan-Quinn criter.	-3.864485
F-statistic	4.746237	Durbin-Watson stat	2.026107
Prob(F-statistic)	0.009174		

Inverted MA Roots	-.17

From the above statistics, both of the coefficients are significant, the model looks quite reasonable.

(iv) Testing

Do the residuals look random?



From the graph above, the residuals look random. The mean of residuals is approximately zero, which indicates random walk.

Does the correlogram suggest random residuals?

Correlogram of Residuals

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.014	-0.014	0.0774	
		2	-0.083	-0.084	2.9417	0.086
		3	0.006	0.004	2.9572	0.228
		4	0.044	0.037	3.7588	0.289
		5	0.012	0.015	3.8229	0.431
		6	-0.009	-0.002	3.8558	0.570
		7	0.071	0.073	5.9516	0.429
		8	0.014	0.013	6.0305	0.536
		9	-0.013	-0.002	6.0984	0.636
		10	-0.014	-0.013	6.1854	0.721
		11	0.155	0.150	16.262	0.092
		12	0.006	0.005	16.277	0.131
		13	-0.007	0.020	16.296	0.178
		14	0.030	0.028	16.689	0.214
		15	0.034	0.025	17.181	0.247
		16	0.035	0.037	17.715	0.278
		17	0.004	0.014	17.723	0.340
		18	0.056	0.042	19.070	0.325
		19	-0.001	-0.006	19.071	0.387
		20	0.079	0.087	21.741	0.297
		21	0.009	0.011	21.778	0.353
		22	0.030	0.016	22.175	0.389
		23	0.025	0.021	22.446	0.434
		24	0.044	0.045	23.295	0.444
		25	-0.009	-0.021	23.332	0.500
		26	0.067	0.069	25.267	0.447
		27	-0.022	-0.047	25.478	0.492
		28	0.003	0.007	25.483	0.547
		29	0.004	-0.022	25.491	0.601
		30	-0.034	-0.040	25.989	0.626
		31	0.059	0.024	27.526	0.596
		32	-0.009	-0.021	27.565	0.644
		33	-0.032	-0.046	28.030	0.668
		34	-0.052	-0.071	29.253	0.654
		35	0.065	0.038	31.144	0.608
		36	-0.033	-0.054	31.638	0.631

The correlogram suggest random residuals.

The Box-Pierce Q-statistic: no p value under 5%, thus there is no Q-statistics is significant. Thus we cannot reject null hypothesis, the model fits the data well.

To find an alternative model which has better or comparable fit, and which also has no residual autocorrelation, we tried the following models:

ARMA (2, 0):

Dependent Variable: DLOG(GOLD)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 02/13/19 Time: 20:01
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 15 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003473	0.001897	1.830899	0.0679
AR(1)	0.150628	0.039910	3.774163	0.0002
AR(2)	-0.105918	0.043571	-2.430929	0.0155
SIGMASQ	0.001188	6.36E-05	18.67461	0.0000

R-squared	0.029621	Mean dependent var	0.003484
Adjusted R-squared	0.022398	S.D. dependent var	0.035029
S.E. of regression	0.034634	Akaike info criterion	-3.878078
Sum squared resid	0.483406	Schwarz criterion	-3.838679
Log likelihood	793.1888	Hannan-Quinn criter.	-3.862486
F-statistic	4.100590	Durbin-Watson stat	1.992539
Prob(F-statistic)	0.006942		

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

ARMA (0, 2):

Dependent Variable: DLOG(GOLD)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 02/13/19 Time: 20:01
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 16 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003479	0.001948	1.786143	0.0748
MA(1)	0.151899	0.040588	3.742491	0.0002
MA(2)	-0.079066	0.043340	-1.824306	0.0688
SIGMASQ	0.001188	6.36E-05	18.67115	0.0000

R-squared	0.029432	Mean dependent var	0.003484
Adjusted R-squared	0.022207	S.D. dependent var	0.035029
S.E. of regression	0.034637	Akaike info criterion	-3.877886
Sum squared resid	0.483500	Schwarz criterion	-3.838487
Log likelihood	793.1497	Hannan-Quinn criter.	-3.862294
F-statistic	4.073607	Durbin-Watson stat	1.996835
Prob(F-statistic)	0.007200		

Inverted MA Roots	.22	-.37

ARMA (1, 0):

Dependent Variable: DLOG(GOLD)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 02/13/19 Time: 20:02
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 11 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003486	0.002101	1.659647	0.0978
AR(1)	0.136010	0.039860	3.412218	0.0007
SIGMASQ	0.001201	6.43E-05	18.67665	0.0000

R-squared	0.018565	Mean dependent var	0.003484
Adjusted R-squared	0.013706	S.D. dependent var	0.035029
S.E. of regression	0.034788	Akaike info criterion	-3.871717
Sum squared resid	0.488914	Schwarz criterion	-3.842168
Log likelihood	790.8945	Hannan-Quinn criter.	-3.860024
F-statistic	3.820989	Durbin-Watson stat	1.969347
Prob(F-statistic)	0.022702		

Inverted AR Roots	.14

ARMA (1, 1):

Dependent Variable: DLOG(GOLD)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 02/13/19 Time: 20:02
Sample: 1985M02 2018M12
Included observations: 407
Convergence achieved after 14 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003484	0.002013	1.731338	0.0842
AR(1)	-0.330921	0.215195	-1.537772	0.1249
MA(1)	0.490279	0.203645	2.407521	0.0165
SIGMASQ	0.001190	6.33E-05	18.80114	0.0000

R-squared	0.027818	Mean dependent var	0.003484
Adjusted R-squared	0.020581	S.D. dependent var	0.035029
S.E. of regression	0.034666	Akaike info criterion	-3.876232
Sum squared resid	0.484304	Schwarz criterion	-3.836833
Log likelihood	792.8132	Hannan-Quinn criter.	-3.860640
F-statistic	3.843834	Durbin-Watson stat	2.011501
Prob(F-statistic)	0.009822		

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

ARMA (2, 0) model gives the lowest AIC (-3.878), so we choose p = 2, q = 0 as the final parameters for our model. The coefficients of AR (2,0) are significant.

(v) Forecasting

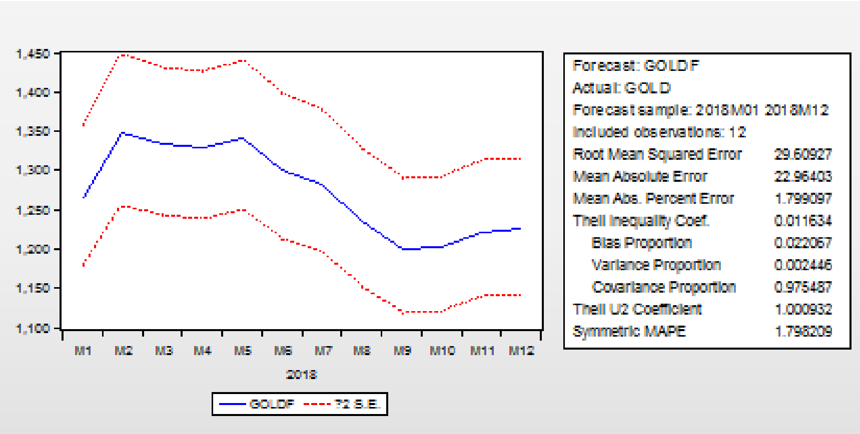
Dependent Variable: DLOG(GOLD)
Method: ARMA Generalized Least Squares (BFGS)
Date: 02/13/19 Time: 20:07
Sample: 1985M02 2017M12
Included observations: 395
Convergence achieved after 3 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003602	0.002054	1.753633	0.0803
MA(1)	0.168036	0.049747	3.377795	0.0008

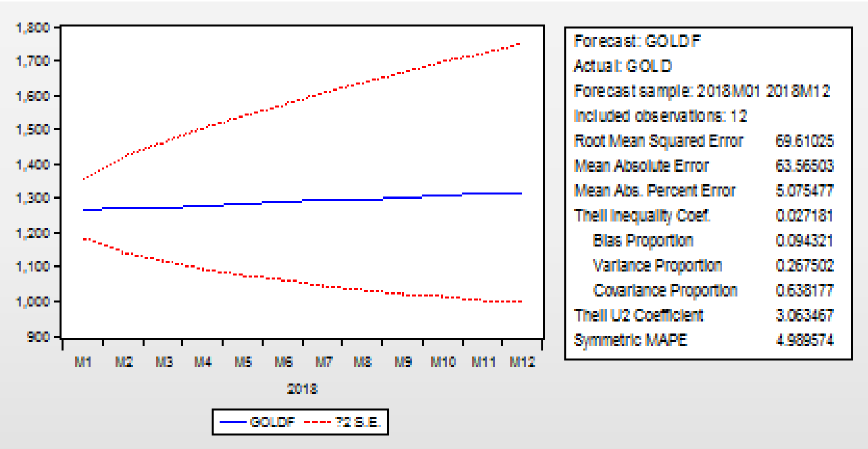
R-squared	0.022688	Mean dependent var	0.003619
Adjusted R-squared	0.020201	S.D. dependent var	0.035318
S.E. of regression	0.034959	Akaike info criterion	-3.864134
Sum squared resid	0.480310	Schwarz criterion	-3.843988
Log likelihood	765.1665	Hannan-Quinn criter.	-3.856152
F-statistic	9.123316	Durbin-Watson stat	2.028732
Prob(F-statistic)	0.002689		

Inverted MA Roots	-.17

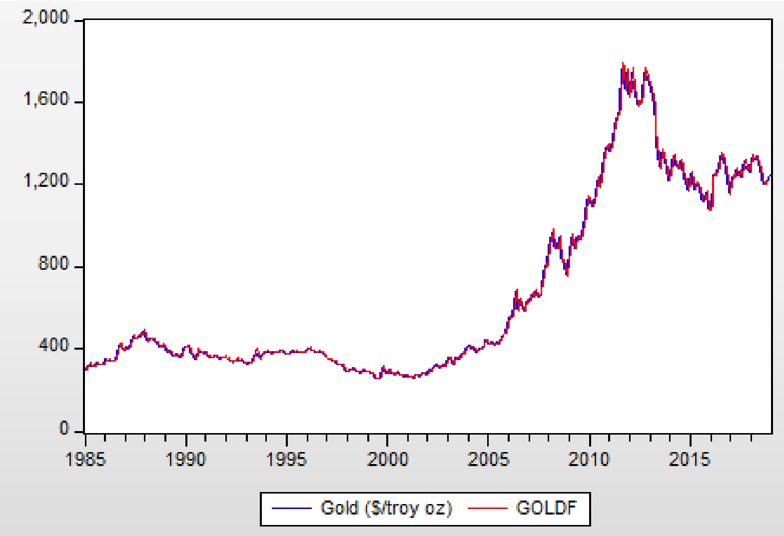
Static forecast



Dynamic forecast

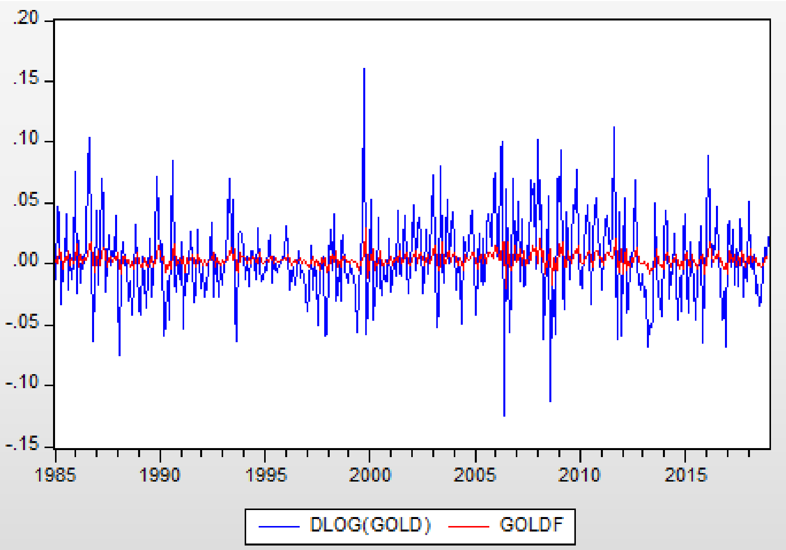


Produce Static forecasts for Gold and then plot these forecasts, goldF, and gold on the same graph by selecting Quick Graph. How good is the fit?



From the graph above, we can see the actual and forecast for gold fit quite well.

Produce Static forecasts for DLOG(gold) by specifying this at the top left of the forecast dialog box. Plot the forecasts and DLOG(gold) on the same graph. How good is the fit?



The graph above shows that the Dlog and GoldF are relatively stable at zero. Thus they are fitted quite good.

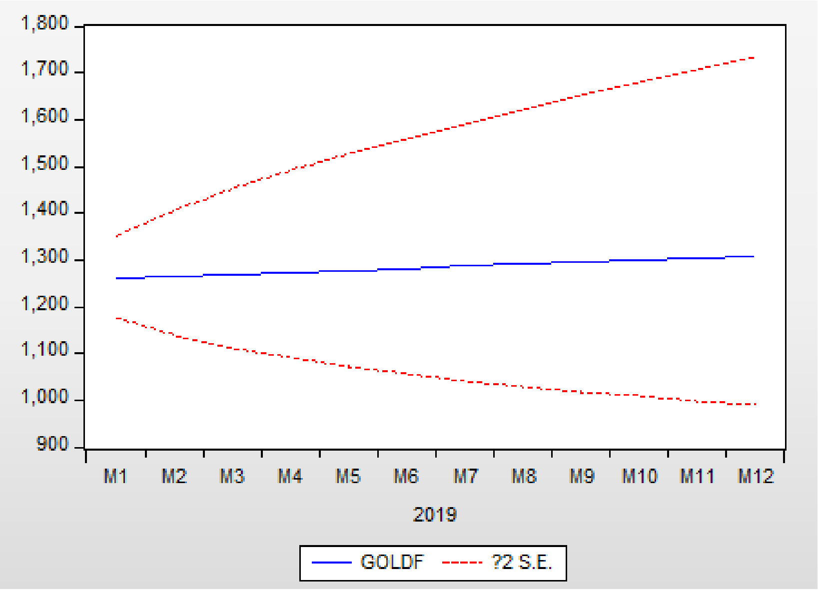
Do you expect gold prices to go up or down in the next 12 months? How about risk? What is the prediction interval?

From the dynamic forecast, the gold price trends towards 1300 dollars.

The solid line in the graph represents the prediction, and two dashed lines provide the confidence interval with 2 standard deviations. With the increase of predictive period, the prediction moves towards the mean of the series. Next to the graph, we have a Thell inequality coefficient of 0.027, which means the model has a good predictive ability. The decomposition implies that the proportion of bias is low and the proportion of covariance is high. So the actual series fluctuates more seriously than the prediction series.

Click the Forecast button which can be found in the menu at the top of the current equation window. [FORECAST observations 2019m01 to 2019m12]. In the top right of the dialog box, try a Dynamic forecasting Method and click OK.

Why can't you use the Static Forecasting method?



The curve is almost horizontal, one of the potential reason is that the forecasting period is too far away from the actual period.