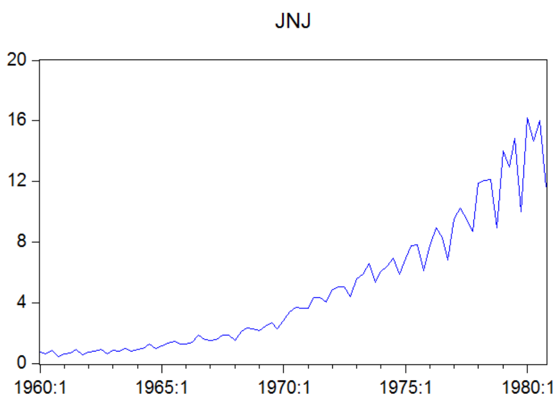
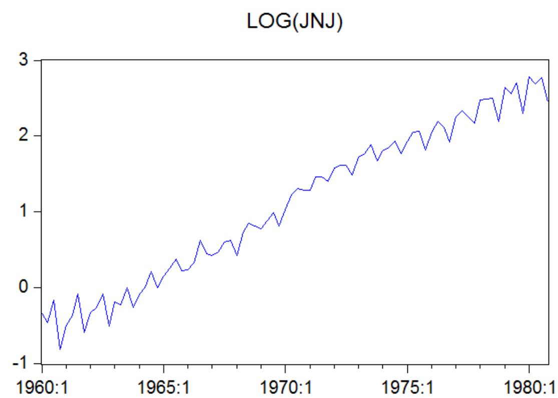
Homework 7

Eco 4306 Economic and Business Forecasting
Spring 2017
Due: Thursday, April 6, before the class

Problem 1

(a) Figure below shows the earnings per share for Johnson and Johnson, and the log transformed earnings per share for Johnson and Johnson. Both have clear seasonal pattern and grow over time, earnings per share along an exponential trend, and log transformed earnings per share along a linear trend.





(b) The Augmented Dickey-Fuller unit root test for log transformed earnings per share $\log JNJ_t$, and for the first difference of the log transformed earnings per share $\Delta \log JNJ_t$ are below.

Null Hypothesis: LJNJ has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.696535	0.7428
Test critical values:	1% level	-4.090602	
	5% level	-3.473447	
	10% level	-3.163967	

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

Null Hypothesis: D(LJNJ) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-19.93554	0.0001
Test critical values:	1% level	-4.090602	
	5% level	-3.473447	
	10% level	-3.163967	

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

Linear trend and constant were included in the test for $\log JNJ_t$ since it is growing over time, and only constant was included in the test for ΔJNJ_t since it is not growing or declining over time.

We can not reject the presence of a unit root process in $\log JNJ_t$, since the p-value is 0.7428, but we strongly reject the presence of a unit root process in $\Delta \log JNJ_t$ since the p-value is 0.0001.

Thus $\log JNJ_t$ is integrated of order 1, so $I(1)$.

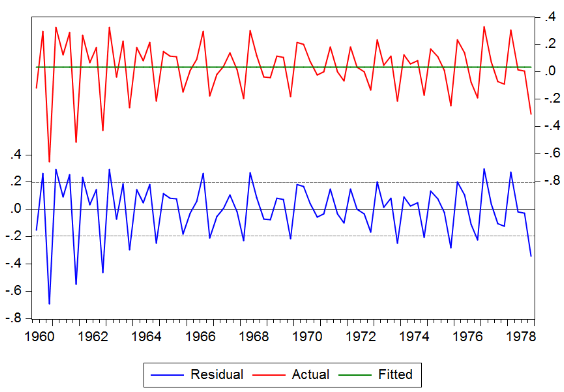
(c) Estimating a model for the first difference of log transformed earnings per share that only includes a constant: $\Delta \log JNJ_t = \beta_0 + \varepsilon_t$ yields:

Dependent Variable: DLOG(JNJ)
Method: Least Squares
Date: 04/09/17 Time: 03:58
Sample (adjusted): 1960Q2 1978Q4
Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.033729	0.022813	1.478481	0.1435

R-squared	0.000000	Mean dependent var	0.033729
Adjusted R-squared	0.000000	S.D. dependent var	0.197568
S.E. of regression	0.197568	Akaike info criterion	-0.392224
Sum squared resid	2.888452	Schwarz criterion	-0.361324
Log likelihood	15.70839	Hannan-Quinn criter.	-0.379886
Durbin-Watson stat	2.856858		

(d) The actual, fitted, residuals graph, and also the correlogram for residuals are below.



Date: 04/09/17 Time: 03:58
Sample: 1960Q1 1978Q4
Included observations: 75

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.453	-0.453	16.012	0.000
		2	-0.018	-0.281	16.038	0.000
		3	-0.343	-0.656	25.469	0.000
		4	0.701	0.311	65.428	0.000
		5	-0.347	0.061	75.356	0.000
		6	-0.040	-0.105	75.489	0.000
		7	-0.220	-0.059	79.600	0.000
		8	0.557	0.111	106.38	0.000
		9	-0.294	0.032	113.96	0.000
		10	-0.007	0.109	113.97	0.000
		11	-0.215	-0.061	118.15	0.000
		12	0.453	-0.039	136.93	0.000
		13	-0.203	0.106	140.77	0.000
		14	-0.046	-0.038	140.97	0.000
		15	-0.143	0.025	142.93	0.000
		16	0.325	-0.037	153.26	0.000

Residuals are not white noise - there is a clear seasonal pattern, ACF show slow decay and the first 4 components of the PACF are significant. It thus makes sense to consider a model with AR(4) innovations, so that

$$\log rGDP_t = \beta_0 + \beta_1 t + u_t$$
$$u_t = \phi_1 u_{t-1} + \phi_2 u_{t-2} + \phi_3 u_{t-3} + \phi_4 u_{t-4} + \varepsilon_t$$

(e) The results of the estimation for this model are below.

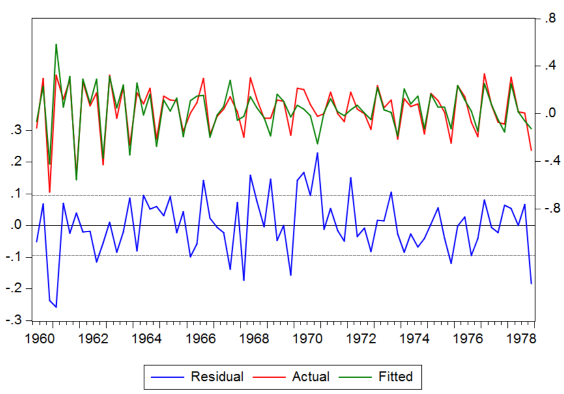
Dependent Variable: DLOG(JNJ)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 04/09/17 Time: 03:58
Sample: 1960Q2 1978Q4
Included observations: 75
Convergence achieved after 63 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.038782	0.004573	8.481121	0.0000
AR(1)	-0.653389	0.120181	-5.436707	0.0000
AR(2)	-0.582882	0.124725	-4.673325	0.0000
AR(3)	-0.601417	0.136049	-4.420583	0.0000
AR(4)	0.298030	0.138453	2.152573	0.0349
SIGMASQ	0.008360	0.001380	6.060289	0.0000

R-squared	0.782918	Mean dependent var	0.033729
Adjusted R-squared	0.767187	S.D. dependent var	0.197568
S.E. of regression	0.095328	Akaike info criterion	-1.714232
Sum squared resid	0.627031	Schwarz criterion	-1.528833
Log likelihood	70.28370	Hannan-Quinn criter.	-1.640204
F-statistic	49.77047	Durbin-Watson stat	1.950902
Prob(F-statistic)	0.000000		

Inverted AR Roots	.33	.00+.96i	.00-.96i	-.99

The actual, fitted, residuals graph, and also the correlogram for residuals are below.



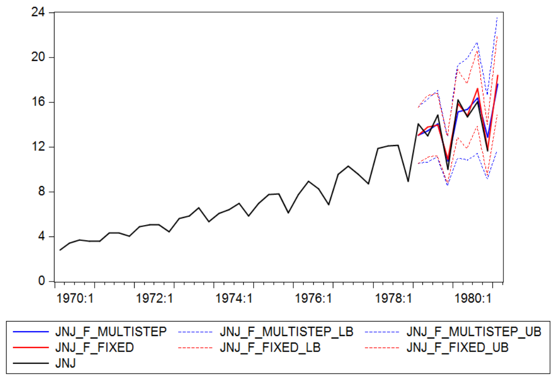
Date: 04/09/17 Time: 03:58
Sample: 1960Q1 1978Q4
Included observations: 75
Q-statistic probabilities adjusted for 4 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.004	-0.004	0.0014	
		2	0.070	0.070	0.3887	
		3	0.029	0.030	0.4565	
		4	-0.168	-0.174	2.7511	
		5	0.102	0.101	3.6158	0.057
		6	-0.020	0.004	3.6500	0.161
		7	0.261	0.267	9.4481	0.024
		8	0.022	-0.022	9.4882	0.050
		9	-0.014	-0.015	9.5057	0.091
		10	0.050	0.015	9.7304	0.136
		11	-0.180	-0.098	12.668	0.081
		12	0.108	0.073	13.737	0.089
		13	-0.125	-0.135	15.193	0.086
		14	0.017	-0.027	15.221	0.124
		15	-0.087	-0.159	15.944	0.143
		16	-0.079	0.002	16.555	0.167

Residuals no longer show any clear seasonal pattern, and with the exception of lag 7 ACF and PACF are insignificant. - residuals can thus be consider white noise.

(f) Figure below shows the multistep forecast for JNJ_t for period 1979Q1-1981Q1; the RMSE for this forecast is 0.8516.

(g) Figure below shows a sequence of one step ahead forecasts for JNJ_t for period 1979Q1-1981Q1 using fixed forecasting scheme. The RMSE for this forecast is 0.7852.



(h) The multistep forecast is as always less precise than the fixed scheme forecast. Recall that for the model based on the assumption of a deterministic trend lec16slides.pdf we got RMSE for the multistep forecast 0.9913, and RMSE for the fixed scheme forecast 0.8480. The model with stochastic trend thus performs better, results in smaller forecasting errors.