

Homework 7

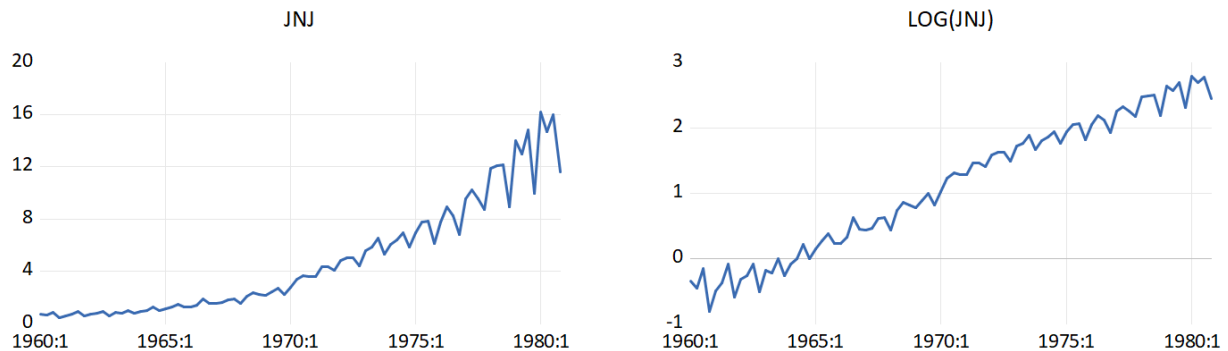
Eco 4306 Economic and Business Forecasting

Spring 2019

Due: Friday, April 19, 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: 4 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.576202	0.7920
Test critical values: 1% level	-4.100935	
5% level	-3.478305	
10% level	-3.166788	

*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	-19.58957	0.0001
Test critical values: 1% level	-4.098741	
5% level	-3.477275	
10% level	-3.166190	

*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 $I(1)$.

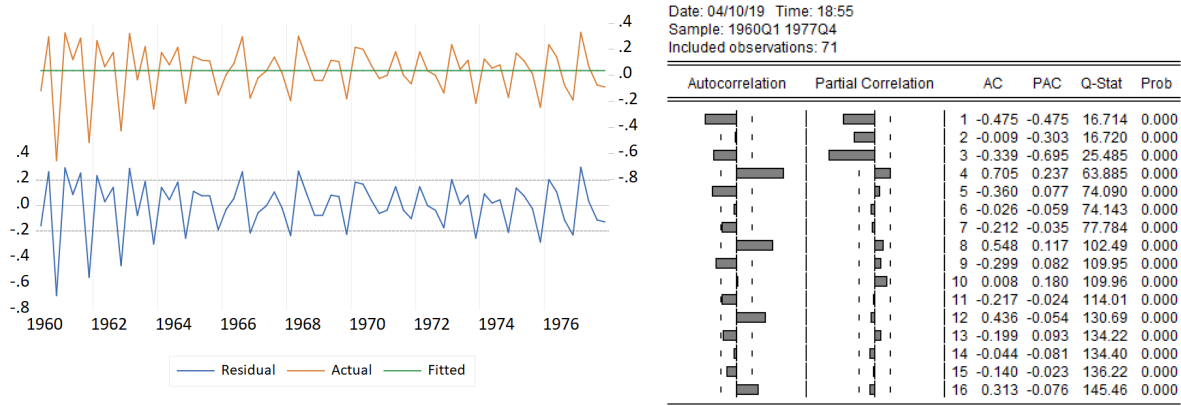
- (c) Estimating a model for the first difference of log transformed earnings per share that only includes a constant: $\Delta \log JNJ_t = \beta_0 + \varepsilon_t$ yields:

Dependent Variable: DLOG(JNJ)
Method: Least Squares
Date: 04/10/19 Time: 18:55
Sample (adjusted): 1960Q2 1977Q4
Included observations: 71 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.035342	0.023281	1.518065	0.1335

R-squared	0.000000	Mean dependent var	0.035342
Adjusted R-squared	0.000000	S.D. dependent var	0.196167
S.E. of regression	0.196167	Akaike info criterion	-0.405720
Sum squared resid	2.693696	Schwarz criterion	-0.373851
Log likelihood	15.40305	Hannan-Quinn criter.	-0.393047
Durbin-Watson stat	2.935606		

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



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.

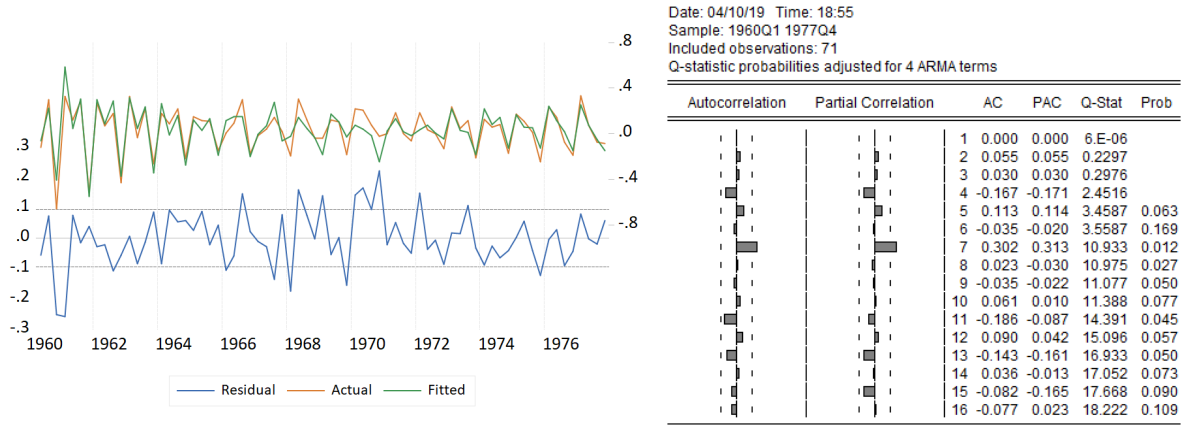
Dependent Variable: DLOG(JNJ)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 04/10/19 Time: 18:55
Sample: 1960Q2 1977Q4
Included observations: 71
Convergence achieved after 79 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.039046	0.004827	8.089756	0.0000
AR(1)	-0.639854	0.121950	-5.246831	0.0000
AR(2)	-0.559625	0.128823	-4.344158	0.0001
AR(3)	-0.565419	0.144694	-3.907674	0.0002
AR(4)	0.319165	0.144859	2.203278	0.0311
SIGMASQ	0.008278	0.001412	5.861144	0.0000

R-squared	0.781798	Mean dependent var	0.035342
Adjusted R-squared	0.765013	S.D. dependent var	0.196167
S.E. of regression	0.095093	Akaike info criterion	-1.715594
Sum squared resid	0.587770	Schwarz criterion	-1.524382
Log likelihood	66.90359	Hannan-Quinn criter.	-1.639555
F-statistic	46.57782	Durbin-Watson stat	1.988047
Prob(F-statistic)	0.000000		

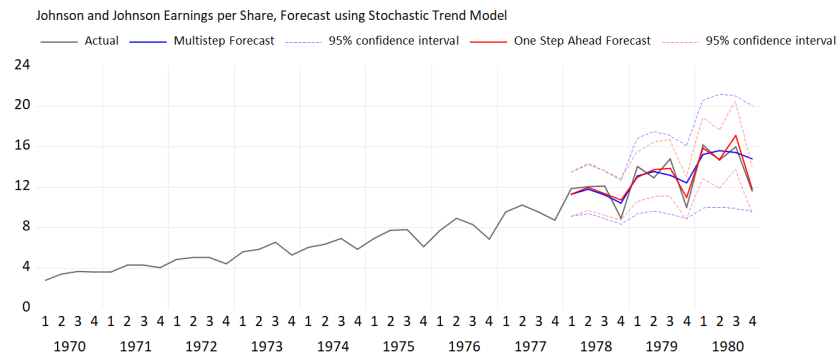
Inverted AR Roots	.36	-.01+.95i	-.01-.95i	-.99
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The actual, fitted, residuals graph, and also the correlogram for residuals are below.



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.