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Instructor	Dr. C.G.H. Diks	Academic year	2007/2008
Course name	Financial Econometrics-1	Semester, block	First

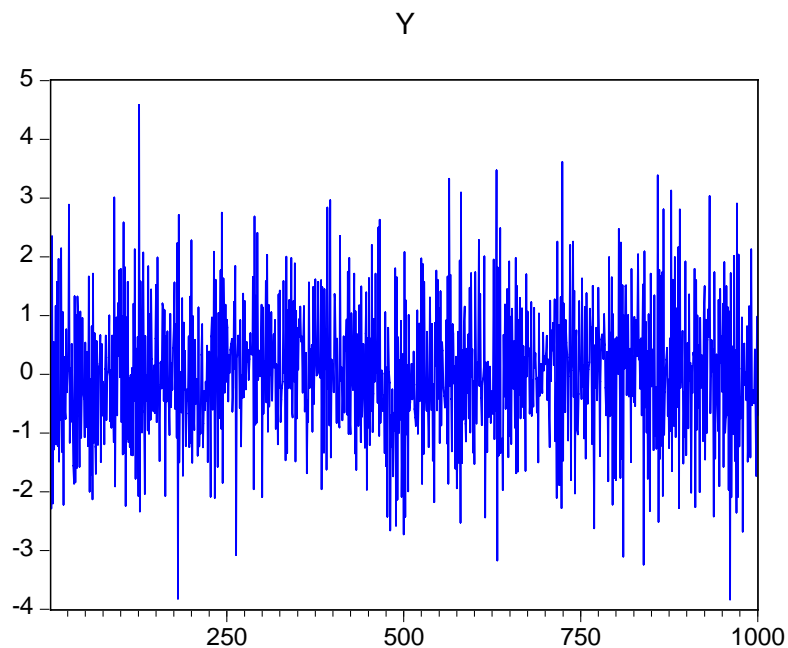
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Assignment # 3

Part I. Simulated data, Series Y

1) Step one: stationary or non-stationary?

First of all, we would like to check the graph for series y, which we study. As one can see, the series of y looks like a return on a share: y fluctuates around zero without any particular trend. This graph suggests there that y is a stationary process.



After informal graphic analysis we use ADF¹ test with intercept to test whether y is a stationary time series.

¹ We do not include trend in ADF test as we can hardly give a rationale for it given a graph of y, which clearly shows that there is no trend.

ADF test is using the following regression:

$$\Delta y_t = \alpha \cdot y_{t-1} + \beta_1 \cdot \Delta y_{t-1} + \dots + \beta_p \cdot \Delta y_{t-p} + v_t$$

$$H_0 : \alpha = 0$$

$$H_1 : \alpha < 0$$

The null hypotheses — time series is non-stationary (unit root). The p lag is chosen automatically by Eviews with the usage of Schwarz information criterion. The results are presented in table below. According to the table y is a stationary process: calculated t-stat of ADF test is -25 is lower than critical value of ADF test statistic at 5% level, which is -2.86. This implies that we reject the null hypothesis that there is a unit root (y is a non-stationary process) at 5% significance level. So y – is a stationary process and we do not to take difference.

Null Hypothesis: Y has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic based on SIC, MAXLAG=21)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-25.32333	0.0000
Test critical values:		
1% level	-3.436683	
5% level	-2.864225	
10% level	-2.568251	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(Y)

Method: Least Squares

Date: 11/25/07 Time: 22:55

Sample (adjusted): 3 1000

Included observations: 998 after adjustments

	Coefficien			
	t	Std. Error	t-Statistic	Prob.
Y(-1)	-1.401159	0.055331	-25.32333	0.0000
D(Y(-1))	-0.089926	0.031522	-2.852762	0.0044
C	0.036364	0.031728	1.146132	0.2520
R-squared	0.772555	Mean dependent var		0.001591
Adjusted R-squared	0.772098	S.D. dependent var		2.097605
S.E. of regression	1.001378	Akaike info criterion		2.843633
Sum squared resid	997.7447	Schwarz criterion		2.858380
Log likelihood	-1415.973	Hannan-Quinn criter.		2.849239
F-statistic	1689.840	Durbin-Watson stat		2.000533
Prob(F-statistic)	0.000000			

2) Identification

To identify the order of AR and MA we start from analyzing correlogram of y (see below). Correlogram for y seems to have a pattern of AR model, because we see a pacf that cuts-off after the first lag (or second) and acf slowly (geometrically) declines.

Date: 11/25/07 Time: 22:57
 Sample: 1 1000
 Included observations: 1000

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
****	****	1	-0.541	-0.541	293.13	0.000
***	*	2	0.355	0.089	419.71	0.000
*		3	-0.199	0.034	459.54	0.000
*		4	0.160	0.061	485.43	0.000
		5	-0.061	0.069	489.21	0.000
		6	0.043	0.018	491.09	0.000
		7	-0.015	0.005	491.32	0.000
		8	0.022	0.014	491.81	0.000
	*	9	0.042	0.076	493.63	0.000
		10	-0.019	0.034	493.97	0.000
		11	0.064	0.063	498.14	0.000
		12	-0.044	0.011	500.07	0.000
		13	0.046	-0.003	502.22	0.000
		14	-0.018	0.009	502.53	0.000
		15	0.048	0.042	504.84	0.000
		16	-0.016	0.027	505.12	0.000
		17	0.014	-0.005	505.30	0.000
		18	0.050	0.068	507.83	0.000
		19	-0.059	-0.028	511.39	0.000
*		20	0.077	0.011	517.46	0.000
		21	-0.022	0.054	517.97	0.000

According to correlogram, the most probable model is AR(1). In order to specify orders p and q , we estimate Schwarz Information criterion for orders p and q from 1 to 3. As we can see from the table below, the best SIC has the model with ARMA(2,1).

q\p	Schwarz Information criterion			
0	2.862002	2.85838	2.864016	
1	2.867973	2.861113	2.847879	2.852559
2	2.882697	2.867457	2.871096	2.859339
3	2.883206	2.871476	2.860088	2.86591

3) Estimating of ARMA(2,1)

Below you can find estimates for ARMA(2,1) model. All the coefficients (except intercept) are significant at 5% level. Inverted AR and MA roots are lower than one.

Dependent Variable: Y
 Method: Least Squares
 Date: 11/29/07 Time: 00:08
 Sample (adjusted): 3 1000
 Included observations: 998 after adjustments
 Convergence achieved after 9 iterations
 MA Backcast: 2

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.030085	0.046494	0.647066	0.5177
AR(1)	0.400295	0.034282	11.67639	0.0000
AR(2)	0.551983	0.026789	20.60472	0.0000
MA(1)	-0.930454	0.028001	-33.22916	0.0000
R-squared	0.310126	Mean dependent var		0.026402
Adjusted R-squared	0.308044	S.D. dependent var		1.193973
S.E. of regression	0.993193	Akaike info criterion		2.828216
Sum squared resid	980.5137	Schwarz criterion		2.847879
Log likelihood	-1407.280	Hannan-Quinn criter.		2.835690
F-statistic	148.9476	Durbin-Watson stat		1.959784
Prob(F-statistic)	0.000000			
Inverted AR Roots	.97	-.57		
Inverted MA Roots	.93			

4) Diagnostic testing of ARMA(2,1)

We use Breusch-Godfrey Serial Correlation LM Test to test ARMA (2,1) model (it's residuals) for serial autocorrelation. The results are presented in a table below. According to the table, there is no serial autocorrelation in residuals of ARMA(2,1) implying that the model is well specified. The calculated p-value of F-statistics is 70% which is lower than critical p-value of 5%, that implies that we cannot reject the null hypothesis of no serial autocorrelation in residuals at 5% significance level.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.723915	Prob. F(10,984)	0.7024
Obs*R-squared	7.282045	Prob. Chi-Square(10)	0.6986

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 11/29/07 Time: 00:08

Sample: 3 1000

Included observations: 998

Presample missing value lagged residuals set to zero.

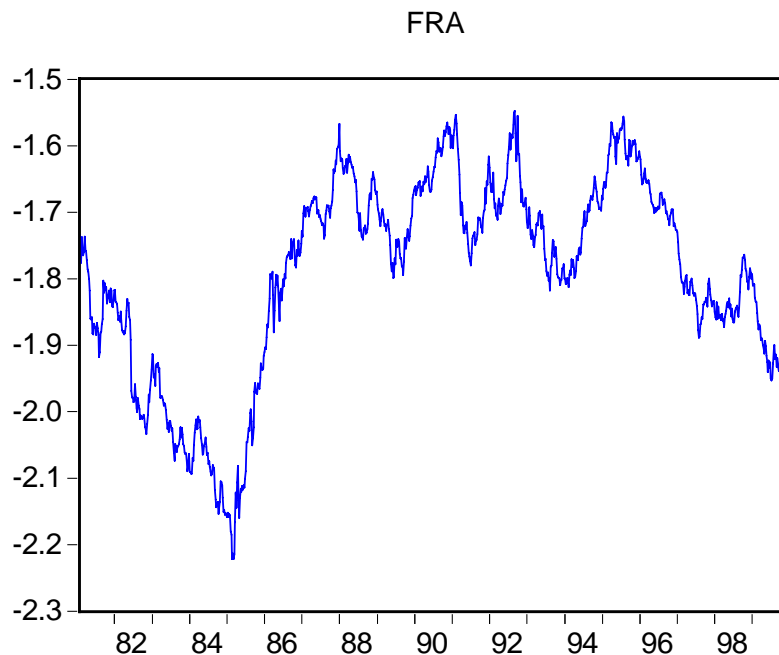
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001820	0.046629	0.039039	0.9689
AR(1)	-0.489666	0.399599	-1.225394	0.2207
AR(2)	0.483588	0.385030	1.255976	0.2094
MA(1)	-0.019562	0.053368	-0.366541	0.7140
RESID(-1)	0.528248	0.399110	1.323565	0.1860
RESID(-2)	-0.262645	0.232812	-1.128138	0.2595
RESID(-3)	0.153080	0.134487	1.138252	0.2553
RESID(-4)	-0.046143	0.085402	-0.540307	0.5891
RESID(-5)	0.052136	0.056443	0.923692	0.3559
RESID(-6)	-0.055039	0.045475	-1.210312	0.2264
RESID(-7)	-0.004196	0.039333	-0.106674	0.9151
RESID(-8)	0.011987	0.037284	0.321509	0.7479
RESID(-9)	0.045212	0.035786	1.263386	0.2067
RESID(-10)	0.008182	0.035292	0.231834	0.8167
R-squared	0.007297	Mean dependent var		0.002535
Adjusted R-squared	-0.005818	S.D. dependent var		0.991694
S.E. of regression	0.994575	Akaike info criterion		2.840927
Sum squared resid	973.3529	Schwarz criterion		2.909745
Log likelihood	-1403.622	Hannan-Quinn criter.		2.867085
F-statistic	0.556359	Durbin-Watson stat		2.002021
Prob(F-statistic)	0.889010			

Part II. Real Exchange Rates: France-USA

1) Step one: stationary or non-stationary?

We analyze the logarithm of France-US real exchange rate time series for a period of 2/01/1981-31/12/1999

First of all we study the graph of FRA. As we can see it is non-stationary.



To test whether FRA is a stationary process or not we use ADF test with intercept and trend as we suspect that FRA might have a trend (from a graph). The results are presented in table below: as one can find that we do not reject the null hypothesis of unit root (non-stationary process) at 5% level: calculated t-stat of ADF test is -1.47 which is larger than -3.41 (critical value of ADF t-stat at 5% significance level), so we do not reject the null hypothesis of unit root at 5% level. So the FRA is a non-stationary process.

Null Hypothesis: FRA has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

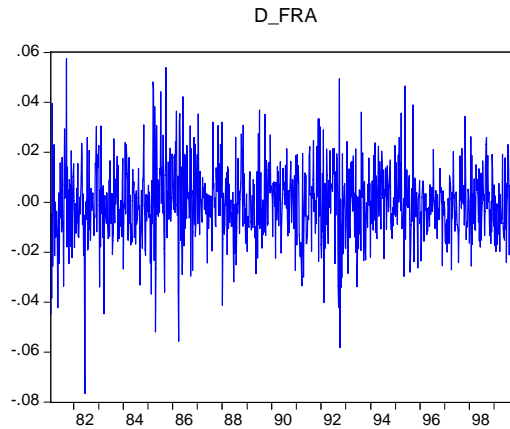
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.471402	0.8388
Test critical values:		
1% level	-3.967364	
5% level	-3.414368	
10% level	-3.129310	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(FRA)
 Method: Least Squares
 Date: 11/29/07 Time: 01:33
 Sample: 1/30/1981 12/31/1999
 Included observations: 988

	Coefficient	Std. Error	t-Statistic	Prob.
FRA(-1)	-0.005142	0.003494	-1.471402	0.1415
C	-0.009841	0.006704	-1.467826	0.1425
@TREND(1/30/1981)	6.65E-07	1.84E-06	0.361342	0.7179
R-squared	0.002255	Mean dependent var		-0.000284
Adjusted R-squared	0.000229	S.D. dependent var		0.015121
S.E. of regression	0.015119	Akaike info criterion		-5.542642
Sum squared resid	0.225168	Schwarz criterion		-5.527776
Log likelihood	2741.065	Hannan-Quinn criter.		-5.536989
F-statistic	1.113131	Durbin-Watson stat		1.952918
Prob(F-statistic)	0.328942			

Graph below illustrates FRA after taking first difference: as we can see D_FRA is stationary and is fluctuating around zero



We use ADF test with intercept to determine whether first difference of FRA is a stationary process. Results are presented below in the table, as one can find calculated t-stat (-31) is lower than critical value of t-stat (-2.86) at 5% level, so we reject the null hypothesis of unit root (non-stationary process) at 5% significance level. This implies that D(FRA) is a stationary process.

Null Hypothesis: D(FRA) has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic based on SIC, MAXLAG=21)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-30.81716	0.0000
Test critical values:		
1% level	-3.436749	
5% level	-2.864254	
10% level	-2.568267	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(FRA,2)
 Method: Least Squares
 Date: 11/29/07 Time: 01:35
 Sample: 1/30/1981 12/31/1999
 Included observations: 988

	Coefficient	Std. Error	t-Statistic	Prob.
D(FRA(-1))	-0.981031	0.031834	-30.81716	0.0000
C	-0.000278	0.000481	-0.578548	0.5630
R-squared	0.490623	Mean dependent var		3.77E-06
Adjusted R-squared	0.490106	S.D. dependent var		0.021183
S.E. of regression	0.015126	Akaike info criterion		-5.542769

Sum squared resid	0.225596	Schwarz criterion	-5.532858
Log likelihood	2740.128	Hannan-Quinn criter.	-5.539000
F-statistic	949.6971	Durbin-Watson stat	1.997613
Prob(F-statistic)	0.000000		

2) Identification

We start from correlogram of D(FRA): as we can see from the table below the AC and PAC are very low for all the lags. Q-Stat has a high calculated p-value large than 5% level of significance: that means that we do not reject the null hypothesis of zero serial correlation at 5% significance level. This implies that D(FRA) is behaving as a random walk.

Date: 11/29/07 Time: 01:36
Sample: 1/30/1981 12/31/1999
Included observations: 988

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
		1	0.016	0.016	0.2551	0.613
		2	0.026	0.026	0.9481	0.622
		3	-0.005	-0.006	0.9742	0.807
		4	0.044	0.044	2.9350	0.569
		5	-0.021	-0.022	3.3540	0.646
		6	-0.039	-0.040	4.8338	0.565
		7	0.026	0.029	5.5000	0.599
		8	0.057	0.056	8.7290	0.366
		9	-0.011	-0.013	8.8424	0.452
		10	-0.024	-0.023	9.3996	0.495
		11	0.044	0.043	11.372	0.413
		12	0.000	-0.005	11.372	0.497
		13	0.002	0.004	11.374	0.580
		14	0.054	0.061	14.319	0.426
		15	0.027	0.016	15.039	0.449
		16	-0.027	-0.035	15.792	0.468
		17	0.003	0.010	15.800	0.538
		18	-0.028	-0.031	16.581	0.552
		19	0.028	0.023	17.355	0.566
		20	-0.016	-0.006	17.620	0.612
		21	0.018	0.016	17.961	0.651

3) Estimation.

We estimate random walk by regressing D(FRA) to a constant. The results are presented in table below. The constant is very close to zero and p-value of calculated t-stat is 51% higher than 5% significance level, so we do not reject the null hypothesis that constant is equal to zero.

Dependent Variable: D(FRA)
 Method: Least Squares
 Date: 11/29/07 Time: 01:38
 Sample: 1/02/1981 12/31/1999
 Included observations: 992

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000315	0.000480	-0.655969	0.5120
R-squared	0.000000	Mean dependent var		-0.000315
Adjusted R-squared	0.000000	S.D. dependent var		0.015104
S.E. of regression	0.015104	Akaike info criterion		-5.546665
Sum squared resid	0.226087	Schwarz criterion		-5.541726
Log likelihood	2752.146	Hannan-Quinn criter.		-5.544787
Durbin-Watson stat	1.960495			

4) Diagnostic testing

We use Breusch-Godfrey Serial Correlation LM Test to test for serial correlation. Results are presented in table below. P-value of calculated F-stat is 50% - higher than critical value of 5%, so we do not reject the null hypothesis of no serial autocorrelation. So the model is well specified.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.934470	Prob. F(10,981)	0.5003
Obs*R-squared	9.360317	Prob. Chi-Square(10)	0.4983

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 11/29/07 Time: 01:39

Sample: 1/02/1981 12/31/1999

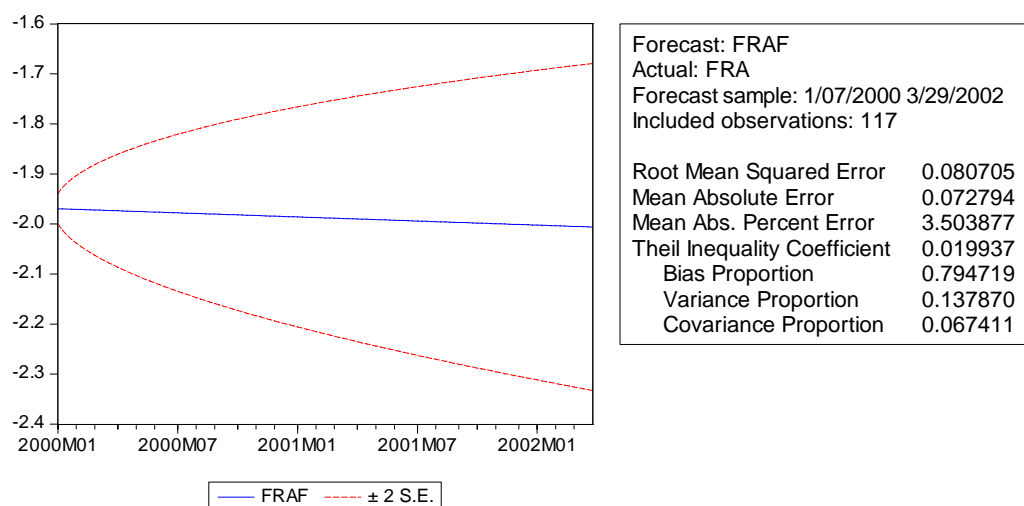
Included observations: 992

Presample missing value lagged residuals set to zero.

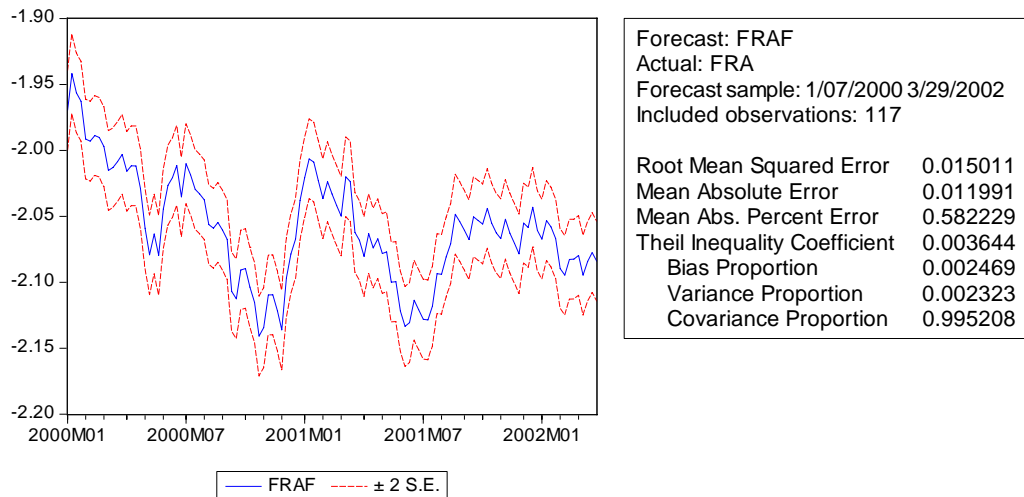
	Coefficient	Std. Error	t-Statistic	Prob.
C	2.51E-07	0.000480	0.000523	0.9996
RESID(-1)	0.018995	0.031927	0.594940	0.5520
RESID(-2)	0.033018	0.031937	1.033852	0.3015
RESID(-3)	-0.003791	0.031906	-0.118826	0.9054
RESID(-4)	0.042373	0.031912	1.327810	0.1845
RESID(-5)	-0.022329	0.031925	-0.699431	0.4844
RESID(-6)	-0.038206	0.031944	-1.196030	0.2320
RESID(-7)	0.025756	0.031940	0.806375	0.4202
RESID(-8)	0.056337	0.031954	1.763055	0.0782
RESID(-9)	-0.011629	0.031993	-0.363489	0.7163
RESID(-10)	-0.022868	0.032007	-0.714486	0.4751
R-squared	0.009436	Mean dependent var		3.66E-18
Adjusted R-squared	-0.000662	S.D. dependent var		0.015104
S.E. of regression	0.015109	Akaike info criterion		-5.535985
Sum squared resid	0.223954	Schwarz criterion		-5.481653
Log likelihood	2756.848	Hannan-Quinn criter.		-5.515327
F-statistic	0.934470	Durbin-Watson stat		1.997129
Prob(F-statistic)	0.500324			

5. Forecasting

Dynamic forecast is presented in a graph below: as one can see the estimate of standard error of forecast is increasing with a projection horizon — a well know property of random walk.



Static forecast: the graph below shows the static forecast. Static forecast is more precise than dynamic, because each time (step) information set is updated. Dynamic forecast is done only with one information set.



Quality of forecasts: Static Forecast is more precise than dynamic according to Root Mean Squared Error (0.015 vs 0.081), Mean Absolute Error (0.012 vs 0.073) and Mean Absolute Pers. Error (0.58 vs 3.50). The fact that static forecast is more precise follows from the definition of static and dynamic forecasts. Dynamic forecast uses less information than static that leads to a lower forecast power.