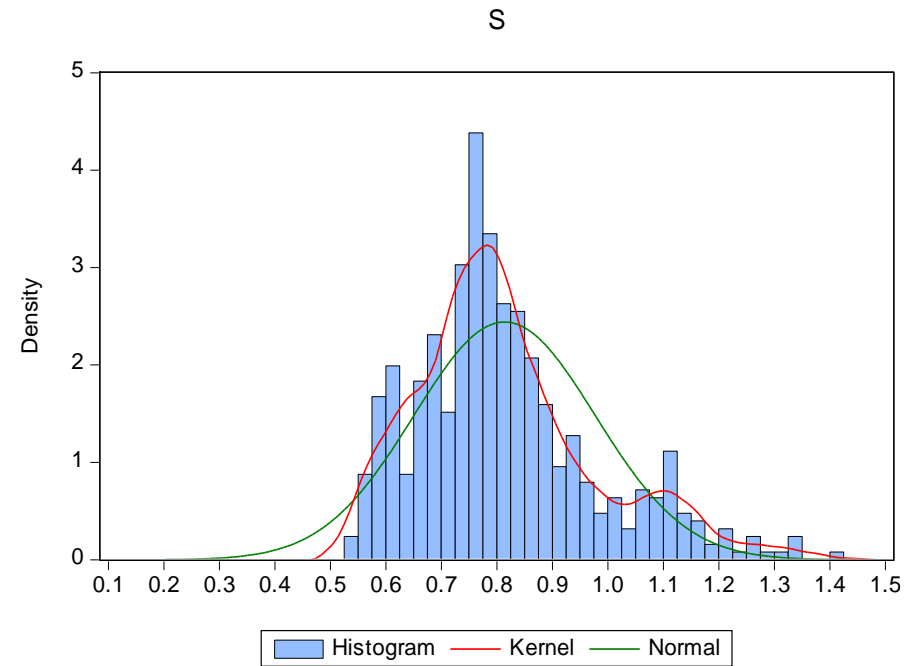
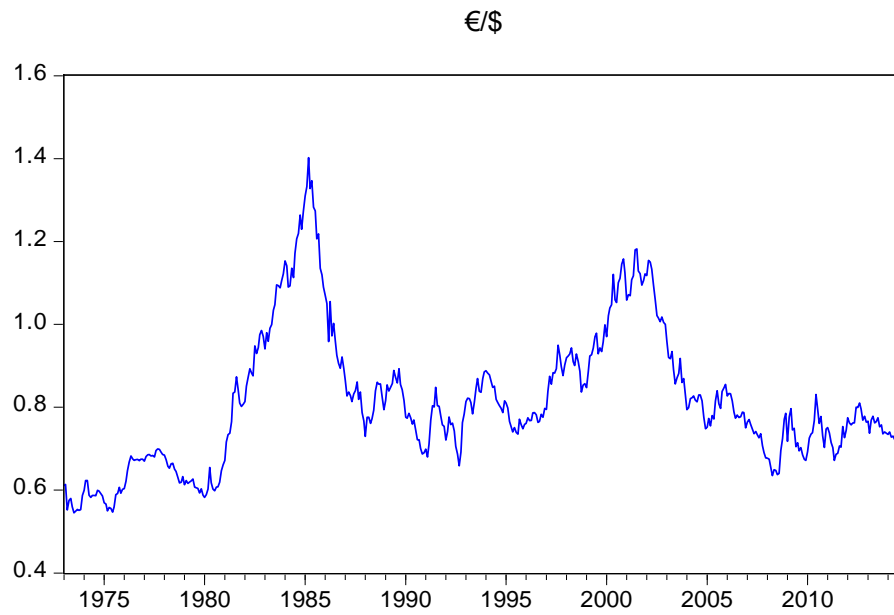


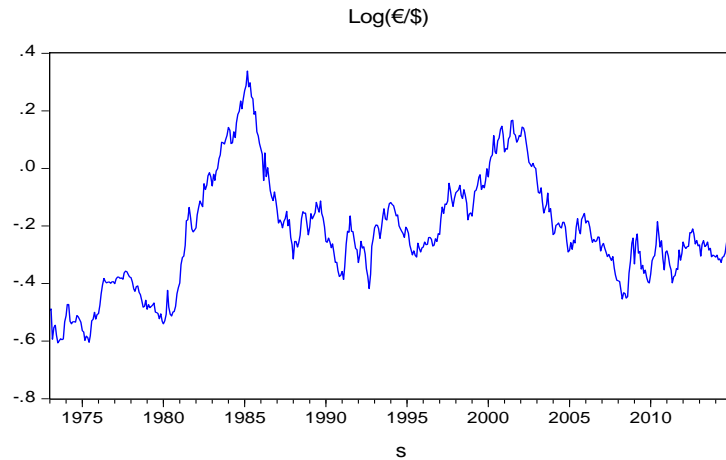
*Μονομεταβλητή ανάλυση χρονοσειράς
ισοτιμίας Ευρώ/Δολάριο*

1.€/ \$ description (Statistics and Histogram)

Exchange rate €/€



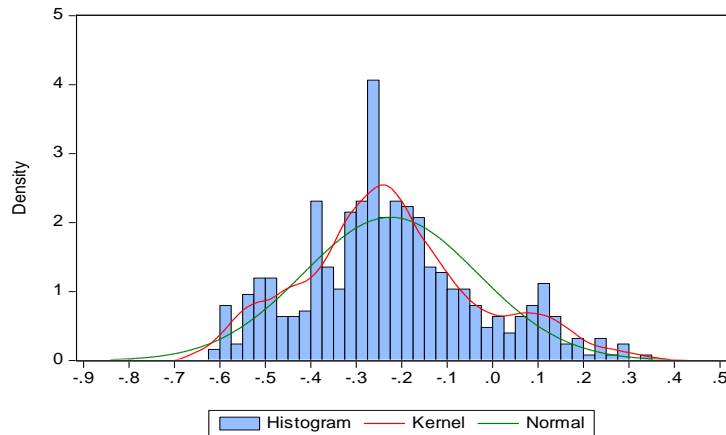
Log – Exchange rate €/€



Series: Log(€/€)
 Sample 1973M01 2014M10
 Observations 502

Mean -0.224667
 Median -0.245434
 Maximum 0.338171
 Minimum -0.606474
 Std. Dev. 0.192173
 Skewness 0.387264
 Kurtosis 2.895283

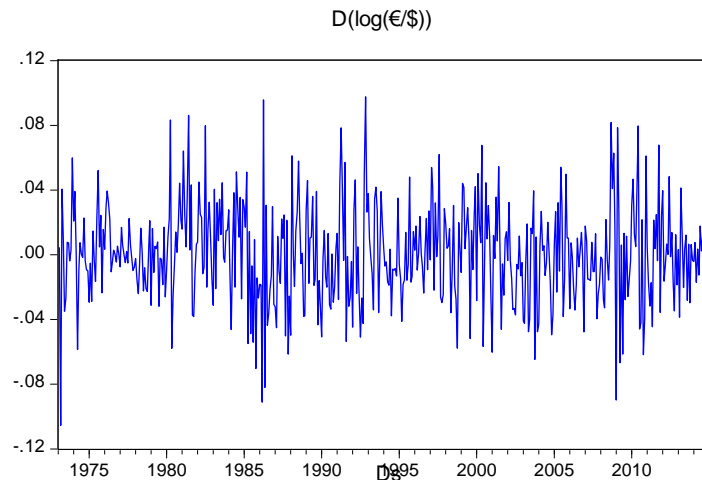
Jarque-Bera 12.77713
 Probability 0.001681



Sample: 1973M01 2014M10
 Included observations: 502

	AC	PAC	Q-Stat	Prob
1	0.985	0.985	490.45	0.000
2	0.971	-0.022	967.08	0.000
3	0.952	-0.117	1427.0	0.000
4	0.934	-0.025	1870.0	0.000
5	0.916	0.030	2297.1	0.000
6	0.897	-0.033	2707.7	0.000
7	0.879	0.012	3103.1	0.000
8	0.860	-0.048	3482.3	0.000
9	0.841	-0.028	3845.3	0.000
10	0.821	-0.017	4192.0	0.000
11	0.801	-0.025	4522.4	0.000
12	0.780	-0.033	4836.3	0.000
13	0.761	0.064	5135.7	0.000
14	0.742	-0.006	5420.9	0.000
15	0.723	-0.002	5692.7	0.000
16	0.704	-0.038	5951.1	0.000
17	0.683	-0.088	6194.6	0.000
18	0.664	0.058	6425.0	0.000
19	0.643	-0.054	6641.3	0.000
20	0.621	-0.041	6843.9	0.000
21	0.600	-0.003	7033.3	0.000
22	0.578	-0.017	7209.5	0.000
23	0.556	-0.050	7372.7	0.000
24	0.534	0.002	7523.4	0.000

Returns €/\$



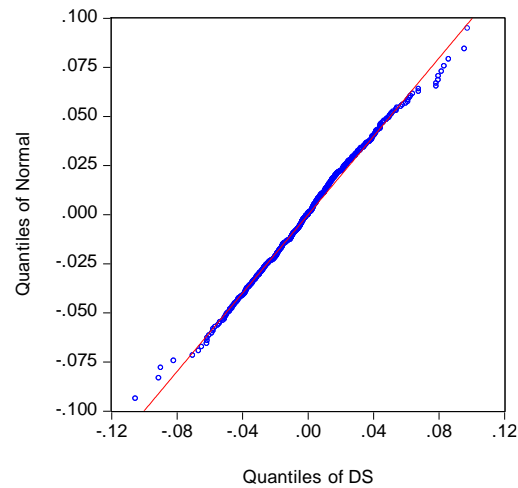
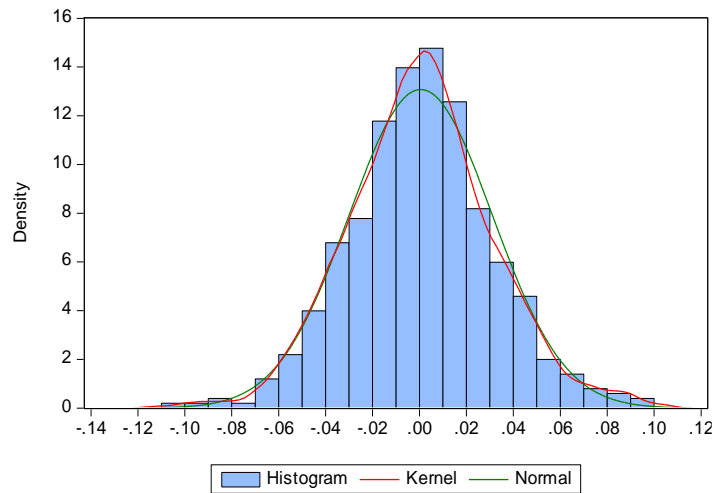
Series: DS
 Sample 1973M01 2014M10
 Observations 501

Mean 0.000536
 Median 0.000444
 Maximum 0.097543
 Minimum -0.105348
 Std. Dev. 0.030509
 Skewness 0.094456
 Kurtosis 3.498490

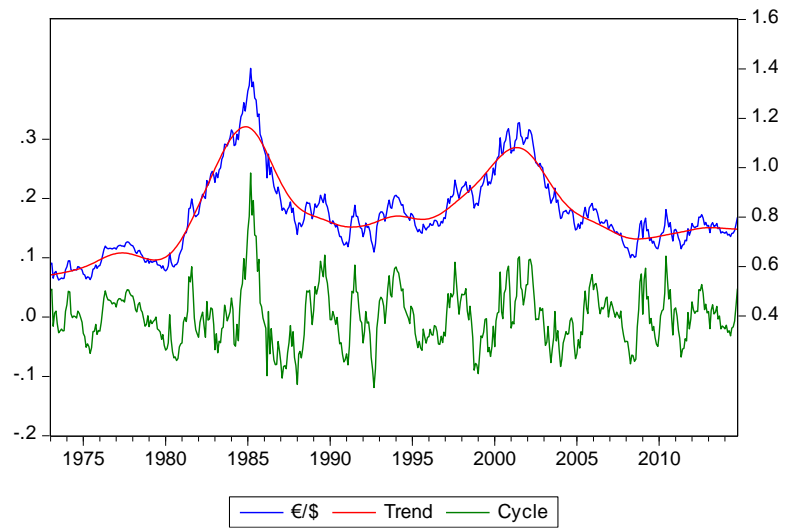
Jarque-Bera 5.932256
 Probability 0.051502

Sample: 1973M01 2014M10
 Included observations: 501

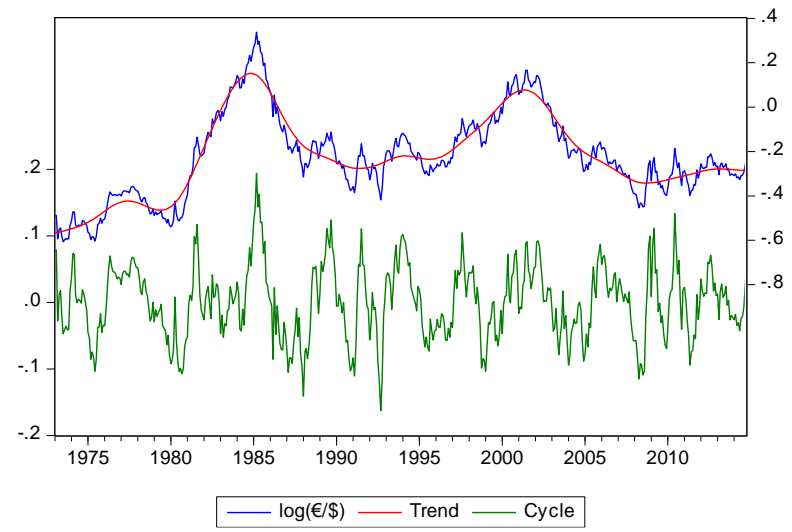
	AC	PAC	Q-Stat	Prob
1	0.019	0.019	0.191	0.662
2	0.065	0.064	2.307	0.316
3	0.044	0.042	3.290	0.349
4	-0.026	-0.032	3.640	0.457
5	0.010	0.005	3.687	0.595
6	-0.048	-0.046	4.840	0.564
7	0.051	0.055	6.192	0.518
8	0.021	0.024	6.409	0.601
9	0.013	0.010	6.494	0.690
10	0.026	0.015	6.832	0.741
11	0.058	0.058	8.549	0.663
12	-0.066	-0.075	10.810	0.545
13	0.018	0.018	10.983	0.612
14	-0.027	-0.024	11.360	0.658
15	-0.007	0.000	11.386	0.725
16	0.082	0.081	14.890	0.533
17	-0.069	-0.067	17.377	0.429
18	0.072	0.052	20.097	0.327
19	0.010	0.016	20.154	0.385
20	0.008	0.007	20.191	0.446
21	0.012	0.001	20.268	0.504
22	0.021	0.032	20.498	0.552
23	-0.013	-0.025	20.586	0.606
24	-0.040	-0.039	21.446	0.612



Hodrick-Prescott Filter (lambda=14400)



Hodrick-Prescott Filter (lambda=14400)



Φίλτρο Hodrick-Prescott

Μια τεχνητή χρονοσειρά (φίλτρο) s_t , $t=1, \dots, T$ που ελαχιστοποιεί:

$$\sum_{t=1}^T (y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1} ((s_{t+1} - s_t) - (s_t - s_{t-1}))^2$$

λ ελέγχει τον βαθμό του smoothing

$$\lambda = 1600 * [(\# \text{ παρατηρήσεων ανα έτος})/4]^2$$

$$\lambda = \begin{cases} 100 & \text{for annual data} \\ 1,600 & \text{for quarterly data} \\ 14,400 & \text{for monthly data} \end{cases}$$

Stationarity Tests in $\log(\text{€}/\text{\$})$ (Levels, FDs, ADF, ERS)

Stationarity Tests

Levels – ADF

Null Hypothesis: S has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=17)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.950	0.626
Test critical values:		
1% level	-3.976	
5% level	-3.419	
10% level	-3.132	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(S)
 Method: Least Squares
 Date: 11/11/14 Time: 09:24
 Sample (adjusted): 1973M02 2014M10
 Included observations: 501 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
S(-1)	-0.014	0.007	-1.950	0.052
C	-0.002	0.003	-0.593	0.553
@TREND(1973M01)	-0.000	0.000	-0.240	0.811

R-squared	0.008	Mean dependent var	0.001
Adjusted R-squared	0.005	S.D. dependent var	0.031
S.E. of regression	0.030	Akaike info criterion	-4.140
Sum squared resid	0.461	Schwarz criterion	-4.115
Log likelihood	1040.104	Hannan-Quinn criter.	-4.130
F-statistic	2.134	Durbin-Watson stat	1.947
Prob(F-statistic)	0.119		

Stationarity Tests Levels – ERS (advanced near unit root test)

Null Hypothesis: S has a unit root

Exogenous: Constant, Linear Trend

Lag length: 0 (Spectral OLS AR based on SIC, maxlag=17)

Sample: 1973M01 2014M10

	P-Statistic
<hr/> <hr/>	
Elliott-Rothenberg-Stock test statistic	17.936
Test critical values:	
1% level	3.960
5% level	5.620
10% level	6.890
<hr/> <hr/>	
*Elliott-Rothenberg-Stock (1996, Table 1)	
<hr/> <hr/>	
HAC corrected variance (Spectral OLS autoregression)	0.001
<hr/> <hr/>	

Stationarity Tests log first differences (returns) - ADF

Null Hypothesis: DS has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag=17)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-21.852	0.000
Test critical values:		
1% level	-3.977	
5% level	-3.419	
10% level	-3.132	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(DS)
 Method: Least Squares
 Date: 11/11/14 Time: 09:45
 Sample (adjusted): 1973M03 2014M10
 Included observations: 500 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DS(-1)	-0.981	0.045	-21.852	0.000
C	0.002	0.003	0.757	0.450
@TREND(1973M01)	-0.000	0.000	-0.655	0.513

R-squared	0.490	Mean dependent var	0.000
Adjusted R-squared	0.488	S.D. dependent var	0.043
S.E. of regression	0.031	Akaike info criterion	-4.131
Sum squared resid	0.465	Schwarz criterion	-4.106
Log likelihood	1035.715	Hannan-Quinn criter.	-4.121
F-statistic	238.764	Durbin-Watson stat	1.974
Prob(F-statistic)	0.000		

IIDness tests: VR and BDS Tests for $\text{dlog}(\text{€}/\text{\$})$

Null Hypothesis: DS is a martingale

Date: 11/13/14 Time: 15:32

Sample: 1973M01 2014M10

Included observations: 500 (after adjustments)

Heteroskedasticity robust standard error estimates

User-specified lags: 2 4 8 16

Joint Tests		Value	df	Probability
Max z (at period 2)*		7.468888	500	0.0000
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.471998	0.070693	-7.468888	0.0000
4	0.260912	0.121309	-6.092625	0.0000
8	0.126016	0.171049	-5.109549	0.0000
16	0.060155	0.231486	-4.060060	0.0000

*Probability approximation using studentized maximum modulus with parameter value 4 and infinite degrees of freedom

Test Details (Mean = 6.23069481298e-05)

Period	Variance	Var. Ratio	Obs.
1	0.00183	--	500
2	0.00086	0.47200	499
4	0.00048	0.26091	497
8	0.00023	0.12602	493
16	0.00011	0.06015	485

BDS Test for DS

Date: 11/13/14 Time: 15:33

Sample: 1973M01 2014M10

Included observations: 502

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.007618	0.003207	2.375424	0.0175
3	0.020217	0.005078	3.981100	0.0001
4	0.027919	0.006024	4.634589	0.0000
5	0.032178	0.006254	5.145200	0.0000
6	0.035149	0.006007	5.851170	0.0000

Raw epsilon	0.043845		
Pairs within epsilon	176291.0	V-Statistic	0.702352
Triples within epsilon	66541821	V-Statistic	0.529153

Dimension	C(m,n)	c(m,n)	C(1,n-(m-1))	c(1,n-(m-1))	c(1,n-(m-1))^k
2	62448.00	0.500585	87589.00	0.702116	0.492967
3	45573.00	0.366782	87276.00	0.702417	0.346565
4	33500.00	0.270701	86868.00	0.701947	0.242782
5	24878.00	0.201840	86442.00	0.701321	0.169662
6	18881.00	0.153804	86054.00	0.700994	0.118655

Heteroskedasticity Tests in ds

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.005568	Prob. F(1,280)	0.9406
Obs*R-squared	0.005607	Prob. Chi-Square(1)	0.9403
Scaled explained SS	0.008035	Prob. Chi-Square(1)	0.9286

Test Equation:
 Dependent Variable: RESID^2
 Method: Least Squares
 Date: 11/22/14 Time: 17:56
 Sample: 1991M03 2014M08
 Included observations: 282

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000890	9.07E-05	9.814403	0.0000
DS(-1)	-0.000226	0.003028	-0.074617	0.9406

R-squared	0.000020	Mean dependent var	0.000890
Adjusted R-squared	-0.003551	S.D. dependent var	0.001520
S.E. of regression	0.001523	Akaike info criterion	-10.12975
Sum squared resid	0.000649	Schwarz criterion	-10.10392
Log likelihood	1430.295	Hannan-Quinn criter.	-10.11940
F-statistic	0.005568	Durbin-Watson stat	1.714908
Prob(F-statistic)	0.940573		

Heteroskedasticity Test: ARCH

F-statistic	6.589801	Prob. F(2,277)	0.0016
Obs*R-squared	12.71726	Prob. Chi-Square(2)	0.0017

Test Equation:
 Dependent Variable: RESID^2
 Method: Least Squares
 Date: 11/22/14 Time: 17:59
 Sample (adjusted): 1991M05 2014M08
 Included observations: 280 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000633	0.000106	5.980416	0.0000
RESID^2(-1)	0.074682	0.058814	1.269811	0.2052
RESID^2(-2)	0.178189	0.053810	3.311432	0.0011

R-squared	0.045419	Mean dependent var	0.000856
Adjusted R-squared	0.038526	S.D. dependent var	0.001395
S.E. of regression	0.001367	Akaike info criterion	-10.34112
Sum squared resid	0.000518	Schwarz criterion	-10.30218
Log likelihood	1450.757	Hannan-Quinn criter.	-10.32550
F-statistic	6.589801	Durbin-Watson stat	2.028382
Prob(F-statistic)	0.001600		

Heteroskedasticity Test: White

F-statistic	0.545588	Prob. F(2,279)	0.5801
Obs*R-squared	1.098613	Prob. Chi-Square(2)	0.5774
Scaled explained SS	1.574323	Prob. Chi-Square(2)	0.4551

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 11/22/14 Time: 18:00

Sample: 1991M03 2014M08

Included observations: 282

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000834	0.000105	7.914955	0.0000
DS(-1)	-0.000896	0.003096	-0.289413	0.7725
DS(-1)^2	0.062634	0.060114	1.041925	0.2983

R-squared	0.003896	Mean dependent var	0.000890
Adjusted R-squared	-0.003245	S.D. dependent var	0.001520
S.E. of regression	0.001522	Akaike info criterion	-10.12655
Sum squared resid	0.000647	Schwarz criterion	-10.08780
Log likelihood	1430.843	Hannan-Quinn criter.	-10.11101
F-statistic	0.545588	Durbin-Watson stat	1.857119
Prob(F-statistic)	0.580118		

Models

Random Walk with Drift

Dependent Variable: D(S)

Method: Least Squares

Sample (adjusted): 1973M02 2014M10

Included observations: 501 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.001	0.393	0.694

R-squared	0.000	Mean dependent var	0.001
Adjusted R-squared	0.000	S.D. dependent var	0.031
S.E. of regression	0.031	Akaike info criterion	-4.140
Sum squared resid	0.465	Schwarz criterion	-4.131
Log likelihood	1037.967	Hannan-Quinn criter.	-4.136
Durbin-Watson stat	1.958		

Sample: 1973M02
2014M10 (501 obs)

	AC	PAC	Q-Stat	Prob
1	0.019	0.019	0.191	0.662
2	0.065	0.064	2.307	0.316
3	0.044	0.042	3.290	0.349
4	-0.026	-0.032	3.640	0.457
5	0.010	0.005	3.687	0.595
6	-0.048	-0.046	4.840	0.564
7	0.051	0.055	6.192	0.518
8	0.021	0.024	6.409	0.601
9	0.013	0.010	6.494	0.690
10	0.026	0.015	6.832	0.741
11	0.058	0.058	8.549	0.663
12	-0.066	-0.075	10.810	0.545
13	0.018	0.018	10.983	0.612
14	-0.027	-0.024	11.360	0.658
15	-0.007	0.000	11.386	0.725
16	0.082	0.081	14.890	0.533
17	-0.069	-0.067	17.377	0.429
18	0.072	0.052	20.097	0.327
19	0.010	0.016	20.154	0.385
20	0.008	0.007	20.191	0.446
21	0.012	0.001	20.268	0.504
22	0.021	0.032	20.498	0.552
23	-0.013	-0.025	20.586	0.606
24	-0.040	-0.039	21.446	0.612

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.138	Prob. F(2,498)	0.321
Obs*R-squared	2.279	Prob. Chi-Square(2)	0.320

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Sample: 1973M02 2014M10

Included observations: 501

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000	0.001	0.007	0.994
RESID(-1)	0.018	0.045	0.412	0.681
RESID(-2)	0.065	0.045	1.444	0.149

R-squared	0.005	Mean dependent var	0.000
Adjusted R-squared	0.001	S.D. dependent var	0.031
S.E. of regression	0.031	Akaike info criterion	-4.136
Sum squared resid	0.463	Schwarz criterion	-4.111
Log likelihood	1039.109	Hannan-Quinn criter.	-4.126
F-statistic	1.138	Durbin-Watson stat	2.003
Prob(F-statistic)	0.321		

The First-Order Autoregressive Model

$$\Delta s_t = a + \beta \Delta s_{t-1} + e_t$$

Dependent Variable: DS

Method: Least Squares

Date: 11/15/14 Time: 23:54

Sample (adjusted): 1973M03 2014M10

Included observations: 500 after adjustments

Variable	Coefficien	t	Std. Error	t-Statistic	Prob.
C	0.000519	0.001367	0.379462	0.7045	
DS(-1)	0.019544	0.044862	0.435647	0.6633	
R-squared	0.000381	Mean dependent var	0.000528		
Adjusted R-squared	-0.001626	S.D. dependent var	0.030539		
S.E. of regression	0.030564	Akaike info criterion	4.133997		
Sum squared resid	0.465210	Schwarz criterion	4.117139		
Log likelihood	1035.499	Hannan-Quinn criter.	4.127382		
F-statistic	0.189788	Durbin-Watson stat	1.973980		
Prob(F-statistic)	0.663282				

	AC	PAC	Q-Stat	Prob
1	-0.000	-0.000	6.E-05	0.994
2	0.063	0.063	2.0139	0.365
3	0.043	0.044	2.9622	0.397
4	-0.027	-0.031	3.3317	0.504
5	0.011	0.006	3.3970	0.639
6	-0.049	-0.047	4.6122	0.594
7	0.052	0.054	5.9881	0.541
8	0.019	0.024	6.1803	0.627
9	0.012	0.010	6.2531	0.714
10	0.024	0.014	6.5431	0.768
11	0.058	0.059	8.2967	0.687
12	-0.068	-0.074	10.682	0.556
13	0.020	0.017	10.890	0.620
14	-0.027	-0.023	11.259	0.666
15	-0.008	-0.002	11.293	0.732
16	0.084	0.082	14.920	0.531
17	-0.072	-0.066	17.628	0.413
18	0.073	0.050	20.433	0.309
19	0.009	0.016	20.472	0.367
20	0.008	0.007	20.507	0.427
21	0.012	0.001	20.576	0.485
22	0.021	0.033	20.809	0.533
23	-0.012	-0.023	20.888	0.588
24	-0.041	-0.040	21.758	0.594

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	6.848855	Prob. F(2,496)	0.0012
Obs*R-squared	13.43709	Prob. Chi-Square(2)	0.0012

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 11/16/14 Time: 00:00

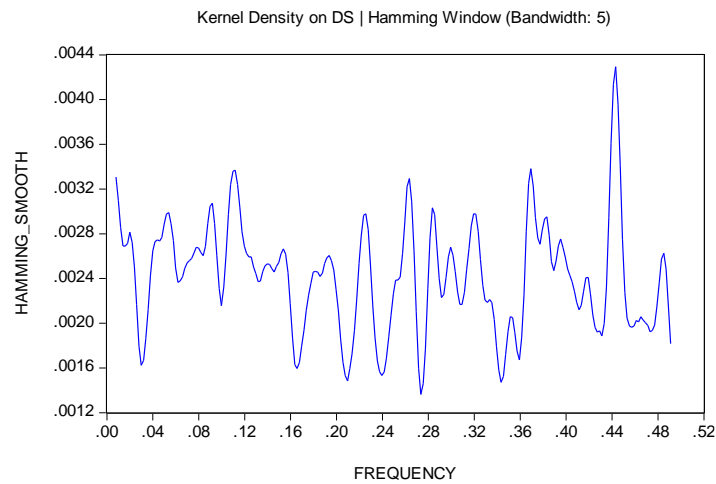
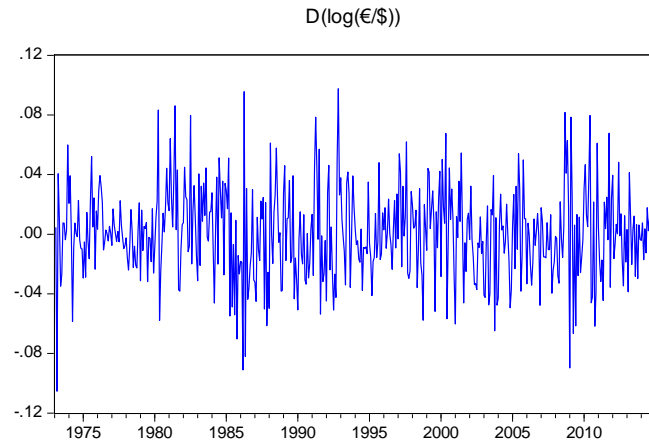
Sample: 1973M03 2014M10

Included observations: 500

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.013697	0.004232	3.236726	0.0013
DS(-1)	-25.47738	7.464049	-3.413346	0.0007
RESID(-1)	25.47740	7.464233	3.413265	0.0007
RESID(-2)	0.561451	0.152484	3.682025	0.0003

R-squared	0.026874	Mean dependent var	7.77E-19
Adjusted R-squared	0.020988	S.D. dependent var	0.030533
S.E. of regression	0.030211	Akaike info criterion	-4.153239
Sum squared resid	0.452708	Schwarz criterion	-4.119522
Log likelihood	1042.310	Hannan-Quinn criter.	-4.140009
F-statistic	4.565903	Durbin-Watson stat	1.984974
Prob(F-statistic)	0.003628		



Periodogram requires (easily installable) add-in
 Flatness suggests there is little predictability in series
 Note periodogram for S is meaningless