

Dependent Variable: R1-RF
 Method: Least Squares
 Date: 10/24/19 Time: 10:23
 Sample: 1960M01 2003M12
 Included observations: 528

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.012192	0.082434	-0.147905	0.8825
RMRF	0.896798	0.019628	45.69048	0.0000
HML	0.272386	0.030257	9.002418	0.0000
SMB	1.252069	0.025830	48.47303	0.0000
UMD	0.004131	0.019786	0.208788	0.8347
R-squared	0.922954	Mean dependent var	0.791042	
Adjusted R-squared	0.922365	S.D. dependent var	6.384388	
S.E. of regression	1.778889	Akaike info criterion	3.999280	
Sum squared resid	1655.006	Schwarz criterion	4.039707	
Log likelihood	-1050.810	Hannan-Quinn criter.	4.015107	
F-statistic	1566.287	Durbin-Watson stat	2.088172	
Prob(F-statistic)	0.000000			

Dependent Variable: R1-RF
 Method: Least Squares
 Date: 10/24/19 Time: 10:26
 Sample: 1960M01 2003M12
 Included observations: 528

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RMRF	0.895916	0.019154	46.77449	0.0000
HML	0.270629	0.029024	9.324335	0.0000
SMB	1.251828	0.025705	48.69924	0.0000
R-squared	0.922946	Mean dependent var	0.791042	
Adjusted R-squared	0.922653	S.D. dependent var	6.384388	
S.E. of regression	1.775588	Akaike info criterion	3.991806	
Sum squared resid	1655.175	Schwarz criterion	4.016062	
Log likelihood	-1050.837	Hannan-Quinn criter.	4.001302	
Durbin-Watson stat	2.082176			

Chow Breakpoint Test: 2003M01
 Null Hypothesis: No breaks at specified breakpoints
 Varying regressors: All equation variables
 Equation Sample: 1960M01 2003M12

F-statistic	1.74989	Prob. F(5,518)	0.1216
Log likelihood ratio	8.84390	Prob. Chi-Squa (5)	0.1155
Wald Statistic	8.74947	Prob. Chi-Squa (5)	0.1195

Ramsey RESET Test
 Specification: R1-RF C RMRF HML SMB UMD
 Omitted Variables: Powers of fitted values from 2 to 4

	Value	df	Probability
F-statistic	1.52874	(3, 520)	0.2061
Likelihood ratio	4.63638	3	0.2004

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	14.4690	3	4.823016
Restricted SSR	1655.00	523	3.164448
Unrestricted SSR	1640.53	520	3.154879

LR test summary:

	Value	df
Restricted LogL	1050.810	523
Unrestricted LogL	1048.492	520

Unrestricted Test Equation:
 Dependent Variable: R1-RF
 Sample: 1960M01 2003M12
 Included observations: 528

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.13908	0.102284	-1.359800	0.1745
RMRF	0.90132	0.022237	40.53353	0.0000
HML	0.27477	0.030936	8.882193	0.0000
SMB	1.24523	0.030589	40.70796	0.0000
UMD	0.01000	0.020233	0.494369	0.6213
FITTED^2	0.00414	0.002046	2.027299	0.0431
FITTED^3	-1.51E-06	5.16E-05	-0.029198	0.9767
FITTED^4	-4.64E-06	3.19E-06	-1.455897	0.1460

R-squared	0.923628	Mean depend var	0.791042
Adjusted R-squa	0.922599	S.D. depend var	6.384388
S.E. of regression	1.776198	Akaike info crit	4.001863
Sum squared resid	1640.537	Schwarz criterion	4.066546
Log likelihood	-1048.492	Hannan-Quinn crit	4.027185
F-statistic	898.3908	Durbin-Watson st	2.093559
Prob(F-statistic)	0.000000		

Quandt-Andrews unknown breakpoint test
 Null Hypothesis: No breakpoints within 15% trimmed data
 Varying regressors: All equation variables
 Equation Sample: 1960M01 2003M12
 Test Sample: 1966M09 1997M05
 Number of breaks compared: 369

Statistic	Value	Prob.
Maximum LR F-statistic (1973M01)	7.913114	0.0000
Maximum Wald F-statistic (1973M01)	39.56557	0.0000
Exp LR F-statistic	2.261628	0.0004
Exp Wald F-statistic	16.28310	0.0000
Ave LR F-statistic	4.006523	0.0000
Ave Wald F-statistic	20.03261	0.0000

Note: probabilities calculated using Hansen's (1997) method

Dependent Variable: R1-RF
Method: Least Squares
Sample: 1960M01 2003M12
Included observations: 528

Variable	Coeff.	Std. Error	t-Stat.	Prob.
C	-0.195860	0.075063	-2.609278	0.0093
JANDUM	3.125605	0.309967	10.08366	0.0000
RMRF	0.891656	0.019155	46.55023	0.0000
RMJAN	-0.069405	0.051735	-1.341531	0.1803
HML	0.244881	0.030713	7.973313	0.0000
HMJAN	-0.259879	0.082013	-3.168764	0.0016
SMB	1.212854	0.024675	49.15281	0.0000

R-squared	0.936031	Mean depend.t var	0.791042
Adjusted R-squared	0.935294	S.D. depend. Var	6.384388
S.E. of regression	1.624015	Akaike info criter.	3.820849
Sum squar. resid	1374.098	Schwarz criterion	3.877447
Log likelihood	-1001.704	Hannan-Quinn criter.	3.843006
F-statistic	1270.598	Durbin-Watson stat	1.918973
Prob(F-statistic)	0.000000		

Correlogram of Residuals
Sample: 1960M01 2003M12
Included observations: 528

Autocorrel.	Partial Correl.	AC	PAC	Q-Stat	Prob	
. .	. .	1	0.040	0.040	0.8311	0.362
. .	. .	2	0.055	0.054	2.4596	0.292
. .	. .	3	-0.032	-0.036	2.9906	0.393
. *	. *	4	0.074	0.074	5.9047	0.206
* .	* .	5	-0.070	-0.073	8.5567	0.128
. .	. .	6	0.072	0.070	11.318	0.079
. .	. .	7	-0.003	0.003	11.323	0.125
. *	. *	8	0.117	0.102	18.729	0.016
* .	* .	9	-0.087	-0.086	22.830	0.007
. .	. .	10	0.071	0.058	25.565	0.004
. .	. .	11	0.033	0.050	26.141	0.006
. *	. *	12	0.169	0.142	41.713	0.000
* .	* .	13	-0.076	-0.072	44.862	0.000
. .	. .	14	0.017	-0.018	45.024	0.000
. .	. .	15	0.002	0.030	45.027	0.000
. *	. *	16	0.132	0.105	54.527	0.000
. .	. .	17	-0.043	-0.019	55.528	0.000
. .	. .	18	0.072	0.021	58.404	0.000
. .	. .	19	0.003	0.010	58.408	0.000
. .	. .	20	-0.004	-0.046	58.417	0.000
. .	. *	21	0.026	0.089	58.803	0.000
. .	* .	22	-0.015	-0.079	58.925	0.000
. .	* .	23	-0.063	-0.068	61.160	0.000
. .	. .	24	0.044	0.018	62.219	0.000

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.295370	Prob. F(10,511)	0.0122
Obs*R-squared	22.69776	Prob. Chi-Squa(10)	0.0119

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 12/17/19 Time: 18:13

Sample: 1960M01 2003M12

Included observations: 528

Presample missing value lagged residuals set to zero.

Variable	Coefficien	t	Std. Error	t-Statistic	Prob.
C	0.006452	0.074504	0.086602	0.9310	
	-				
JANDUM	0.063352	0.318837	-0.198698	0.8426	
RMRF	0.001271	0.019201	0.066173	0.9473	
RMJAN	0.004437	0.051670	0.085874	0.9316	
HML	-0.00232	0.030618	-0.076036	0.9394	
HMJAN	0.009406	0.082469	0.114049	0.9092	
SMB	0.000623	0.025087	0.024829	0.9802	
RESID(-1)	0.065887	0.045283	1.454998	0.1463	
RESID(-2)	0.028922	0.044923	0.643819	0.5200	
RESID(-3)	-0.01813	0.044374	-0.408663	0.6830	
RESID(-4)	0.057903	0.044648	1.296880	0.1953	
RESID(-5)	-0.06509	0.044485	-1.463299	0.1440	
RESID(-6)	0.062283	0.044478	1.400308	0.1620	
RESID(-7)	0.001637	0.044813	0.036537	0.9709	
RESID(-8)	0.108666	0.044857	2.422509	0.0158	
RESID(-9)	-0.08996	0.044845	-2.006065	0.0454	
RESID(-10)	0.060292	0.045009	1.339546	0.1810	
R-squared	0.042988	Mean depend. Var		8.87E-17	
Adjusted R-sqd	0.013023	S.D. dependent var		1.614743	
S.E. of regression	1.604195	Akaike info criterion		3.814788	
Sum squar. resid	1315.028	Schwarz criterion		3.952240	
Log likelihood	-990.104	Hannan-Quinn crit.		3.868598	
F-statistic	1.434606	Durbin-Watson stat		2.006899	
Prob(F-statistic)	0.120340				

Heteroskedasticity Test: White

F-statistic	5.344221	Prob. F(6,521)	0.0000
Obs*R-squared	30.61210	Prob. Chi-Square(6)	0.0000
Scaled expln. SS	54.92698	Prob. Chi-Square(6)	0.0000

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 12/10/20 Time: 09:39

Sample: 1960M01 2003M12

Included observations: 528

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.034542	0.260742	7.802908	0.0000
JANDUM^2	1.518155	1.037185	1.463727	0.1439
RMRF^2	-0.003142	0.006072	-0.517417	0.6051
RMJAN^2	-0.013732	0.020945	-0.655638	0.5123
HML^2	0.061841	0.014460	4.276787	0.0000
HMJAN^2	-0.071694	0.047791	-1.500140	0.1342
SMB^2	0.009078	0.008597	1.056002	0.2915

R-squared	0.057977	Mean dependent var	2.602458
Adjusted R-squared	0.047129	S.D. dependent var	5.000955
S.E. of regression	4.881688	Akaike info criterion	6.022028
Sum squared resid	12415.89	Schwarz criterion	6.078626
Log likelihood	-1582.815	Hannan-Quinn criter.	6.044185
F-statistic	5.344221	Durbin-Watson stat	1.919554
Prob(F-statistic)	0.000023		

Dependent Variable: EXR1

Method: Least Squares

Date: 12/10/20 Time: 09:41

Sample: 1960M01 2003M12

Included observations: 528

White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.195860	0.073356	-2.669997	0.0078
JANDUM	3.125605	0.383460	8.151064	0.0000
RMRF	0.891656	0.019594	45.50690	0.0000
RMJAN	-0.069405	0.052045	-1.333562	0.1829
HML	0.244881	0.041447	5.908322	0.0000
HMJAN	-0.259879	0.096277	-2.699286	0.0072
SMB	1.212854	0.032885	36.88200	0.0000

R-squared	0.936031	Mean dependent var	0.791042
Adjusted R-squared	0.935294	S.D. dependent var	6.384388
S.E. of regression	1.624015	Akaike info criterion	3.820849
Sum squared resid	1374.098	Schwarz criterion	3.877447
Log likelihood	-1001.704	Hannan-Quinn criter.	3.843006
F-statistic	1270.598	Durbin-Watson stat	1.918973
Prob(F-statistic)	0.000000	Wald F-statistic	1172.143
Prob(Wald F-statistic)	0.000000		

Dependent Variable: EXR1
 Method: Least Squares
 Date: 12/10/20 Time: 09:44
 Sample: 1960M01 2003M12
 Included observations: 528
 HAC standard errors & covariance (Bartlett kernel, Newey-West
 fixed bandwidth = 6.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.195860	0.074414	-2.632028	0.0087
JANDUM	3.125605	0.375950	8.313896	0.0000
RMRF	0.891656	0.017515	50.90737	0.0000
RMJAN	-0.069405	0.051280	-1.353459	0.1765
HML	0.244881	0.041083	5.960607	0.0000
HMJAN	-0.259879	0.091286	-2.846854	0.0046
SMB	1.212854	0.035520	34.14562	0.0000
R-squared	0.936031	Mean dependent var	0.791042	
Adjusted R-squared	0.935294	S.D. dependent var	6.384388	
S.E. of regression	1.624015	Akaike info criterion	3.820849	
Sum squared resid	1374.098	Schwarz criterion	3.877447	
Log likelihood	-1001.704	Hannan-Quinn criter.	3.843006	
F-statistic	1270.598	Durbin-Watson stat	1.918973	
Prob(F-statistic)	0.000000	Wald F-statistic	1118.379	
Prob(Wald F-statistic)	0.000000			

Correlogram of Squared Residuals
 Sample: 1960M01 2003M12
 Included observations: 528

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
. *	. *	1 0.160	0.160	13.608	0.000
. **	. **	2 0.250	0.231	46.969	0.000
. *	. *	3 0.187	0.129	65.518	0.000
. *	. .	4 0.140	0.053	75.928	0.000
. *	. .	5 0.102	0.013	81.449	0.000
. *	. .	6 0.077	0.003	84.616	0.000
. *	. *	7 0.166	0.120	99.427	0.000
. *	. *	8 0.191	0.145	119.09	0.000
. *	. .	9 0.143	0.051	130.10	0.000
. *	. *	10 0.195	0.085	150.62	0.000
. **	. *	11 0.247	0.149	183.66	0.000
. *	. .	12 0.171	0.054	199.59	0.000
. *	. .	13 0.167	0.039	214.79	0.000
. *	. *	14 0.192	0.080	234.88	0.000
. *	. .	15 0.154	0.036	247.90	0.000
. *	. .	16 0.167	0.056	263.06	0.000
. **	. *	17 0.262	0.178	300.62	0.000
. *	. .	18 0.104	-0.047	306.58	0.000
. .	* .	19 0.071	-0.121	309.33	0.000
. .	* .	20 0.050	-0.085	310.69	0.000
. .	. .	21 0.058	-0.050	312.56	0.000
. *	. .	22 0.106	0.028	318.81	0.000

Dependent Variable: EXR1
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 1960M01 2003M12
Included observations: 528
Convergence achieved after 29 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(8) + C(9)*RESID(-1)^2 + C(10)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.219106	0.065127	-3.364275	0.0008
JANDUM	2.850963	0.297413	9.585889	0.0000
RMRF	0.896901	0.015992	56.08439	0.0000
RMJAN	-0.063492	0.040949	-1.550538	0.1210
HML	0.242576	0.026368	9.199734	0.0000
HMJAN	-0.239158	0.077520	-3.085108	0.0020
SMB	1.212157	0.019798	61.22526	0.0000

Variance Equation

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.057519	0.029318	1.961883	0.0498
RESID(-1)^2	0.095485	0.025556	3.736274	0.0002
GARCH(-1)	0.884029	0.028112	31.44632	0.0000

R-squared	0.935868	Mean dependent var	0.791042
Adjusted R-squared	0.935129	S.D. dependent var	6.384388
S.E. of regression	1.626089	Akaike info criterion	3.666188
Sum squared resid	1377.610	Schwarz criterion	3.747043
Log likelihood	-957.8738	Hannan-Quinn criter.	3.697841
Durbin-Watson stat	1.931248		

Dependent Variable: EXR1
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Sample: 1960M01 2003M12
Included observations: 528
Convergence achieved after 29 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(7) + C(8)*ABS(RESID(-1)/@SQRT(GARCH(-1))) +
C(9)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
JANDUM	2.573751	0.294561	8.737571	0.0000
RMRF	0.895623	0.016175	55.36964	0.0000
RMJAN	-0.060973	0.042835	-1.423444	0.1546
HML	0.242499	0.025189	9.627083	0.0000
HMJAN	-0.229997	0.076218	-3.017620	0.0025
SMB	1.214897	0.020217	60.09151	0.0000

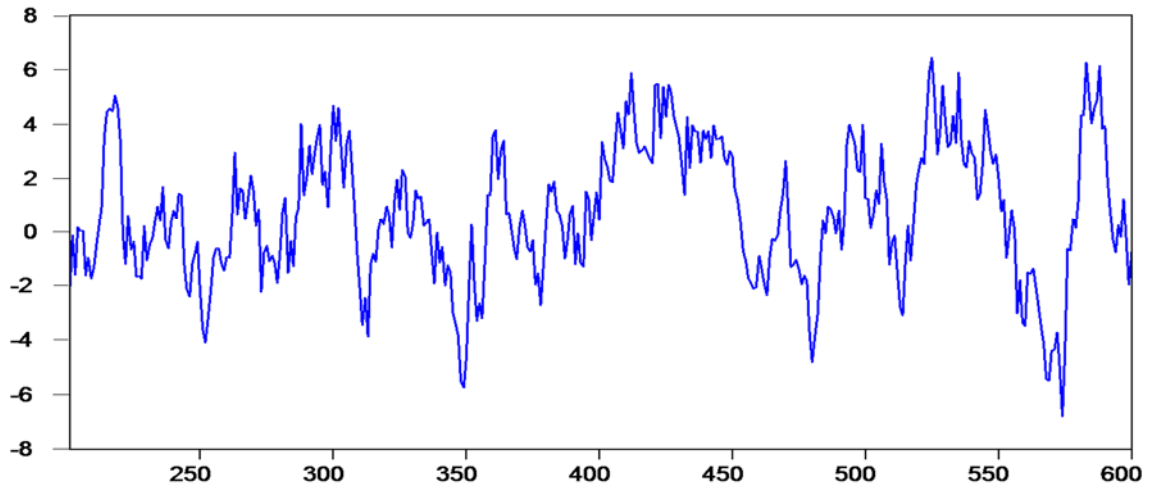
Variance Equation

	Coefficient	Std. Error	z-Statistic	Prob.
C(7)	-0.114345	0.028775	-3.973802	0.0001
C(8)	0.170104	0.040102	4.241809	0.0000
C(9)	0.977167	0.011749	83.16798	0.0000

R-squared	0.934963	Mean dependent var	0.791042
Adjusted R-squared	0.934340	S.D. dependent var	6.384388
S.E. of regression	1.635950	Akaike info criterion	3.687386
Sum squared resid	1397.046	Schwarz criterion	3.760155
Log likelihood	-964.4700	Hannan-Quinn criter.	3.715874
Durbin-Watson stat	1.927902		

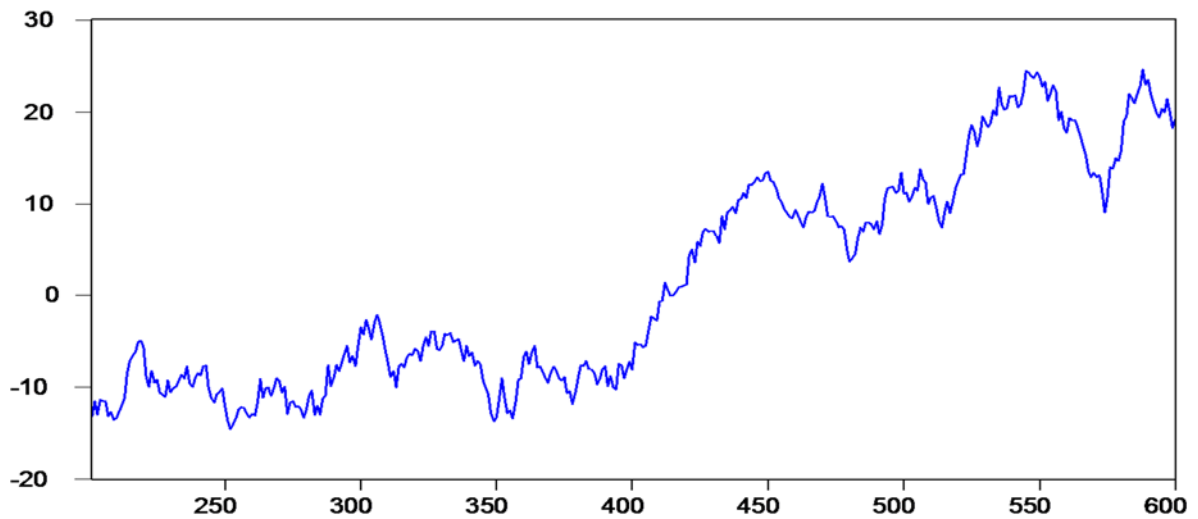
$$y_t = 0.89 * y_{t-1} + u_t \quad u_t \sim N(0, 1.0)$$

Y



$$x_t = x_{t-1} + u_t \quad u_t \sim N(0, 1.0)$$

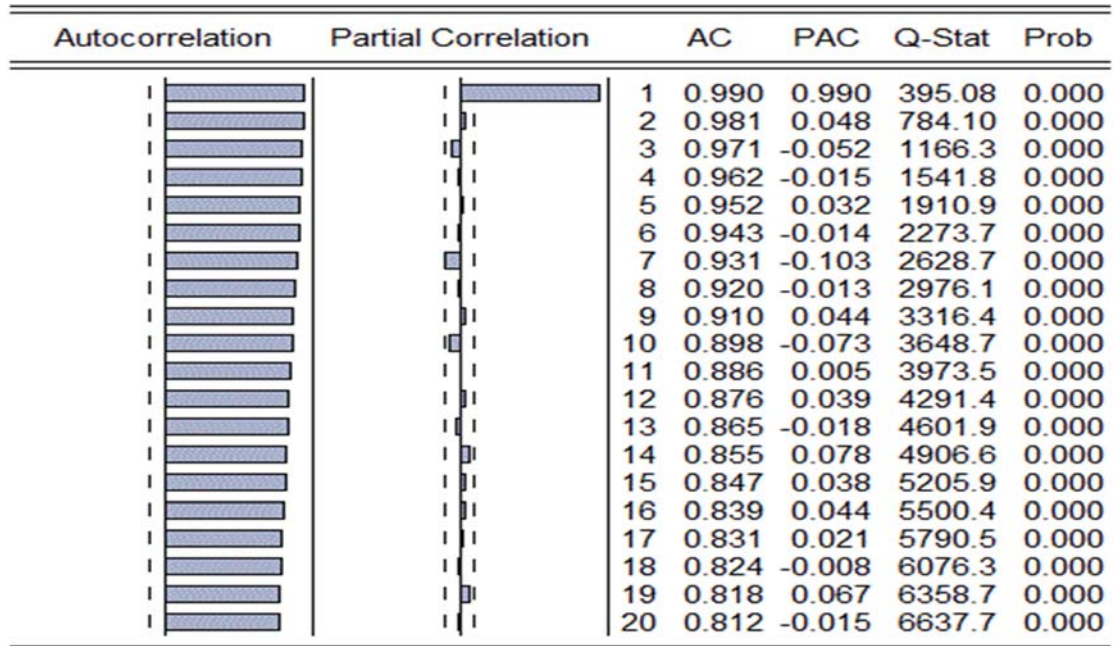
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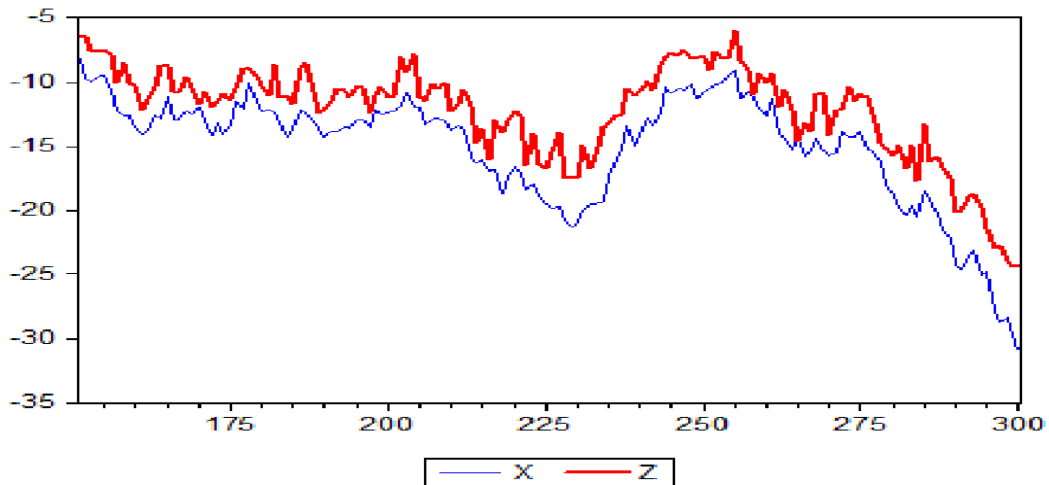
ACF of y_t

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
		1	0.875	0.875	308.20	0.000
		2	0.771	0.027	548.38	0.000
		3	0.677	-0.010	734.15	0.000
		4	0.594	-0.003	877.62	0.000
		5	0.527	0.022	990.61	0.000
		6	0.464	-0.011	1078.5	0.000
		7	0.364	-0.193	1132.6	0.000
		8	0.272	-0.049	1163.0	0.000
		9	0.218	0.094	1182.5	0.000
		10	0.140	-0.140	1190.5	0.000
		11	0.089	0.034	1193.8	0.000
		12	0.049	0.016	1194.8	0.000
		13	0.008	-0.008	1194.8	0.000
		14	-0.015	0.038	1194.9	0.000
		15	-0.034	-0.037	1195.4	0.000
		16	-0.044	0.051	1196.2	0.000
		17	-0.038	0.058	1196.8	0.000
		18	-0.031	-0.036	1197.2	0.000
		19	-0.014	0.077	1197.3	0.000
		20	0.001	-0.015	1197.3	0.000

ACF of x_t



$$x_t = x_{t-1} + u_t \quad u_t \sim N(0,1), \quad z_t = 0.8x_t + v_t \quad v_t \sim N(0,1)$$



Null Hypothesis: X has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=13)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.587089	0.8688
Test critical vals: 1% level	-3.474265	
5% level	-2.880722	
10% level	-2.577077	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(X)

Method: Least Squares

Sample: 151 300

Included observations: 150

Variable	Coeff.	Std. Error	t-Statistic	Prob.
X(-1)	-0.01199	0.02043	-0.58708	0.5580
C	-0.03221	0.24501	-0.13149	0.8956
R-squared	0.002323	Mean dependent var		0.10208
Adjusted R-squared	-0.00441	S.D. dependent var		1.07229
S.E. of regression	1.074605	Akaike info criterion		2.995027
Sum squared resid	170.9068	Schwarz criterion		3.035169
Log likelihood	-222.6270	Hannan-Quinn criter.		3.011335
F-statistic	0.344674	Durbin-Watson stat		1.919334
Prob(F-statistic)	0.558038			

Null Hypothesis: Z has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=13)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.672676	0.4431
Test critical values: 1% level	-3.474265	
5% level	-2.880722	
10% level	-2.577077	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(Z)

Method: Least Squares

Sample: 151 300

Included observations: 150

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Z(-1)	-0.060881	0.036397	-1.672676	0.0965
D(Z(-1))	-0.261170	0.080947	-3.226429	0.0015
C	-0.436570	0.350084	-1.247043	0.2144
R-squared	0.104379	Mean dependent var		0.082516
Adjusted R-squared	0.092193	S.D. dependent var		1.600769
S.E. of regression	1.525195	Akaike info criterion		3.701918
Sum squared resid	341.9541	Schwarz criterion		3.762131
Log likelihood	-274.6439	Hannan-Quinn criter.		3.726381
F-statistic	8.565945	Durbin-Watson stat		2.029275
Prob(F-statistic)	0.000303			

Dependent Variable: Z
 Method: Least Squares
 Date: 03/02/22 Time: 20:43
 Sample: 151 300
 Included observations: 150

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.026485	0.335575	0.078923	0.9372
X	0.793674	0.021192	37.45134	0.0000
R-squared	0.904553	Mean dependent var		12.22931
Adjusted R-squared	0.903908	S.D. dependent var		3.171762
S.E. of regression	0.983204	Akaike info criterion		2.817242
Sum squared resid	143.0700	Schwarz criterion		2.857384
Log likelihood	-209.2932	Hannan-Quinn criter.		2.833551
F-statistic	1402.603	Durbin-Watson stat		2.031562
Prob(F-statistic)	0.000000			

Residuals from the above equation

Null Hypothesis: RES_EQ3 has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=13)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-10.59976	0.0000
Test critical values: 1% level	-3.474567	
5% level	-2.880853	
10% level	-2.577147	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(RES_EQ3)
 Sample (adjusted): 152 300
 Included observations: 149 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RES_EQ3(-1)	-0.856658	0.080819	-10.59976	0.0000
C	-0.013728	0.078557	-0.174751	0.8615
R-squared	0.433209	Mean dependent var		0.019292
Adjusted R-squared	0.429353	S.D. dependent var		1.269362
S.E. of regression	0.958891	Akaike info criterion		2.767252
Sum squared resid	135.1623	Schwarz criterion		2.807574
Log likelihood	-204.1603	Hannan-Quinn criter.		2.783634
F-statistic	112.3549	Durbin-Watson stat		1.973825
Prob(F-statistic)	0.000000			

ECM

Dependent Variable: DZ

Method: Least Squares
Sample (adjusted): 152 300
Included observations: 149 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.017575	0.079120	-0.222136	0.8245
DX	0.824420	0.073693	11.18724	0.0000
RES_EQ3(-1)	-0.853300	0.081293	-10.49663	0.0000
R-squared	0.636936	Mean dependent var	0.061173	
Adjusted R-squared	0.631962	S.D. dependent var	1.584609	
S.E. of regression	0.961321	Akaike info criterion	2.778911	
Sum squared resid	134.9240	Schwarz criterion	2.839393	
Log likelihood	-204.0289	Hannan-Quinn criter.	2.803484	
F-statistic	128.0664	Durbin-Watson stat	1.973967	
Prob(F-statistic)	0.000000			