Time Series Analysis **Final Examination**
Summer 2008 **Dr. S. Kestel**

Use the following to solve questions 1-3 (each 10 points)

Given AR(2) process

$X_t = \emptyset_1 X_{t-1} + \emptyset_2 X_{t-2} + Z_t$, where $Z_t \sim WN(0, \sigma^2)$.

Q.1. Write the Yule-Walker equations for h=1,2,3 and find the variance of the process **(10 points)**

Q.2. Find the autocorrelations for lags 1,2,3, $(\rho(1), \rho(2), \rho(3))$ **(5 points)**

Q.3. For the seasonal ARIMA model of order **$(1,1,0)*(0,0,2)_2$** write the model in operator form and difference equation form. **(10 points)**

Use following to solve 4-6 (each 10 points)
Consider the model $\boldsymbol{X_t = \emptyset X_{t-2} + Z_t - \theta Z_{t-3}}$ where $\boldsymbol{Z_t \sim WN(0, \sigma^2)}$.

Q.4 Show if the model is stationary and invertible for $\emptyset = 4 \; and \; \theta = 1/8$?

Q.5. Assuming invertibility, find π_1, π_2, π_3, π_4, π_5 in terms of parameters.

Q.6. Find the first three forecasts and the error variances.

Q.7. Explain the following briefly (5 points)

A. Why it is sometimes hard to distinguish between a trend stationary time series and a random walk with intercept when only analyzing the graph?

B. What is the main idea behind cointegration analysis. Discuss also the differences between cointegration and correlation.

Use Outputs I and II to solve questions 8-10 (each 5 points)

Output I

Variable: S_P_500_INDEX
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=28)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-1.926797**	**0.3201**
Test critical values:	1% level	-3.432187	
	5% level	-2.862237	
	10% level	-2.567185	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(S_P_500_INDEX)
Method: Least Squares
Date: 06/18/08 Time: 20:01
Sample (adjusted): 1/03/1995 12/31/2007
Included observations: 3228 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
S_P_500_INDEX(-1)	-0.001493	0.000775	-1.926797	0.0541
C	1.942350	0.872543	2.226080	0.0261

R-squared	0.001149	Mean dependent var	0.312655
Adjusted R-squared	0.000840	S.D. dependent var	12.18334
S.E. of regression	12.17822	Akaike info criterion	7.837794
Sum squared resid	478444.8	Schwarz criterion	7.841561
Log likelihood	-12648.20	F-statistic	3.712547
Durbin-Watson stat	2.086200	Prob(F-statistic)	0.054093

Output II

Variable: DIF_S_P_500_INDEX
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=28)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-59.09627**	**0.0001**
Test critical values:	1% level	-3.432188	
	5% level	-2.862237	
	10% level	-2.567185	

*MacKinnon (1996) one-sided p-values.
Dependent Variable: D(DIF_S_P_500_INDEX)
Method: Least Squares
Date: 06/18/08 Time: 21:44
Sample (adjusted): 1/04/1995 12/31/2007
Included observations: 3227 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DIF_S_P_500_INDEX(-1)	-1.039872	0.017596	-59.09627	0.0000
C	0.000375	0.000190	1.973382	0.0485

R-squared	0.519901	Mean dependent var	-2.13E-06
Adjusted R-squared	0.519752	S.D. dependent var	0.015557
S.E. of regression	0.010781	Akaike info criterion	-6.221451
Sum squared resid	0.374839	Schwarz criterion	-6.217683
Log likelihood	10040.31	F-statistic	3492.369
Durbin-Watson stat	2.000633	Prob(F-statistic)	0.000000

Q.8. Write the hypothesis tested in the outputs both in words and notation**.(5 points)**

H_0:_____ H_0:_____

Q.9. Write the decisions in both tests and state the reason for your decision**.(5 points)**

Output 1: _____

Output 2: _____

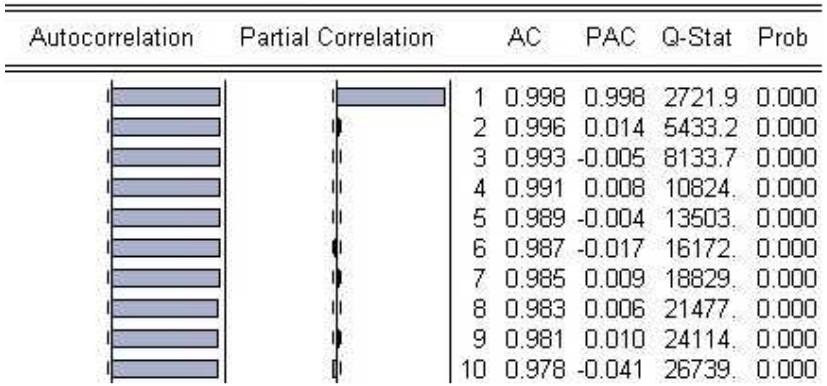
Q.10. Based on these outputs, can we distinguish if the series is trend stationary or not? Explain how? **(5 points)**

Use following to solve 11 (10 points)

Q.11 For each part given below write the appropriate model, its components (if exists) and comment on their stationarity

Correlogram

Date: 08/05/08 Time: 09:51
Sample: 1/02/1997 12/31/2007
ncluded observations: 2731



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.998	0.998	2721.9	0.000
		2	0.996	0.014	5433.2	0.000
		3	0.993	-0.005	8133.7	0.000
		4	0.991	0.008	10824.	0.000
		5	0.989	-0.004	13503.	0.000
		6	0.987	-0.017	16172.	0.000
		7	0.985	0.009	18829.	0.000
		8	0.983	0.006	21477.	0.000
		9	0.981	0.010	24114.	0.000
		10	0.978	-0.041	26739.	0.000

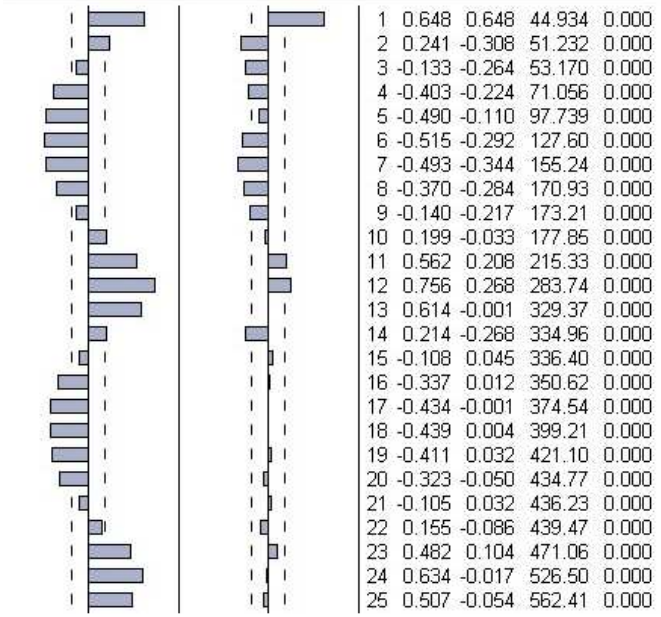
A. The model _____

Components: _____

Comment _____

Correlogram

Date: 08/05/08 Time: 10:13
Sample: 1 105
ncluded observations: 104

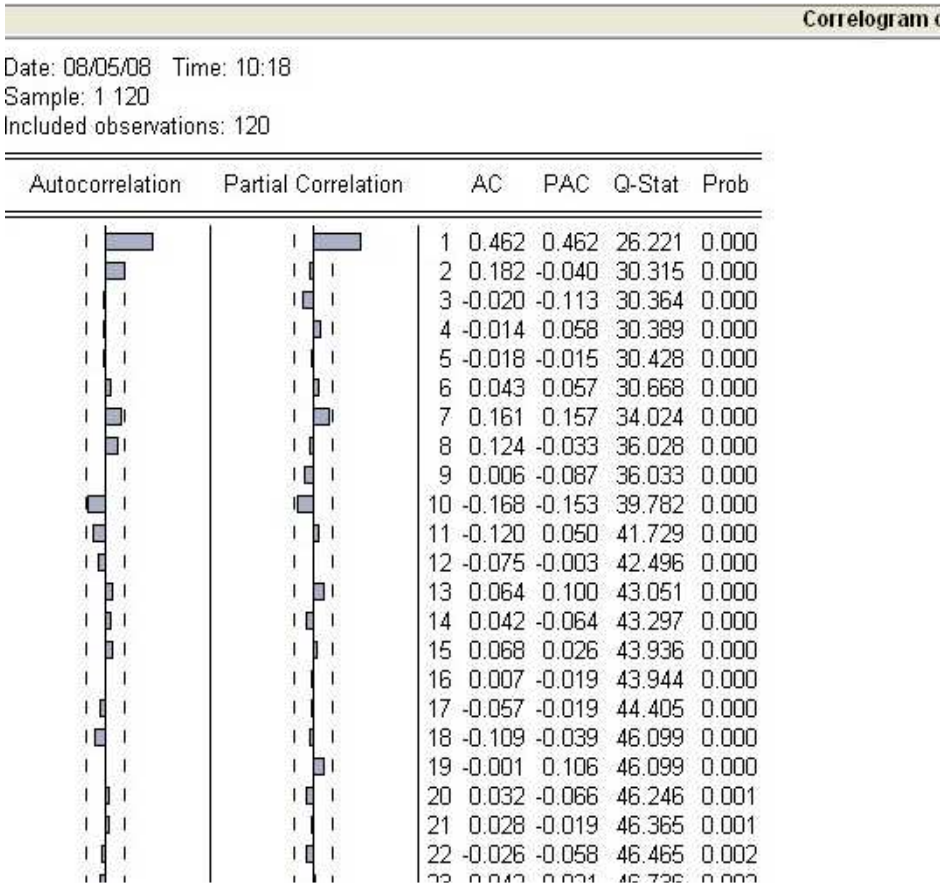


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.648	0.648	44.934	0.000
		2	0.241	-0.308	51.232	0.000
		3	-0.133	-0.264	53.170	0.000
		4	-0.403	-0.224	71.056	0.000
		5	-0.490	-0.110	97.739	0.000
		6	-0.515	-0.292	127.60	0.000
		7	-0.493	-0.344	155.24	0.000
		8	-0.370	-0.284	170.93	0.000
		9	-0.140	-0.217	173.21	0.000
		10	0.199	-0.033	177.85	0.000
		11	0.562	0.208	215.33	0.000
		12	0.756	0.268	283.74	0.000
		13	0.614	-0.001	329.37	0.000
		14	0.214	-0.268	334.96	0.000
		15	-0.108	0.045	336.40	0.000
		16	-0.337	0.012	350.62	0.000
		17	-0.434	-0.001	374.54	0.000
		18	-0.439	0.004	399.21	0.000
		19	-0.411	0.032	421.10	0.000
		20	-0.323	-0.050	434.77	0.000
		21	-0.105	0.032	436.23	0.000
		22	0.155	-0.086	439.47	0.000
		23	0.482	0.104	471.06	0.000
		24	0.634	-0.017	526.50	0.000
		25	0.507	-0.054	562.41	0.000

B. The model _____

Component _____

Comment _____



Correlogram (

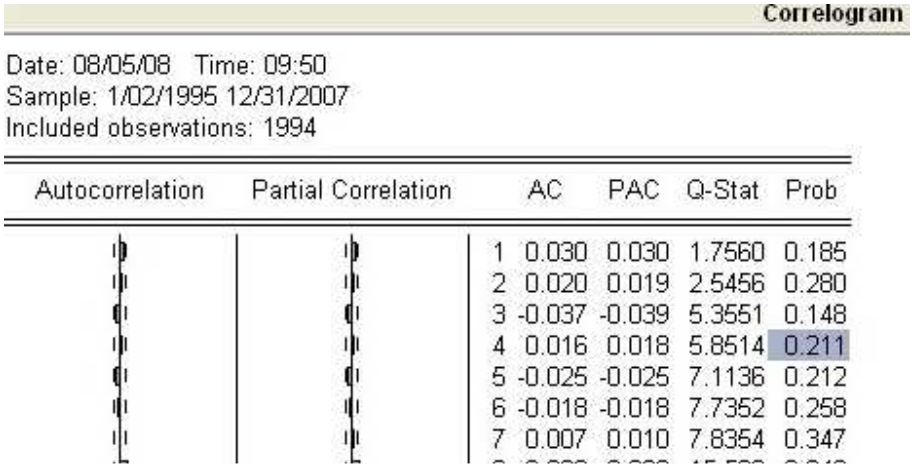
Date: 08/05/08 Time: 10:18
Sample: 1 120
Included observations: 120

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.462	0.462	26.221	0.000
		2	0.182	-0.040	30.315	0.000
		3	-0.020	-0.113	30.364	0.000
		4	-0.014	0.058	30.389	0.000
		5	-0.018	-0.015	30.428	0.000
		6	0.043	0.057	30.668	0.000
		7	0.161	0.157	34.024	0.000
		8	0.124	-0.033	36.028	0.000
		9	0.006	-0.087	36.033	0.000
		10	-0.168	-0.153	39.782	0.000
		11	-0.120	0.050	41.729	0.000
		12	-0.075	-0.003	42.496	0.000
		13	0.064	0.100	43.051	0.000
		14	0.042	-0.064	43.297	0.000
		15	0.068	0.026	43.936	0.000
		16	0.007	-0.019	43.944	0.000
		17	-0.057	-0.019	44.405	0.000
		18	-0.109	-0.039	46.099	0.000
		19	-0.001	0.106	46.099	0.000
		20	0.032	-0.066	46.246	0.001
		21	0.028	-0.019	46.365	0.001
		22	-0.026	-0.058	46.465	0.002

C. The model _____

Components _____

Comments _____



Correlogram

Date: 08/05/08 Time: 09:50
Sample: 1/02/1995 12/31/2007
Included observations: 1994

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.030	0.030	1.7560	0.185
		2	0.020	0.019	2.5456	0.280
		3	-0.037	-0.039	5.3551	0.148
		4	0.016	0.018	5.8514	0.211
		5	-0.025	-0.025	7.1136	0.212
		6	-0.018	-0.018	7.7352	0.258
		7	0.007	0.010	7.8354	0.347

D. The model is _____

Components _____

Comments _____

Q.12 For each part given below write the model and state which one of the models should be chosen with reasons.

Dependent Variable: DGLOBAL
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 07/22/08 Time: 17:54
Sample (adjusted): 1/06/2000 12/31/2007
Included observations: 1993 after adjustments
Convergence achieved after 26 iterations
Variance backcast: ON
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.353507	0.222367	1.589745	0.1119
AR(1)	-0.061567	0.025442	-2.419941	0.0155
Variance Equation				
C	1.012125	0.238564	4.242566	0.0000
RESID(-1)^2	0.044272	0.006532	6.777346	0.0000
GARCH(-1)	0.949223	0.007228	131.3304	0.0000

R-squared	-0.001767	Mean dependent var	0.033241
Adjusted R-squared	-0.000241	S.D. dependent var	13.07855
S.E. of regression	13.08013	Akaike info criterion	7.741455
Sum squared resid	340126.7	Schwarz criterion	7.755498
Log likelihood	-7709.360	F-statistic	0.879863
Durbin-Watson stat	1.981887	Prob(F-statistic)	0.475130

Inverted AR Roots -.06

MODEL 1

Dependent Variable: DGLOBAL
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 07/22/08 Time: 17:55
Sample (adjusted): 1/13/2000 12/31/2007
Included observations: 1989 after adjustments
Convergence achieved after 21 iterations
Variance backcast: ON
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.346259	0.214226	1.616330	0.1060
AR(1)	-0.062668	0.025534	-2.454306	0.0141
AR(5)	-0.047644	0.023200	-2.053601	0.0400
Variance Equation				
C	1.064236	0.253974	4.190330	0.0000
RESID(-1)^2	0.046589	0.006826	6.824785	0.0000
GARCH(-1)	0.946787	0.007575	124.9805	0.0000

R-squared	0.003643	Mean dependent var	0.018155
Adjusted R-squared	0.001131	S.D. dependent var	13.06297
S.E. of regression	13.05558	Akaike info criterion	7.739272
Sum squared resid	337998.8	Schwarz criterion	7.756151
Log likelihood	-7690.706	F-statistic	1.450252
Durbin-Watson stat	1.981132	Prob(F-statistic)	0.203151

Inverted AR Roots .43+.32i .43-.32i -.18-.52i -.18+.52i

MODEL 2

Q.12 For each part given below write the model and state which one of the models should be chosen with reasons (10 points).

MODEL 1: _____

MODEL 2: _____

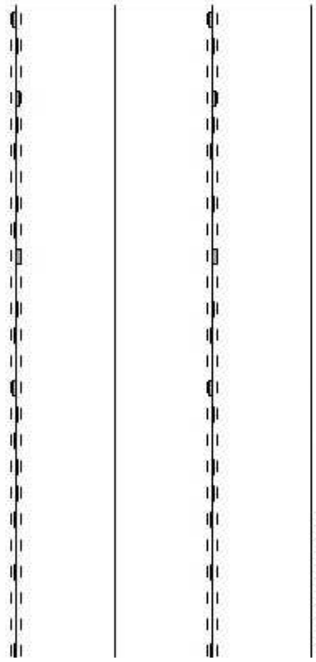
MODEL CHOSEN: _____

REASONS: _____

Q.13. Interpret the Q-statistics and state the relevant hypothesis for the following Correlogram. (5 points)

Correlogram of Standardized Residuals Squared

Date: 07/22/08 Time: 18:01
Sample: 1/13/2000 12/31/2007
Included observations: 1989
Q-statistic probabilities adjusted for 2 ARMA term(s)



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.037	-0.037	2.7648	
		2	0.012	0.011	3.0487	
		3	0.002	0.003	3.0596	0.080
		4	0.026	0.026	4.4236	0.110
		5	0.018	0.019	5.0381	0.169
		6	-0.012	-0.011	5.3059	0.257
		7	-0.005	-0.006	5.3561	0.374
		8	0.015	0.014	5.8236	0.443
		9	-0.008	-0.008	5.9611	0.544
		10	0.053	0.053	11.628	0.169
		11	-0.003	0.001	11.651	0.234
		12	0.013	0.011	11.999	0.285
		13	-0.014	-0.013	12.366	0.337
		14	-0.003	-0.007	12.389	0.415
		15	-0.030	-0.033	14.241	0.357
		16	0.023	0.022	15.339	0.355
		17	-0.010	-0.007	15.550	0.413
		18	0.012	0.011	15.839	0.464
		19	0.011	0.014	16.083	0.518
		20	-0.010	-0.013	16.283	0.573
		21	0.006	0.004	16.347	0.634
		22	-0.019	-0.020	17.096	0.647
		23	0.006	0.006	17.163	0.701
		24	0.006	0.007	17.245	0.750
		25	-0.024	-0.019	18.426	0.734

Answer: