Texas Tech University
Department of Economics
Spring 2018
Eco 4306: Economic and Business Forecasting

Final Exam

Name:

ID:

Short questions (40 points)

Q1. 4 points
Q2. 4 points
Q3. 4 points
Q4. 4 points
Q5. 4 points
Q6. 4 points
Q7. 4 points
Q8. 4 points
Q9. 4 points
Q10. 4 points

Applied problems (64 points)

Q11. 8 points
Q12. 8 points
Q13. 8 points
Q14. 8 points
Q15. 8 points
Q16. 8 points
Q17. 8 points
Q18. 8 points

Good luck!

Question 1. (4 points)

What is Granger causality and how do we test it?

Question 2. (4 points)

Explain what spurious regression problem is and give an example.

Question 3. (4 points)

Explain what is means if X_t and Y_t are cointegrated. Give an example.

Question 4. (4 points)

Explain the idea behind error correction model. Draw a diagram illustrating the error correction mechanism.

Question 5. (4 points)

Explain what volatility clustering means.

Question 6. (4 points)

Explain the difference between moving average (MA) and exponentially weighted moving average (EWMA) models of the conditional variance.

Question 7. (4 points)

Write the equation for the autoregressive conditional heteroscedasticity ARCH(1) model. Explain the intuition behind this model.

Question 8. (4 points)

What are some weaknesses of ARCH models, and which alternative models have been developed to address them?

Question 9. (4 points)

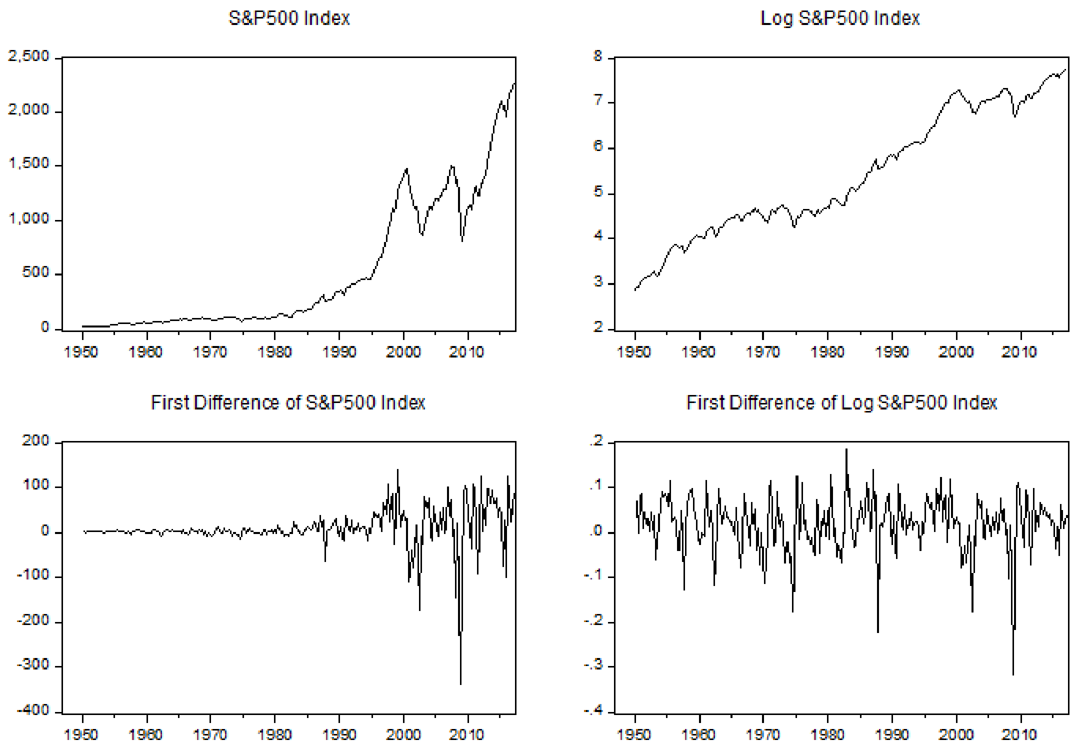
Explain what 1% VaR is and draw a diagram to illustrate this.

Question 10. (4 points)

Consider a GARCH(1,1) model for daily S&P 500 returns from 1/2/1998 to 7/25/2008 sample. With normal innovations, the number of violations $r_t < r_t^{VaR(0.01)}$ is 42 which represents 1.58% of observations. With innovations from Student-t distribution the number of violations $r_t < r_t^{VaR(0.01)}$ is 30 or 1.13% of the sample. Which of these two models would be more suitable for risk management purposes and why?

Question 11 (8 points)

Figure below shows the time series for the S&P500 Index, the log transformed S&P500 Index, and also their first differences. Explain which of the four series are nonstationary, first order weakly stationary, second order weakly stationary.

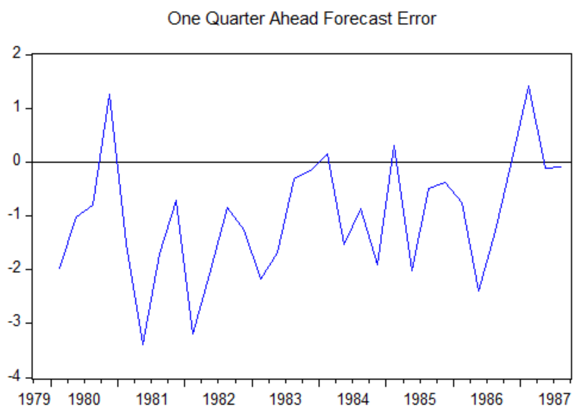


Question 12 (8 points)

Consider the one quarter ahead Fed's forecast for inflation during the 1979Q4-1987Q3 period.

Suppose that we want to test whether the Fed's forecast are optimal under the symmetric quadratic loss function, which would imply that $E(y_{t+1}) = f_{t,1}$ and thus the forecast error $e_{t,1} = y_{t+1} - f_{t,1}$ would have to satify $E(e_{t,1}) = 0$, and in the regression $e_{t,1} = \beta_0 + e_t$ coefficient β_0 should be zero. Figure below shows that time series plot for the forecast errors, and the results of that regression.

Interpret these results; what can we say about Fed's loss function during 1979Q4-1987Q3 based on them?



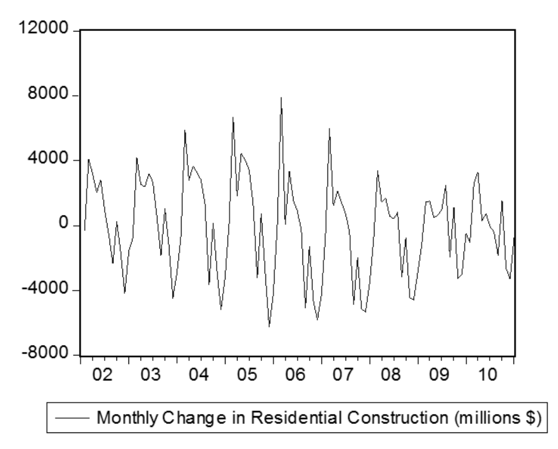
Dependent Variable: GPGDP_E1
Method: Least Squares
Date: 02/24/17 Time: 19:34
Sample (adjusted): 1980Q1 1987Q3
Included observations: 31 after adjustments

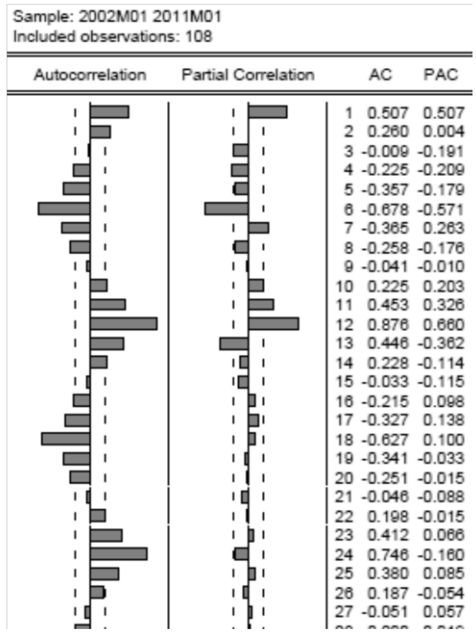
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.017073	0.202722	-5.017080	0.0000

R-squared	0.000000	Mean dependent var	-1.017073
Adjusted R-squared	0.000000	S.D. dependent var	1.128708
S.E. of regression	1.128708	Akaike info criterion	3.111751
Sum squared resid	38.21948	Schwarz criterion	3.158009
Log likelihood	-47.23215	Hannan-Quinn criter.	3.126830
Durbin-Watson stat	1.562466		

Question 13 (8 points)

Consider the data for monthly changes in U.S. residential construction for the period January 2002-January 2011 shown below. Discuss what kind of model would you would estimate for this time series, write its equation, and explain why you would choose this model.





Sample: 2002M01 2011M01
Included observations: 108

Lag	AC	PAC
1	0.507	0.507
2	0.260	0.004
3	-0.009	-0.191
4	-0.225	-0.209
5	-0.357	-0.179
6	-0.678	-0.571
7	-0.365	0.263
8	-0.258	-0.176
9	-0.041	-0.010
10	0.225	0.203
11	0.453	0.326
12	0.876	0.660
13	0.446	-0.362
14	0.228	-0.114
15	-0.033	-0.115
16	-0.215	0.098
17	-0.327	0.138
18	-0.627	0.100
19	-0.341	-0.033
20	-0.251	-0.015
21	-0.046	-0.088
22	0.198	-0.015
23	0.412	0.066
24	0.746	-0.160
25	0.380	0.085
26	0.187	-0.054
27	-0.051	0.057

Question 14 (8 points)

Consider two candidate models for change in monthly private residential construction spending, AR(1) and AR(2)+SAR(1), the results for which are below. Evaluate the adequacy of these models based on the correlograms of residuals, AIC and BIC, and statistical significance of coefficients.

Dependent Variable: DCONST
Method: ARMA Maximum Likelihood (BFGS)
Date: 04/11/18 Time: 16:28
Sample: 1993M02 2013M12
Included observations: 251
Convergence achieved after 3 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	34.02301	284.5681	0.119560	0.9049
AR(1)	0.503787	0.082472	6.108569	0.0000
SIGMASQ	4263658.	311155.6	13.70266	0.0000

R-squared	0.254386	Mean dependent var	49.44223
Adjusted R-squared	0.248373	S.D. dependent var	2396.078
S.E. of regression	2077.314	Akaike info criterion	18.12859
Sum squared resid	1.07E+09	Schwarz criterion	18.17072
Log likelihood	-2272.138	Hannan-Quinn criter.	18.14554
F-statistic	42.30579	Durbin-Watson stat	2.030264
Prob(F-statistic)	0.000000		

Date: 04/11/18 Time: 16:30
Sample: 1993M01 2013M12
Included observations: 251
Q-statistic probabilities adjusted for 1 ARMA term

	AC	PAC	Q-Stat	Prob
1	-0.016	-0.016	0.0654	
2	0.196	0.196	9.8361	0.002
3	-0.156	-0.156	16.045	0.000
4	-0.152	-0.202	21.954	0.000
5	-0.073	-0.014	23.343	0.000
6	-0.437	-0.430	72.819	0.000
7	-0.077	-0.174	74.368	0.000
8	-0.167	-0.097	81.652	0.000
9	-0.141	-0.424	86.868	0.000
10	0.174	-0.055	94.847	0.000
11	-0.004	-0.168	94.852	0.000
12	0.928	0.873	323.74	0.000
13	-0.022	0.004	323.87	0.000
14	0.191	-0.179	333.60	0.000
15	-0.170	-0.052	341.37	0.000
16	-0.138	0.000	346.48	0.000
17	-0.073	-0.027	347.93	0.000
18	-0.426	0.036	397.29	0.000
19	-0.074	0.040	398.77	0.000
20	-0.181	-0.046	407.75	0.000
21	-0.107	0.110	410.89	0.000
22	0.145	-0.070	416.75	0.000
23	0.014	-0.017	416.81	0.000
24	0.859	-0.003	623.42	0.000
25	-0.023	0.005	623.56	0.000
26	0.187	-0.009	633.38	0.000
27	-0.183	-0.013	642.88	0.000
28	-0.128	-0.051	647.55	0.000
29	-0.074	-0.018	649.09	0.000
30	-0.408	0.052	696.98	0.000
31	-0.070	-0.020	698.38	0.000
32	-0.203	-0.115	710.36	0.000
33	-0.069	0.028	711.77	0.000
34	0.118	-0.001	715.82	0.000
35	0.035	-0.014	716.18	0.000
36	0.783	-0.102	897.23	0.000

Dependent Variable: DCONST
Method: ARMA Maximum Likelihood (BFGS)
Date: 04/11/18 Time: 16:26
Sample: 1993M02 2013M12
Included observations: 251
Convergence achieved after 7 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	214.4219	1374.109	0.156044	0.8761
AR(1)	0.497140	0.054595	9.105947	0.0000
AR(2)	0.116143	0.052147	2.227211	0.0268
SAR(12)	0.944592	0.013249	71.29646	0.0000
SIGMASQ	373960.6	26485.07	14.11968	0.0000

R-squared	0.934603	Mean dependent var	49.44223
Adjusted R-squared	0.933540	S.D. dependent var	2396.078
S.E. of regression	617.7066	Akaike info criterion	15.81783
Sum squared resid	93864109	Schwarz criterion	15.88805
Log likelihood	-1980.137	Hannan-Quinn criter.	15.84609
F-statistic	878.9103	Durbin-Watson stat	1.975678
Prob(F-statistic)	0.000000		

Date: 04/11/18 Time: 16:26
Sample: 1993M01 2013M12
Included observations: 251
Q-statistic probabilities adjusted for 3 ARMA terms

	AC	PAC	Q-Stat	Prob
1	0.011	0.011	0.0322	
2	0.054	0.054	0.7743	
3	-0.054	-0.056	1.5282	
4	-0.032	-0.034	1.7972	0.180
5	0.042	0.049	2.2539	0.324
6	-0.091	-0.092	4.3953	0.222
7	-0.081	-0.089	6.1091	0.191
8	0.112	0.132	9.3965	0.094
9	-0.073	-0.078	10.799	0.095
10	-0.031	-0.065	11.048	0.137
11	-0.041	-0.009	11.501	0.175
12	-0.005	-0.001	11.507	0.243
13	-0.013	-0.053	11.553	0.316
14	-0.007	0.014	11.565	0.397
15	0.006	0.021	11.575	0.480
16	0.019	-0.024	11.670	0.555
17	0.040	0.045	12.109	0.598
18	-0.095	-0.096	14.580	0.482
19	0.042	0.037	15.068	0.520
20	0.070	0.082	16.416	0.495
21	-0.041	-0.061	16.875	0.532
22	0.010	-0.006	16.904	0.596
23	-0.005	0.036	16.912	0.659
24	0.158	0.146	23.933	0.296
25	0.008	-0.038	23.952	0.350
26	-0.075	-0.038	25.527	0.324
27	-0.033	-0.021	25.837	0.362
28	0.024	0.018	25.999	0.408
29	-0.044	-0.047	26.564	0.432
30	-0.043	-0.024	27.097	0.459
31	-0.037	-0.000	27.498	0.491
32	0.064	0.024	28.673	0.482
33	0.022	0.028	28.816	0.527
34	0.044	0.058	29.388	0.549
35	-0.016	-0.004	29.459	0.596
36	-0.071	-0.119	30.955	0.569

Question 15 (8 points)

Consider two models for U.S. real GDP, used to construct forecast for the period 2010Q1-2016Q4:

- model A: deterministic trend model for which the sequence of 1-step ahead forecasts has RMSE=103.45 and the multistep forecast has RMSE=1649.06
- model B: stochastic trend model for which the sequence of 1-step ahead forecasts has RMSE=77.32 and the multistep forecast has RMSE=905.18.

The 1-step ahead forecasts are then used to perform the test of equal predictive ability be estimating

$$\Delta L_{t+j,1} = \beta_0 + u_{t+j} \quad \text{with } j = 0, 1, 2, \ldots, T - t - 1$$

where $\Delta L_{t+j,1} = (e^A_{t+j,1})^2 - (e^B_{t+j,1})^2$, and $e^k_{t+j,1}$ is the one step ahead forecast error for forecast from model k in period $t + j$. Explain the idea behind this test and interpret its results below. Discuss how we would use it together with above RMSE values in model selection process.

Dependent Variable: DL_TREND
Method: Least Squares
Date: 04/09/17 Time: 18:34
Sample (adjusted): 2010Q1 2016Q4
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5454.311	1293.939	4.215275	0.0002

R-squared	0.000000	Mean dependent var	5454.311
Adjusted R-squared	0.000000	S.D. dependent var	6846.884
S.E. of regression	6846.884	Akaike info criterion	20.53604
Sum squared resid	1.27E+09	Schwarz criterion	20.58361
Log likelihood	-286.5045	Hannan-Quinn criter.	20.55058
Durbin-Watson stat	2.683486		

Question 16. (8 points)

Interpret the results of the Granger causality test for a VAR with three variables: $y_{1,t} = 400\Delta \log GDP_t$ is the growth rate of the U.S. real GDP and $y_{2,t} = 400(\Delta \log SP500_t - \Delta \log p_t^{GDP})$ is the inflation adjusted return of S&P 500, and y_{3t} is the Leading Index for the United States.

Explain what these Granger causality imply about the usefulness of each of the threes variables when it comes to predicting the other ones. Is there any economic intuition behind these results?

Dependent variable: GRGDP

Excluded	Chi-sq	df	Prob.
RRSP500	3.689833	1	0.0547
LI	22.08652	1	0.0000
All	27.70217	2	0.0000

Dependent variable: RRSP500

Excluded	Chi-sq	df	Prob.
GRGDP	0.021518	1	0.8834
LI	0.206983	1	0.6491
All	0.673715	2	0.7140

Dependent variable: LI

Excluded	Chi-sq	df	Prob.
GRGDP	2.487304	1	0.1148
RRSP500	9.320140	1	0.0023
All	12.78463	2	0.0017

Question 17. (8 points)

Consider a bivariate VEC

$$\begin{aligned}\Delta \log p_t^{GAS} &= \gamma_1 z_{t-1} + \kappa_{11}\Delta \log p_{t-1}^{GAS} + \kappa_{12}\Delta \log p_{t-2}^{GAS} + \phi_{11}\Delta \log p_{t-1}^{OIL} + \phi_{12}\Delta \log p_{t-2}^{OIL} + \varepsilon_{1,t}\\ \Delta \log p_t^{OIL} &= \gamma_2 z_{t-1} + \kappa_{21}\Delta \log p_{t-1}^{GAS} + \kappa_{22}\Delta \log p_{t-2}^{GAS} + \phi_{21}\Delta \log p_{t-1}^{OIL} + \phi_{22}\Delta \log p_{t-2}^{OIL} + \varepsilon_{2,t}\end{aligned}$$

where $z_{t-1} = \log p_{t-1}^{GAS} - \beta_1 \log p_{t-1}^{OIL} - \beta_0$ is the error terms period $t-1$.

Is the coefficient β_1 statistically significant? Interpret what the estimated value for β_1 means.

Are γ_1 and γ_2 statistically significant? Are the signs of γ_1 and γ_2 in the estimated VEC model consistent with error correction mechanism that moves the system back to the long run equilibrium, whenever there is a disruption and $z_{t-1} \neq 0$?

Sample (adjusted): 1995M04 2010M12
Included observations: 189 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LOG(PGAS(-1))	1.000000	
LOG(POIL(-1))	-0.631247 (0.01394) [-45.2872]	
C	1.738756 (0.05040) [34.4992]	
Error Correction:	**D(LOG(PGAS))**	**D(LOG(POIL))**
CointEq1	-0.334163 (0.07765) [-4.30353]	-0.029007 (0.12377) [-0.23435]
D(LOG(PGAS(-1)))	0.353684 (0.09534) [3.70974]	-0.138917 (0.15197) [-0.91409]
D(LOG(PGAS(-2)))	-0.143176 (0.09105) [-1.57241]	-0.057373 (0.14514) [-0.39529]
D(LOG(POIL(-1)))	0.135581 (0.06819) [1.98830]	0.275317 (0.10870) [2.53293]
D(LOG(POIL(-2)))	0.017021 (0.06806) [0.25011]	0.170246 (0.10848) [1.56934]

Question 18. (8 points)

Consider the GARCH(1,1) model for the S&P 500 daily returns.

Dependent Variable: R
Method: ML - ARCH (BHHH) - Normal distribution
Sample: 5815 8471
Included observations: 2657
Convergence achieved after 10 iterations
Bollerslev-Wooldrige robust standard errors & covariance
Variance backcast: ON
GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.036267	0.017439	2.079665	0.0376
Variance Equation				
C	0.010421	0.005245	1.987099	0.0469
RESID(-1)^2	0.065649	0.011338	5.790038	0.0000
GARCH(-1)	0.927400	0.011045	83.96233	0.0000

R-squared	-0.000534	Mean dependent var	0.009761
Adjusted R-squared	-0.001666	S.D. dependent var	1.146761
S.E. of regression	1.147716	Akaike info criterion	2.888638
Sum squared resid	3494.671	Schwarz criterion	2.897498
Log likelihood	-3833.556	Durbin-Watson stat	2.079139

Write the equations for the estimated GARCH(1,1) model, with estimated parameter values plugged into these equations.

On April 2, 2008, the 1-day-ahead conditional mean is $\mu_{t|t-1} = 0.036$, the 1-day-ahead conditional standard deviation $\sigma_{t|t-1} = 1.785$. Calculate the 1% VaR and 5% VaR, given that $\Phi^{-1}(0.05) = -1.645$ and $\Phi^{-1}(0.01) = -2.326$. Interpret these numbers, given a portfolio worth 1 million dollars.