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ECO 5375
Eco. & Bus. Forecasting

Prof. Tom Fomby
Fall 2015

MID-TERM EXAM

Instructions: Write in your name and student ID above. You have 1 hour and 30 minutes to complete this exam. This exam is worth a total of 97 points. The points for the separate question are broken out as follows:

Q1 – Q7 = 2 points each.
Q8 = 4 points
Q9 = 5 points
Q10 = 3 points
Q11 – Q13 = 2 points each
Q14 = (2, 2, 2) = 6 points
Q15 = 2 points
Q16 = 6 points
Q17 = 4 points
Q18 = (6, 2) = 8 points
Q19 = (5, 2) = 7 points
Q20 – Q28 = 2 points each
Q29 = (2, 2, 2) = 6 points
Q30 = 4 points
Q31 = 4 points

② 1. In an additive decomposition of time series we assume that any time series potentially consists of four components. These components are Trend, season, Cycle, Irregular

② 2. SAS programs have two basic steps. They are the Data step and the Proc step.

② 3. The basic punctuation following each executable statement in SAS is
   a. Quotation mark (“)
   b. Period (“.”)
   [✓ c.] Semicolon (“;”)
   d. Dash (“-“)

② 4. To put comments in a SAS program
   a. Enclose the comments between quotation marks as in: “content”
   [✓ b.] Enclose the comments between /* and */ as in /*content*/
   c. Enclose the comments between (and) as in (content)
   d. Enclose the comments between # and # as in #content#

② 5. [✓ True] or False. If a time series is slow-turning around a mean, it is probably a nonstationary time series and needs to be differenced before analyzing it.

② 6. If a time series y_t exhibits an exponential growth pattern, it can be transformed to stationarity by the transformation
   a. Δy_t
   [✓ b.] $\Delta \log_e(y_t)$
   c. $\exp(y_t)$
   d. $\tan^{-1}(y_t)$

② 7. [✓ True] or False. If some time series data, say x, data needs to be differenced to be made stationary, then the identify statement in the SAS Procedure ARIMA should read “identify var = x(1);”

Consider the AR(1) Box-Jenkins Model $y_t = \emptyset_1 y_{t-1} + a_t$ (Model (1))

8. The four properties that we assume for the error term a_t in Model (1) are

④
$E(a_t) = 0, \forall t$
$Var(a_t) = \sigma_a^2 \quad \forall t$
$Cov(a_t, a_s) = 0 \quad \forall s \neq t$
$a_t \sim N(0, \sigma_a^2) \quad \forall t$

9. Fill in the following blanks as they relate to the above Model (1) with $|\emptyset_1| < 1$.

⑤
$E(y_t) =$ 0
$\text{Var}(y_t) =$ $\sigma_a^2 / (1 - \phi_1^2)$
$\text{Corr}(y_t, y_{t-j}) =$ ϕ_1^j
$\hat{y}_{t+h} =$ $\phi_1^h y_t$
$se(e_{t+h}) =$ $\text{sqrt}[\sigma_a^2 (1 + \phi_1^2 + \phi_1^4 + \cdots + \phi_1^{2(h-1)})]$

③ 10. Suppose that the last available observation we have available on some time series data described by Model (1), $y_t = 4$. Assume that by the method of least squares we determine that a reasonable model for the data is $y_t = 0.5y_{t-1} + \hat{a}_t$ with $sd(a_t) = 1.0$ or equivalently, $Var(a_t) = 1.0$. Then the one-step-ahead forecast for y is $\hat{y}_{t+1} =$ 2 . The 95% prediction interval for this forecast is (0.04 , 3.96). Show your work below to receive full credit.

$2 \pm 1.96 se(e_{t+1})$
$= 2 \pm 1.96(1)$

$\hat{y}_{t+1} = \hat{\phi}_1 y_t = 0.5(4) = 2$

$se(e_{t+1}) = sqrt[\sigma_a^2(1)] = sqrt(1^2) = 1$

② 11. In the Unit Root case of Model (1), suppose that the last available observation in our time series is $y_t = 4$ and $\sigma_a^2 = 1$. Then $\hat{y}_{t+2} =$ 4 and $se(e_{t+2}) =$ $\sqrt{2}$.

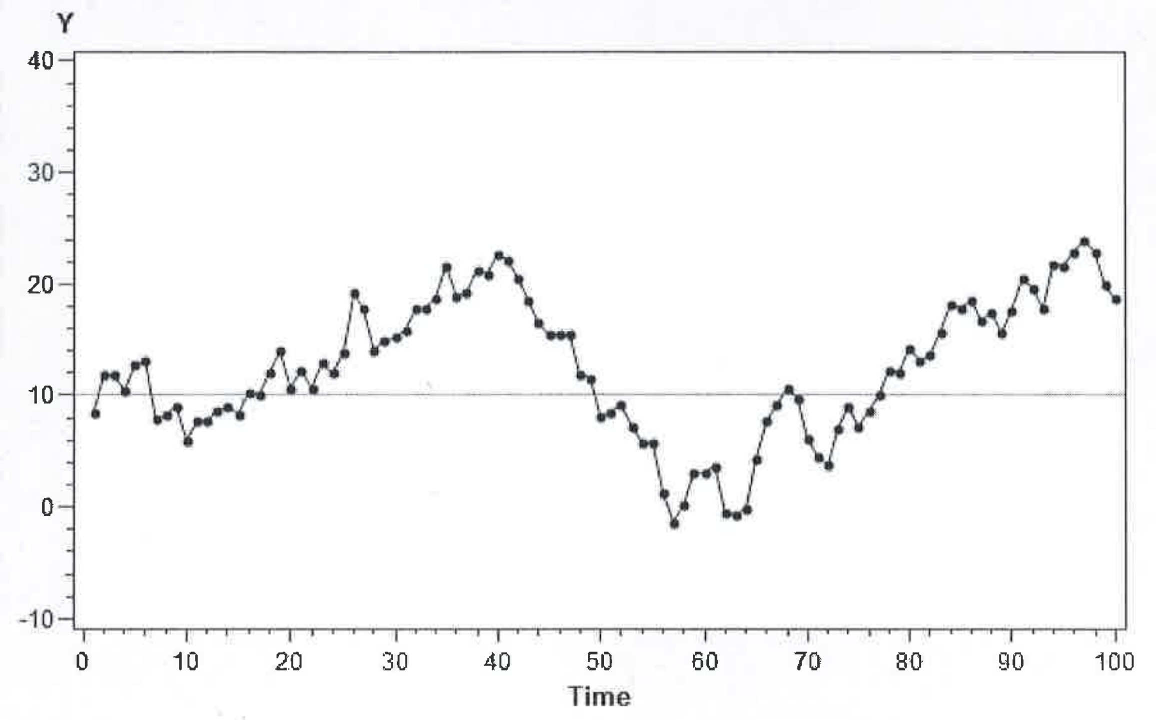
$\hat{y}_{t+h} = y_t$ $se(e_{t+h}) = \sqrt{h\sigma_a^2}$

② 12. [✓ True] or False. The “Damping” and “Cutting Off” patterns of the ACF and PACF of the stationary form of a time series provide a way to identify the orders of pure Box-Jenkins processes.

② 13. If the ACF has 3 spikes in it and then cuts off and if the PACF tails off, the ARMA model that is appropriate for the data is ARMA(0 , 3).

14. Consider the time series plotted in **Figure 1** below.

Figure 1



② (a) Does this time series look stationary to you? Explain your answer.

NO. It is slow-turning and looks like a random walk without drift.

② (b) Is it all right to apply the Box-Jenkins modeling approach to this data directly or should you transform the data first and, if so, how? Explain your answer.

As the data is similar to the process $y_t = y_{t-1} + a_t$ with $y_0 = 10$, we should difference the data to make it stationary

② (c) Formally, state the conditions for a time series y_t to be **stationary**.

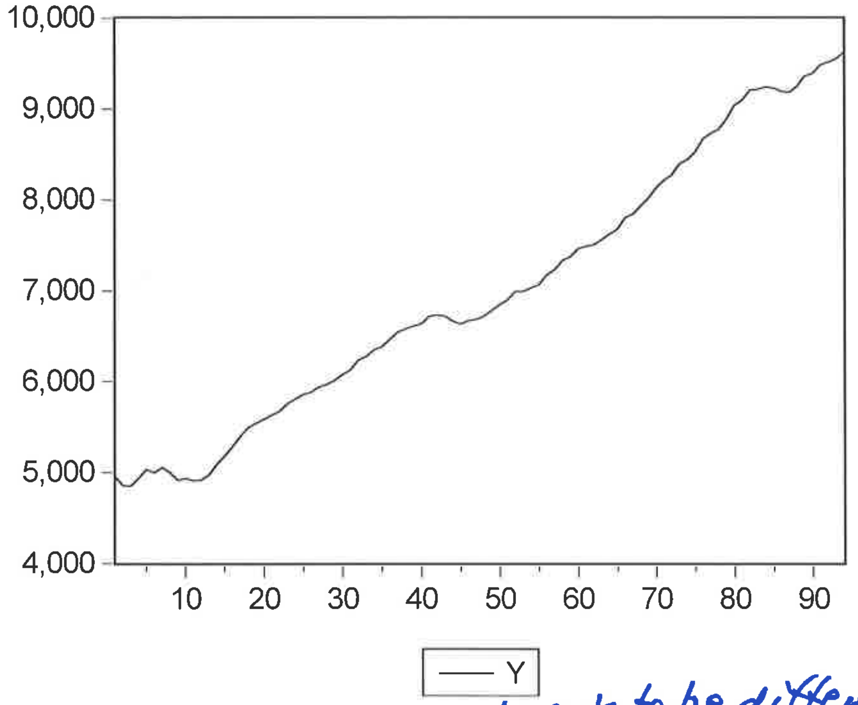
The time series y_t is stationary if

weak stationarity
- (i) $E(y_t) = \mu \ \forall t$ (constant mean)
- (ii) $Var(y_t) = \sigma^2 \ \forall t$ (constant variance)
- (iii) $Cov(y_t, y_{t-j}) = \gamma_j \ \forall t$ and arbitrary integer $j > 0$ (constant covariance)
- (iv) y_t is normally distributed

If you add condition (iv) you have strong stationarity.

Now let us conduct a unit root test on the data in **Figure 2**. In the **EVIEWS Computer Output # 1** there is some information that should allow you to answer the following ~~3~~ 2 questions.

Figure 2



② 15. The null hypothesis of the Dickey-Fuller test for the data in Figure 2 is data has stochastic trend and needs to be differenced to make it stationary (i.e. the time series has a unit root). The alternative hypothesis is the data follows a deterministic trend and should be modeled as $y_t = a + bt + a_t$.

16. Using **EVIEWS Computer Output # 1** and the correct Dickey-Fuller case for this data (Y), report the following information:

⑥

- (a) The appropriate case for the Dickey-Fuller test is Zero Mean / Single Mean / [✓ Trend] (circle a choice)
- (b) The number of augmenting terms chosen for the test is = 2
- (c) Dickey-Fuller t-statistic (tau) = -1.983249
- (d) Probability Value of DF t-statistic = 0.6023
- (e) This test result indicates that the time series Y (is/[✓ is not]) stationary and ([✓ does]/does not) need to be differenced to make the series stationary.

D(Y(-1))
D(Y(-2))

Now consider the **SAS Computer Output # 2**. Use this output to determine a best Box-Jenkins model for the data plotted in **Figure 2**. **Assume that the time series is observed <u>monthly</u>**.

17. Using the sample ACF and sample PACF that is provided by SAS **Computer Output # 2**, give me a tentative identification of the p and q values for the Y series. Explain your answer.

②

p = 1, q = 0.

②

Explanation: The PACF has one spike and then cuts off while the ACF damps out.

18. Using **Computer Output # 2**, fill in the following P-Q box. Be sure to tell me what the entries of the cells of your box are. Which model is indicated to be the best model in the P-Q box? Explain your reasoning.

Legend: in cells
AIC
SBC
Q_{24}
(p-value) of Q_{24}

⑥

Q

P

	0	1	2
0	985.1017 987.6342 30.39 (0.1723)	977.6966 982.7618 18.01 (0.7568)	976.0719 983.6697 15.89 (0.8214)
1	974.0883 979.1535 16.23 (0.8452)	974.1618 981.7596 14.96 (0.8641)	
2	973.9127 981.5105 15.05 (0.8602)		

② Reasoning: The AIC chooses the AR(2) model while the SBC chooses the AR(1) model. The ACF and PACF favor the AR(1) model. The overfitting exercise below will support the AR(1) model over the AR(2) model. The residuals of both models are w.n.

19. Use **Computer Output #2** to conduct an overfitting exercise on the model you chose from the P-Q box. Below, report the overfitting coefficient of each overfitting model and its corresponding t-statistic. What conclusion do you draw from the overfitting exercise? Explain your answer.

2.5

Overfitting Model 1 is ARMA(2 , 0).
The overfitting coefficient is 0.15330. AR1, 2 coefficient
The T-statistic of the overfitting coefficient is 1.47.
Therefore the overfitting coefficient from this model is statistically (significant/ [✓ insignificant]). Circle one alternative.

2.5

Overfitting Model 2 is ARMA(1 , 1).
The overfitting coefficient is 0.32538. MA1, 1 coefficient
The T-statistic of the overfitting coefficient is 1.32.
Therefore the overfitting coefficient from this model is statistically (significant/ [✓ insignificant]). Circle one alternative.

② My conclusion is From the overfitting exercises we see that the extra coefficients added to the AR(1) model are statistically insignificant therefore we choose the AR(1) model as our final model.

② 20. In the below space write out the final model that you have chosen for the Y time series in **Computer Output # 2** with accompanying t-statistics, standard errors, goodness-of-fit measures, and a test statistic for white noise residuals with accompanying p-value. (You can report your estimated model either in the intercept-form or the deviation-from-mean form.)

Intercept form:

$\Delta y_t = 31.15467 + \underset{(0.09787)}{0.36274}\Delta y_{t-1} + \hat{a}_t$

Deviation-from-mean form:

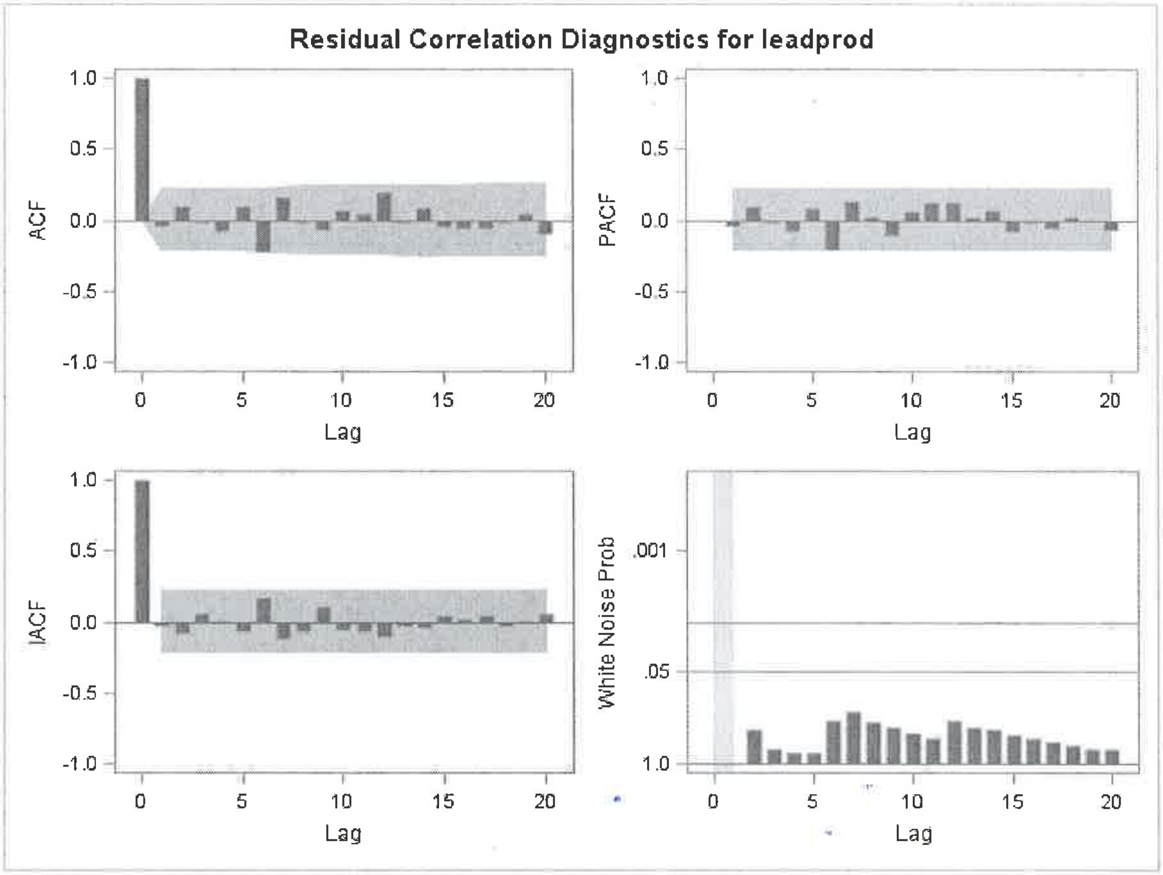
$(\Delta y_t - 48.88861) = 0.36274 \cdot (\Delta y_{t-1} - 48.88861) + \hat{a}_t$

AIC = 974.0883
SBC = 979.15
$Q_{24} = 16.23$
$p = 0.854$

② 21. One reason we use Information Criteria, tests for white noise residuals, and overfitting exercises to pick "best" Box-Jenkins models is because

a. Choosing the wrong Box-Jenkins model can lead to poor forecasting accuracy.
b. Sometimes the sample ACF and PACF functions are not pristine in the sense that they don't sharply distinguish between competing Box-Jenkins models.
c. Box-Jenkins models whose residuals are not white noise are incomplete in that they have not explained all of the variation in the times series and, therefore, more parameters need to be added to the B-J model to produce more accurate forecasts.
[✓ d.] All of the above statements are true.

22. Consider the following graph:



Are the residuals of this fitted Box-Jenkins model white noise? Explain:

② Yes, the residuals of this model are white noise. The ACF and PACF do not have any significant spikes in them and the Q-statistics at the various 2-20 lags all have p-values greater than 0.05. All of these items indicate white noise residuals.

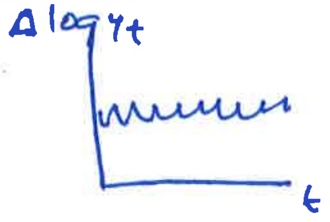
② 23. When forecasting aggregate sales by summing up individual product sales forecasts, we are utilizing the bottom-up approach to forecasting aggregate sales.

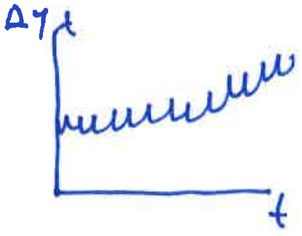
② 24. When forecasting individual product sales from the aggregate sales forecast, we are utilizing the top-down approach to producing individual product sales forecasts.

② 25. The purpose of looking at the SAS programs MCARLO_Det_Trend_Pred_Intervals.sas and MCARLO_RW_Pred_Intervals.sas during our class was to compare the prediction intervals of stochastic trends versus deterministic trends.

when the data contains a stochastic trend the deterministic trend prediction intervals are too narrow and thus too optimistic. when the data contains a deterministic the stochastic trend prediction intervals are too wide and thus are too pessimistic.

② 26. Suppose that $\Delta logy_t$ is the correct transformation of a time series to stationarity. Draw a diagram below that has Δy_t on the y-axis and time (t) on the x-axis and then in the graph draw the Δy_t time series that shows that the level transformation is the incorrect transformation.





The incorrect transform Δy_t is slowly trending up and becoming more variable.

② 27. Consider the following output produced by the SAS Macro %logtest:

TRANS	LOGLIK	RMSE	AIC	SBC
NONE	-252.221	53.0128	516.442	530.267
LOG	-219.245	46.2693	450.490	464.314

In this case which transformation of the data is preferred? Explain your answer.

The log transformation is to be preferred. The %log test macro produces the smallest RMSE, AIC, and SBC for the log transform and the largest log likelihood value.

② 28. Suppose that the last available observation on y is $y_T = 100$. Further suppose that the y_t series has a unit root in it and that we have built a good Box-Jenkins model that produced the two forecasts $\widehat{\Delta y_{T+1}} = 20$ and $\widehat{\Delta y_{T+2}} = 10$. Then we know that $\hat{y}_{T+2} =$ 130 ________.

$\hat{y}_{T+2} = 100 + 20 + 10 = y_T + \hat{\Delta} y_{T+1} + \hat{\Delta} y_{T+2}$

29. Suppose you have applied ordinary least squares model to a DTDS model that produces the following table.

OLS regression to get the DW statistic

The REG Procedure
Model: MODEL1
Dependent Variable: TOT

Durbin-Watson D	0.432
Pr < DW	<.0001
Pr > DW	1.0000
Number of Observations	312
1st Order Autocorrelation	0.783

Note: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation

② (a) What are the null and alternative hypotheses of this test?

H_0: The errors of the model are uncorrelated

H_1: The errors of the model are autocorrelated

② (b) Given the above result, what is the conclusion of this test?

Since Pr< DW is <.0001 and thus we reject H_0 and accept H_1 that the errors of the model are autocorrelated.

② (c) In further testing of the DTDS model that you are investigating, would you be inclined to use Ordinary Least Squares Output (Proc Reg) or Generalized Least Squares Output (Proc Autoreg)? Explain your answer.

Since the errors of the model are autocorrelated we should use the Generalized Least Squares method for estimation and inference (i.e. Proc Autoreg)

30. Given the computer output below, does it look like there is significant seasonality in the data? (It is assumed that the proper choice of OLS and GLS has been chosen for the DTDS model.) Explain your reasoning. What are the null and alternative hypotheses of the test result reported in this output?

④ The below F-test is testing the joint significant of the dummy variable coefficients in the DTDS model. The null hypothesis is H_0: no seasonality in data while H_1: seasonality is present in the data. Since the probability of the F-statistic is less than 0.05 we reject H_0 and accept H_1. There is seasonality in the data.

Test				
Source	**DF**	**Mean Square**	**F Value**	**Pr > F**
Numerator	11	29317586854	24.37	<.0001
Denominator	298	1202946247		

31. Consider the computer output below. Suppose that the DTDS model has produced the following output. Which months of the year are weak? Which months are strong? Which is the weakest month? Which is the strongest month? Thoroughly explain your answer.

④

Obs	**sum**	**d1a**	**d2a**	**d3a**	**d4a**	**d5a**	**d6a**
1	1.97E-15	-0.0231	-0.146	0.21651	-0.1997	-0.2707	0.19076

d7a	**d8a**	**d9a**	**d10a**	**d11a**	**d12a**
0.42398	0.59343	-0.37016	-0.22391	-0.27397	0.082865

The strongest month is the 8th month (August). This month has the largest positive coefficient. (0.59343) The weakest month is the 9th month (september). This month has the most negative coefficient (-0.37016) The weak months are those with negative signs {Jan., Feb., Apr., May, Sept., Oct., Nov.}

The strong months have positive coefficients {Mar, June, July, Aug., Dec.}

Computer Output #1

```
Null Hypothesis: Y has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=11)
==========================================================================
                                               t-Statistic     Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic          5.312408       1.0000
Test critical values:          1% level        -2.590340
                               5% level        -1.944364
                               10% level       -1.614441
==========================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(Y)
Method: Least Squares
Date: 10/19/13   Time: 11:52
Sample (adjusted): 3 94
Included observations: 92 after adjustments
==========================================================================
     Variable          Coefficient    Std. Error    t-Statistic    Prob.
==========================================================================
      Y(-1)             0.004872      0.000917      5.312408      0.0000
     D(Y(-1))           0.342754      0.094485      3.627604      0.0005
==========================================================================
R-squared               0.147427   Mean dependent var           51.82283
Adjusted R-squared      0.137954   S.D. dependent var           45.59209
S.E. of regression      42.33063   Akaike info criterion        10.35040
Sum squared resid       161269.4   Schwarz criterion            10.40522
Log likelihood         -474.1183   Hannan-Quinn criter.         10.37252
Durbin-Watson stat      2.096705
==========================================================================
```

```
Null Hypothesis: Y has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)
========================================================================
                                                  t-Statistic   Prob.*
========================================================================
Augmented Dickey-Fuller test statistic             0.820061     0.9939
Test critical values:          1% level           -3.503049
                               5% level           -2.893230
                               10% level          -2.583740
========================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(Y)
Method: Least Squares
Date: 10/19/13   Time: 11:53
Sample (adjusted): 3 94
Included observations: 92 after adjustments
========================================================================
        Variable         Coefficient    Std. Error   t-Statistic   Prob.
========================================================================
          Y(-1)           0.002599      0.003170     0.820061     0.4144
         D(Y(-1))         0.343837      0.094727     3.629753     0.0005
            C             16.49044      22.01721     0.748979     0.4558
========================================================================
R-squared                 0.152767   Mean dependent var          51.82283
Adjusted R-squared        0.133728   S.D. dependent var          45.59209
S.E. of regression        42.43425   Akaike info criterion       10.36585
Sum squared resid         160259.3   Schwarz criterion           10.44809
Log likelihood           -473.8293   Hannan-Quinn criter.        10.39904
F-statistic               8.023939   Durbin-Watson stat          2.107897
Prob(F-statistic)         0.000625
========================================================================
```

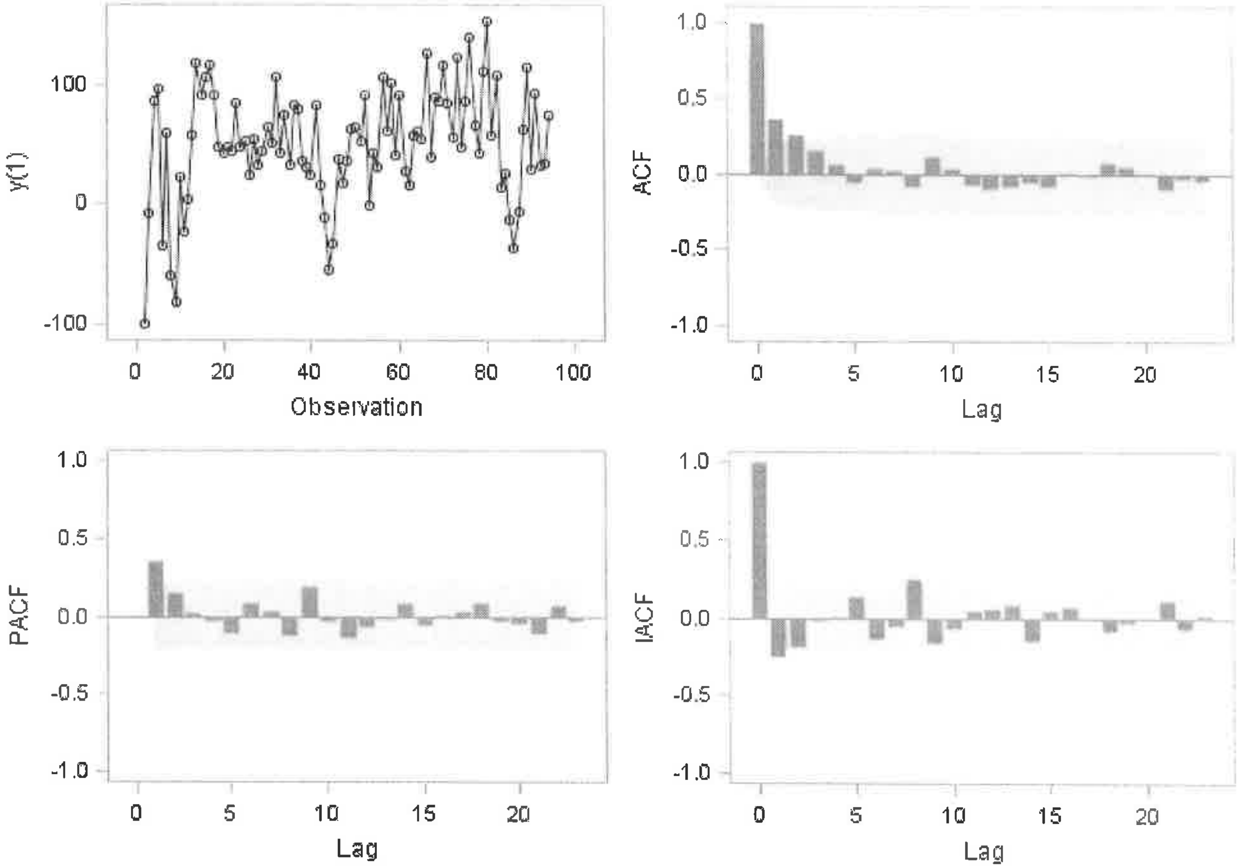
```
Null Hypothesis: Y has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=11)
==============================================================================
                                                    t-Statistic     Prob.*
==============================================================================
Augmented Dickey-Fuller test statistic              -1.983249      0.6023
Test critical values:          1% level             -4.062040
                               5% level             -3.459950
                              10% level             -3.156109
==============================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(Y)
Method: Least Squares
Date: 10/19/13   Time: 11:55
Sample (adjusted): 4 94
Included observations: 91 after adjustments
==============================================================================
      Variable          Coefficient     Std. Error     t-Statistic     Prob.
==============================================================================
        Y(-1)            -0.047957       0.024181      -1.983249      0.0505
      D(Y(-1))            0.293021       0.104490       2.804304      0.0062
      D(Y(-2))            0.157670       0.100263       1.572572      0.1195
          C               235.8543       107.2270       2.199580      0.0305
     @TREND("1")          2.705673       1.306515       2.070909      0.0414
==============================================================================
R-squared                 0.196223    Mean dependent var           52.47473
Adjusted R-squared        0.158838    S.D. dependent var           45.41148
S.E. of regression        41.64909    Akaike info criterion        10.34981
Sum squared resid         149179.6    Schwarz criterion            10.48777
Log likelihood           -465.9165    Hannan-Quinn criter.         10.40547
F-statistic               5.248705    Durbin-Watson stat           1.958721
Prob(F-statistic)         0.000786
==============================================================================
```

CODE FOR COMPUTER OUTPUT # 2

```
data MT;
input y;
datalines;
4958.900
4857.800
4850.300
4936.600
5032.500
4997.300

.

.

.

9485.600
9518.200
9552.000
9625.500
;

proc arima data = MT;
  identify var = y(1);
  e p = 0 q = 0;
  e p = 1 q = 0;
  e p = 2 q = 0;
  e p = 0 q = 1;
  e p = 0 q = 2;
  e p = 1 q = 1;
  run;
```

COMPUTER OUTPUT # 2

```
                         The ARIMA Procedure
                         Name of Variable = y

              Period(s) of Differencing                    1
              Mean of Working Series                50.17849
              Standard Deviation                    47.77749
              Number of Observations                      93
              Observation(s) eliminated by differencing    1

                  Autocorrelation Check for White Noise

To Lag  Chi-Square  DF  Pr > ChiSq               Autocorrelations
     6       22.15   6      0.0011   0.360   0.261   0.153  0.061  -0.053   0.029
    12       26.08  12      0.0105   0.027  -0.082   0.112  0.038  -0.069  -0.103
    18       28.50  18      0.0548  -0.079  -0.055  -0.078  0.004  -0.019   0.075
```


Trend and Correlation Analysis for y(1)

Conditional Least Squares Estimation

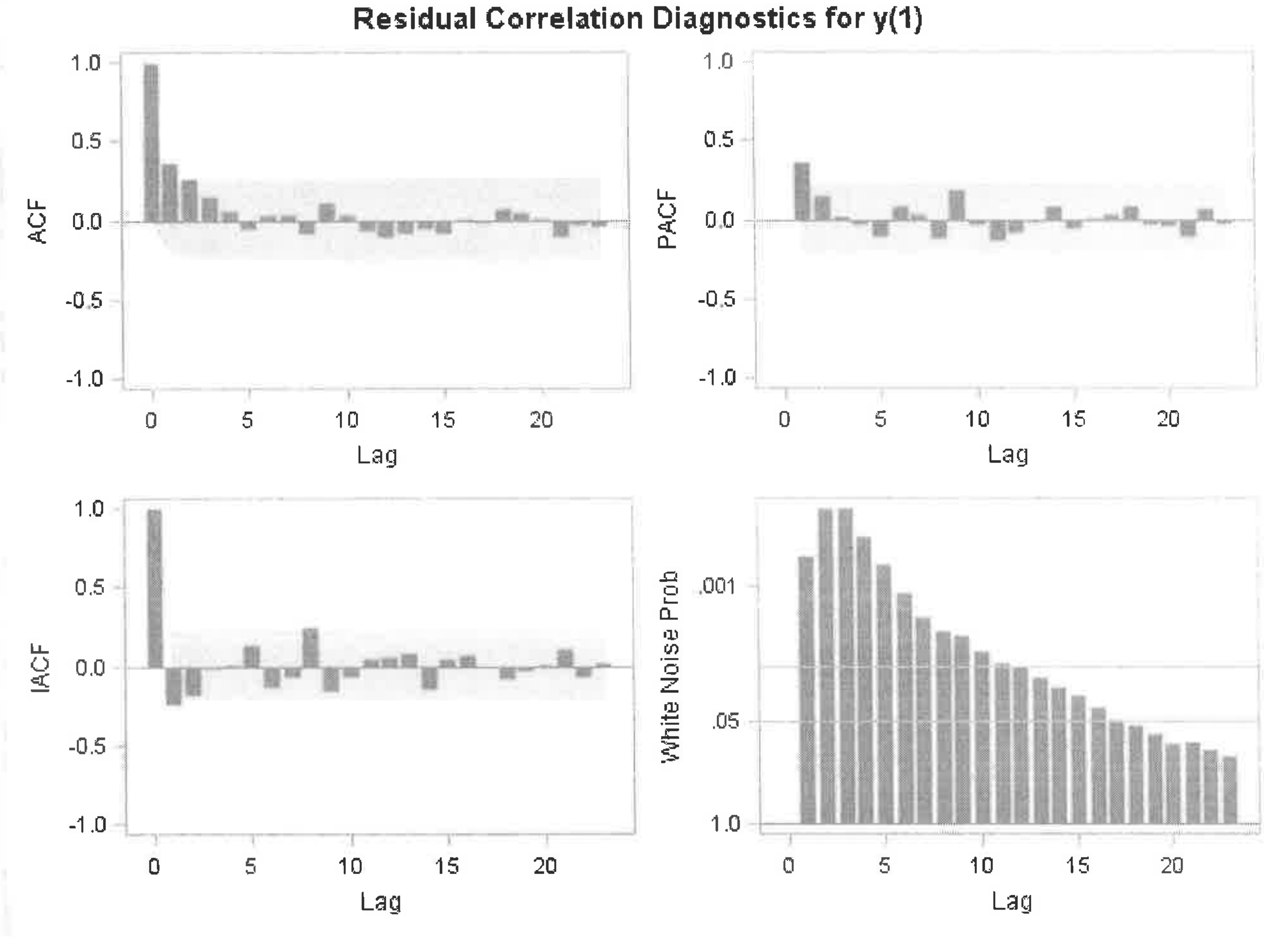
Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|	Lag
MU	50.17849	4.98115	10.07	<.0001	0

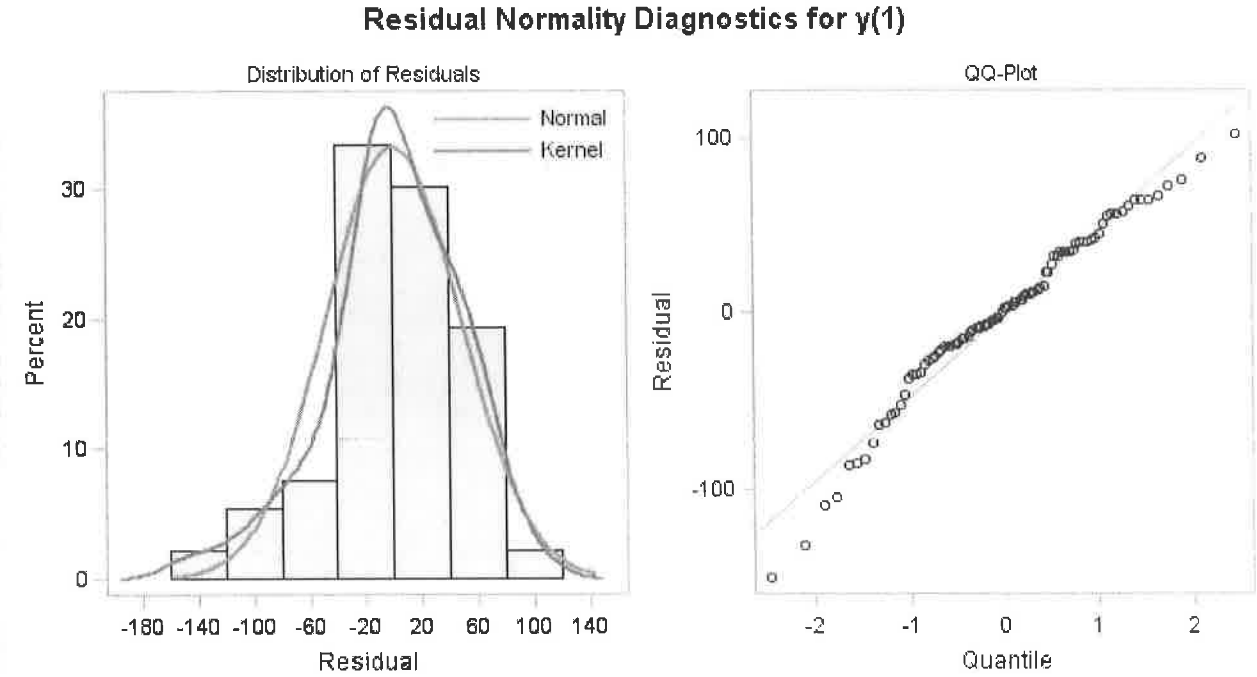
Constant Estimate	50.17849
Variance Estimate	2307.501
Std Error Estimate	48.03645
AIC	985.1017
SBC	987.6343
Number of Residuals	93

*** AIC and SBC do not include log determinant.**

Autocorrelation Check of Residuals

To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
6	22.15	6	0.0011	0.360	0.261	0.153	0.061	-0.053	0.029
12	26.08	12	0.0105	0.027	-0.082	0.112	0.038	-0.069	-0.103
18	28.50	18	0.0548	-0.079	-0.055	-0.078	0.004	-0.019	0.075
24	30.39	24	0.1723	0.045	0.012	-0.102	-0.028	-0.045	0.002





Model for variable y

Estimated Mean	50.17849
Period(s) of Differencing	1

Conditional Least Squares Estimation

Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|	Lag
MU	48.88861	7.27282	6.72	<.0001	0
AR1,1	0.36274	0.09787	3.71	0.0004	1

Constant Estimate	31.15467
Variance Estimate	2028.233
Std Error Estimate	45.03591
AIC	974.0883
SBC	979.1535
Number of Residuals	93

*** AIC and SBC do not include log determinant.**

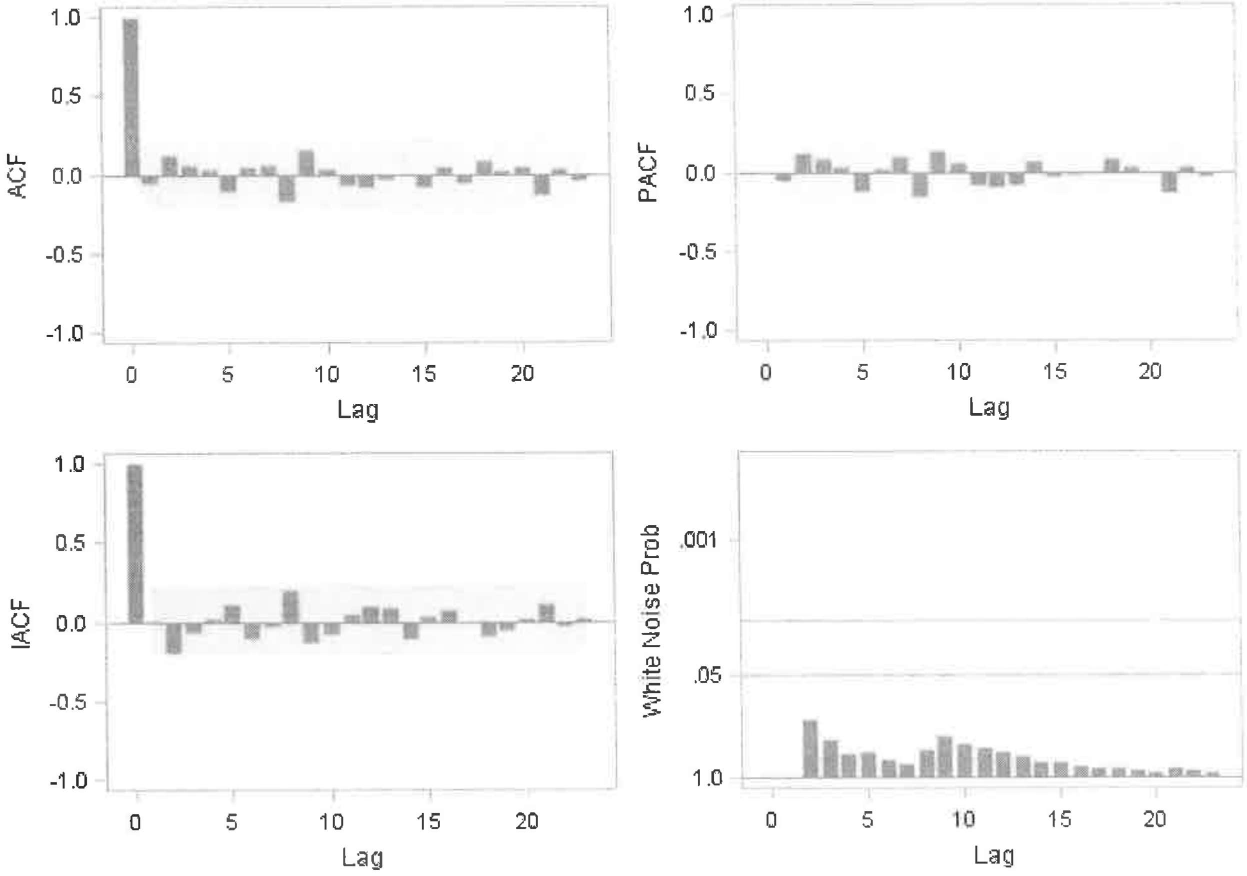
Correlations of Parameter Estimates

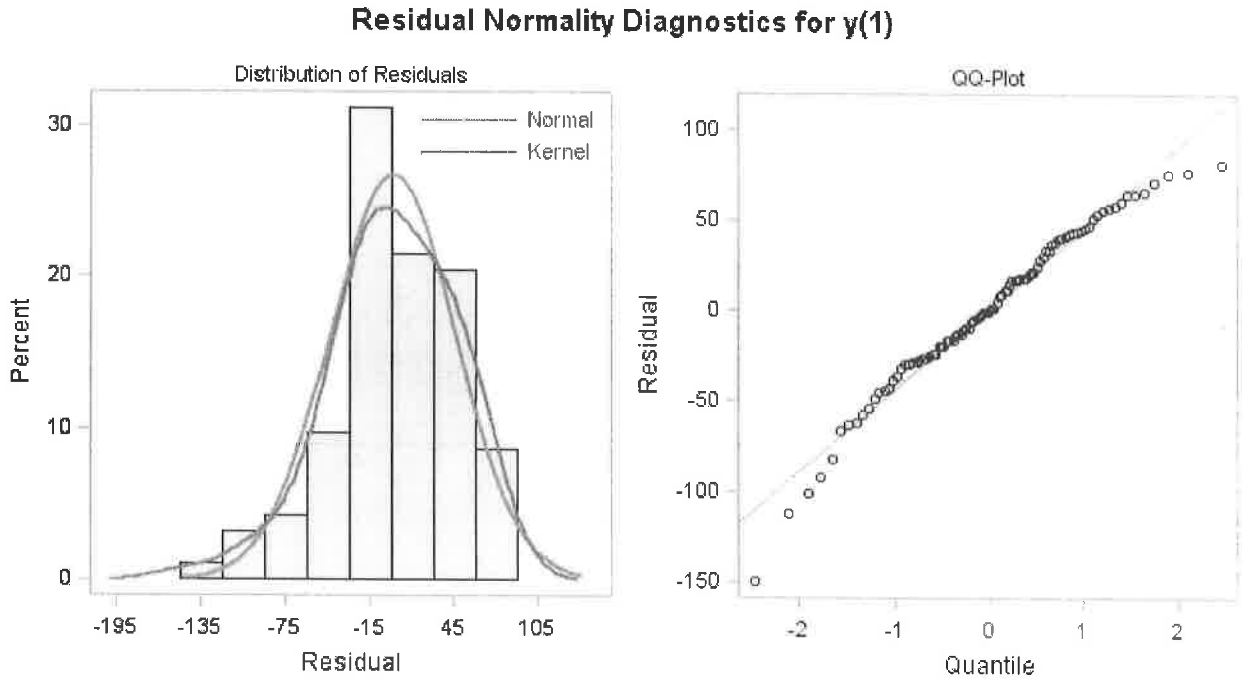
Parameter	MU	AR1,1
MU	1.000	-0.021
AR1,1	-0.021	1.000

Autocorrelation Check of Residuals

To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
6	3.83	5	0.5741	-0.055	0.126	0.064	0.040	-0.107	0.052
12	10.88	11	0.4532	0.060	-0.164	0.163	0.032	-0.061	-0.072
18	13.21	17	0.7222	-0.032	-0.006	-0.075	0.050	-0.058	0.088
24	16.23	23	0.8452	0.026	0.041	-0.126	0.028	-0.047	0.056

Residual Correlation Diagnostics for y(1)





Residual Normality Diagnostics for y(1)

Distribution of Residuals

QQ-Plot

Model for variable y

Estimated Mean	48.88861
Period(s) of Differencing	1

Autoregressive Factors

Factor 1: 1 - 0.36274 B**(1)

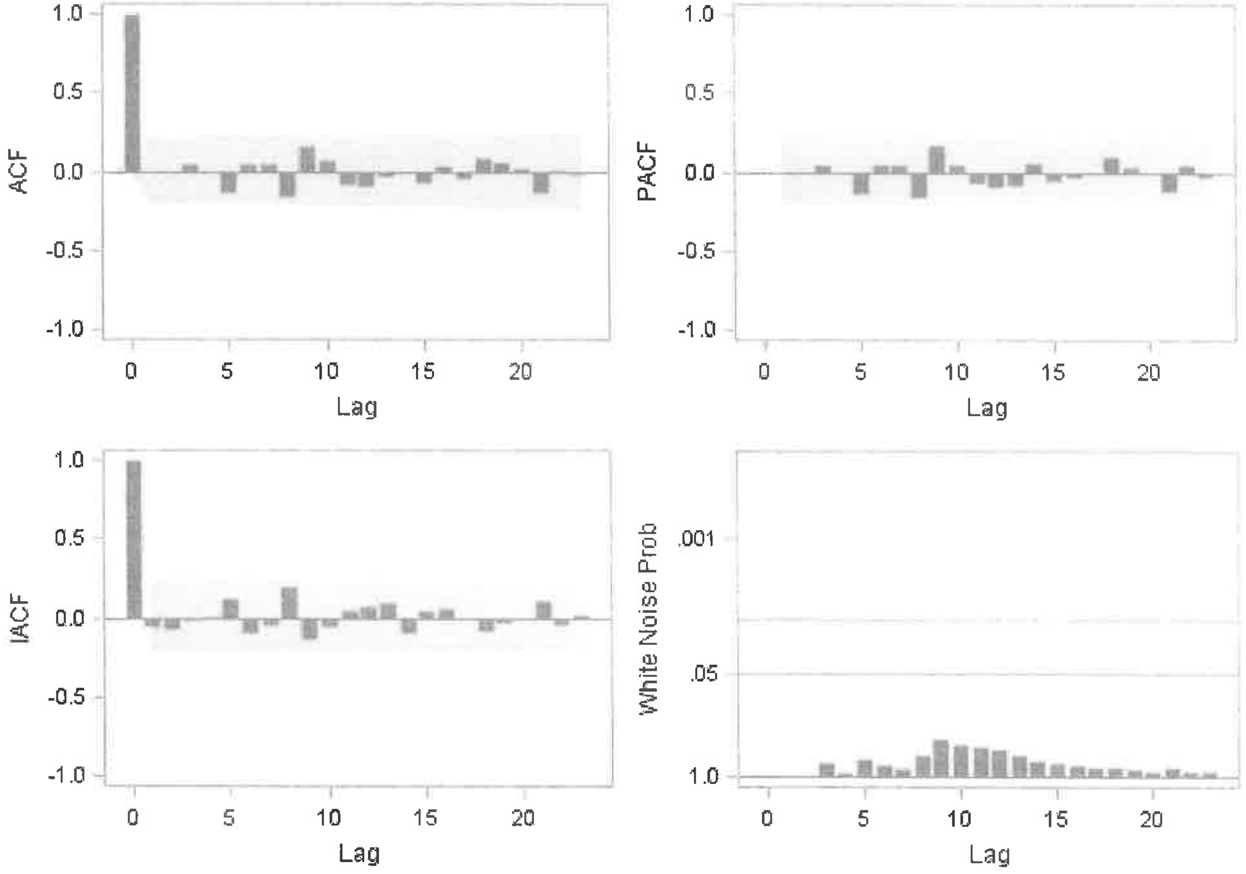
Conditional Least Squares Estimation

Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|	Lag
MU	47.76943	8.49179	5.63	<.0001	0
AR1,1	0.30844	0.10446	2.95	0.0040	1
AR1,2	0.15330	0.10456	1.47	0.1461	2

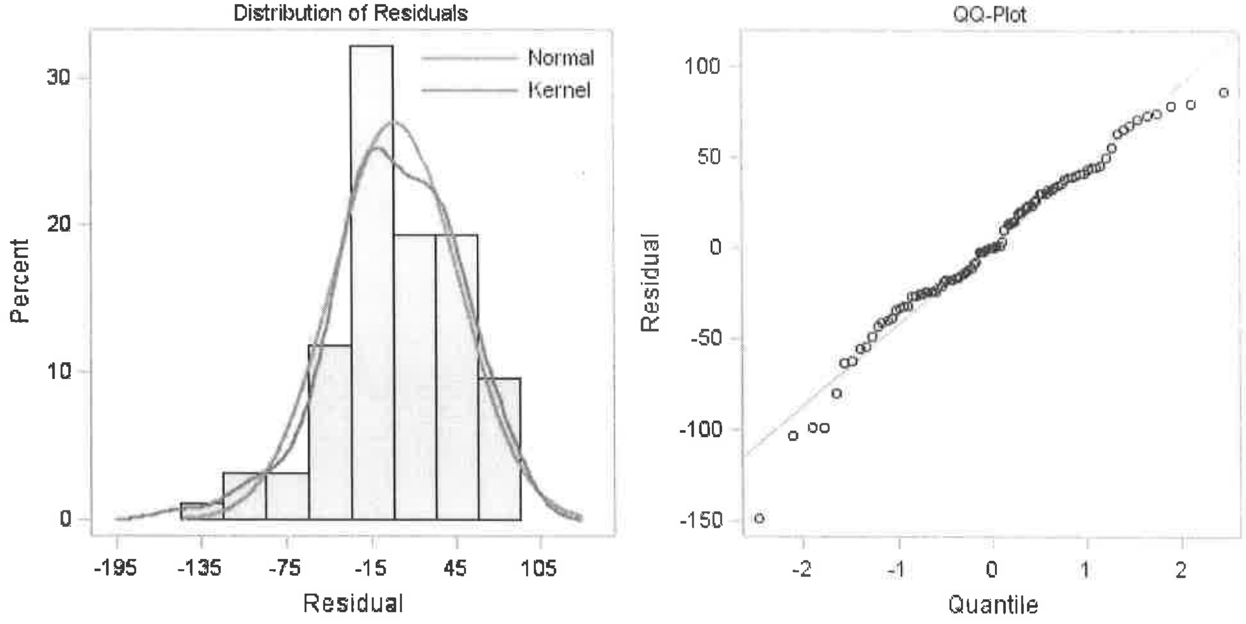
Constant Estimate	25.71258
Variance Estimate	2003.35
Std Error Estimate	44.7588
AIC	973.9127

```
                    SBC                        981.5105
                    Number of Residuals              93

               * AIC and SBC do not include log determinant.
                  Correlations of Parameter Estimates
                  Parameter        MU     AR1,1    AR1,2
                  MU            1.000    -0.018   -0.036
                  AR1,1        -0.018     1.000   -0.365
                  AR1,2        -0.036    -0.365    1.000

                   Autocorrelation Check of Residuals
To Lag  Chi-Square  DF  Pr > ChiSq                 Autocorrelations
     6        2.14   4      0.7095  -0.003  -0.003   0.048  -0.002  -0.128   0.052
    12        9.96  10      0.4438   0.045  -0.160   0.169   0.072  -0.075  -0.085
    18       11.81  16      0.7570  -0.025  -0.003  -0.065   0.037  -0.041   0.089
    24       15.05  22      0.8602   0.057   0.028  -0.128   0.008  -0.016   0.075
```

Residual Correlation Diagnostics for y(1)



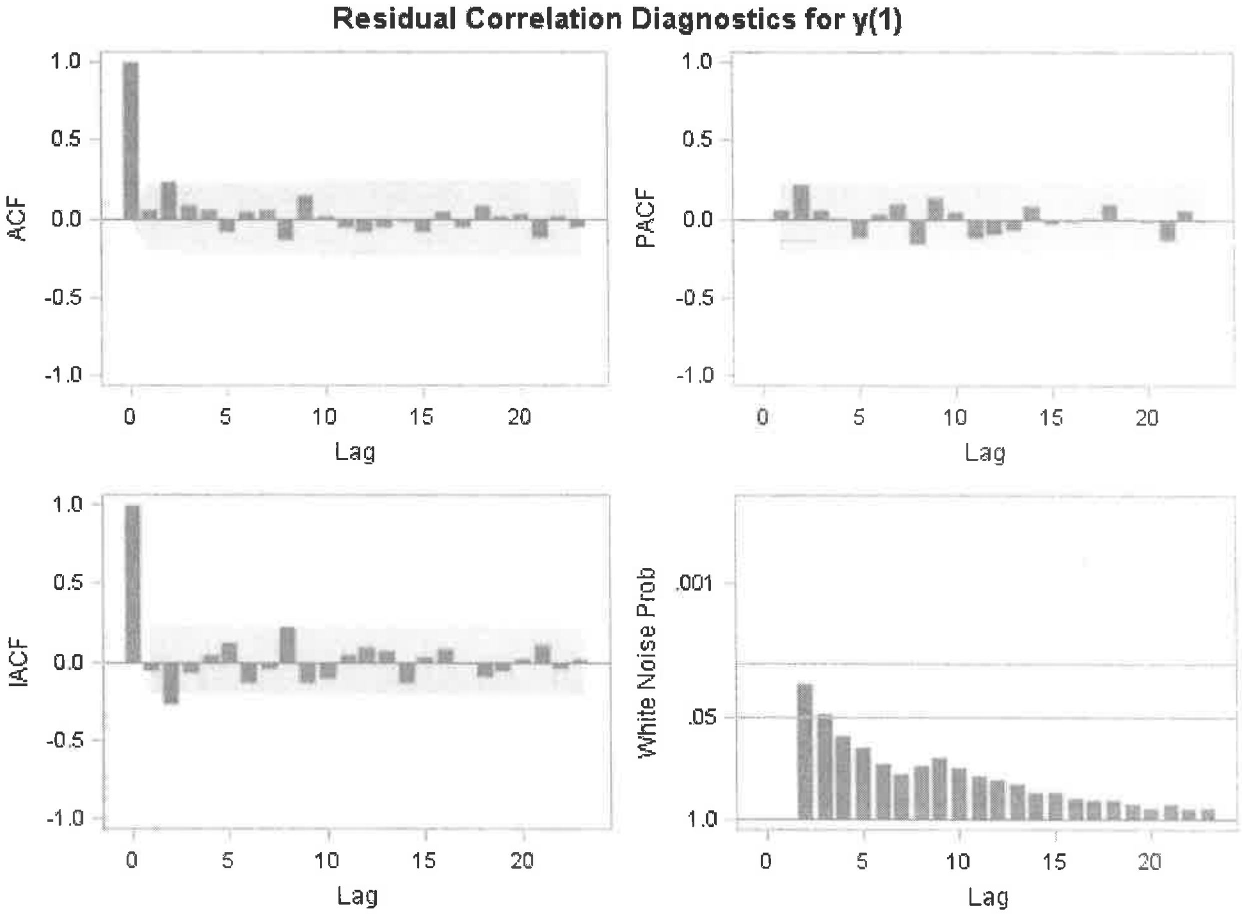
Residual Normality Diagnostics for y(1)



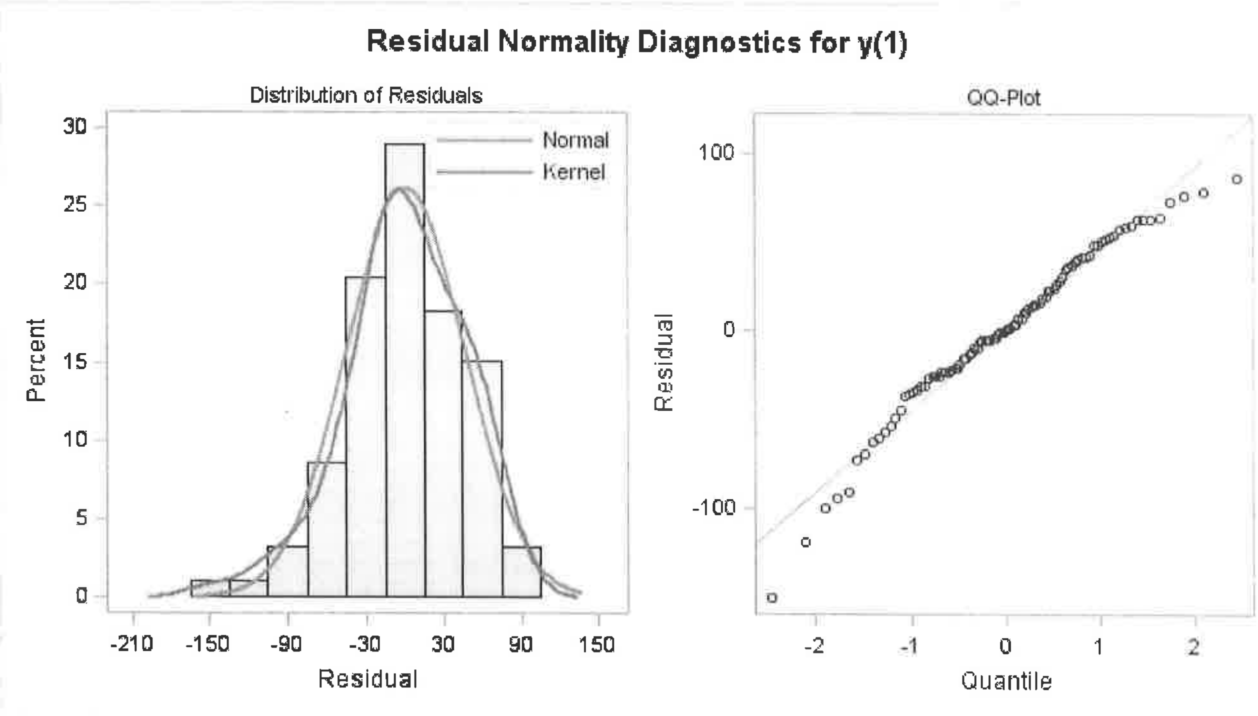
```
                         Model for variable y

                    Estimated Mean             47.76943

                    Period(s) of Differencing         1

                       Autoregressive Factors

              Factor 1:  1 - 0.30844 B**(1) - 0.1533 B**(2)

                Conditional Least Squares Estimation

      Parameter  Estimate  Standard Error  t Value  Approx   Lag
                                                    Pr > |t|

      MU         49.71299         6.04443     8.22  <.0001     0

      MA1,1      -0.27289         0.10104    -2.70  0.0082     1

                    Constant Estimate      49.71299

                    Variance Estimate      2108.473

                    Std Error Estimate     45.91811

                    AIC                    977.6966

                    SBC                    982.7618

                    Number of Residuals          93


             * AIC and SBC do not include log determinant.
                     Correlations of Parameter
                             Estimates

                     Parameter      MU   MA1,1

                     MU          1.000   0.005

                     MA1,1       0.005   1.000

                  Autocorrelation Check of Residuals

To Lag  Chi-Square  DF  Pr > ChiSq                  Autocorrelations

     6        7.50   5      0.1859   0.059   0.233   0.082  0.064  -0.081   0.040

    12       12.91  11      0.2991   0.053  -0.135   0.144  0.016  -0.055  -0.079

    18       15.40  17      0.5665  -0.052  -0.021  -0.081  0.041  -0.052   0.087
```

Autocorrelation Check of Residuals

To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
24	18.01	23	0.7568	0.017	0.040	-0.120	0.019	-0.059	0.034



Residual Correlation Diagnostics for y(1)



Model for variable y

Estimated Mean	49.71299
Period(s) of Differencing	1

Moving Average Factors

Factor 1: 1 + 0.27289 B**(1)

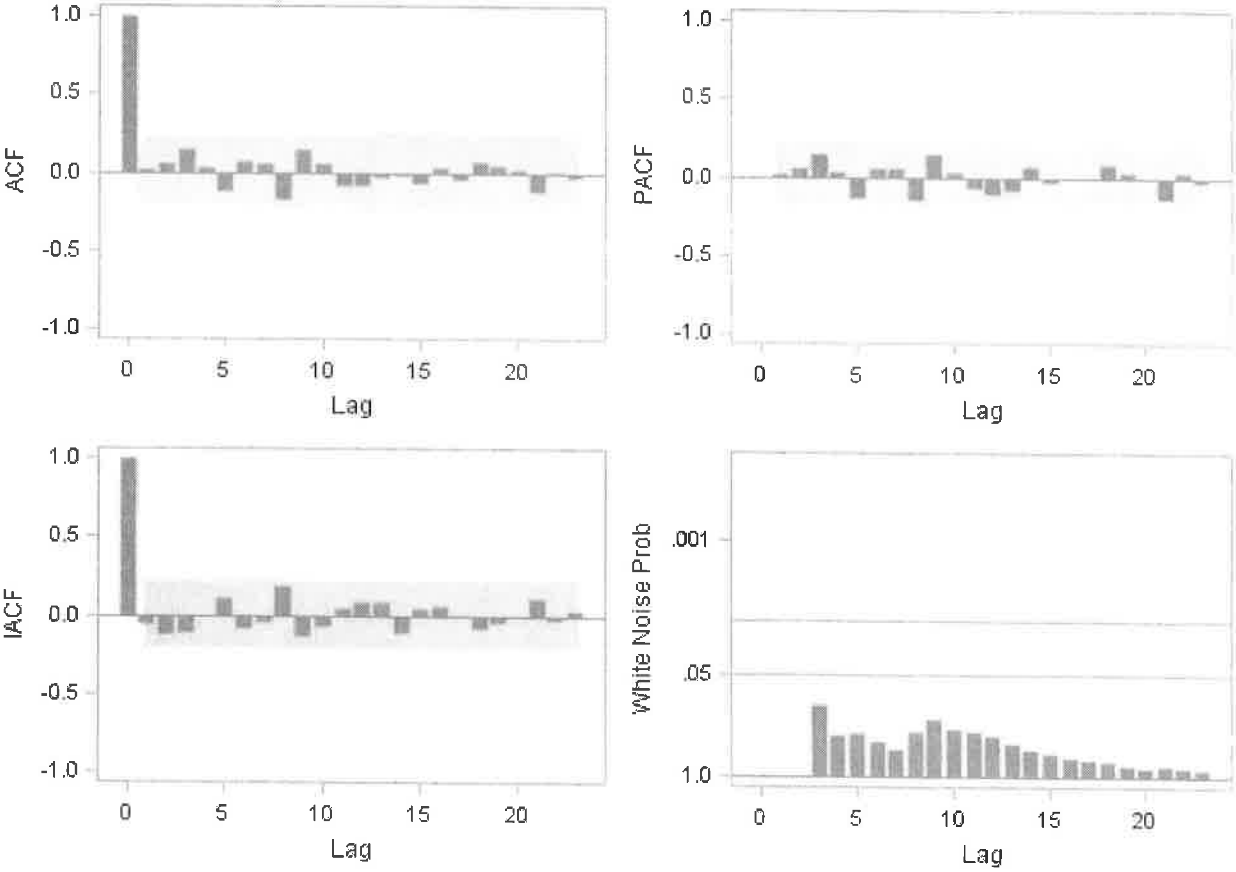
Conditional Least Squares Estimation

Parameter	Estimate	Standard Error	t Value	Approx Pr > |t|	Lag
MU	49.09344	6.83021	7.19	<.0001	0
MA1,1	-0.28720	0.10419	-2.76	0.0071	1
MA1,2	-0.17595	0.10429	-1.69	0.0950	2

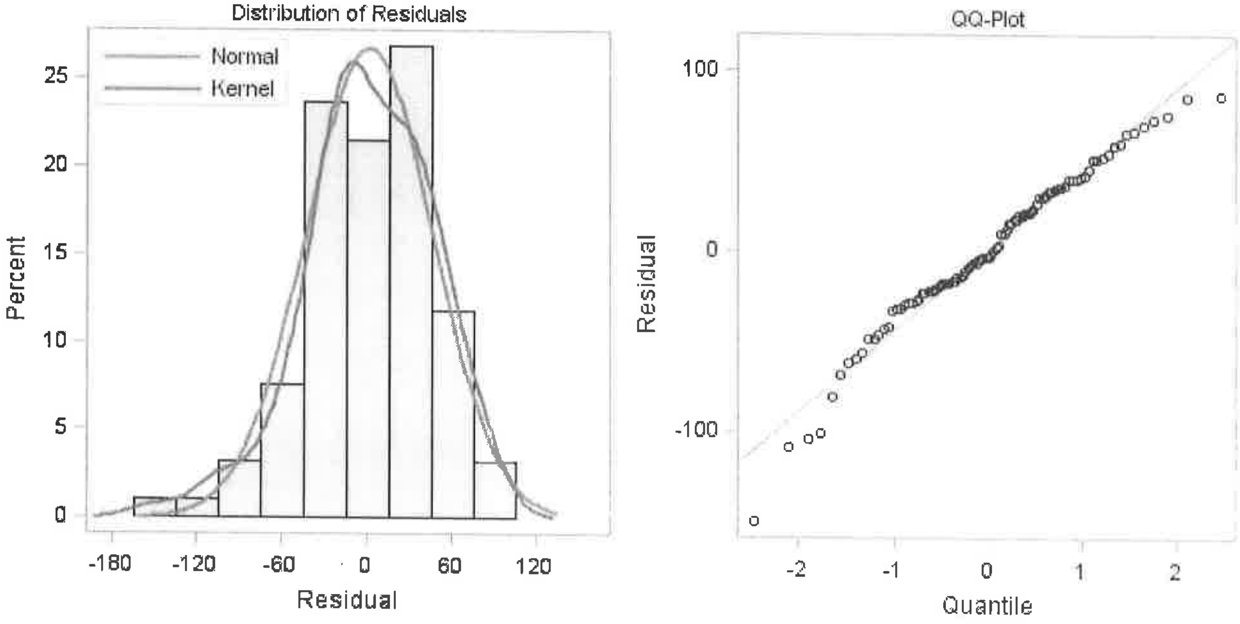
Constant Estimate	49.09344
Variance Estimate	2050.408
Std Error Estimate	45.28143
AIC	976.0719

```
                SBC                         983.6697
                Number of Residuals               93

              * AIC and SBC do not include log determinant.
             Correlations of Parameter Estimates
             Parameter      MU    MA1,1   MA1,2
             MU          1.000    0.007   0.014
             MA1,1       0.007    1.000   0.240
             MA1,2       0.014    0.240   1.000

              Autocorrelation Check of Residuals
To Lag  Chi-Square  DF  Pr > ChiSq              Autocorrelations
     6        4.47   4      0.3459   0.027   0.056   0.145  0.036  -0.117   0.073
    12       11.90  10      0.2920   0.055  -0.167   0.153  0.057  -0.084  -0.078
    18       13.51  16      0.6351  -0.024  -0.017  -0.070  0.038  -0.045   0.069
    24       15.89  22      0.8214   0.048   0.025  -0.116  0.008  -0.034   0.043
```

Residual Correlation Diagnostics for y(1)



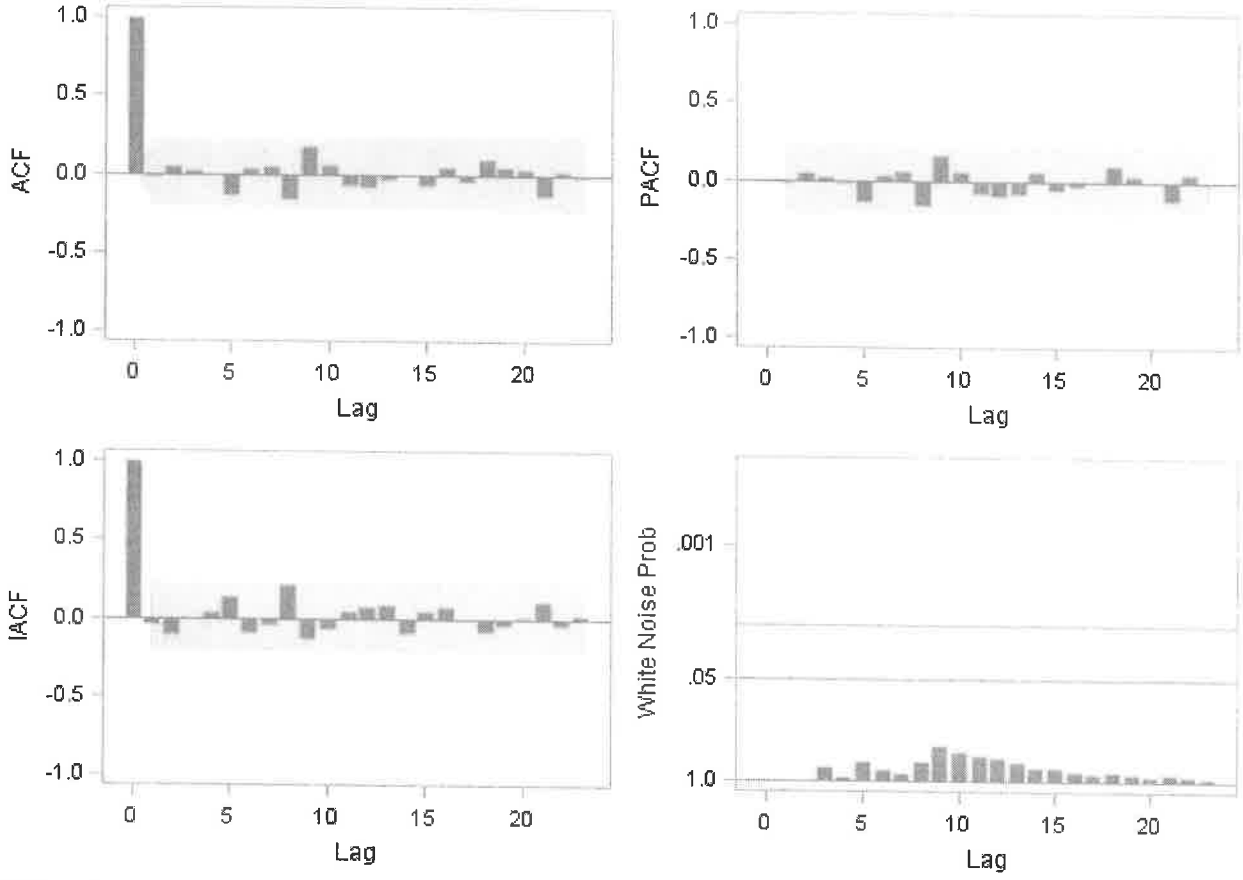
Residual Normality Diagnostics for y(1)



```
                         Model for variable y
                    Estimated Mean              49.09344
                    Period(s) of Differencing          1

                        Moving Average Factors
               Factor 1:  1 + 0.2872 B**(1) + 0.17595 B**(2)

                  Conditional Least Squares Estimation
          Parameter  Estimate  Standard Error  t Value  Approx  Lag
                                                        Pr > |t|
          MU         47.70871         8.73031     5.46  <.0001    0
          MA1,1       0.32538         0.24581     1.32  0.1890    1
          AR1,1       0.64697         0.19839     3.26  0.0016    1

                     Constant Estimate      16.84271
                     Variance Estimate      2008.722
                     Std Error Estimate     44.81877
                     AIC                    974.1618
                     SBC                    981.7596
                     Number of Residuals          93

                * AIC and SBC do not include log determinant.
                  Correlations of Parameter Estimates
                  Parameter      MU    MA1,1   AR1,1
                  MU          1.000   -0.043  -0.059
                  MA1,1      -0.043    1.000   0.914
                  AR1,1      -0.059    0.914   1.000

                   Autocorrelation Check of Residuals
To Lag  Chi-Square  DF  Pr > ChiSq              Autocorrelations
     6        2.17   4      0.7036  -0.014   0.043  0.019  -0.010  -0.134   0.037
    12        9.49  10      0.4866   0.044  -0.155  0.171   0.060  -0.065  -0.082
```

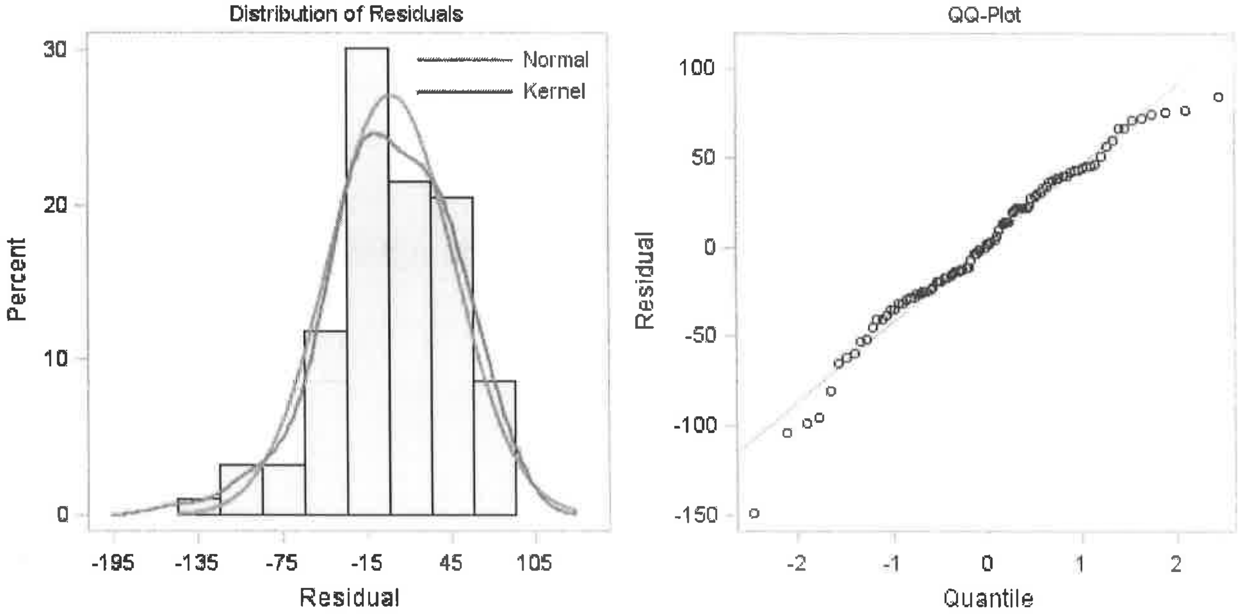
Autocorrelation Check of Residuals

To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
18	11.68	16	0.7657	-0.033	-0.005	-0.068	0.043	-0.042	0.098
24	14.96	22	0.8641	0.049	0.035	-0.127	0.016	-0.022	0.077



Residual Correlation Diagnostics for y(1)

Residual Normality Diagnostics for y(1)



Model for variable y

Estimated Mean	47.70871
Period(s) of Differencing	1

Autoregressive Factors

Factor 1: 1 - 0.64697 B**(1)

Moving Average Factors

Factor 1: 1 - 0.32538 B**(1)