Part I:

Data with Quarter Dummies and Structural Dummies:

SAS CODE:
```
PROC IMPORT OUT= WORK.bijesh
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-
DATA1_SEAS.tx
t"
            DBMS=TAB REPLACE;
     GETNAMES=YES;
     DATAROW=2;
RUN;
proc print;
run;
```

The SAS System

Obs	QTR	HWIND	UNEMR	ST	Q1	Q2	Q3	Q4
1	1	104.63	5.63	1	1	0	0	0
2	2	103.53	5.46	1	0	1	0	0
3	3	97.3	5.63	1	0	0	1	0
4	4	95.96	5.6	1	0	0	0	1
5	1	98.83	5.83	1	1	0	0	0
6	2	97.23	5.76	1	0	1	0	0
7	3	99.06	5.56	1	0	0	1	0
8	4	113.66	5.63	1	0	0	0	1
9	1	117	5.46	1	1	0	0	0
10	2	119.66	5.26	1	0	1	0	0
11	3	124.33	5.06	1	0	0	1	0
12	4	133	5.06	1	0	0	0	1
13	1	143.33	4.83	1	1	0	0	0
14	2	144.66	4.73	1	0	1	0	0
15	3	152.33	4.46	1	0	0	1	0
16	4	178.33	4.2	1	0	0	0	1
17	1	192	3.83	0	1	0	0	0
18	2	186	3.9	0	0	1	0	0
19	3	188	3.86	0	0	0	1	0
20	4	193.33	3.7	0	0	0	0	1
21	1	187.66	3.63	0	1	0	0	0
22	2	175.33	3.83	0	0	1	0	0
23	3	178	3.93	0	0	0	1	0
24	4	187.66	3.96	0	0	0	0	1

1.

SAS Code:

```
proc reg data = bijesh;
model hwind = unemr q1 q2 q3;
run;
```

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: HWIND

Number of Observations Read	24
Number of Observations Used	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	31632	7908.03139	253.45	<.0001
Error	19	592.82929	31.20154		
Corrected Total	23	32225			

Root MSE	5.58583	R-Square	0.9816
Dependent Mean	142.11750	Adj R-Sq	0.9777
Coeff Var	3.93043		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	367.74397	7.25783	50.67	<.0001
UNEMR	1	-46.34188	1.46862	-31.55	<.0001
Q1	1	-1.56127	3.23540	-0.48	0.6349
Q2	1	-6.48665	3.23077	-2.01	0.0591
Q3	1	-7.78339	3.22612	-2.41	0.0261

hwind = 367.74397 -46.34188 unmer -1.56127q1 – 6.48665q2 - 7.78339q3 + e.

When, help wanted index is rising, there are a relatively large amount of position needing to be filled and can be interpreted as shortage of workers. Since fourth quarter is typically s period of increased retail activity, the labor shortage should be high and the help wanted index value should be high compared to other seasons. i.e. Help wanted index should have negative sign in comparison to fourth quarter and three seasons retain the predicted sign.

Looking at p-values, third quarter dummy (q3) is significantly different from zero but other are not at 5% level of significance but intercept and UNEMR are.

2.

SAS Code:
```
proc reg data = bijesh;
model hwind = unemr q1 q2 q3;
run;
test q1 = q2 = q3 = 0;
run;
```

The SAS System

The REG Procedure
Model: MODEL1

Test 4 Results for Dependent Variable HWIND				
Source	DF	Mean Square	F Value	Pr > F
Numerator	3	84.86107	2.72	0.0733
Denominator	19	31.20154		

Looking at the p-value (0.0733) of F-test, the dummy variables are not significantly different than zero at 5% significance level. So, they should not be included in the equation.

3.

If the above model was estimated without seasonal dummy variables, the estimate would not answer the question whether different season affect help wanted index. Also, we would not be able to answer in which direction each season affect in the help wanted index. The seasonal dummy variable is omitted from the analysis.

4.

SAS Code:
I separated data into two files: (HW3-DATA1_SEAS1) one with seaonal dummy = 1 and (HW3-DATA1_SEAS0) another with seasonal dummy = 0

```
Run Regression with variables which has seasonal dummy =1;
PROC IMPORT OUT= WORK.bijesh
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-
DATA1_SEAS1.tx
t"
            DBMS=TAB REPLACE;
     GETNAMES=YES;
     DATAROW=2;
RUN;

proc reg data = bijesh;
model hwind = unemr q1 q2 q3;
run;

Run Regression with variables which has seasonal dummy =0;
PROC IMPORT OUT= WORK.bijesh
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-
DATA1_SEAS0.tx
t"
            DBMS=TAB REPLACE;
     GETNAMES=YES;
     DATAROW=2;
RUN;
proc reg data = bijesh;
model hwind = unemr q1 q2 q3;
run;

Run Full Model with complete Data:
PROC IMPORT OUT= WORK.bijesh
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-
DATA1_SEAS.tx
t"
            DBMS=TAB REPLACE;
     GETNAMES=YES;
     DATAROW=2;
RUN;
proc print;
run;
proc reg data = bijesh;
model hwind = unemr q1 q2 q3 st;
run;
```

I would expect negative sign as first 16 observations (low value) has 1 and last 8 observations (high value) has 0 for structural change dummy.

Null Hypothesis: There is no structural Change. i.e. beta coefficients for UNEMR, Q1, Q2 and Q3 when seasonal dummy =1 and that when seasonal dummy = 0 are equal.

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: HWIND

Number of Observations Read	16
Number of Observations Used	16

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr
Model	4	8587.09834	2146.77459	92.49	<.0
Error	11	255.31476	23.21043		
Corrected Total	15	8842.41310			

Root MSE	4.81772	R-Square	0.9711
Dependent Mean	120.17750	Adj R-Sq	0.9606
Coeff Var	4.00884		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	381.31359	13.70785	27.82	<.0001
UNEMR	1	-49.01437	2.63437	-18.61	<.0001
Q1	1	1.14953	3.50626	0.33	0.7492
Q2	1	-5.14491	3.43949	-1.50	0.1628
Q3	1	-9.28671	3.40972	-2.72	0.0198

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: HWIND

Number of Observations Read	8
Number of Observations Used	8

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	146.00452	36.50113	0.84	0.5826
Error	3	131.08443	43.69481		
Corrected Total	7	277.08895			

Root MSE	6.61021	R-Square	0.5269
Dependent Mean	185.99750	Adj R-Sq	-0.1038
Coeff Var	3.55392		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	208.74133	104.59928	2.00	0.1399
UNEMR	1	-4.76405	27.28324	-0.17	0.8725
Q1	1	-1.14141	7.15112	-0.16	0.8833
Q2	1	-9.66326	6.67882	-1.45	0.2437
Q3	1	-7.18534	6.84396	-1.05	0.3709

Figure Regression model with seasonal dummy = 1 (left) and with seasonal dummy = 0 (right)

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: HWIND

Number of Observations Read	24
Number of Observations Used	24

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	31632	7908.03139	253.45	<.0001
Error	19	592.82929	31.20154		
Corrected Total	23	32225			

Root MSE	5.58583	R-Square	0.9816
Dependent Mean	142.11750	Adj R-Sq	0.9777
Coeff Var	3.93043		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	367.74397	7.25783	50.67	<.0001
UNEMR	1	-46.34188	1.46862	-31.55	<.0001
Q1	1	-1.56127	3.23540	-0.48	0.6349
Q2	1	-6.48665	3.23077	-2.01	0.0591
Q3	1	-7.78339	3.22612	-2.41	0.0261

Figure: Full model

SSE_U = 255.31476+131.08443 = 386.39919

SSE_R = 592.82929

Numerator df = 5

Denominator df = 24 – 10 = 14.

Fcalc = ((592.82929-386.39919)/5)/(386.39919/14) = 1.495873

Fcric (Prob = 0.05, N df = 5, D df = 14) = 2.96

Since, F-calc > F cric, we fail to reject null hypothesis. i.e. indicates no structural break.

5.

SAS Code:

```
proc reg data = bijesh;
model hwind = unemr q1 q2 q3 st;
run;
test st = 0;
run;
```

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: HWIND

Number of Observations Read	24
Number of Observations Used	24

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	31636	6327.29845	193.54	<.0001
Error	18	588.46260	32.69237		
Corrected Total	23	32225			

Root MSE	5.71772	R-Square	0.9817
Dependent Mean	142.11750	Adj R-Sq	0.9767
Coeff Var	4.02324		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	371.03952	11.68350	31.76	<.0001
UNEMR	1	-47.30348	3.03032	-15.61	<.0001
Q1	1	-1.39138	3.34426	-0.42	0.6823
Q2	1	-6.36004	3.32515	-1.91	0.0718
Q3	1	-7.72730	3.30586	-2.34	0.0312
ST	1	1.82398	4.99077	0.37	0.7190

The SAS System

The REG Procedure
Model: MODEL1

Test 1 Results for Dependent Variable HWIND

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	4.36669	0.13	0.7190
Denominator	18	32.69237		

H_o: $\beta_{st} = 0$ and H_a: $\beta_{st} \neq 0$,

The test with alternative hypothesis that the coefficient of the structural change dummy is zero is also not statistically significant as P-value is greater than 0.05. So we fail to reject null hypothesis.

6. Null Hypothesis: There is no structural break.

Alternative Hypothesis: There is seasonal break.

SAS Code:
Chow test without seasonal dummy variables:
```
proc autoreg data = bijesh;
model hwind = unemr/chow = (17);
run;
```
SAS Code:
Chow test with seasonal dummy variables:
```
proc autoreg data = bijesh;
model hwind = unemr q1 q2 q3/chow = (17);
run;
```

The SAS System

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	592.829289	DFE	19
MSE	31.20154	Root MSE	5.58583
SBC	160.963782	AIC	155.073513
MAE	3.88690449	AICC	158.406847
MAPE	2.88260269	HQC	156.636203
Durbin-Watson	1.4008	Total R-Square	0.9816

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	17	5	14	1.50	0.2532

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	367.7440	7.2578	50.67	<.0001
UNEMR	1	-46.3419	1.4686	-31.55	<.0001
Q1	1	-1.5613	3.2354	-0.48	0.6349
Q2	1	-6.4867	3.2308	-2.01	0.0591
Q3	1	-7.7834	3.2261	-2.41	0.0261

The SAS System

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	847.412486	DFE	22
MSE	38.51875	Root MSE	6.20635
SBC	160.004367	AIC	157.648259
MAE	5.0663095	AICC	158.219688
MAPE	3.81669697	HQC	158.273335
Durbin-Watson	1.5934	Total R-Square	0.9737

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	17	2	20	0.96	0.3993

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	364.0475	7.8783	46.21	<.0001
UNEMR	1	-46.3965	1.6256	-28.54	<.0001

We fail to reject null hypothesis in both models indicating no structural break. The seasonal effect is not significant in the chow test for both models—with and without seasonal dummies. This result is also consistent with the model when seasonal dummy was included in the model instead of doing chow test. Both intercept and unemr are significant in both models. Chow test with seasonal variable is similar to the analysis on question 4.

Part II:

```
PROC IMPORT OUT= WORK.bm
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-DATA2.xl
s"
            DBMS=EXCEL REPLACE;
     RANGE="'FOOD COST$'";
     GETNAMES=YES;
     MIXED=NO;
     SCANTEXT=YES;
     USEDATE=YES;
     SCANTIME=YES;
RUN;

data bm; set bm;
y = y;
x = x;
sqx = x**2;
cubx = X**3;
run;
```

Total cost function:

$Y = 134.65598 + 57.9702\ X_1 - 11.02894\ X_1^2 + 1.143\ X_1^3 + e$

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	134.65598	44.80010	3.01	0.0061
x	x	1	57.97021	29.97024	1.93	0.0650
sqx		1	-11.02893	5.76461	-1.91	0.0677
cubx		1	1.14312	0.33591	3.40	0.0023

1. Marginal cost function is the first derivative of total cost function.

$Y = 57.9702 - 2 * 11.02894\ X_1 + 3*1.143\ X_1^2 + e$
$Y\_marginal = 57.9702 - 22.05788\ X_1 + 3.429\ X_1^2 + e$

2. Average Cost Function: total cost divided by total unit of production i.e. X_1.

$Y\_average = 134.65598/\ X_1 + 57.9702 - 11.02894\ X_1 + 1.143\ X_1^2 + e$

3. CI = Parameter Estimates (β) ± t-cric (df)* standard error.

t-cric(24) = 2.064 at alpha = 0.05/2.
CI for β_2 = 57.97021 ± 2.064 * 29.97024 = [-3.885325, 119.8257]
CI for β_3 = -11.02893 ± 2.064 * 5.76461 = [-22.92651, 0.8686457]
CI for β_4 = 1.143118 ± 2.064 * 0.33591 = [0.44983, 1.836405]

4.

Ramsey RESET Test:
SAS Code:
```
proc autoreg data = bm;
model y = x sqx/reset;
run;
```

Null hypothesis: the model does not have omitted variable.

Alternative hypothesis: The model has omitted variable.

The SAS System

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	17104.5631	DFE	25
MSE	684.18252	Root MSE	26.15688
SBC	269.074261	AIC	265.077647
MAE	20.0768933	AICC	266.077647
MAPE	7.33221229	HQC	266.299452
Durbin-Watson	1.3437	Total R-Square	0.9703

Ramsey's RESET Test		
Power	RESET	Pr > F
2	9.3208	0.0055
3	5.7121	0.0097
4	3.7917	0.0248

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	270.4372	24.3040	11.13	<.0001	
x	1	-39.5460	10.4730	-3.78	0.0009	x
sqx	1	8.4022	0.9449	8.89	<.0001	

The P-value of RESET test for are not significantly different than zero as it is greater than 0.05. So we reject the null hypothesis which means the test is able to detect misspecification in the model. So, linear function would not be a good fit.

5.

```
proc autoreg data = bm;
model y = x sqx cubx/reset;
run;
```

Null hypothesis: the model does not have omitted variable.

Alternative hypothesis: The model has omitted variable.

The SAS System

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	11537.4473	DFE	24
MSE	480.72697	Root MSE	21.92549
SBC	261.381542	AIC	256.052724
MAE	16.2005518	AICC	257.791855
MAPE	5.99533749	HQC	257.681797
Durbin-Watson	1.5174	Total R-Square	0.9800

Ramsey's RESET Test		
Power	RESET	Pr > F
2	0.9874	0.3307
3	0.5456	0.5871
4	0.5906	0.6280

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	134.6560	44.8001	3.01	0.0061	
x	1	57.9702	29.9702	1.93	0.0650	x
sqx	1	-11.0289	5.7646	-1.91	0.0677	
cubx	1	1.1431	0.3359	3.40	0.0023	

The P-value of RESET test are not significantly different than zero as they are greater than 0.05. So we fail to reject the null hypothesis which means the test is not able to detect any misspecification. Shows, quadratic function is a better fit.

6.

```
proc reg data = bm;
model y = x sqx cubx;
run;
test x = sqx = cubx = 0;
run;
```

Average cost function is not linear.

H_o: $\beta_x = \beta_{sqx} = \beta_{cubx} = 0$

H_a: At least one of them is different.

The SAS System

The REG Procedure
Model: MODEL1

Test 4 Results for Dependent Variable y

Source	DF	Mean Square	F Value	Pr > F
Numerator	3	188070	391.22	<.0001
Denominator	24	480.72697		

We reject null hypothesis. So, average cost is non-linear.

7: Original Cubic Cost Function and Log-log function outputs.

```
data bm; set bm;
y = y;
x = x;
lny = log(y);
lnx = log(x);
sqlnx = lnx**2;
run;
proc autoreg data = bm;
model y = x sqx cubx/reset;
run;

proc autoreg data = bm;
model lny = lnx sqlnx/reset;
run;
```

The SAS System

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	11537.4473	DFE	24
MSE	480.72697	Root MSE	21.92549
SBC	261.381542	AIC	256.052724
MAE	16.2005518	AICC	257.791855
MAPE	5.99533749	HQC	257.681797
Durbin-Watson	1.5174	Total R-Square	0.9800

Ramsey's RESET Test		
Power	RESET	Pr > F
2	0.9874	0.3307
3	0.5456	0.5871
4	0.5906	0.6280

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	134.6560	44.8001	3.01	0.0061	
x	1	57.9702	29.9702	1.93	0.0650	x
sqx	1	-11.0289	5.7646	-1.91	0.0677	
cubx	1	1.1431	0.3359	3.40	0.0023	

The SAS System

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	0.32244655	DFE	25
MSE	0.01290	Root MSE	0.11357
SBC	-35.535456	AIC	-39.53207
MAE	0.09196309	AICC	-38.53207
MAPE	1.62183883	HQC	-38.310265
Durbin-Watson	1.4837	Total R-Square	0.9211

Ramsey's RESET Test		
Power	RESET	Pr > F
2	19.6788	0.0002
3	9.9185	0.0008
4	6.3410	0.0029

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	5.5062	0.1434	38.38	<.0001
lnx	1	-0.5080	0.2238	-2.27	0.0321
sqlnx	1	0.4009	0.0783	5.12	<.0001

In the original cubic function, the RESET test did not detect the omitted variable as the P-value is greater than 0.05. However, in the log-log model, the RESET test detect model misspecification as the P-value is less than 0.05 and there is room for improvement. So, I prefer original cubic function instead of log-log model.

SAS Code Compilation:
HW3-DATA1:

```
PROC IMPORT OUT= WORK.bijesh
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-
DATA1_SEAS0.tx
t"
            DBMS=TAB REPLACE;
     GETNAMES=YES;
     DATAROW=2;
RUN;
proc print;
run;
proc reg data = bijesh;
model hwind = unemr q1 q2 q3;
run;
test q1 = q2 = q3 = 0;
run;
PROC IMPORT OUT= WORK.bijesh
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-
DATA1_SEAS1.tx
t"
            DBMS=TAB REPLACE;
     GETNAMES=YES;
     DATAROW=2;
RUN;
proc print;
run;
proc reg data = bijesh;
model hwind = unemr q1 q2 q3;
run;
test q1 = q2 = q3 = 0;
run;

PROC IMPORT OUT= WORK.bijesh
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-
DATA1_SEAS.tx
t"
            DBMS=TAB REPLACE;
     GETNAMES=YES;
     DATAROW=2;
RUN;
proc print;
run;
proc reg data = bijesh;
model hwind = unemr q1 q2 q3 st;
run;
test st = 0;
run;

proc autoreg data = bijesh;
model hwind = unemr q1 q2 q3/chow = (17);
run;
```

```
proc autoreg data = bijesh;
model hwind = unemr/chow = (17);
run;

proc print;
run;

SAS Code:
PART II:
PROC IMPORT OUT= WORK.bm
            DATAFILE= "C:\Users\bmishra\Dropbox\Ph.D. Courseworks\Semest
er II, Spring 2019\Econometric Methods\Homeworks\Homework 3\HW3-DATA2.xl
s"
            DBMS=EXCEL REPLACE;
     RANGE="'FOOD COST$'";
     GETNAMES=YES;
     MIXED=NO;
     SCANTEXT=YES;
     USEDATE=YES;
     SCANTIME=YES;
RUN;
proc print;
run;

data bm; set bm;
y = y;
x = x;
sqx = x**2;
cubx = X**3;
run;
proc print;
run;
proc reg data = bm;
model y = x sqx cubx;
run;
test x = 0;
test sqx = 0;
test cubx = 0;
test x = sqx = cubx = 0;
run;

proc autoreg data = bm;
model y = x sqx/reset;
run;
proc autoreg data = bm;
model y = x sqx cubx/reset;
run;

data bm; set bm;
y = y;
x = x;
lny = log(y);
lnx = log(x);
sqlnx = lnx**2;
run;
proc autoreg data = bm;
model y = x sqx cubx/reset;
```

```
run;
proc autoreg data = bm;
model lny = lnx sqlnx/reset;
run;
```

AGEC5213: *ECONOMETRIC METHODS*
Spring 2019

PROBLEM SET NO. 3 - due on March 27, 2019

Part I. (10 points). Consider the data set, *HW3-DATA1.txt,* to investigate the relationship between a help-wanted index (*HWIND*) and the level of unemployment (*UNEMR, %*). The data are quarterly data covering the period 2002-2007. Previously specified models assumed there was no seasonal influence on the help wanted index, other than that which would be captured by seasonal changes in the unemployment rate. Let us investigate whether this assumption is a reasonable one. Consider the model

$$HWIND_t = \beta_0 + \beta_1 UNEMR_t + \delta_1 S_{1t} + \delta_2 S_{2t} + \delta_3 S_{3t} + e_t$$

where S_{1t} takes the value 1 for first-quarter observations and 0 otherwise, S_{2t} takes the value 1 for second-quarter observations (0 otherwise) and S_{3t} takes the value 1 for third-quarter observations (0 otherwise).

1) Report the estimated least-squares equation. Do the estimates of δ_1, δ_2 and δ_3 have the expected signs? (**Hint**: the fourth-quarter is typically a period of increased retail activity) Are they significantly different from zero at a 5% level of significance?

2) Jointly test whether the seasonal dummy variables should be included in the equation. Use a 5% level of significance.

3) Suppose a student estimates above model without the seasonal dummy variables. What are the limitations do you expect from this estimation?

4) Suppose that a dummy variable taking the value 1 for the first 16 observations is included. If you suspect there has been a structural change such that a given level of $UNEMR_t$ implies a higher value for $HWIND_t$ during the last 8 observations, what sign do you expect on the coefficient of the dummy variable. Retaining the model with the seasonal dummies, and using a 5% significance level, test the hypothesis that the coefficient of the structural-change dummy is zero against the alternative that it has the sign you expected.

5) Redo the test with the alternative hypothesis that the coefficient of the structural-change dummy is non zero.

6) A better way to investigate the structural change between the first 16 quarters and the rest of the period is to use the Chow Test. Do the Chow Test with and without seasonal dummy variables, and compare these two results.

Part II. (10 points). Consider the following total cost function where y_t represents total cost for the t-th firm and x_t represents quantity of output.

$$y_t = \beta_1 + \beta_2 x_t + \beta_3 x_t^2 + \beta_4 x_t^3 + e_t$$

Data on a sample of 28 firms in the food processing industry are in the file *HW3-DATA2.xls*

1) Write down the marginal cost function corresponding to the above total cost function. What sign would you expect for β_4?
2) Write down the average cost function that corresponds to the above total cost function.
3) Find 95% confidence interval for the parameters β_2, β_3, β_4.
4) Test whether the data suggest that a linear function will suffice.
5) Test whether the data suggest that a quadratic function will suffice.
6) What parameter restrictions imply a linear average cost function? Test these restrictions.
7) Estimate a log-log cost function of the form $\ln y_t = \alpha_1 + \alpha_2 \ln x_t + \alpha_3 (\ln x_t)^2 + e_t$. Does the RESET test suggest the log-log function is preferable to the original cubic cost function?