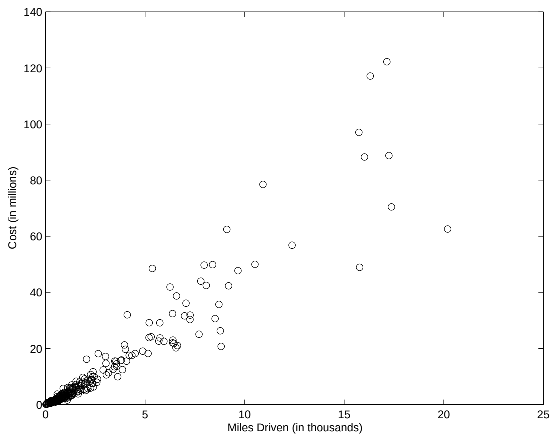
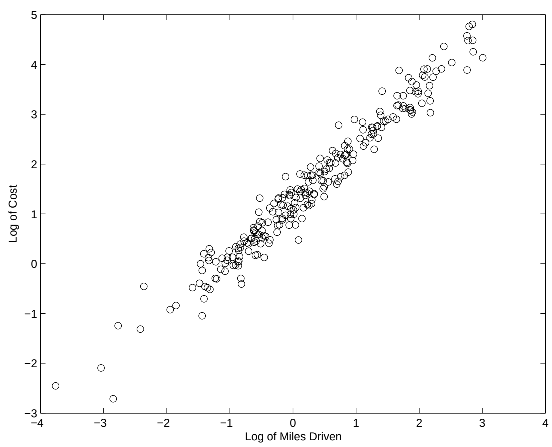
Cost Functions for U.S. Bus Companies

Economics 321

April 7, 2005






```
echo on
% Read in the bus cost data, which are described in Problem 5 of Chapter 6
% and further examined in Problems 1 to 3 of Chapter 9
% The data describe the total operating costs of 246 bus companies,
% in thousands of dollars, and the total miles driven by each company's
% buses, which serves as a measure of output. We'll read in the data
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% and then divide each of these variables by 1000 so that total costs
% are expressed in millions of dollars and total miles in thousands.
M = csvread('buscost.csv',1,0);
Obs = M(:,1) ;
TotalCost = M(:,2)./1000.0 ;
RVM = M(:,3)./1000.0 ;
RVM_SQ = RVM.*RVM ;
LogTotalCost = log(TotalCost);
LogRVM = log(RVM) ;
LogRVM_SQ = LogRVM .* LogRVM ;

plot(RVM,TotalCost,'ko')
     xlabel('Miles Driven (in thousands)')
     ylabel('Cost (in millions)')
print -depsc BusCost

plot(LogRVM,LogTotalCost,'ko')
     xlabel('Log of Miles Driven')
     ylabel('Log of Cost')
print -depsc LogBusCost

format short g

% Regression with only the RVM explanatory variable and a constant
% Ask for all type of output from the regstats command
OutPut = regstats(TotalCost,RVM,'linear')

OutPut =

        source: 'regstats'
             Q: [246x2 double]
             R: [2x2 double]
          beta: [2x1 double]
          covb: [2x2 double]
          yhat: [246x1 double]
             r: [246x1 double]
           mse: 41.442
       rsquare: 0.88792
    adjrsquare: 0.887
      leverage: [246x1 double]
        hatmat: [246x246 double]
          s2_i: [246x1 double]
        beta_i: [2x246 double]
      standres: [246x1 double]
       studres: [246x1 double]
       dfbetas: [2x246 double]
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          dffit: [246x1 double]
         dffits: [246x1 double]
       covratio: [246x1 double]
          cookd: [246x1 double]
          tstat: [1x1 struct]
          fstat: [1x1 struct]

% Show coefficients, standard errors, and t-stats
[OutPut.tstat.beta OutPut.tstat.se OutPut.tstat.t]

ans =

      -1.5194      0.51296      -2.9621
        5.018      0.11413       43.966


% Show s-squared
OutPut.mse

ans =

       41.442


% Conduct a Wald test of the hypothesis that the RVM coefficient = 0
% at the 0.01 significance level
beta = OutPut.beta

beta =

      -1.5194
        5.018

Var = OutPut.covb

Var =

      0.26313    -0.035116
    -0.035116     0.013027


R = [0 1];
r = 0;

diff = R*beta - r
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diff =

       5.018

Vdiff = R*Var*R'

Vdiff =

     0.013027


% The Wald test statistic is
W = diff'*inv(Vdiff)*diff

W =

         1933


% Show the chi-squared density function for 1 degree of freedom
df = size(R,1) ;

Sig = 0.01 ;
Reject = chi2inv(1-Sig,df)

Reject =

       6.6349

% Compare the W statistic to the rejection value
W

W =

         1933


% Regression with RVM and its square RVM_SQ and a constant
% Ask for all type of output from the regstats command
OutPut = regstats(TotalCost,[RVM RVM_SQ],'linear')

OutPut =

        source: 'regstats'
             Q: [246x3 double]
             R: [3x3 double]
```

```
          beta: [3x1 double]
          covb: [3x3 double]
          yhat: [246x1 double]
             r: [246x1 double]
           mse: 41.555
       rsquare: 0.88807
    adjrsquare: 0.88669
      leverage: [246x1 double]
        hatmat: [246x246 double]
          s2_i: [246x1 double]
        beta_i: [3x246 double]
      standres: [246x1 double]
       studres: [246x1 double]
       dfbetas: [3x246 double]
         dffit: [246x1 double]
        dffits: [246x1 double]
      covratio: [246x1 double]
         cookd: [246x1 double]
         tstat: [1x1 struct]
         fstat: [1x1 struct]

% Show coefficients, standard errors, and t-stats
[OutPut.tstat.beta OutPut.tstat.se OutPut.tstat.t]

ans =

      -1.3056      0.63224       -2.065
       4.8505      0.31046       15.624
      0.01176     0.020273      0.58007


% Show s-squared
OutPut.mse

ans =

       41.555


% Conduct a Wald test of the hypothesis that both RVM coefficients = 0
beta = OutPut.beta

beta =

      -1.3056
       4.8505
```

```
      0.01176

Var = OutPut.covb

Var =

      0.39973     -0.14162    0.0074732
     -0.14162     0.096383   -0.0058518
    0.0074732   -0.0058518   0.00041098


R = [0 1 0; 0 0 1];
r = [0;0] ;

diff = R*beta - r

diff =

       4.8505
      0.01176

Vdiff = R*Var*R'

Vdiff =

     0.096383   -0.0058518
   -0.0058518   0.00041098


% The Wald test statistic is
W = diff'*inv(Vdiff)*diff

W =

       1928.1


% Use the chi-squared density function for 2 degrees of freedom
% to test this hypothesis at the 0.01 significance level
df = size(R,1)

df =

     2
```

```
Sig = 0.01 ;
Reject = chi2inv(1-Sig,df)

Reject =

       9.2103

% Compare the W statistic to the rejection value
W

W =

       1928.1


%
% Now repeat the analysis above using the log versions of total
% costs and miles driven
%
% Regression with only the LogRVM explanatory variable and a constant
% Ask for all type of output from the regstats command
OutPut = regstats(LogTotalCost,LogRVM,'linear')

OutPut =

        source: 'regstats'
             Q: [246x2 double]
             R: [2x2 double]
          beta: [2x1 double]
          covb: [2x2 double]
          yhat: [246x1 double]
             r: [246x1 double]
           mse: 0.080412
       rsquare: 0.95909
    adjrsquare: 0.95876
      leverage: [246x1 double]
        hatmat: [246x246 double]
          s2_i: [246x1 double]
        beta_i: [2x246 double]
      standres: [246x1 double]
       studres: [246x1 double]
       dfbetas: [2x246 double]
         dffit: [246x1 double]
        dffits: [246x1 double]
      covratio: [246x1 double]
         cookd: [246x1 double]
```

```
         tstat: [1x1 struct]
         fstat: [1x1 struct]

% Show coefficients, standard errors, and t-stats
[OutPut.tstat.beta OutPut.tstat.se OutPut.tstat.t]

ans =

        1.241     0.018566       66.842
       1.1183     0.014785       75.633


% Show s-squared
OutPut.mse

ans =

     0.080412


% Conduct a Wald test of the hypothesis that the RVM coefficient = 0
% at the 0.01 significance level
beta = OutPut.beta

beta =

        1.241
       1.1183

Var = OutPut.covb

Var =

   0.00034471 -6.2425e-005
 -6.2425e-005   0.00021861


R = [0 1];
r = 0;

diff = R*beta - r

diff =

       1.1183
```

```
Vdiff = R*Var*R'

Vdiff =

   0.00021861


% The Wald test statistic is
W = diff'*inv(Vdiff)*diff

W =

       5720.4


% Show the chi-squared density function for 1 degree of freedom
df = size(R,1) ;

Sig = 0.01 ;
Reject = chi2inv(1-Sig,df)

Reject =

       6.6349

% Compare the W statistic to the rejection value
W

W =

       5720.4


% Regression with LogRVM and its square LogRVM_SQ and a constant
% Ask for all type of output from the regstats command
OutPut = regstats(LogTotalCost,[LogRVM LogRVM_SQ],'linear')

OutPut =

        source: 'regstats'
             Q: [246x3 double]
             R: [3x3 double]
          beta: [3x1 double]
          covb: [3x3 double]
          yhat: [246x1 double]
             r: [246x1 double]
```

```
          mse: 0.079391
      rsquare: 0.95978
   adjrsquare: 0.95928
     leverage: [246x1 double]
       hatmat: [246x246 double]
         s2_i: [246x1 double]
       beta_i: [3x246 double]
     standres: [246x1 double]
      studres: [246x1 double]
      dfbetas: [3x246 double]
        dffit: [246x1 double]
       dffits: [246x1 double]
     covratio: [246x1 double]
        cookd: [246x1 double]
        tstat: [1x1 struct]
        fstat: [1x1 struct]

% Show coefficients, standard errors, and t-stats
[OutPut.tstat.beta OutPut.tstat.se OutPut.tstat.t]

ans =

       1.2159     0.022201       54.765
       1.1091     0.015361       72.202
     0.017594    0.0086463       2.0348


% NOTE that now the squared term is statistically significant
% Show s-squared
OutPut.mse

ans =

     0.079391


% Conduct a Wald test of the hypothesis that both RVM coefficients = 0
beta = OutPut.beta

beta =

       1.2159
       1.1091
     0.017594

Var = OutPut.covb
```

```
Var =

    0.0004929 -6.1938e-006   -0.0001068
 -6.1938e-006   0.00023597 -3.8806e-005
   -0.0001068 -3.8806e-005  7.4758e-005


R = [0 1 0; 0 0 1];
r = [0;0] ;

diff = R*beta - r

diff =

       1.1091
     0.017594

Vdiff = R*Var*R'

Vdiff =

   0.00023597 -3.8806e-005
 -3.8806e-005  7.4758e-005


% The Wald test statistic is
W = diff'*inv(Vdiff)*diff

W =

       5798.1


% Use the chi-squared density function for 2 degrees of freedom
% to test this hypothesis at the 0.01 significance level
df = size(R,1) ;

Sig = 0.01 ;
Reject = chi2inv(1-Sig,df)

Reject =

       9.2103

% Compare the W statistic to the rejection value
```

```
W

W =

       5798.1
```