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CAWG 8: Thursday 11th April 2019 – Glasgow

Professor Andrew Smith

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Simple example

Ln Cost = a + b Ln CSV

Where CSV = MEAV^0.37*REPEXW^0.53

Ln Cost = a + b Ln (MEAV^0.37*REPEXW^0.53)

Ln Cost = a + 0.37b Ln MEAV + 0.53b Ln REPEXW

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Illustrative output

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=LNCOST   Mean                  =       11.04090
             Standard deviation    =         .19051
----------   No. of observations   =               8  DegFreedom   Mean square
Regression   Sum of Squares        =    .511594E-01           1        .05116
Residual     Sum of Squares        =        .202890           6        .03382
Total        Sum of Squares        =        .254050           7        .03629
----------   Standard error of e   =         .18389  Root MSE          .15925
Fit          R-squared             =         .20138  R-bar squared     .06827
Model test   F[  1,     6]         =        1.51292  Prob F > F*       .26473
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
  LNCOST|  Coefficient       Error       t    |t|>T*         Interval
--------+--------------------------------------------------------------------
Constant|    8.02844**      2.45000     3.28  .0169     2.03350  14.02338
   LNCSV|     .57594         .46824     1.23  .2647     -.56980   1.72169
--------+--------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Feb 25, 2019 at 10:01:04 AM
-----------------------------------------------------------------------------
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-----------------------------------------------------------------------------
Restricted   least squares regression ............
LHS=LNCOST   Mean                  =       11.04090
             Standard deviation    =         .19051
----------   No. of observations   =               8  DegFreedom   Mean square
Regression   Sum of Squares        =    .511594E-01           1        .05116
Residual     Sum of Squares        =        .202890           6        .03382
Total        Sum of Squares        =        .254050           7        .03629
----------   Standard error of e   =         .18389  Root MSE          .15925
Fit          R-squared             =         .20138  R-bar squared     .06827
Model test   F[  1,     6]         =        1.51292  Prob F > F*       .26473
Restrictions F[  1,     5]         =         .06259  Prob F > F*       .81241
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
  LNCOST|  Coefficient       Error       t    |t|>T*         Interval
--------+--------------------------------------------------------------------
Constant|    8.02844**      2.45000     3.28  .0220     1.73051  14.32637
  LNMEAV|     .21310         .17325     1.23  .2734     -.23225    .65845
 LNREPEX|     .30525         .24817     1.23  .2734     -.33269    .94319
--------+--------------------------------------------------------------------
```

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Totex CSV weights

0.369583	MEAV		
0.058605	Emergency CSV		
0.057604	External condition reports		
0.055867	Maintenance MEAV		
0.420355	Repex workload		
0.020751	Connections workload		
0.017235	Mains workload		

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Totex model outputs [1]

```
-----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=LNTOT    Mean                 =        5.17671
             Standard deviation   =         .23973
----------   No. of observations  =             40  DegFreedom   Mean square
Regression   Sum of Squares       =        2.11136           5        .42227
Residual     Sum of Squares       =        .129937          34        .00382
Total        Sum of Squares       =        2.24130          39        .05747
----------   Standard error of e  =         .06182  Root MSE          .05699
Fit          R-squared            =         .94203  R-bar squared     .93350
Model test   F[  5,    34]        =      110.49425  Prob F > F*       .00000
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
   LNTOT|  Coefficient       Error       t    |t|>T*         Interval
--------+--------------------------------------------------------------------
Constant|    -.13411         .23264     -.58  .5681     -.60689    .33866
  LNCSV1|     .78238***      .03377    23.17  .0000      .71375    .85102
     DY2|    -.00226         .03094     -.07  .9423     -.06514    .06063
     DY3|    -.04376         .03091    -1.42  .1660     -.10658    .01906
     DY4|    -.04831         .03092    -1.56  .1275     -.11115    .01453
     DY5|    -.09213***      .03093    -2.98  .0053     -.15498   -.02927
--------+--------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Apr 09, 2019 at 00:48:14 PM
-----------------------------------------------------------------------------
```

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-----------------------------------------------------------------------------
Restricted   least squares regression ............
LHS=LNTOT    Mean                 =        5.17671
             Standard deviation   =         .23973
----------   No. of observations  =             40  DegFreedom   Mean square
Regression   Sum of Squares       =        2.11137           5        .42227
Residual     Sum of Squares       =        .129927          34        .00382
Total        Sum of Squares       =        2.24130          39        .05747
----------   Standard error of e  =         .06182  Root MSE          .05699
Fit          R-squared            =         .94203  R-bar squared     .93351
Model test   F[  5,    34]        =      110.50313  Prob F > F*       .00000
Restrictions F[  6,    28]        =        9.79611  Prob F > F*       .00001
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
   LNTOT|  Coefficient       Error       t    |t|>T*         Interval
--------+--------------------------------------------------------------------
Constant|    -.13419         .23263     -.58  .5687     -.61071    .34233
  LNMEAV|     .28916***      .01248    23.17  .0000      .26359    .31473
  LNEMER|     .04585***      .00198    23.17  .0000      .04180    .04991
   LNEXT|     .04507***      .00195    23.17  .0000      .04108    .04905
 LNMMEAV|     .04371***      .00189    23.17  .0000      .03985    .04758
   LNREP|     .32888***      .01420    23.17  .0000      .29980    .35796
 LNCONNW|     .01624***      .00070    23.17  .0000      .01480    .01767
 LNMAINW|     .01348***      .00058    23.17  .0000      .01229    .01468
     DY2|    -.00226         .03094     -.07  .9423     -.06564    .06113
     DY3|    -.04375         .03091    -1.42  .1679     -.10707    .01956
     DY4|    -.04831         .03092    -1.56  .1294     -.11164    .01503
     DY5|    -.09213***      .03093    -2.98  .0059     -.15548   -.02877
--------+--------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Apr 09, 2019 at 00:48:57 PM
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Totex model outputs [2]

```
----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=LNTOT    Mean                 =        5.17671
             Standard deviation   =         .23973
----------   No. of observations  =             40  DegFreedom   Mean square
Regression   Sum of Squares       =        2.19938          11        .19994
Residual     Sum of Squares       =    .419232E-01          28        .00150
Total        Sum of Squares       =        2.24130          39        .05747
----------   Standard error of e  =         .03869  Root MSE          .03237
Fit          R-squared            =         .98130  R-bar squared     .97395
Model test   F[ 11,    28]        =      133.53976  Prob F > F*       .00000
--------+-------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
   LNTOT|  Coefficient       Error       t    |t|>T*         Interval
--------+-------------------------------------------------------------------
Constant|   -3.45165***      .79843    -4.32  .0002    -5.08716  -1.81614
  LNMEAV|    -.10643         .26930     -.40  .6957     -.65806    .44521
  LNEMER|     .57414***      .20203     2.84  .0083      .16029    .98799
   LNEXT|    -.06725         .06607    -1.02  .3175     -.20259    .06809
 LNMMEAV|     .17389         .10721     1.62  .1160     -.04571    .39349
   LNREP|     .23894***      .06123     3.90  .0005      .11353    .36436
 LNCONNW|     .06230         .03863     1.61  .1180     -.01682    .14142
 LNMAINW|    -.05326**       .02391    -2.23  .0341     -.10223   -.00428
     DY2|    -.00672         .02034     -.33  .7435     -.04840    .03495
     DY3|    -.04543**       .02195    -2.07  .0478     -.09039   -.00047
     DY4|    -.06490***      .02144    -3.03  .0052     -.10881   -.02099
     DY5|    -.11640***      .02223    -5.24  .0000     -.16193   -.07086
--------+-------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Apr 09, 2019 at 00:48:57 PM
----------------------------------------------------------------------------
```

- The restrictions can be tested

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Totex model outputs [2]

```
----------------------------------------------------------------------------
Ordinary     least squares regression ............
LHS=LNTOT    Mean                 =        5.17671
             Standard deviation   =         .23973
----------   No. of observations  =             40  DegFreedom   Mean square
Regression   Sum of Squares       =        2.19938          11        .19994
Residual     Sum of Squares       =    .419232E-01          28        .00150
Total        Sum of Squares       =        2.24130          39        .05747
----------   Standard error of e  =         .03869  Root MSE          .03237
Fit          R-squared            =         .98130  R-bar squared     .97395
Model test   F[ 11,    28]        =      133.53976  Prob F > F*       .00000
--------+-------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
   LNTOT|  Coefficient       Error       t    |t|>T*         Interval
--------+-------------------------------------------------------------------
Constant|   -3.45165***      .79843    -4.32  .0002    -5.08716  -1.81614
  LNMEAV|    -.10643         .26930     -.40  .6957     -.65806    .44521
  LNEMER|     .57414***      .20203     2.84  .0083      .16029    .98799
   LNEXT|    -.06725         .06607    -1.02  .3175     -.20259    .06809
 LNMMEAV|     .17389         .10721     1.62  .1160     -.04571    .39349
   LNREP|     .23894***      .06123     3.90  .0005      .11353    .36436
 LNCONNW|     .06230         .03863     1.61  .1180     -.01682    .14142
 LNMAINW|    -.05326**       .02391    -2.23  .0341     -.10223   -.00428
     DY2|    -.00672         .02034     -.33  .7435     -.04840    .03495
     DY3|    -.04543**       .02195    -2.07  .0478     -.09039   -.00047
     DY4|    -.06490***      .02144    -3.03  .0052     -.10881   -.02099
     DY5|    -.11640***      .02223    -5.24  .0000     -.16193   -.07086
--------+-------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Apr 09, 2019 at 00:48:57 PM
----------------------------------------------------------------------------
```

- The restrictions can be tested

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Reflections

- Implications – use the data to explore weightings?
- Presumably this has been tried before though…
- Understand the assumptions / restrictions underpinning the current approach in more depth
- For example:

Elasticity = MC / AC

Hence Elasticity * AC = MC

Check reasonableness of the implied MC estimates?

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DEA method

- Non-parametric optimisation method
- We don’t estimate parameters – elasticities in log models
- So we are not assessing if a cost driver is statistically significant or not
- Specifies inputs (e.g. number of staff; or costs) and outputs (e.g. customer numbers)
- It then selects weights for each firm to compute its efficiency (giving the most favourable view of the firm)
- It may therefore give zero weight to some inputs or outputs – to maximise the ratio of say one output to one input
- Uses different weights for different firms

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DEA arguments

- Multiple cost drivers / outputs – can be hard to get the model to distinguish different units
- Sometimes a two stage method used – but what goes in the two stages (also is using econometrics now anyway)
- Different weights across firms – and zero weights – general issue of transparency
- Basic version assumes CRS – VRS approach exists – but transparency?
- Dealing with random noise in the data? Could use judgement
- Key point for gas distribution - if just one variable (CSV) then just a simple unit cost comparison
- And if multiple drivers: would firms have faith in a model that applied zero weights and different weights to different companies?
- Always can be thought of as a candidate – and could be tried for completeness
- Limited usefulness – cost function more transparent

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SFA

- Benefits could be overstated in regulation
- But recommend trying at least for completion
- Under the SFA assumption – non-correlation between error and regressors – OLS gives unbiased and consistent estimates of the parameters
- So potentially the issue here is about **decomposing the error term**
- Could use COLS plus UQ adjustment or other regulatory judgement
- Better or worse than the arbitrary distributional assumptions in SFA?
- Sample sizes relatively small
- Structured time varying model? Study convergence? Long panel. Dealing with time invariant differences between firms.
- Candidate model for further exploration

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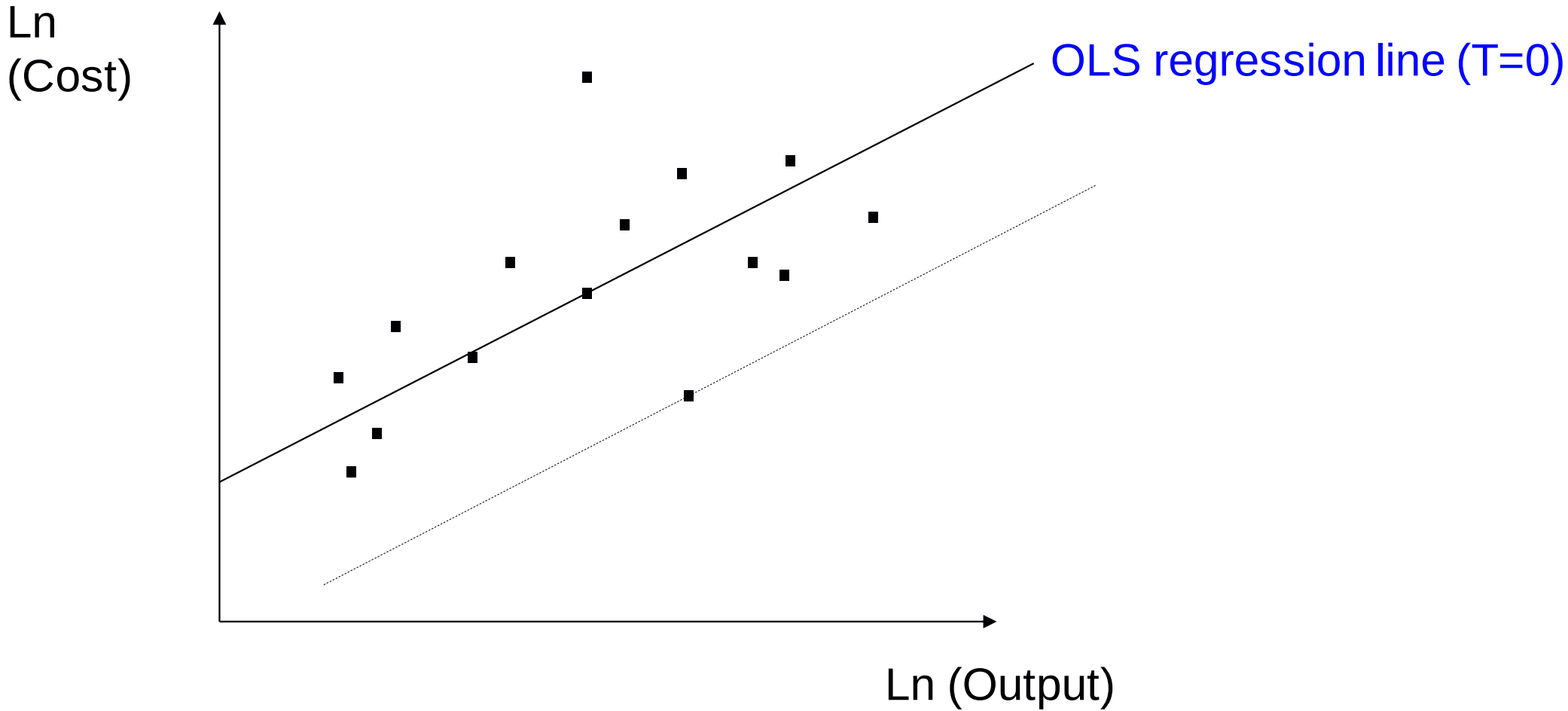
COLS



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