MPP-C6: Statistics II

Session ?

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- Panel data methods can be used with data structures that do not involve time
- Hierarchical data structures contain clusters of observation which share common characteristics
- When these characteristics are unobservable and correlated with other explanatory variables, pooled OLS will give us estimates that are biased and inefficient

- Consider a geographical dataset that observes variables for small areas (in this case MSOAs, or Middle Layer Super Output Areas)
- Each small area belongs to a local authority
- If local authority attributes that we cannot observe affect our other variables, we will get biased and inefficient estimates using OLS

Remember that OLS regression is estimated using the equation

$$y_i = \beta_0 + \beta_1 x_i + u_i$$

When we use panel methods across time, our equation becomes

$$y_{it} = \beta_0 + \beta_1 x_{it} + a_i + u_{it}$$

Here the variable a_i captures all unobserved, time-constant factors that affect y_{it}

By constructing our dataset and a fixed effects model carefully, we can also account for fixed effects given by local authorities with the equation

$$y_{pc} = \beta_0 + \beta_1 x_{pc} + a_p + u_{pc}$$

where, given our hierarchical data structure, p indexes the parent (local authority) and c indexes the child (MSOA)

Here the local authority fixed effect is given by a_p, and the coefficient $\beta_1 x_{pc}$ describes the effect of our explanatory variable on our independent variable x *within* local authorities.

Applying Panel Data Methods to Other Data Structures

Pooled OLS

When we use a pooled OLS regression on our dataset to estimate the effect of income on household energy consumption, we get the following results

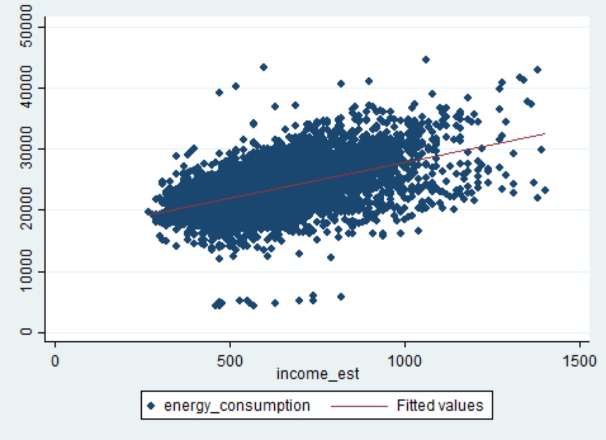
Interactive Stata example

```
. reg energy_consumption income_est

      Source |       SS           df       MS      Number of obs   =     7,133
-------------+----------------------------------   F(1, 7131)      =   2766.55
       Model |  2.6921e+10         1  2.6921e+10   Prob > F        =    0.0000
    Residual |  6.9391e+10     7,131  9730852.07   R-squared       =    0.2795
-------------+----------------------------------   Adj R-squared   =    0.2794
       Total |  9.6312e+10     7,132  13504151.6   Root MSE        =    3119.4

------------------------------------------------------------------------------
energy_con~n |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  income_est |   11.68066   .2220741    52.60   0.000     11.24533    12.11599
       _cons |   16142.07    139.382   115.81   0.000     15868.84     16415.3
------------------------------------------------------------------------------
```

Applying Panel Data Methods to Other Data Structures
Pooled OLS

Interactive Stata example

```
graph twoway (scatter energy_consumption income_est) ///
(lfit energy_consumption income_est)
```



When we use a fixed effects model to estimate the effect of income on household energy consumption *within* local authorities, the size of the effect changes.

Interactive Stata example

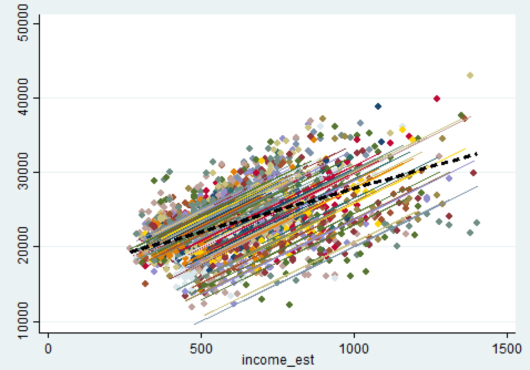
```
. xtreg energy_consumption income_est, fe

Fixed-effects (within) regression               Number of obs     =      7,133
Group variable: LA_CODE                         Number of groups  =        376

R-sq:                                           Obs per group:
     within  = 0.5160                                         min =          1
     between = 0.1057                                         avg =       19.0
     overall = 0.2795                                         max =        131

                                                F(1,6756)         =    7201.69
corr(u_i, Xb)  = -0.5247                        Prob > F          =     0.0000

------------------------------------------------------------------------------
energy_con~n |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  income_est |   20.11081   .2369803    84.86   0.000     19.64625    20.57536
       _cons |   11040.14   145.7513    75.75   0.000     10754.42    11325.86
-------------+----------------------------------------------------------------
     sigma_u |  2773.6255
     sigma_e |  2192.6781
         rho |  .61539872   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(375, 6756) = 20.47                 Prob > F = 0.0000

```

Applying Panel Data Methods to Other Data Structures

Fixed Effects

Interactive Stata example

```
. xi: regress energy_consumption income_est i.LA_CODE
. predict energy_consumption_fitted
(option xb assumed; fitted values)
. separate energy_consumption, by(LA_CODE)
. separate energy_consumption_fitted, by(LA_CODE)
. graph twoway (scatter energy_consumption1-energy_consumption80 income_est) ///
>         (line energy_consumption_fitted1-energy_consumption_fitted80 income_est) ///
>         (lfit energy_consumption income_est, ///
>         color(black) lwidth(thick) lpattern(dash)), legend(off)
```



Applying Panel Data Methods to Other Data Structures

Comparing OLS with Fixed Effects Models

Interactive Stata example

```
. esttab ols fe

--------------------------------------------
                      (1)             (2)
             energy_con~n    energy_con~n
--------------------------------------------
income_est          11.68***        20.11***
                  (52.60)         (84.86)

_cons             16142.1***      11040.1***
                 (115.81)         (75.75)
--------------------------------------------
N                    7133            7133
--------------------------------------------
t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001
```