Applied Panel Econometrics (MPP-E1161) - Winter Term 2015
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Take Home Exam 2

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Contents

1 Part I: Basic Questions [12pt: each 2pt]

Briefly explain why your chosen answer is correct.

1. **Question**

   False or true: When the between group variance of a panel data set is small, the random effects estimator looks similar to the fixed-effects estimator.

   Answer

   True. The fixed-effects estimator discards information between panels and only concentrates on variation within panels. The random-effects estimator is different to the fixed-effects estimator because it takes into account between-group variation as well as within group variation; if between group variance is small, then the difference betweeen FE and RE will also be small.

2. **Question**

   False or true: A variable z serves as a good instrument for an endogenous explanatory variable x, if it is sufficiently correlated with the dependent variable y

   Answer

   False. A good instrument z is one that is correlated with x but uncorrelated with the error term ϵ

3. **Question**

   False or true: The Hausman test tests, whether the estimated coefficients of two regressions are not significantly different.

   Answer

   True. The Hausman test shows the probability of there being no significant difference between the coefficients of two regressions.

4. **Question**

   False or true: If the fixed effects and the random effects estimator deliver significantly different coefficients, we should prefer to use the fixed-effects estimator.

Answer

True. If individual effects are correlated with explanatory variables, we violate the assumption of the exogeneity of regressors, rendering our estimate inconsistent and biased. A fixed-effects model controls for individual effects and so will be unbiased and consistent. So if the difference between the estimators of FE and RE models are significantly large, we can assume that exogeneity of regressors is violated and that RE estimators are therefore biased and inconsistent.

5. **Question**

False or true: The larger the correlation between the endogenous variable x and its instrument z, the less precise is the instrumental variable estimator.

Answer

False. The variance of the regressor is given by

$$\hat{Var}(\hat{\beta}_1^{IV}) = \frac{\hat{\sigma}_\epsilon^2 \frac{1}{NT}}{Var(x_{it})\rho_{x,z}^2},$$

where $\rho_{x,z}^2$ is the square of the correlation between x and y.

So an increase in the correlation between x and z will decrease the variance of the IV estimator.

6. **Question**

Even if the single parameter t-test suggests that each coefficient is insignificant, the F-test might say that these coefficients are jointly significant.

Answer

True. We might have two instruments that suffer from multicollinearity. In this case, though the two are jointly significant, each would make the other insignificant.

2 Part II: Model Interpretation [9pt: each 3pt]

1. **Question**

$$spread_{it} = 21 + 0.2debt_{it} + 1.3deficit_{it} + 0.05debt_{it} \cdot deficit_{it} + \epsilon_{it}$$

Answer

- A country with a debt of 0 and a deficit of 0 is expected have a bond yield spread of 21.
- An increase in the deficit by 1 percentage point increases the country's bond yield spread by $1.3 + 0.05 \cdot deficit$
- Thus, for a country with a deficit of 20 percentage points, every percentage point increase in the debt is expected to increase the bond yield spread by 2.3

2. **Question**

$$spread_{it} = 13 + 0.15debt_{it} + 23crisis + 0.3debt \cdot crisis + \epsilon_{it}$$

Answer

- A country without any debt is expected to have a bond yield spread of 13 outside of a crisis and $(13 + 23) = 36$ during a crisis.
- Outside of a crisis, every percentage point increase in debt is expected to increase bond yield spread by 0.15

- During a crisis, every percentage point increase in debt is expected to increase bond yield spread by $(0.15 + 0.3) = 0.45$

3. **Question**

$$spread_{it} = 2.1debt_{it} - 0.01debt_{it}^2 + \epsilon_{it}$$

Answer

- Debt levels have a diminishing effect on bond yield spreads.
- The effect of debt levels on bond yield spreads follows an inverted U-shape. At low levels it has positive marginal effects, but at higher levels it has negative marginal effects.
- The marginal effect of debt levels on bond yield spreads is

$$\frac{\partial Spread}{\partial Debt} = 2.1 - 2 \cdot 0.01$$

- The highest bond yield spreads are estimated at

$$debt* = \frac{2.1}{2 \cdot 0.01} = 105$$

- When $debt < 105$, bond yield spreads increase with every additional percentage point of debt. When $debt > 105$, bond yield spreads decrease with every additional percentage point of debt

3 Part III: OLS and IV regression [20pt]

$$spread_{it} = \alpha_i + \beta_1 deficit + u_{it}$$

1. **Question**
   Write down the formula for $\hat{\beta}_1^{FE}$ and $\hat{\alpha}_i$

Answer

$$Y_{it} = \beta_1 X_{it} + \alpha_i + u_{it}$$
$$y_{it}^* = x_{it}^* \beta + u_i^* t,$$

where

$y_{it}^* = y_{it} - \bar{y}_i$ and $x_{it}^* = x_{it} - \bar{x}_i$,

so

$$\hat{\beta}_1^{FE} = \frac{cov(x_{it}, y_{it})}{var(x_{it})}$$

and

$$\hat{\alpha}_i = \bar{y}_i - \bar{x}_i \hat{\beta}$$

2. **Question**
   Calculate $\hat{\beta}_1^{FE}$ and $\hat{\alpha}_i$ and write down the regression equation for all three countries. (10pt)

Answer

Ireland: $Spread_t = 617.4 - 66(Deficit_t) + \epsilon$
Netherlands: $Spread_t = 76.6 - 66(Deficit_t) + \epsilon$
Spain: $Spread_t = 272.2 - 66(Deficit_t) + \epsilon$

3. **Question**
   We assume that the variable $deficit$ is endogenous and we want to estimate regression (1) with an instrumental variable estimation, where lagged deficit ($L.deficit$) serves as an instrument for $deficit$. Explain, why $L.deficit$ might be a suitable instrument for deficit. (4pt)

   Answer
   We have an endogeneity problem because a high bond yield spreads push up the cost of borrowing and therefore increase the deficit. An instrumental variable must be exogenous and informative or relevant. Lagged deficit should correlated with the current deficit (relevant), but should be independent of the error term (exogenous).

4. **Question**
   Add $z_{it} = L.deficit_{it}$ in the empty column in the Table. It might happen that you have missing observations. (2p5)

   Answer

5. **Question**
   Write the IV formula for $\hat{\beta}_1^{IV}$ and $\hat{\alpha}_i^{IV}$

   Answer

$$\hat{\beta}_1^{IV} = \frac{Cov(z_{it}, y_{it})}{Cov(z_{it}, x_{it})} \text{ and } \hat{\alpha}_i^{IV} = \bar{y}_i - \bar{x}_i\hat{\beta}$$

6. **Question**
   Calculate (not estimate) $\hat{\beta}_1^{IV}$ and $\hat{\alpha}_i^{IV}$ and write down the IV regression equation for all three countries. You may extend the table with as many columns as necessary. Write down all calculations (Covariances, Variances, etc.) that are necessary. (10pt)

   Answer

Ireland: $Spread_t = 594.3 - 62.5(Deficit_t) + \epsilon$
Netherlands: $Spread_t = 74.5 - 62.5(Deficit_t) + \epsilon$
Spain: $Spread_t = 261.7 - 62.5(Deficit_t) + \epsilon$

4 Part III: Current Account Imbalances and Exchange Rate Regimes - Continue [37pt]

1. **Deriving the model specification**

   (a) **Question**
   Explore, whether you prefer pooled OLS, the fixed- or the random effects estimation. Explain, how you have derived your conclusion. [4pt]

   Answer

Stata Example 1: Testing for Heteroskedasticity

```
. local x regime trade_openness gdpgrowth finance

. reg abs_cagdp `x'

      Source |       SS           df       MS      Number of obs   =     1,855
-------------+----------------------------------   F(4, 1850)      =     73.03
       Model |  9397.16018         4  2349.29004   Prob > F        =    0.0000
    Residual |  59512.4541     1,850  32.1688941   R-squared       =    0.1364
-------------+----------------------------------   Adj R-squared   =    0.1345
       Total |  68909.6142     1,854  37.1680767   Root MSE        =    5.6718

--------------------------------------------------------------------------------
     abs_cagdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
        regime |   1.199144   .1743265     6.88   0.000     .8572467    1.541041
trade_openness |   .0391744    .003697    10.60   0.000     .0319237    .0464251
     gdpgrowth |   .0589071   .0325478     1.81   0.070    -.0049273    .1227415
       finance |  -.2897215   .0897705    -3.23   0.001    -.4657837   -.1136593
         _cons |   1.192841   .3255092     3.66   0.000     .5544373    1.831245
--------------------------------------------------------------------------------

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of abs_cagdp

         chi2(1)      =   438.51
         Prob > chi2  =   0.0000

. est store ols

.
```

- A Breusch-Pagan LM test found that the probability of constant variance was close to 0, meaning that we should be wary of pooled OLS and consider panel techniques (see Stata Output 1)
- After running a fixed-effects model, the F test score of 13.08 (p = 0.0000) makes it clear that FE is more efficient than pooled OLS (see Stata Output 2).
- The Hausman test (see see Stata Output 3) finds that the estimated coefficients of FE and RE do not differ significantly. We should therefore prefer a random-effects model, which will be unbiased and more efficient.

(b) **Question**

Test for the presence of serial correlation, cross-sectional dependence and panel heteroscedasticity. [3pt]

Answer

- Stata Output 4, with it's very large chi^2 score of 53631.68, and p score of close to 0 gives a clear sign of the presence of panel heteroscedasticity.
- Because N is larger than T in our dataset, we use a cross-sectional dependence (CD) test to test for cross-sectional dependence ove the LM test. Pesaran and Frees abundantly reject the hypothesis that there is no cross sectional dependence see 5, while Frees reports that the absence of CD is almost certain. Pesaran is optimised for unbalanced panels, which our dataset is, and is also similar to the results of Frees' test, so we would rather accept that there is cross sectional dependence.

Stata Example 2: Fixed-Effects: F-test

```
. xtreg abs_cagdp `x', fe

Fixed-effects (within) regression               Number of obs     =      1,855
Group variable: country2                        Number of groups  =         59

R-sq:                                           Obs per group:
     within  = 0.0181                                         min =         16
     between = 0.3106                                         avg =       31.4
     overall = 0.1237                                         max =         35

                                                F(4,1792)         =       8.25
corr(u_i, Xb)  = 0.1975                         Prob > F          =     0.0000

--------------------------------------------------------------------------------
     abs_cagdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
        regime |   .7194034   .2112564     3.41   0.001     .3050687    1.133738
trade_openness |   .0292849   .0075704     3.87   0.000     .0144372    .0441326
     gdpgrowth |   .0618739   .0288483     2.14   0.032     .0052941    .1184537
       finance |   .0810876   .1213976     0.67   0.504     -.157008    .3191833
         _cons |   2.424857   .6668928     3.64   0.000     1.116888    3.732826
---------------+----------------------------------------------------------------
       sigma_u |  3.3211165
       sigma_e |  4.8303098
           rho |  .32099147   (fraction of variance due to u_i)
--------------------------------------------------------------------------------
F test that all u_i=0: F(58, 1792) = 13.08                   Prob > F = 0.0000

. est store fe

.
```

- Woolridge

(c) **Question**

Explain, why we need to take the residual structure into account. [2pt]

Answer

Both RE and FE models assume that the the presence of α_i captures all correlation between the unobservables in different time periods, and so u_{it} is assumed to be uncorrelated over individuals over time and i.i.d. distributed. If this is not the case then the estimated coefficients will still be unbiased and consistent but the standard errors and resulting tests will be innacurate, and the estimators are no longer efficient.

(d) **Question**

Estimate your preferred model (pooled OLS, fixed- or random effects) taking the residual structure into account to get unbiased and efficient results. Explain the choice of your estimator. [2pt]

Answer

Stata Output 7 shows FE and RE models with panel-corrected standard errors. They are corrected for panel heteroscedasticity, autocorrelation and contemporaneously cross-sectional correlation, all which are present in the data. We previously preferred a RE specification, but a Hausman test on RE and FE panel-corrected standard error models shows significant differences 8

(e) **Question**

Indicate, whether the Friedman Hypothesis holds. [1pt]

Answer

It is now unclear whether the Friedman hypothesis holds. The effect of regime (though it is problematic to treat it as a continuous variable as the distance between 1 and

Stata Example 3: Comparing Fixed and Random Effects

```
. quietly xtreg abs_cagdp `x', re

. est store re

. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
      regime |    .7194034     .8366188       -.1172153        .0664919
trade_open~s |    .0292849     .0354598       -.0061748        .0041944
   gdpgrowth |    .0618739     .0611339        .0007399        .0024548
     finance |    .0810876    -.0079567        .0890443        .0409043
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        6.14
                Prob>chi2 =      0.1887

.
```

2 is not the same as the distance between 2 and 3) is positive in all models (supporting Friedman's Hypothesis), but, once correcting for panel heteroscedasticity, autocorrelation and contemporaneously cross-sectional dependence, only significant in a random-effects models (See Stata Output 7). The hypothesis is heavily dependent on model-specification, and I would be inclined to treat any confirmation of the hypothesis with caution.

2. **Estimation with interaction variables**

(a) **Question**

Generate an interaction variable between the variable *regime* and the dummy *id* and repeat your regression by adding this interaction variable together with the dummy *id*. [2pt]

Answer

Stata output 9 shows the results of a regression in pcse models for fixed and random effects including all previous regressors, the dummy variable *id* (describing if a country is industrialised or not) and an interaction *reg_x_id* of id and regime.

(b) **Question**

Hypothesis testing: Test the hypothesis that the country type matters for the size of current account imbalances.

Answer

Stata output 10 Shows that, for pcse Random effects, country type is significant.

(c) **Question**

Hypothesis testing: Test, whether in case of industrial countries the exchange rate regime affects current account imbalances.

Answer

Stata output 11, which runs the same regressions as before but only on industrial countries, shows that, for industrial countries, regime type is insignificant.

Stata Example 4: Panel Heteroskedasticity

```
. quietly xtreg abs_cagdp `x', fe

. xttest3

Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (59)  =    53631.68
Prob>chi2 =       0.0000


.
```

Stata Example 5: Cross Sectional Dependence

```
. xtcsd, pesaran


Pesaran's test of cross sectional independence =    18.703, Pr = 0.0000

. xtcsd, frees


  Frees' test of cross sectional independence =    14.801
|--------------------------------------------------------|
  Critical values from Frees' Q distribution
                      alpha = 0.10 :   0.4892
                      alpha = 0.05 :   0.6860
                      alpha = 0.01 :   1.1046

. xtcsd, friedman


Friedman's test of cross sectional independence =    14.136, Pr = 1.0000

.
```

(d) **Question**

Give a numerical interpretation of the effect of the exchange rate regime on current account imbalances for industrial and non-industrial countries [2pt].

Answer

- For countries that are not industrialised, a one unit increase in regime type predicts a 0.705 percentage point increase in the absolute value of the current account deficit relative to GDP (abs_cagdp).
- For countries that are industrialised, a one unit increase in regime type predicts a $0.705 - 1.163 = -0.458$ percentage point change in abs_cagdp.

(e) **Question**

Based on your estimation results, what would you recommend policymakers, when you are asked about the preferred exchange rate regime.

Answer

I would be very wary of giving unambiguous recommendations, but I may point out that for industrialised countries there is little evidence to suggest that a fixed exchange rate regime reduces current current account imbalances. However, for non-

Stata Example 6: Serial Correlation

```
. xtserial abs_cagdp `x', output

Linear regression                               Number of obs     =      1,790
                                                F(4, 58)          =       5.28
                                                Prob > F          =     0.0011
                                                R-squared         =     0.0204
                                                Root MSE          =     4.0983

                                (Std. Err. adjusted for 59 clusters in country2)
--------------------------------------------------------------------------------
               |               Robust
   D.abs_cagdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
        regime |
           D1. |   .0049165   .2395933     0.02   0.984    -.4746815    .4845145
               |
trade_openness |
           D1. |   .0681842   .0218231     3.12   0.003     .0245004     .111868
               |
     gdpgrowth |
           D1. |   .0718731   .0377009     1.91   0.062    -.0035934    .1473397
               |
       finance |
           D1. |  -.1370897    .218783    -0.63   0.533    -.5750314     .300852
--------------------------------------------------------------------------------

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      58) =     77.240
           Prob > F =      0.0000

.
```

industrialised countries, the data does support the Friedman hypothesis, so it may be sensible to advise such countries to adopt a fixed exchange rate regime.

Stata Example 7: Estimating with Panel Corrected Standard Errors

```
. quietly xtpcse abs_cagdp `x', corr(ar1)

. est store pcse_RE

. esttab fe re pcse_FE pcse_RE, drop(_*) mtitle

----------------------------------------------------------------------------
                      (1)             (2)             (3)             (4)
                       fe              re         pcse_FE         pcse_RE
----------------------------------------------------------------------------
regime              0.719***        0.837***        0.322           0.464*
                   (3.41)          (4.17)          (1.63)          (2.53)

trade_open~s       0.0293***       0.0355***       0.0474***       0.0521***
                   (3.87)          (5.63)          (3.81)          (6.84)

gdpgrowth          0.0619*         0.0611*         0.0763***       0.0765***
                   (2.14)          (2.13)          (3.42)          (3.62)

finance            0.0811        -0.00796         -0.0296          -0.288
                   (0.67)         (-0.07)         (-0.18)         (-1.88)
----------------------------------------------------------------------------
N                    1855            1855            1855            1855
----------------------------------------------------------------------------
t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

.
```

Stata Example 8: Hasuman Test for PCSE models

```
. hausman pcse_RE pcse_FE

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |    pcse_RE      pcse_FE       Difference          S.E.
-------------+----------------------------------------------------------------
      regime |    .4642339      .321978        .1422559               .
trade_open~s |    .0521397     .0473998          .00474               .
   gdpgrowth |    .0765439     .0763115        .0002324               .
     finance |   -.2880132    -.0296291       -.2583841               .
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtpcse
           B = inconsistent under Ha, efficient under Ho; obtained from xtpcse

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       28.26
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)

.
```

Stata Example 9: Introducing an Interaction term

```
. cap gen reg_x_ind = regime*ind

. local x_inter regime trade_openness gdpgrowth finance ind reg_x_ind

. xi: quietly xtpcse abs_cagdp `x_inter' i.country2, corr(ar1)
i.country2        _Icountry2_1-59     (naturally coded; _Icountry2_1 omitted)

. est store pcse_FE_inter

. quietly xtpcse abs_cagdp `x_inter', corr(ar1)

. est store pcse_RE_inter

. esttab pcse_FE pcse_RE pcse_FE_inter pcse_RE_inter, drop(_*) mtitle

----------------------------------------------------------------------------
                      (1)             (2)             (3)             (4)
                  pcse_FE         pcse_RE    pcse_FE_in~r    pcse_RE_in~r
----------------------------------------------------------------------------
regime              0.322           0.464*          0.462           0.705**
                   (1.63)          (2.53)          (1.81)          (2.97)

trade_open~s       0.0474***       0.0521***       0.0476***       0.0495***
                   (3.81)          (6.84)          (3.85)          (6.35)

gdpgrowth          0.0763***       0.0765***       0.0765***       0.0750***
                   (3.42)          (3.62)          (3.41)          (3.53)

finance           -0.0296          -0.288         -0.0205         -0.0383
                  (-0.18)         (-1.88)         (-0.13)         (-0.24)

ind                                                 4.770*         -1.558**
                                                   (2.08)         (-2.66)

reg_x_ind                                          -0.482         -1.163***
                                                  (-1.54)         (-3.89)
----------------------------------------------------------------------------
N                    1855            1855            1855            1855
----------------------------------------------------------------------------
t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

.
```

Stata Example 10: Country Type

```
. test ind

 ( 1)  ind = 0

           chi2(  1) =    7.07
         Prob > chi2 =    0.0078

.
```

Stata Example 11: Country Type

```
. xi: quietly xtpcse abs_cagdp `x' i.country2 if ind==1, corr(ar1)
i.country2        _Icountry2_1-59     (naturally coded; _Icountry2_1 omitted)

. est store pcse_FE_ind

. quietly xtpcse abs_cagdp `x' if ind==1, corr(ar1)

. est store pcse_RE_ind

. esttab pcse_FE_ind pcse_RE_ind, drop(_*) mtitle

--------------------------------------------
                      (1)             (2)
              pcse_FE_ind     pcse_RE_ind
--------------------------------------------
regime             0.0463         -0.0226
                   (0.18)         (-0.09)

trade_open~s       0.0513**        0.0274**
                   (3.21)          (2.65)

gdpgrowth           0.113**         0.131***
                   (3.01)          (3.58)

finance             0.264          0.0764
                   (1.25)          (0.36)
--------------------------------------------
N                     738             738
--------------------------------------------
t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

. test regime

 ( 1)  regime = 0

           chi2(  1) =    0.01
         Prob > chi2 =    0.9270

.
```