

## Take Home Exam 2

Max Callaghan

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### 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 between 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  $\epsilon$

#### 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

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

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

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

$$Y_{it} = \beta_1 X_{it} + \alpha_i + u_{it}$$

$$y_{it}^* = x_{it}^* \beta + u_{it}^*$$

where

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

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 be 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. (2pt)

**Answer**

Sheet 2 is the same as sheet 1 but all the observations for which  $z$  is missing are removed.

**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:**  $Spread_t = 587.375 - 62.5(Deficit_t) + \epsilon_t$

**Netherlands:**  $Spread_t = 74.625 - 62.5(Deficit_t) + \epsilon_t$

**Spain:**  $Spread_t = 253.75 - 62.5(Deficit_t) + \epsilon_t$

## 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
Model	9397.16018	4	2349.29004	F(4, 1850)	=	73.03
Residual	59512.4541	1,850	32.1688941	Prob > F	=	0.0000
				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.

*Stata Example 2: Fixed-Effects: F-test*

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

Fixed-effects (within) regression  
Group variable: country2

Number of obs = 1,855  
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

corr(u\_i, Xb) = 0.1975                      F(4,1792) = 8.25  
   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
```

(b) **Question**

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

**Answer**

- The Wald test in Stata Output 4, with its 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 over the LM test. Pesaran and Frees tests show that we can 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.
- The Woolridge test for autocorrelation in panel data 6 suggests that the probability of the null hypothesis of no first order autocorrelation is close to 0.

*Stata Example 3: Comparing Fixed and Random Effects*

```
. quietly xtreg abs_cagdp 'x', re
. est store re
. hausman fe re
```

	(b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) 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
.
```

(c) **Question**

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

**Answer**

Both RE and FE models assume that the presence of  $\alpha_i$  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 inaccurate, and the estimators are no longer efficient.

#### 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

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 of which are present in the data. We prefer this to a GLS model, which is only feasible if the time dimension is larger than the cross-sectional dimension, which is not the case. We previously preferred a RE specification, but a Hausman test on RE and FE panel-corrected standard error models shows significant differences 8, I therefore report results from both models from this point on.

#### (e) Question

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

#### Answer

It is now unclear whether the Friedman hypothesis holds. The effect of regime (though



### 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)

D.abs_cagdp	Coef.	Robust 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

it is problematic to treat it as a continuous variable as the distance between 1 and 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 though there are reasons to confirm the hypothesis, one 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

*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) fe	(2) re	(3) pcse_FE	(4) pcse_RE
regime	0.719*** (3.41)	0.837*** (4.17)	0.322 (1.63)	0.464* (2.53)
trade_open~s	0.0293*** (3.87)	0.0355*** (5.63)	0.0474*** (3.81)	0.0521*** (6.84)
gdpgrowth	0.0619* (2.14)	0.0611* (2.13)	0.0763*** (3.42)	0.0765*** (3.62)
finance	0.0811 (0.67)	-0.00796 (-0.07)	-0.0296 (-0.18)	-0.288 (-1.88)
N	1855	1855	1855	1855

t statistics in parentheses  
\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

*Stata Example 8: Hausman Test for PCSE models*

```
. hausman pcse_RE pcse_FE
```

	---- Coefficients ----		(b-B)	sqrt(diag(V_b-V_B))
	(b)	(B)	Difference	S.E.
	pcse_RE	pcse_FE		
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) pcse_FE	(2) pcse_RE	(3) pcse_FE_in~r	(4) pcse_RE_in~r
regime	0.322 (1.63)	0.464* (2.53)	0.462 (1.81)	0.705** (2.97)
trade_open~s	0.0474*** (3.81)	0.0521*** (6.84)	0.0476*** (3.85)	0.0495*** (6.35)
gdpgrowth	0.0763*** (3.42)	0.0765*** (3.62)	0.0765*** (3.41)	0.0750*** (3.53)
finance	-0.0296 (-0.18)	-0.288 (-1.88)	-0.0205 (-0.13)	-0.0383 (-0.24)
ind			4.770* (2.08)	-1.558** (-2.66)
reg_x_ind			-0.482 (-1.54)	-1.163*** (-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

.
```

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.

(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-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.